*Closure Plan Report*

# Dutchess County Balefill Landfill Closure Town of Wappinger Dutchess County, New York

Order on Consent No. R3-20030411-34

September 2008

THE Chazen COMPANIES

Prepared for:

Dutchess County Department of Public Works
22 Market Street
Poughkeepsie, New York 12601

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Prepared by:

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# 1.0 INTRODUCTION

The Chazen Companies (TCC) was retained by the Dutchess County Department of Public Works (DCDPW) to prepare a Landfill Closure Plan for the Dutchess County Balefill. The required elements of the Closure Plan, as listed in Section 1.1, are included in this report.

## 1.1 Project Objectives

The objectives of the Landfill Closure Plan is to provide closure details for the Balefill in general conformance with the regulations governing the closure of landfills as specified in Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 360-2.15. Specifically, the scope of work included the following:

- Meet the requirements of 6 NYCRR Part 360-2.15(b)(1) and (2), and 6 NYCRR Part 360-2.15(d) through 360-2.15(j);
- Meet the requirements of 6 NYCRR Part 360-2.15(k), including the Post-Closure Monitoring and Facility Maintenance Plan prepared in accordance with 6 NYCRR Part 360-2.15(k)(7) (Appendix B) ;
- Address unacceptable environmental impacts identified in the Closure Investigation Report (Chazen, 2006), as required in 6 NYCRR Part 360-2.15(a)(5);
- Provide an estimate of the landfill area to be covered;
- Provide a closure construction schedule that conforms to the requirements of 6 NYCRR Part 360-2.15(d);
- Provide amended closure and post-closure monitoring and maintenance cost estimates, prepared in accordance with 6 NYCRR Part 360-2.19(b) and (c) (to be finalized after approval of the Post-Closure Monitoring and Facility Maintenance Plan).

## 1.2 Site Background

The Dutchess County Balefill is located at the east end of Citation Drive near the north end of the north/south runway at the Dutchess County Airport in the Town of Wappinger, New York (Figure 1). The County Balefill consists of bundled commercial and municipal waste which was stacked in an area approximately 2.5 acres in size. The bales of waste are presently covered by a soil cap, the integrity

of which has been compromised by the growth of plants and trees. The balefill was constructed in 1976 and was closed by late 1977. Bales of compressed municipal waste and cardboard were stacked in a roughly rectangular landfill area for disposal. The site was then stabilized somewhat informally in 1977 with steep slopes and a temporary soil cover. It appears that a more permanent cover was never installed because the site had additional capacity and there was uncertainty about potential for continued use of the site.

In 1987, NYSDEC investigated the Balefill as part of its evaluation of potential inactive hazardous waste sites across New York State. As part of the investigation, 5 groundwater monitoring wells were installed and sampled around the balefill, and surface water and sediment samples were collected from the Wappinger Creek and from onsite water bodies. Based on the 1987 study results, it was concluded that there were leachate impacts to groundwater characteristic of municipal solid waste and installation of an improved cap was recommended, but otherwise the study found no significant contaminant levels (Wehran, October 1987). Based on the results of this investigation, the NYSDEC did not list the balefill as an inactive hazardous waste site.

In 2006 a Landfill Closure Investigation (Chazen, 2006) was conducted to characterize the existing conditions at the Balefill. Based on that investigation, it was determined that the approximate size of the landfill to be capped is 6 acres. Section 2.0 summarizes the findings of this investigation.

### 1.3 Certification

"I certify that this Closure Plan Report meets the requirements of 6 NYCRR Part 360-2.15 (c) and complies with the Order on Consent #R3-20030411-34 dated January 5, 2005."

Daniel Stone

Seal

## 2.0 CLOSURE INVESTIGATION

The objectives of the Landfill Closure Investigation (Chazen, 2006) were to characterize the existing conditions at the Balefill in conformance with Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 360-2.15. Specifically, the scope of work included the following:

- A hydrogeologic investigation;
- An investigation of leachate outbreaks;
- An investigation into the construction of the Balefill;
- An onsite wetland delineation
- An explosive gas investigation;
- An investigation of vectors;
- Update of the site-survey.

The investigation determined that the waste was a mix of baled cardboard and paper wastes as well as more typical municipal solid waste (MSW). The wastes are covered with between 2 and 3 feet of silty sand. It also appeared that the northwestern portion of the Balefill site had a higher percentage of MSW than the eastern portion of the Balefill.

Elevated gas levels were detected within the waste in portions of the Balefill. The survey of the perimeter did not detect any migration of landfill gas away from the Balefill. In addition, vectors did not appear to be a problem at the site.

In general, groundwater quality in the overburden water-bearing unit down gradient of, and beneath the Balefill, exhibited some evidence of leachate impacts with elevated iron and manganese concentrations and elevated ammonia and BOD levels. While groundwater quality standards (GWQS) exceedances for these parameters were more or less widespread, the impacts to groundwater quality from the Balefill did not appear to be severe. Volatile organic contaminants were detected at low level concentrations, some above GWQS, in the two southeastern most onsite overburden wells, and in the up gradient overburden well. Based on the VOC concentrations reported and their presence in the up gradient well, it seems probable that these compounds are related to a historic offsite release, most likely related to the airport located to the south. No impact to the bedrock aquifer from

the Balefill is apparent based on the data from the single down gradient bedrock well on the site.

The analytical results from the iron floc deposits associated with a seep on the bank of the Wappinger Creek showed elevated aluminum, arsenic, iron, manganese and TOC. While below the concentrations where severe impact can occur, the levels reported are above the State's Sediment Guidance values for lowest effect indicating that these concentration can have an impact on aquatic life in the Creek.

Data from both the boring and test pit programs indicated that a coarser sediment horizon extends between the Balefill and Wappinger Creek. Based on these findings it is likely that the sand and gravel between the Balefill and the Creek, which is in contact with the alluvial sediments beneath the waste, is acting as a preferential pathway for iron rich groundwater flow between the Balefill and the Creek which is resulting in the leachate impacted groundwater outbreak on the bank of the Wappinger Creek.

While the water level elevations indicate slight mounding of groundwater beneath the Balefill, data from the borings through the waste indicated that the bottom of the waste is above the shallow water-table. As such, the groundwater impacts which have been identified should be reduced and eventually eliminated with the elimination of the infiltration of precipitation through the balefill waste. Re-grading the site to facilitate better drainage off the top of the balefill and eliminate the ponding which has resulted in three small wetland areas on top of the balefill, followed by installation of adequate cap over the balefill, is expected to largely eliminate the generation of leachate associated with the infiltration of precipitation through the waste. Following the reduction of infiltration of precipitation through the balefill, groundwater quality improvements should occur along with reductions in leachate characteristics reaching the Wappinger Creek seep.

In addition to regrading and capping the balefill, measures to maintain and keep clear the present ditch flowing past the balefill near MW-1S/D and another drainage ditch further west from the balefill were recommended. This ditch may be helping to drain shallow groundwater from the vicinity of the balefill, thereby contributing to the present beneficial water table position below the bottom of the waste. If water levels are perpetually lowered in this manner near the balefill, it will ensure long-term separation of the shallow groundwater from the balefill wastes.

## 3.0 LANDFILL CAP DESIGN

This section discusses the design features of the landfill closure that were prepared to meet the requirements set forth in6 NYCRR Part 360-2.15(d), Final Cover System. The regulations require the following capping components:

- Gas venting layer (12 inches minimum)
- Low permeability layer (18 inches 1 X $10^{-7}$ cm/sec clay layer or a 40-mil geomembrane)
- Barrier protection layer (24 inches minimum)
- Topsoil (6 inches minimum)

### 3.1 Requested Variances to Final Cover System

Based on the results of the closure investigation and other pre-design evaluations, one variance to the capping components listed above are requested. This variance includes the reduction of the barrier protection layer thickness. In accordance with the Local Government Regulatory Relief Initiative (February 26, 1993) Section C, the minimum 24-inch barrier protection layer requirements contained in 6 NYCRR Part 360-2.13(r)(iii) may be reduced to 12 inches if the following requirements are met:

- A written affirmation by a soil scientist, agronomist of local Soil and Water Conservation District should be submitted to affirm that the topsoil and barrier protection layer will, acting together, continually support growth of the proposed vegetative cover and not result in root damage to the barrier layer.
- There should be a geomembrane barrier layer and the soil under the geomembrane should be sufficiently well drained to prevent frost heave impacts on the geomembrane.

In Appendix C (Design Specifications), Section 02300 – Earthwork, stipulates the physical characteristics of the materials that will meet these requirements. Additionally, a geocomposite drainage layer is included to facilitate the movement of infiltrating water. The variance request form is included in Appendix E.

Therefore, the proposed final capping profile includes the following:

- Gas venting layer (12 inches)
- Low permeability layer (40-mil geomembrane)
- Drainage layer (geocomposite)
- Barrier protection layer (12 inches)
- Topsoil (6 inches)

The designed cap section, with the final capping layers, is detailed in the drawing set provided as Appendix F.

## 3.2 Landfill Cap Components

### 3.2.1 Subgrade

To prepare the site for closure construction activities, the area will be cleared and grubbed within the approximate limit of the waste boundary, or as required within the project work limits to perform the work. All trees including stumps will be removed and hauled off-site. Voids will be filled with select granular fill. The three small wetlands that formed on the surface of the fill area due to settlement of the waste mass will be filled in. The existing slopes will be regraded to the proposed elevations/contours using 4% minimum/33% maximum allowable slopes. The select granular fill will be used where required to meet the specified grades.

### 3.2.2 Gas Venting Layer

Geotextile and a 12-inch thick gas venting layer will be placed above the subgrade. The geotextile will be composed of a 10-ounce non-woven material and is designed to prevent mixing of the subgrade and gas venting materials. The gas venting layer will be composed of a sand material with a minimum permeability of 1 x $10^{-3}$ cm/sec. The gas vent layer is designed to allow landfill gas that may rise to migrate toward passive gas vents.

Passive gas vents will be installed in the venting layer. The vents will be installed a minimum of 5 feet into the waste. The vents will be constructed of 6-inch diameter PVC (SDR-26) riser pipe and screen. A total of seven gas vents are proposed.

### 3.2.3 Geomembrane Cover

A geomembrane cover will be placed over the gas venting layer. The geomembrane cover will be comprised of a 40-mil linear low density polyethylene (LLDPE) textured geomembrane.

### 3.2.4 Geocomposite Drainage Layer

The drainage layer will consist of a high density polyethylene drainage net-geotextile geocomposite. The geocomposite is able to transmit appreciable volumes of water over a relatively thin layer (about an inch), thus eliminating the need for additional soil material and minimizing cap thickness.

### 3.2.5 Barrier Protection Layer

A barrier protection layer will be placed over the geomembrane cover. As discussed in Section 3.1, a variance has been requested to reduce the thickness of this layer from 24 inches to 12 inches. The reduction in thickness will reduce the cost and schedule to install the cap, while providing adequate thickness (coupled with the topsoil layer) to support vegetative growth. This layer will be composed of 12 inches of silty soil.

### 3.2.6 Topsoil Layer

A 6-inch layer of topsoil, with seed and mulch or erosion control blankets (as required depending on slopes) will be placed over the barrier protection layer to provide permanent vegetative cover. All disturbed areas outside of the landfill cap will also receive a 6-inch layer of topsoil, with seed and mulch to provide permanent vegetative cover.

## 3.3 Stormwater Management

Stormwater will be managed at the site in accordance with 6 NYCRR Part 360-2.1(k) (2). The cap will be graded and seeded and mulched to minimize erosion of the cover soil and minimize ponding on the landfill cap. Perimeter drainage will be designed to handle the peak discharge from the 24-hour, 25-year storm.

In accordance with General Permit GP-0-08-001, a Stormwater Pollution Prevention Plan has been prepared and will be submitted to the NYSDEC under separate cover. The SWPPP provides additional detail regarding runoff flow calculations and erosion control measures. Pertinent runoff calculations are provided in Appendix D of this Report.

## 3.4 Leachate Collection System

A leachate seep has been identified north of the Balefill along the banks of the Wappinger Creek. The seep is believed to emanate via the infiltration of precipitation through the landfill mass, and then flow horizontally through a permeable sand and gravel layer between the landfill and the creek. During the closure investigation, it was determined that the elevation of the water table within the landfill footprint was beneath the landfill mass. It is anticipated that after the landfill cap is constructed, infiltration will be eliminated, the residual saturation in the landfill mass will equilibrate over time, and the quality of the seep will improve. While oxidized floc is present in the area where the groundwater daylights near the creek bank, this material will be removed and consolidated under the cap during construction. Because no active leachate seep is anticipated after a post-closure equilibration period, a leachate collection system is not proposed for this closure.

## 3.5 Site Grading

The landfill will be graded to promote positive drainage and minimize erosion of the cover soil. In accordance with 6 NYCRR Part 360-2.13(r) (2) (ii), the low permeability layer will be placed at slopes between 4 and 33 percent. In order to achieve the required grades, additional fill will be required. Granular fill from an off-site source will be used to achieve the required subgrade elevations and slopes.

# 4.0 LANDFILL CAP CONSTRUCTION/OPERATION AND MAINTENANCE

This section discusses the proposed schedule for closure construction as well as post-closure operation and monitoring activities. Accordingly, financial assurance for post-closure operation and monitoring and maintenance (6 NYCRR Part 360-2.19(b)) will be addressed upon completion of the cap closure and prior to commencement of post-closure activities.

## 4.1 Construction Schedule

The proposed schedule for the closure construction is presented in Figure 2. This schedule conforms to the requirements of 6 NYCRR Part 360-2.15(c).

Assuming that the Closure Plan is approved around October 14, 2008, it is anticipated that a final bid package will be prepared for the Dutchess County Department of Public Works and bids will be solicited by March 30, 2009. Contractors will be selected by May 8, 2009. The mobilization of materials, equipment, and labor to commence construction phase activities is anticipated to be completed around May 27, 2009. Mobilization is contingent upon successful selection of qualified contractors and suppliers. It is anticipated that the landfill cap will be significantly complete with the gas venting layer, geomembrane cover, barrier protection layer, and vegetative layers in place by September 25, 2009.

## 4.2 Closure Report and Construction Certification

An Engineer's Certification Report will be prepared to outline the completed activities associated with the closure of the landfill. The Engineer's Certification Report will also include the construction certifications as required under 6 NYCRR Part 360. Certifications are required to provide documentation that the project plans and specifications were met during construction.

## 4.3 Operation, Monitoring, and Maintenance

A comprehensive Post-Closure Monitoring and Facility Maintenance Plan has been developed in accordance with 6 NYCRR Part 360-2.15(k) for the site, and is provided in Appendix B.

### 4.3.1 Landfill Maintenance

In accordance with 6 NYCRR Part 360-2.15(k)(3), site inspections will be performed on a quarterly basis to ensure that the final landfill cover and drainage structures are functioning within accepted design standards. The inspections will

include visual checks of rip-rap, swales, and berms/benchs, if present, to ensure erosion problems are not occurring. Erosion occurrences associated with drainage will be repaired and restored. Eroded soil or displaced rip-rap will be replaced. Exposed or unvegetated soil will be reseeded, fertilized, and mulched.

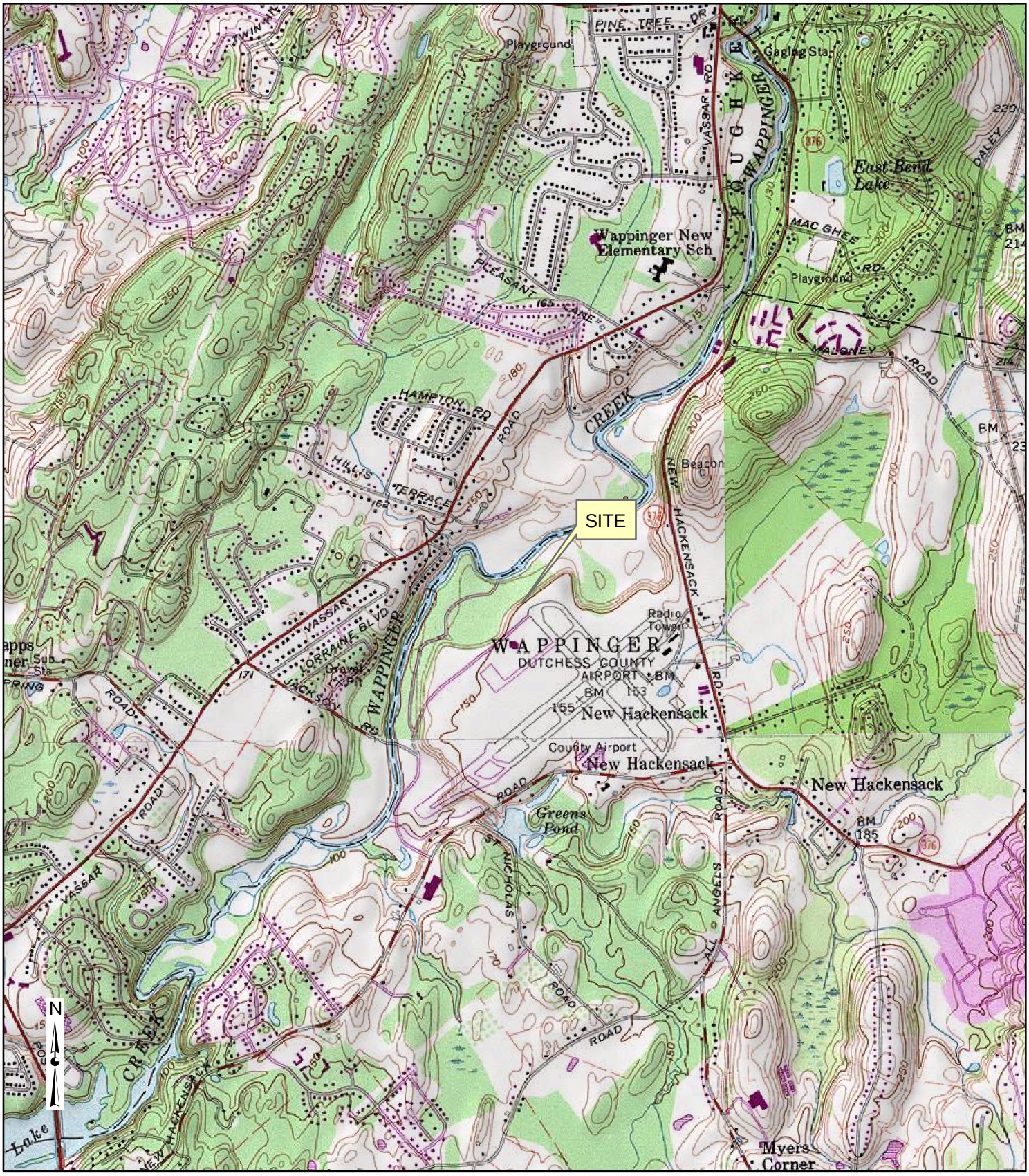
Areas of concern with final landfill cover systems typically include erosion, loss of vegetative cover, and settlement or cracking on the top or side slopes. If cracks or settlement occur, the inspector will determine if the barrier layer is affected.

The presence of any vectors (e.g., rodents, borrowing animals, etc.) on the site will be noted during the routine inspection. Extermination or treatment that will remove the vecting population(s) will be implemented, as appropriate.

Monitoring well casings, concrete aprons, locks, and gas vents will be inspected to ensure that they are undamaged and functional. Damaged components will be repaired immediately and all structures will be re-secured.

Following each inspection, a report will be prepared and submitted to the owner and the New York State Department of Environmental Conservation. The inspection report will include, at a minimum, the date and time of the inspection; personnel conducting the inspection; visual observations of the inspectors; a list of items inspected; and a brief description of any repair work, if required, including the nature of the damage, the repairs completed, and the estimated cost of the repairs. The report will also describe any items that will need future attention or repairs not completed during the course of the inspection, along with other pertinent comments. This report will be included as part of the Quarterly Monitoring Event Letter Report that details the engineer's inspection and quarterly monitoring results.

# FIGURES

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# FIGURE 1-SITE LOCATION MAP

**Dutchess County Balefill**
**Town of Wappinger, Dutchess County, New York**

USGS Topographic Map of the Poughkeepsie, NY Quadrangle
Dated 1995. 7.5 Minute Series.

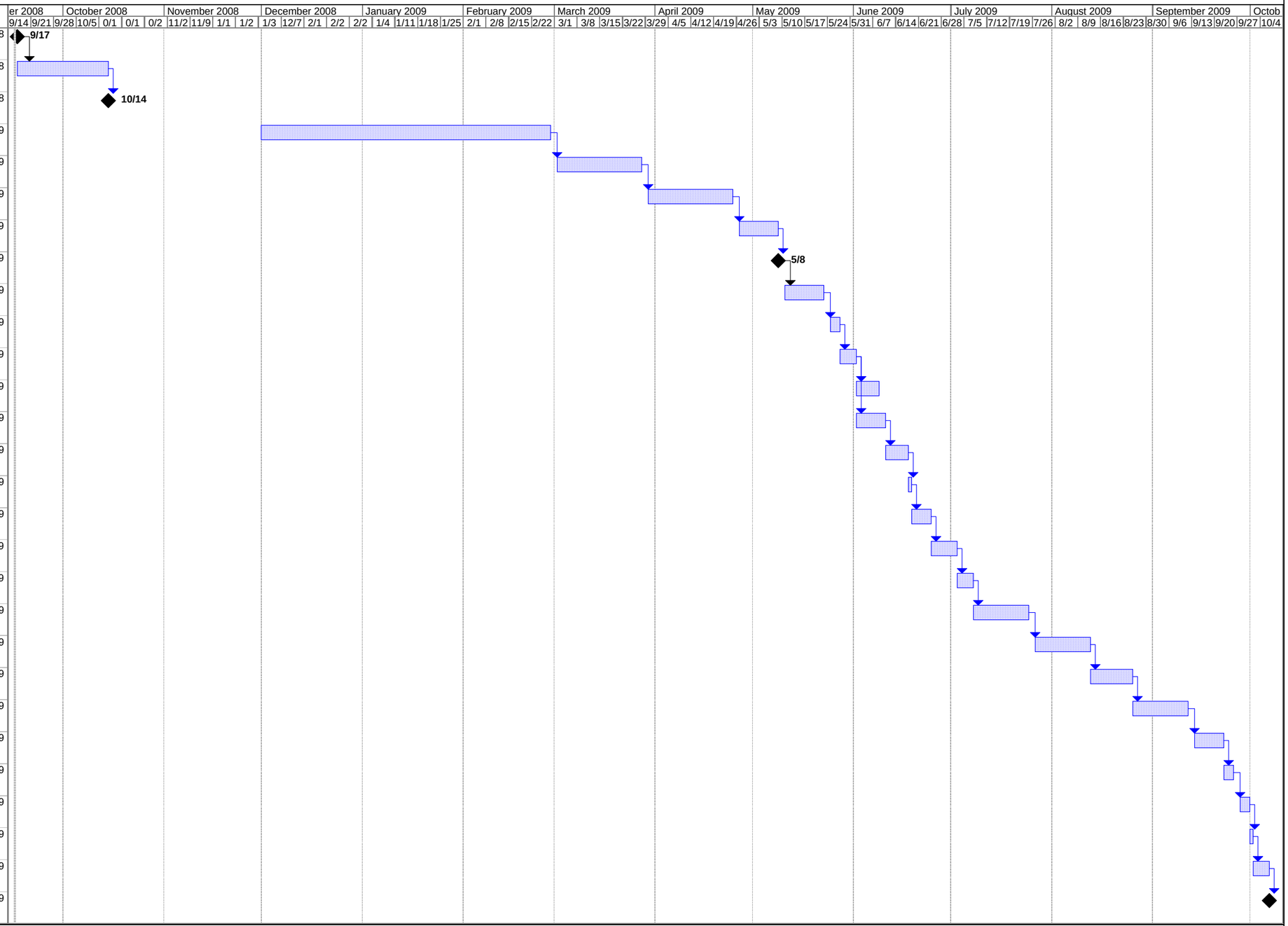
Date:
February 2005

Scale:
1 in equals 2,000 ft

Project #:
40313.01

Figure 2
Dutchess County Balefill
Landfill Closure Schedule
Wappinger, New York

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | Submit Final Closure Plan to NYSDEC | 0 days | 9/17/08 | 9/17/08 |
| 2 | NYSDEC Review | 20 days | 9/17/08 | 10/14/08 |
| 3 | NYSDEC Approval | 0 days | 10/14/08 | 10/14/08 |
| 4 | Secure Legislative Approval for Funding | 65 days | 12/1/08 | 2/27/09 |
| 5 | Prepare Bid Documents | 20 days | 3/2/09 | 3/27/09 |
| 6 | Public Bid | 20 days | 3/30/09 | 4/24/09 |
| 7 | Review/Evaluate Bids | 10 days | 4/27/09 | 5/8/09 |
| 8 | Select Contractor | 0 days | 5/8/09 | 5/8/09 |
| 9 | Finalize Contract | 10 days | 5/11/09 | 5/22/09 |
| 10 | Mobilization | 3 days | 5/25/09 | 5/27/09 |
| 11 | Install Erosion Control Measures | 3 days | 5/28/09 | 6/1/09 |
| 12 | Clearing and Grubbing | 5 days | 6/2/09 | 6/8/09 |
| 13 | Improve Haul Road | 7 days | 6/2/09 | 6/10/09 |
| 14 | Install Access Road and Drainage | 5 days | 6/11/09 | 6/17/09 |
| 15 | Install Construction Entrance | 1 day | 6/18/09 | 6/18/09 |
| 16 | Rough Grading | 4 days | 6/19/09 | 6/24/09 |
| 17 | Install Subgrade | 6 days | 6/25/09 | 7/2/09 |
| 18 | Install Geotextile | 3 days | 7/3/09 | 7/7/09 |
| 19 | Install Gas Vent Layer | 13 days | 7/8/09 | 7/24/09 |
| 20 | Install Geomembrane | 13 days | 7/27/09 | 8/12/09 |
| 21 | Install Geocomposite | 9 days | 8/13/09 | 8/25/09 |
| 22 | Install Barrier Protection Layer | 13 days | 8/26/09 | 9/11/09 |
| 23 | Install Topsoil Layer | 7 days | 9/14/09 | 9/22/09 |
| 24 | Seeding, Mulching, Erosion Blankets | 3 days | 9/23/09 | 9/25/09 |
| 25 | Punch List | 3 days | 9/28/09 | 9/30/09 |
| 26 | Final Inspection | 1 day | 10/1/09 | 10/1/09 |
| 27 | Demobilization | 3 days | 10/2/09 | 10/6/09 |
| 28 | Complete Construction | 0 days | 10/6/09 | 10/6/09 |




Project: DC Balefill Construction Sched
Date: 9/16/08

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

# Appendix A:
# Construction Quality Assurance and Construction Quality Control Plan

*Construction Quality Assurance and*
*Construction Quality Control Plan*

# Dutchess County Balefill
# Landfill Closure
# Town of Wappinger
# Dutchess County, New York

September 2008

THE
Chazen
COMPANIES

Prepared for:

Dutchess County Department of
Public Works

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*Construction Quality Assurance and*
*Construction Quality Control Plan*

# Dutchess County Balefill
# Landfill Closure
# Town of Wappinger
# Dutchess County, New York

September 2008

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# 1.0 INTRODUCTION

## 1.1 STATEMENT OF PURPOSE

This Construction Quality Assurance and Construction Quality Control (CQA/CQC) Plan has been prepared for the Dutchess County Balefill Landfill Closure in Wappinger, New York. This Plan describes the necessary materials testing required under 6 NYCRR Part 360-2.8 and 2.13, (o), (p), (q), (r), and (t) and associated subparts. The purpose of this document is to specify the means of assuring construction quality.

The activities that require specific quality assurance procedures for the landfill closure construction include:

- Erosion and sediment control and stormwater management.
- Site clearing/grading/waste relocation.
- Bedding layer (subgrade) installation.
- Geotextile installation.
- Gas Venting Layer installation.
- Geomembrane installation.
- Geocomposite installation.
- Barrier Protection Layer installation.
- Topsoil Layer installation.

The project construction and installation require verification of specified materials, assurance of material placement, and laboratory and field testing of in-place materials to verify compliance with Contract Drawings and Specifications and good workmanship.

## 1.2 ORGANIZATION

- Section 1 outlines the purpose of this CQA/CQC Plan, and identifies applicable regulatory provisions.
- Section 2 includes a discussion of the responsibilities and authorities for the CQA/CQC management organization, and also addresses pre-construction meetings, progress meetings, problem/deficiency meetings, and pre-final and final inspection meetings.
- Section 3 describes the operational plan to include mobilization, erosion and sediment control, stormwater management facilities, site clearing, subgrade preparation, geotextile installation,

gas venting layer installation, geomembrane installation, geocomposite installation, barrier protection layer installation, and topsoil layer installation.

- Section 4 identifies CQA/CQC training, certifications, and testing requirements.
- Section 5 addresses surveying CQA.
- Section 6 summarizes project closeout documentation requirements.

## 2.0 PROJECT MANAGEMENT/MEETINGS

The construction of the landfill closure in Wappinger, New York requires coordinated efforts of several individuals to successfully meet the landfill closure requirements contained in 6 NYCRR Part 360. These efforts include inspections, testing, and submittal review of materials to be used in the landfill closure construction. A suggested structural organization to provide support to the individuals performing the required quality assurance activities is discussed below. The actual Contractor may have different names for the following individuals, but the general intent should closely resemble what is presented below.

## 2.1 ROLES AND RESPONSIBILITIES

Specific project roles shall be established for the successful completion of this project. The following list presents those project roles and a brief description of their anticipated duties.

### 2.1.1 Contractor's Project Manager

The Contractor's Project Manager shall provide overall project coordination of field efforts and home office efforts. Overall project performance responsibilities include staffing management, ensuring safe work conduct, meeting schedule requirements, subcontractor management, billing and other accounting efforts, and interaction with the Resident Engineer and the New York State Department of Environmental Conservation (NYSDEC) Regional Office. The Contractor's Project Manager serves as the primary contact for project and contractual issues.

### 2.1.2 Resident Engineer

Landfill closure activities at the landfill shall be conducted under the observation of the Resident Engineer. A Resident Project Representative may be designated by the Resident Engineer for the purposes of maintaining a daily presence at the site. For the purposes of this CQA/CQC Plan, the Resident Engineer and the Resident Project Representative shall be considered one and the same.

The role of the Resident Engineer is to provide third-party verification that landfill closure activities and the specified standards of quality are being met (the other party being the NYSDEC Regional Representative). The primary functions of the Resident Engineer include the following:

- Verifying that specified testing procedures are conducted consistently and in the prescribed manner.
- Confirming that testing equipment is functioning properly and is regularly calibrated.
- Documenting that materials and construction activities were performed in accordance with Specifications.
- Confirming that test data are properly recorded and interpreted.
- Recommending to NYSDEC Regional Representatives that the Contractor's work should be accepted.
- Documentation of construction progress and CQA performance.

The Resident Engineer shall work closely with the Contractor's Quality Assurance Officer and NYSDEC Regional Representatives to document that project quality standards are consistently being achieved, without unnecessary duplication of effort. Clear lines of authority and responsibility shall be made known to all parties before construction begins.

### 2.1.3 Contractor's Construction Manager

The Contractor's Construction Manager provides the Contractor's Project Manager with onsite, day-to-day coordination of field activities. Included in the Construction Manager's responsibilities are planning/executing daily work efforts, scheduling and coordination of subcontractors and material suppliers, daily safe work conduct, adherence of the work with the Contract Documents, daily tracking of budget and schedule, and timely and efficient implementation of the construction. The Construction Manager shall be in daily contact with the Contractor's Project Manager to ensure a continual line of communication. The Construction Manager provides the Resident Engineer with an onsite contact for field-related issues.

### 2.1.4 Contractor's Quality Assurance Officer

The Contractor's Quality Assurance Officer is responsible for coordinating inspection and surveillance activities. He/she or their delegate shall monitor site activities. The result of inspections and surveillances shall be documented in the daily reports. Responsibilities include:

- Performance of CQA inspections and field tests and preparation.
- Maintenance of the latest applicable Contract Drawings and Specifications and as-built drawings.
- Review shop drawings and/or other submittals for compliance with the Contract Documents.
- Establish and maintain a rework item list for work that does not conform to the Contract Drawings and Specifications.
- Maintain a dated photographic log of the project.

### 2.1.5 Chief Surveyor

The Chief Surveyor has the responsibility for the overall surveying requirements for the project. He/she shall be a land surveyor registered in the State of New York. All surveying work shall be performed under the direct supervision of the Chief Surveyor.

2.1.5.1 Survey Crew

The survey crew shall consist of the Chief Surveyor and as many crew members as are required to satisfactorily perform the work. Surveying personnel shall be experienced in surveying similar sites, including detailed, accurate documentation.

## 2.2 ORGANIZATIONAL CHART FOR QUALITY ASSURANCE

The Contractor's Project Manager shall provide to the Resident Engineer, within 10 days of award, an organizational structure in chart format that supports successful project completion. Project positions described above shall be presented showing the lines of authority.

## 2.3 COMMUNICATION LINES

Daily construction communication, whether by written report logs or verbally to project personnel, is of paramount importance to the quality of this project. By observing and verifying the daily subcontractor construction performance, the Construction Manager shall implement the quality assurance procedures noted in the Contract Documents at the specified frequencies.

Weekly meetings that include the Resident Engineer, Construction Manager, and the field crew shall highlight the type and number of quality assurance tests required for the these activities. Quality assurance procedures in the Specifications direct the Construction Manager on how and when to test individual materials, and that information is disseminated during the daily meetings. As the construction is performed, the results are recorded on either the daily logs or a specific testing log, as appropriate. Daily and testing logs are forwarded to the Project Manager who checks the logs for possible construction defects. As the information is sent to the Resident Engineer from the Project Manager, the Resident Engineer's involvement in construction performance shall become an important part of the project's progress. The Resident Engineer shall review test results for verification and documentation. The Construction Manager and the Project Manager shall have continuous communications links on a nearly daily basis, as shall the NYSDEC Regional Representative and the Resident Engineer.

## 2.4 PRE-CONSTRUCTION MEETING

A pre-construction meeting shall be held at the site. At a minimum, the meeting shall be attended by the NYSDEC Regional Representative, Resident Engineer, Contractor's Project Manager, Contractor's Construction Manager, Contractor's Quality Assurance Officer, and major subcontractors. Topics considered for this meeting may include:

- Identification of appropriate modifications to the CQA/CQC Plan.
- Review of the responsibilities of each party.
- Review of lines of authority and communication.
- Review of methods for distributing and storing documents and reports.
- Review of methods for documenting and reporting inspection data and procedures for handling construction deficiencies, repairs, and retesting.

- Review of the Site-Specific Safety, Health, and Contingency Plan.
- Review of site security protocols.
- Review of testing and sampling requirements for construction materials.
- Review of schedule for all construction.
- A site walk-around, review of material protection, and storage and stockpiling locations.
- Review of methods of the material(s) placement.
- Review of testing requirements for soil components.

The meeting shall be documented (by a person designated at the beginning of the meeting) and the minutes shall be distributed to all parties in attendance.

## 2.5 PROGRESS MEETINGS

Biweekly progress meetings shall be held at the site, unless more frequent meetings are necessary. The Contractor's Project Manager or Construction Manager, Contractor's Quality Assurance Officer, Resident Engineer, and key subcontractor personnel shall attend (and others as appropriate). These meetings shall include discussions regarding current progress, planned activities, and any new business or revisions. The Resident Engineer shall document problems, decisions, and questions that may arise at these meetings. Any mailer(s) requiring action shall be reported to the appropriate parties.

The meetings shall be documented (by a person designated at the beginning of the meeting) and the minutes shall be distributed to all parties in attendance and filed in the appropriate project files. The NYSDEC Regional Representative shall be notified in advance of the meetings. The general discussions in these meetings can be reported in the Contractor's daily reports. Specific problems/questions shall be addressed in separate correspondence.

## 2.6 PROBLEM/DEFICIENCY MEETINGS

A meeting shall be held when a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by the Resident Engineer and the Contractor's Project Manager. If a problem requires a design modification, the Design Engineer should also be present. The purpose of the meeting is to define and resolve the problem or deficiency as follows:

- Define and discuss the problem or deficiency review solutions.
- Prepare a recommendation to the NYSDEC Regional Representative to implement a plan to address the problem or deficiency.

These meetings shall be documented by the Resident Engineer and the minutes shall be distributed to all parties in attendance and filed in the appropriate project files. The NYSDEC Regional Representative shall be notified in advance of the meetings.

## 2.7 PRE-FINAL AND FINAL INSPECTION MEETINGS

The Resident Engineer shall conduct meetings after both the pre-final and final inspections. The meeting after the pre-final inspection shall assist in documenting any unfinished construction items and deficiencies for inclusion in the pre-final inspection report. A meeting scheduled after the final inspection shall assist in documenting that all unfinished construction items and deficiencies have been addressed. This documentation shall be included in the construction completion report.

The meeting shall be documented by the Resident Engineer and the minutes shall be distributed to all parties in attendance and filed in the appropriate project files.

## 3.0 OPERATIONAL PLAN

The successful outcome of the landfill closure project requires a logical sequencing of operations. This section presents a suggested sequencing that has been developed to accomplish the various activities that must be performed. The Contractor may have a sequence of operations that varies from what is presented below. Such information shall be submitted to the Resident Engineer for review and approval at the pre-construction meeting.

### 3.1 MOBILIZATION

This activity describes assembling the manpower and equipment necessary to perform the project work. Initial activities required to establish the work site should move onto designated areas providing an established field headquarters for the project. Temporary office and supply trailers shall be moved to the project site and become resident for the project duration. As the work progresses, other temporary facilities or equipment shall be moved to the project site as required.

### 3.2 EROSION AND SEDIMENT CONTROL

Erosion and sediment control measures shall be implemented at the landfill work site as per the Contract Documents and Specification Section 02300. This work shall be conducted according to the Contract Documents and may include the placement of berms, silt fencing, stabilized construction entrances, and sediment traps to mitigate the effects of rain runoff. Efforts to de-water specific work areas may be initiated at this time, if necessary.

### 3.3 SITE CLEARING

Crews shall clear and remove vegetative material from the project areas as required. Crews shall remove and dispose of material as specified in Specification Section 02230.

### 3.4 SUBGRADE PREPARATION

In preparation for installation of the geotextile, the Contractor shall perform waste relocation and general site grading as indicated on the Contract Drawings to prepare the subgrade. Select granular fill from an offsite source shall be placed and compacted in maximum 12-inch loose lifts as fill material. The Contractor shall be responsible for procurement of the select granular fill source; such a site will not be specified by the Contract Documents, but the soil from the borrow site must comply with Specification Section 02300. The Contractor shall compact the subgrade material according to the Contract Documents. Samples of select granular fill shall be collected to ensure that the material has the correct moisture content and that compaction efforts meet the Contract Documents.

### 3.5 GEOSYNTHETIC INSTALLATION

Crews shall install the following: (1) 10-ounce non-woven geotextile, (2) 40-mil textured linear low density polyethylene geomembrane liner, and (3) geocomposite drainage layer, from bottom to top in the landfill cap section. These geosynthetics shall be installed according to the Contract Documents. The Contractor shall test, inspect, and collect samples to maintain the project requirements according to the Specifications.

## 3.6 GAS VENTING LAYER INSTALLATION

Soil from an offsite borrow source shall be placed on the geotextile to act as a gas venting layer. This layer is to be constructed to a 12-inch compacted thickness. The Contractor shall be responsible for procurement of this source of borrow material; such a site will not be specified by the Contract Documents, but the soil from the borrow site must comply with the Specification Section 02300. The Contractor shall compact the cover material according to the Contract Documents. Samples shall be collected to ensure that the material has the correct moisture content and that compaction efforts meet the Contract Documents.

## 3.7 BARRIER PROTECTION LAYER INSTALLATION

Soil from an offsite borrow source shall be placed on the geocomposite drainage layer to act as a barrier protection layer. This layer is to be constructed to a 12-inch compacted thickness. The Contractor shall be responsible for procurement of this source of borrow material; such a site will not be specified by the Contract Documents, but the soil from the borrow site must comply with the Specification Section 02300. The Contractor shall compact the cover material according to the Contract Documents. Samples shall be collected to ensure that the material has the correct moisture content and that compaction efforts meet the Contract Documents.

## 3.8 TOPSOIL LAYER INSTALLATION

The Contractor shall supply topsoil from an approved borrow source and place the topsoil over the barrier protection layer. This layer is to be constructed to a 6-inch compacted thickness. The topsoil surface shall be tested to ensure that it meets the Contract Documents, and that the surface is prepared for seeding according to the Specification Section 02920.

## 3.9 SEEDING

After correct topsoil surface preparation, the Contractor shall apply the specified seed mixtures to the landfill cap according to the Specification Section 02920. Areas that were disturbed during construction and were specified in the project design shall also receive the appropriate seeding application.

# 4.0 CONSTRUCTION QUALITY ASSURANCE/CONSTRUCTION QUALITY CONTROL TRAINING, CERTIFICATION, AND TESTING REQUIREMENTS

## 4.1 INDEPENDENT TESTING LABORATORIES

Independent testing laboratories shall be subcontracted by the Contractor to perform materials testing as a part of the CQA/CQC program. The materials that require independent verification of physical properties include:

- Select Granular Fill material.
- Geotextiles.
- Gas Venting Layer material.
- Geomembranes.
- Geocomposites.
- Barrier Protection Layer material.
- Topsoil Layer material.
- Stone and rip rap.

## 4.2 PRESENT QUALIFICATIONS AND CERTIFICATIONS

Testing laboratory qualifications, including verification of demonstrated knowledge, shall be furnished to the Resident Engineer prior to the commencement of work with the materials in question. After materials have been placed and samples taken, the certified testing results of physical properties shall be presented to the Resident Engineer for approval. The testing shall be certified to ensure that it was completed according to the requirements of the Contract Documents and this CQA/CQC program. Testing and results reporting shall be performed according to the project schedule.

## 4.3 OTHER TESTING QUALIFICATIONS

The person or persons who collect material samples for physical properties testing must have demonstrated knowledge of the pertinent testing procedure, and must be approved by the Contractor's Construction Manager and Project Manager. This approval shall include documentation of the technician's qualifications. The Contractor's Quality Assurance Officer is responsible for verifying the technician's qualifications.

## 4.4 NATURAL MATERIAL CONSTRUCTION QUALITY ASSURANCE, CONSTRUCTION QUALITY CONTROL TESTING REQUIREMENTS, AND NATURAL MATERIAL QUALITY ASSURANCE TESTING REQUIREMENTS

This section addresses the CQA testing for natural materials for the landfill closure. The primary means of implementing this CQA/CQC Plan shall be observations made at the site, with sample testing

providing proof of material and installation quality. The Construction Manager is responsible for assuring that the work is completed according to the Contract Documents. Materials that shall receive quality assurance testing during construction include:

- Select Granular Fill material.
- Gas Venting Layer material.
- Barrier Protection Layer material.
- Topsoil Layer material.
- Stone and rip rap.

### 4.4.1 Natural Material Construction Quality Assurance

The Construction Manager shall perform or direct the performance by qualified subcontractors of testing the natural materials. The sample collection and testing shall be performed at the direction and frequency shown in the Specifications and as shown in Table 1 – Natural Material Quality Assurance Testing.

The individual performing the testing or the testing oversight shall have demonstrated knowledge in the pertinent testing procedure, and shall be approved in writing by the Contractor's Project Manager. This written approval shall include documentation of the technician's qualifications. Test results shall be submitted to the Resident Engineer when available.

### 4.4.2 Materials

The soil materials include select granular fill, gas venting layer material, barrier protection layer material, topsoil layer material, stone and rip rap. The Resident Engineer shall observe all materials for consistency with the approved samples. Any materials appearing to deviate from the approved samples shall be re-tested by the Contractor to verify compliance with the Specifications.

### 4.4.3 Construction Evaluation

#### 4.4.3.1 General

The Resident Engineer shall document and observe the construction activity. The responsibilities of the Resident Engineer include the following:

- Monitor removal and disposal of cleared vegetation and preparation of subgrade.
- Review source(s) of construction materials.
- Placement of the select granular fill material, gas venting layer material, barrier protection layer material, topsoil layer material, stone and rip rap.
- Evaluate stockpiling activities.

- Evaluate completed soil components for proper elevation(s) and condition.

- Confirm that the equipment and procedures used to place soil layers have not damaged the impermeable geomembrane and that repair(s), if necessary, are made in a timely manner.

4.4.3.2 Construction Quality Control Testing

Laboratory and field CQA tests shall be performed by the Contractor in accordance with the Specifications, as summarized below:

| Test | Method |
|---|---|
| Particle Size Analysis | ASTM D-422 |
| Atterberg Limits | ASTM D-4318 |
| Unified Soil Classification System | ASTM D-2487 |
| Compaction characteristics of soil | ASTM D-1557 |
| Moisture Content | ASTM D-2216 |
| Hydraulic Conductivity (for granular soils) | ASTM D-2434 |
| Hydraulic Conductivity (for sand, less than 1 x $10^{-5}$ cm/sec) | ASTM D-5084 |
| In-place Density (nuclear density method) | ASTM D-2922 |

Note: ASTM = American Society for Testing and Materials.

The Resident Engineer shall observe the CQA testing in the field and review test results from both laboratory and field testing. He/she shall confirm that the test results of the earthwork construction meet or exceed requirements outlined in the Specifications.

Nuclear density methods shall be performed in accordance with the Specifications and ASTM D-2922 for all density testing due to the ease of testing and the large number of tests that can be run in a specified time. Nuclear gauges used on this project shall be required to have been calibrated within the past 12 months. Standard counts for density and moisture shall be taken on a daily basis. Questions concerning the accuracy of any single test shall be addressed by re-testing in the vicinity of the original test.

Additional testing shall be used at the discretion of the Resident Engineer when visual observations indicate a potential problem. Additional testing shall be considered when:

- Lift thickness is greater than specified.

- Earth fill is at improper and/or variable moisture content.

- Pumping of soil is encountered during compaction.

- Characteristics of the soil change.

During construction, the frequency of testing may be increased in the following situations:

- Adverse weather conditions.

- Breakdown of equipment.

- At the start and finish of grading.
- Materials fail to meet Specifications.

4.4.3. Select Granular Fill

During construction, select granular fill shall be place to prepare the subgrade. The Resident Engineer shall verify the gradation of the soil as required in Specification Section 02300. Nonconforming characteristics shall be identified and replaced.

4.4.3.4 Gas Venting Layer

The gas venting layer shall consist of a 12-inch layer of soil. The Resident Engineer shall verify the gradation and permeability of the soil as required in Specification Section 02300. Nonconforming characteristics shall be identified and replaced.

4.4.3.5 Barrier Protection Layer

The barrier protection layer shall consist of a 12-inch layer of soil. The Resident Engineer shall verify the gradation of the soil as required in Specification Section 02300. Nonconforming characteristics shall be identified and replaced.

4.4.3.6 Stone

The Resident Engineer shall verify the gradation of the stone as required in Specification Section 02300. Nonconforming characteristics shall be identified and replaced.

4.4.3.7 Topsoil Layer

The topsoil layer shall consist of a 6-inch layer of soil. The Resident Engineer shall verify the gradation of the soil as required in Specification Section 02920. Nonconforming characteristics shall be identified and replaced.

The Resident Engineer shall confirm that the final elevations of the topsoil layer are within the requirements of the Project. The final elevations (top of topsoil) shall be provided by the Chief Surveyor.

4.4.3.8 Seeding

It is necessary that the topsoil layer be covered with vegetation at the earliest possible time to stabilize the cover system and prevent erosion. A seeding subcontractor to the Contractor may be used for this work.

The Resident Engineer shall observe the seeding process to confirm that the soil is properly prepared and the seed mixtures are as specified in Specification Section 02920. He/she shall confirm the tilling depth and the application rate of additives, rate of seed and mulch application, amount of uniformity of coverage and consistency, and methods of watering. Seeded areas shall be observed for bare spots. Erosion control blankets shall be installed on all 1V:3H slopes as shown on the Contract Drawings.

The CQA official shall ensure that the seeding and mulching work is performed when weather conditions are favorable.

4.4.3.9 Deficiencies

If a deficiency is identified in the earthworks, the Resident Engineer, together with the Construction Manager, shall immediately determine the extent and nature of the deficiency. If the deficiency is indicated by an unsatisfactory test result, the Resident Engineer shall determine the extent of the deficient area by additional tests, observations, a review of records, or other appropriate methods.

4.4.3.10 Notification

After determining the extent and nature of a deficiency, the Resident Engineer may notify the NYSDEC Regional Representative and the Contractor and schedule appropriate re-testing after the deficiency is corrected.

4.4.3.11 Repairs and Re-Testing

The Contractor shall correct the deficiency to the satisfaction of the Resident Engineer. If a requirement cannot be met, or unusual weather conditions hinder work, then the Resident Engineer may suggest solutions to the NYSDEC Regional Representative and the Contractor to obtain acceptance.

Re-tests performed by the Contractor must confirm that the deficiency has been corrected before any additional work is performed in the area of the deficiency. The Resident Engineer shall confirm that installation requirements are met and that CQC submittals are provided.

4.4.3.12 Acceptance

The Resident Engineer shall recommend to the NYSDEC Regional Representative acceptance of the work performed by the Contractor when soil components are completed in accordance with the Specifications.

4.4.4 Stormwater Management

The Contractor shall be responsible for the excavation and construction of the wet swales to the lines and grade requirements of the Contract Drawings. The Resident Engineer shall observe the excavation for compliance to the Specification.

4.4.4.1 Rip Rap

Material used shall be in accordance with the Specifications. The rip rap shall be placed in one operation to the specified thickness. The rip rap shall be placed to avoid clusters of large stones, small stones, and voids.

The Resident Engineer shall observe the placement of materials for compliance with the Specifications.

#### 4.4.5 Dust Control

The release of dust from the site shall be controlled by water spray on temporary access and haul roads and work areas. Dust generation is expected to be more prevalent during dry weather. It is the Contractor's responsibility to maintain control of nuisance dust.

## 4.5 GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE/CONSTRUCTION QUALITY CONTROL TESTING REQUIREMENTS

This subsection addresses the geosynthetic quality assurance testing for the landfill closure.

The manufacturer shall be responsible for supplying the specified material. The Contractor's Project Manager and the Construction Manager are responsible for the review of this material and the determination that the Specifications have been met. Certifications from the manufacturer shall be included in the final project documentation. The Construction Manager is responsible for observing and verifying that the geotextile, geocomposite, and geomembrane, and their installation proceed according to the requirements of the Specifications and in accordance with Table 2 – Geosynthetic Material Quality Control Testing.

Geosynthetic items that shall receive testing during construction include:

- Geomembrane (manufacturer's CQC testing and supplemental CQA testing).
- Geotextiles (manufacturer's CQC testing).
- Geocomposite Drains (manufacturer's CQC testing).

#### 4.5.1 Geosynthetics Manufacturing and Delivery

##### 4.5.1.1 Manufacturing

The Resident Engineer shall confirm that the geosynthetics meet the Specifications requirements. The Resident Engineer shall examine manufacturer(s) product data, affidavits, and certifications supplied by the installer and shall visually inspect the delivered materials.

The Resident Engineer shall confirm that:

- Material property values are certified by the manufacturer that they meet or exceed all of the requirements given in the Specifications.
- Measurements of properties by the manufacturer are properly documented and that the test methods used are acceptable.
- The CQC certificates are provided at the required frequency and that each certificate identifies the specific rolls sampled.

Rolls

Prior to shipment, the Contractor shall provide the Resident Engineer with the CQC certificates from the manufacturer(s). The CQC certificates shall be signed by a responsible party employed by the manufacturer, such as the production manager. The CQC certificates shall include:

- Manufacturer's name, location, and date of production.
- Roll number(s) and identification.
- Sampling procedures, test methods, and results of CQC tests. At a minimum, results shall be given in accordance with the test methods outlined in the Specifications.
- Other requirements listed in the Specifications.

4.5.1.2 Manufacturer's Construction Quality Control Testing

The Manufacturer's Construction Quality Control Testing requirements for each geosynthetic are as follows:

- Geomembranes listed in Specification Section 02713.
- Geotextiles listed in Specification Section 02714.
- Geocomposite drains listed in Specification Section 02715.

4.5.1.3 Shipment, Storage, and Handling

Shipping of the geosynthetics is the responsibility of the manufacturer(s). Handling onsite is the responsibility of the Contractor. The Resident Engineer shall verify that handling equipment and personnel used do not pose any risk of damage to the geosynthetics. Upon delivery, the installer and the Resident Engineer shall observe all rolls for defects and damage. These observations shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Resident Engineer shall report the following to the Contractor's Project Manager:

- Rolls which should be rejected and removed from the site because they have severe flaws.
- Rolls that include minor, repairable flaws which would not affect the performance of the material.

The Contractor shall be responsible for the storage of the geosynthetics. The Resident Engineer shall identify storage space in a location(s) such that site transportation and handling are minimized. Geosynthetics shall be stored in a manner that protects the product from ultraviolet degradation and other physical and environmental damage.

The Resident Engineer shall confirm that the geosynthetics are protected against dirt, impact, theft, vandalism, and traffic.

4.5.2 General Installation

4.5.2.1 Surface Acceptance

The following shall take place:

- The Engineer shall inspect the subgrade preparation. Prior to geosynthetic installation the subgrade shall be compacted in accordance with the Specifications. Weak or compressible areas which cannot be satisfactorily compacted should be removed and replaced with properly compacted select granular fill.
- All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects, or debris of any kind.
- The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade.
- Standing water or excessive moisture will not be allowed.
- The installer, on a daily basis, shall approve the surface on which the geomembrane shall be installed. After the supporting soil surface has been approved, it shall be the installer's responsibility to indicate to the inspector any changes to its condition that may require repair work.
- Excavate anchor trenches and prevent from sloughing.
- Proceed with installation only after unsatisfactory conditions have been corrected.
- On a daily basis, the Resident Engineer and Contractor shall observe that the completed bedding layer surface remains in the condition required by the Specifications. The installer shall provide the Resident Engineer with a written letter of acceptance that the surface is acceptable for cap section installation.

4.5.3 Geomembrane Installation & Testing

4.5.3.1 Geomembrane Panel Layout Plan

The Contractor shall review the panel layout plan included in the Drawings. The Contractor shall review the plan and confirm that the seams shown are located as follows:

- Oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope.
- All horizontal seams are staggered.
- In corners and odd-shaped locations, the number of seams is minimized.

- Horizontal seams are greater than 5 feet from the toe and top of the slope or areas of potential stress concentrations.

**Panel Nomenclature**

A panel is the section of geomembrane that is placed and seamed in the field. The Contractor shall give each panel a specific and logical identification code consistent with the panel layout plan.

**Installation Weather Conditions**

The geomembrane placement should not be considered if the weather conditions do not permit seaming following placement. Geomembrane placement will not be permitted during rain, in the presence of moisture (e.g., fog, dew), in areas of ponded water, when winds are in excess of 20 miles per hour, at ambient temperatures below 32°F or above 104°F.

**Method of Development**

The Contractor shall ensure the handling equipment used will not damage the geomembrane material and the following:

- The surface underlying the geomembrane (gas venting layer) has not been damaged or deteriorated.
- Unfolding the panels does not cause unacceptable damage to the geomembrane.
- Placement of the geomembrane panel minimizes wrinkles and waves.
- Temporary loads or anchoring of the panel shall not damage the geomembrane and shall prevent uplift by wind.
- Contact with the geomembrane is minimized, and the geomembrane is protected by suitable materials.
- Geomembrane placed in a working day shall be welded on the same day.
- Personnel do not smoke while working on the geomembrane.
- Personnel shall not wear shoes or engage in other activities that could damage the geomembrane.

**Damage and Defects**

The Resident Engineer and Contractor shall observe each placed panel prior to seaming for damage and/or defects. The Resident Engineer shall document which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, that have been rejected shall be marked and removed from the work area. Repairs are to be made using procedures outlined in this subsection and in accordance Specification Section 02713.

4.5.3.2 Accepted Seaming Methods

Extrusion welding is the preferred method for field seaming. The procedures for extrusion welding are listed in Specification Section 02713.

**Seam Preparation**

The procedures for seam preparation are listed in Specification Section 02713.

**Test Seams**

The procedures for test seams are listed in Specification Section 02713.

4.5.3.3 Non-Destructive Seam Testing

The procedures for non-destructive seam testing are listed in Specification Section 02713.

4.5.3.4 Destructive Seam Testing

The procedures for destructive seam testing including all laboratory test sampling, sizes of samples, field testing, destructive test failure, and defects and repairs are listed in Specification Section 02713.

**Geomembrane Protection**

Upon completion of an area of geomembrane (seaming, testing), access over the area shall be restricted until the overlying material(s) is placed. Immediately prior to overlying material placement, the Contractor and the Resident Engineer shall observe the surface of the geomembrane for any potential damage. Any damage observed shall be repaired and tested.

4.5.4 Geocomposite Drain Installation

The Contractor shall place geocomposites to avoid damage and to comply with the following:

- On slopes, anchor the geocomposite and roll it down the slope in such a manner as to continually keep the geocomposite sheet in tension.
- Ballast all geocomposites until cover material is placed.
- Do not entrap stones or dirt in or under the geocomposite.

**Joining Procedures**

The procedures for joining (seaming and overlapping) geocomposites are listed in Specification Section 02715.

**Defects and Repairs**

The procedures for defects and repairs of geocomposites are listed in Specification Section 02715.

**Geocomposite Protection**

Soil materials shall be placed on top of the geocomposite ensuring that:

- Place soil materials in layers not more than 12 inches thick in loose depth above the geocomposite.
- Soil material shall be carefully placed to avoid wrinkling or damage.
- Slippage of the geocomposite on underlying layers is minimal.
- There are no excessive stresses to the geocomposite.
- No vehicular traffic shall be allowed on the geocomposite.
- Personnel working on the geocomposite shall not smoke, wear damaging shoes, or engage in other activities that could create any damage
- Soil materials shall be spread by low ground pressure (LGP) equipment from the toe of slope, to the top of the landfill. Unless otherwise specified by the Owner, equipment operating on soil material overlying the geocomposite shall comply with the following:

| Maximum allowable equipment ground pressure (psi) | Minimum thickness of overlying compacted fill |
|---|---|
| < 5 | 8" |
| < 10 | 18" |
| < 20 | 24" |
| > 20 | 36" |

4.5.5 Geotextile Installation

The Contractor shall place geotextiles to avoid damage and to comply with the following:

- On slopes, anchor the geotextile and roll it down the slope in such a manner as to continually keep the geotextile sheet in tension.
- Ballast all geotextile until cover material is placed.
- Do not entrap stones or dirt in or under the geotextile.

**Defects and Repairs**

The procedures for defects and repairs of geotextile are listed in Specification Section 02714.

**Geotextile Protection**

Soil materials shall be placed on top of the geotextile ensuring that:

- Place soil materials in layers not more than 12 inches thick in loose depth above the geotextile.
- Soil material shall be carefully placed to avoid wrinkling or damage.
- Slippage of the geotextile on underlying layers is minimal.
- There are no excessive stresses to the geotextile.
- No vehicular traffic shall be allowed on the geotextile.
- Personnel working on the geotextile shall not smoke, wear damaging shoes, r engage in other activities that could create any damage
- Soil materials shall be spread by low ground pressure (LGP) equipment from the toe of slope, to the top of the landfill. Unless otherwise specified by the Owner, equipment operating on soil material overlying the geotextile shall comply with the following:

| Maximum allowable equipment ground pressure (psi) | Minimum thickness of Overlying compacted fill |
|---|---|
| < 5 | 8" |
| < 10 | 18" |
| < 20 | 24" |
| > 20 | 36" |

# 5.0 SURVEYING CONSTRUCTION QUALITY ASSURANCE

## 5.1 INTRODUCTION

Surveying of lines and grades is conducted on an ongoing basis during construction of the components. Close CQA of the surveying is absolutely essential to ensure that components are properly constructed. The surveying work performed as part of the Surveying Construction Quality Assurance shall be part of the CQA program and is not intended to supplement or augment the Contractor's surveying for control of line and grade.

## 5.2 SURVEY CONTROL

Temporary benchmarks have been established for the site as shown on the Contract Drawings. Permanent benchmarks shall need to be established by the Contractor. The vertical and horizontal controls for the site construction activities shall be based on the permanent benchmarks.

## 5.3 PRECISION AND ACCURACY

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.01 feet and with a setting accuracy of 20 seconds ($5.6 \times 10^{-3}$ degrees). All components shall meet a maximum tolerance of 0.2 feet except for surface water channels where the maximum tolerance shall be 0.1 feet.

## 5.4 REQUIRED ACTIVITIES

The following shall be surveyed to verify the lines and grades and locations required by the Contract Documents. The survey activities should at least include:

- Initial project stake-out (including waste limits).
- Top of subgrade.
- Top of gas venting layer.
- Top of barrier protection layer.
- Surface of final cover (top of topsoil).
- Location survey of gas vent risers and landfill perimeter road.
- Location and elevations of swales, culverts, flared end sections, toe of slope trench drain, and toe drains.
- See Specification Section 01720 – Field Engineering, Specification Section 01781 – Project Record Documentation, and Specification 02300 – Earthwork for all other items.

## 5.5 FREQUENCY AND SPACING

Surveying CQA shall be carried out upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. In addition, spot checks during construction shall be necessary to assist the Contractor in completing the grades.

The following spacing and locations shall be provided, as a minimum, for survey points:

- Surfaces with slopes less than 10% shall be surveyed on a square grid not wider than 25 feet with additional locations at grade breaks.
- On slopes greater than 10%, a square grid not wider than 25 feet shall be used; in any case, a line at the crest, midpoint, and toe of the slope shall be taken, as well as at grade breaks.
- A line of survey points no farther than 25 feet apart shall be taken along any slope break (this shall include the inside edge and outside edge of any bench on a slope).
- The survey grid shall be consistent and similar in location for each lift and layer, so that the survey points can be checked in the same location to compare and confirm thicknesses.

## 5.6 DOCUMENTATION

Field survey notes shall be retained by the Contractor's chief surveyor. The results from the field surveys shall be documented on a set of survey record (as-built) drawings. These drawings should, at a minimum, show all elevations of the surfaces surveyed.

## 6.0 DOCUMENTATION

The landfill closure construction progress shall be recorded through written reports and photographs. A description of the written reports, and a description of the photographic activities, is presented in this section.

An effective CQA/CQC Plan depends on the documentation of all construction activities. The Resident Engineer shall verify that the CQA requirements have been addressed.

The Resident Engineer shall provide the NYSDEC Regional Representative with signed descriptive reports, remarks, memorandums, data sheets, and checklists to confirm that monitoring, testing, and sampling activities have been completed. The Resident Engineer shall maintain a complete set of Specifications, a CQA/CQC Plan, checklists, test procedures, daily logs, and other pertinent documents at the job site.

### 6.1 DAILY QUALITY CONTROL REPORT

The Contractor's Construction Manager shall be responsible for the completion of the Daily Quality Control Report. This report represents the daily record of the landfill construction, and shall be included in the CQA documentation submitted at project completion. A sample of a suggested report is provided in Attachment A. Daily reports shall be submitted to the Resident Engineer on the day following the report date. At a minimum, this log shall include:

- Sequencing number.
- Date, project name, and location.
- Weather conditions including temperature, prevailing wind direction and speed, cloud cover, etc.
- Meeting minutes of any formal meetings that took place during the day.
- Construction locations/activities underway during the timeframe of the report, including site plans of specific work areas, as appropriate.
- Equipment used.
- Description of work completed during the day.
- Location, horizontal dimensions and depth (as appropriate), and quantity of material placed.
- Survey data which was received and checked.
- Testing performed during the day and approximate locations of tests.
- Description and quantity of any materials received onsite during the day, including CQA documentation.

- Data on the calibrations or re-calibrations of test equipment performed during the day.
- The location, description, purpose, and number of photographs taken during the day.
- Any incidents of substandard quality that occurred during the day, the collective actions taken, as well as the identification number of the problem identification data sheet.
- Reports of safety-related infractions or incidents.
- Signature of the Construction Manager.

## 6.2 PROGRESS REPORTS

The Resident Engineer shall prepare and submit a progress report once per month, or at time intervals established at the pre-construction meeting, for NYSDEC review. At a minimum, this report shall include the following information:

- Identifying number for cross-referencing and document control.
- The date, project name, location, and other information.
- Summary of work activities during progress reporting period.
- Summary of construction problems and deficiencies.
- Summary of weather conditions.
- Brief description of activities anticipated for the next reporting period.
- Signature of the Resident Engineer.

## 6.3 TESTING DATA SHEETS

The Construction Manager is responsible for testing data sheet oversight. The testing reports shall record testing performed during project execution. This information shall be used during construction and in the compilation of the quality assurance documentation submitted at project completion.

- See Table 1 – Natural Material Quality Assurance Testing and Specification Sections 02300 and 02920 for the testing requirements of select granular fill, gas venting layer material, barrier protection layer material, and topsoil.
- See Table 2 – Geosynthetic Material Quality Assurance Testing and Specification Section 02713 for the testing requirements of geomembranes. See Specification Section 02714 for the testing requirements of geotextiles and Specification Section 02715 for the testing requirements of geocomposite drains.

Although testing data sheets may be different according to the type of testing performed, at a minimum, these sheets shall include:

- Sequencing number.
- Date.
- Title.
- Location of the test.
- Description of the test, including the test method being used.
- Test data with calculations, as appropriate.
- Analysis of the test data.
- Tester's name.
- Signature of the Contractor's CQA Supervisor.

## 6.4 PHOTOGRAPHIC RECORD

The Contractor's Construction Manager shall use digital photography necessary to record the landfill construction. The daily log shall note the photographs taken. The Construction Manager shall keep a photographic record log, a description of each photograph, and the date and time taken. Photographs shall be kept in chronological order. Electronic copies of the photographs shall be securely stored for future use. Videotape documentation may be provided at the Contractor's option and expense, but shall not take the place of still photography.

Photographic records shall be kept onsite and presented to and retained by the NYSDEC Regional Representative upon completion of the project. These records shall be made available to designated oversight personnel upon request during construction activities.

## 6.5 DESIGN AND/OR SPECIFICATION CHANGES

Design and/or Specifications changes may be required during construction. In such cases, the Resident Engineer shall notify the Design Engineer.

Design and/or Specifications changes shall be made only with a written agreement of the Resident Engineer and the Design Engineer, and shall take the form of an addendum to the Specifications and CQA/CQC Plan. Approval of design changes must be secured from the NYSDEC Regional Representative prior to implementing any changes.

## 6.6 RECORD/AS-BUILT DRAWINGS

Drawings shall be prepared by the Contractor under the direction of the Resident Engineer. At a minimum, the drawings should include the following information:

- Top elevation of subgrade, gas venting layer, barrier protection layer, and topsoil (final grade).
- Lateral extent of the cap.
- Locations of gas vent risers and access roads.
- Location and elevations of swales, culverts, flared end sections, toe of slope trench drain, and toe drains.
- Location and details of the earthwork construction, including depths, plan dimensions, elevations, soil components thicknesses, etc.

The drawings shall address each of the components and, if necessary, another drawing shall identify problems or unusual conditions of the geomembrane liner. In addition, applicable details shall show constructed components that differ from the Contract Drawings or Specifications.

## 6.7 FINAL CERTIFICATION AND SUMMARY REPORT

An Engineer's Certification Report shall be prepared to outline the completed activities associated with the closure of the landfill. The report shall also address the construction certifications as required under 6 NYCRR Part 360. Certifications are required to provide documentation that the Contract Documents were met during construction.

**TABLE 1**

**NATURAL MATERIAL QUALITY ASSURANCE & CHEMICAL CONTAMINATION TESTING**

| Material | Test | Test Method | Frequency |
|---|---|---|---|
| **Select Granular Fill** | Compaction Characteristics of Soil | ASTM D-1557 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | Density of Soil In-Place by Nuclear Methods | ASTM D-2922 | 9 tests per acre per lift |
| | Rapid Moisture Content | ASTM D-3017 | 9 tests per acre per lift |
| **Sand (Gas Venting Layer)** | Particle Size Analysis | ASTM D-422 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | Atterberg Limits | ASTM D-4318 | 1 test per 1,000 $yd^3$ of borrow, minimum of 2 tests per source, additional rests when material characteristics change |
| **Barrier Protection Layer** | Unified Soil Classification System | ASTM D-2487 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | Moisture Content | ASTM D-2216 | 1 test per 1,000 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | Hydraulic Conductivity (less than 1 x $10^{-3}$ cm/sec) | ASTM D-5084 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change. |
| | VOCs | EPA 8260B | 1 sample per source, a composite of 5 samples |
| | SVOCs | EPA 8270C | 1 sample per source, a composite of 5 samples |
| | PCBs | EPA 8082 | 1 sample per source, a composite of 5 samples |
| | TAL metals | EPA 6010B/6020 | 1 sample per source, a composite of 5 samples |
| | Pesticides | EPA 8081A | 1 sample per source, a composite of 5 samples |
| | Cyanide | EPA 9012B | 1 sample per source, a composite of 5 samples |
| | Chlorinated Herbicides | EPA 8151A | 1 sample per source, a composite of 5 samples |
| **Topsoil** | Organic Content | AASHTO - T194 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | Gradation | ASTM D-422 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | pH | ASTM D-4972 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| | VOCs | EPA 8260B | 1 sample per source, a composite of 5 samples |
| | SVOCs | EPA 8270C | 1 sample per source, a composite of 5 samples |
| | PCBs | EPA 8082 | 1 sample per source, a composite of 5 samples |
| | TAL metals | EPA 6010B/6020 | 1 sample per source, a composite of 5 samples |
| | Pesticides | EPA 8081A | 1 sample per source, a composite of 5 samples |
| | Cyanide | EPA 9012B | 1 sample per source, a composite of 5 samples |
| | Chlorinated Herbicides | EPA 8151A | 1 sample per source, a composite of 5 samples |

NOTE: ASTM = American Society for Testing and Materials
AASHTO = American Association of State Thruway and Transportation Officials
EPA = Environmental Protection Agency

**TABLE 2**

**GEOSYNTHETIC MATERIAL QUALITY ASSURANCE TESTING**

| Material | Test | Test Method | Requirement | Frequency | Reporting |
|---|---|---|---|---|---|
| **Geomembrane Liner (Textured)** | Field Test Seams | ASTM D-6392 | Shear: 60 lb/in. (FTB)<br><br>Peel: 50 lbf/in. (FTB) for hot wedge<br><br>Peel: 44 lbf/in. (FTB) for extrusion fillet | Test seams shall be conducted at the beginning of each seaming period and at least once every 4 hours, for each seaming apparatus, type seam (smooth/smooth, smooth/textured, textured/textured) and personnel used that day and when significant changes in geomembrane temperature are observed. | Within 5 days of performance, and prior to placing overlying |
| | Destructive Seam Test | ASTM D-6392 | Shear: 60 lb/in. (FTB)<br><br>Peel: 50 lbf/in. (FTB) for hot wedge<br><br>Peel: 44 lbf/in. (FTB) for extrusion fillet | 1 test per 500 feet of seam length for each type of field seam (smooth to smooth welds, textured to textured welds and textured to smooth welds), and at a minimum of 1 test for each seaming machine operating on a given day | Within 5 days of performance, and prior to placing overlying |
| | Non-Destructive Seam Test – Air Pressure | ASTM D-5820 | ASTM D-5820 | Wedge-welded seams tested continuously over their full length, as the seaming work progresses | Within 5 days of performance, and prior to placing overlying |
| | Non-Destructive Seam Test – Vacuum Box | ASTM D-5641 | ASTM D-5641 | Field seams tested continuously over their full length, as the seaming work progresses | Within 5 days of performance, and prior to placing overlying |
| | Seam Shear Strength | ASTM D-6392 | 60 lb/in. (FTB) | 1 test per 500 feet of seam length for each type of field seam (smooth to smooth welds, textured to textured welds and textured to smooth welds), and at a minimum of 1 test for each seaming machine operating on a given day | Within 5 days of performance, and prior to placing overlying |
| | Seam Peel Adhesion | ASTM D-6392 | 50 lbf/in. (FTB) for hot wedge<br><br>44 lbf/in. (FTB) for extrusion | 1 test per 500 feet of seam length for each type of field seam (smooth to smooth welds, textured to textured welds and textured to smooth | Within 5 days of performance, and prior to placing |

**TABLE 2**

**GEOSYNTHETIC MATERIAL QUALITY ASSURANCE TESTING**

| | | | | | |
|---|---|---|---|---|---|
| | | | fillet | welds), and at a minimum of 1 test for each seaming machine operating on a given day | overlying |

NOTE: ASTM = American Society for Testing and Materials
FTB = Film Tear Bond

## ATTACHMENT A

## DAILY QUALITY CONTROL REPORT

**Problems:**

**Corrective Actions:**

**Specific Sampling Problems/Alternate Methods:**

**Quality Control Activities:**

**Government Instructions:**

| Onsite Personnel | Affiliation | Job Title | Job Function |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Appendix B:
# Post-Closure Monitoring and Facility Maintenance Plan

*Post-Closure Monitoring and Facility Maintenance Plan*

# Dutchess County Balefill Landfill Closure Town of Wappinger Dutchess County, New York

September 2008

THE Chazen COMPANIES

Prepared for:

Dutchess County Department of Public Works

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*Post-Closure Monitoring and Facility Maintenance Plan*

# Dutchess County Balefill Landfill Closure Town of Wappinger Dutchess County, New York

September 2008

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# 1.0 INTRODUCTION

## 1.1 STATEMENT OF PURPOSE

This Post-Closure Monitoring and Facility Maintenance Plan has been prepared for the Dutchess County Department of Public Works Balefill Landfill, Wappinger, New York. This Plan describes the tasks necessary for maintenance of the site, periodic inspections, and monitoring of ground water and surface water at the facility. The intended use for this Plan is to provide a guide to the current landfill owner for maintenance and facility monitoring for a period of 30 years. The Plan will be re-evaluated after the first 2 ½ years of quarterly monitoring (10 quarters) to ensure that the Plan is applicable and relevant and is in compliance with the regulations.

In general, the following is required as part of the Post-Closure Monitoring and Facility Maintenance Plan:

- Drainage structures and ditches must be maintained to prevent ponding and erosion of the final landfill soil cap.
- Soil cover integrity, slopes, cover vegetation, drainage structures, and the perimeter road must be maintained during the post-closure monitoring and maintenance period.
- Environmental monitoring points must be maintained and sampled during the post-closure period. Quarterly and annual summary reports must be submitted to the Division of Solid and Hazardous Materials, New York State Department of Environmental Conservation (NYSDEC) region 3.
- A vegetative cover must be established and maintained on exposed final cover material, and adequate measures must be taken to ensure the integrity of the final vegetated cover, topsoil layer, and underlying barrier protection layer.
- Records must be maintained of all sampling and analysis results.

## 1.2 ORGANIZATION

Section 1 outlines the purpose of this Post-Closure Monitoring and Facility Maintenance Plan. Section 2 includes a discussion of the maintenance inspections. Section 3 outlines the environmental monitoring program.

## 2.0 MAINTENANCE INSPECTIONS

Quarterly landfill inspections, and inspections after major rainfall events (5-year storms), will be performed at the facility during the post-closure period, unless specific approval is given by NYSDEC to eliminate some or all of these requirements. The inspections will be performed at the facility to ensure that the final landfill cover materials, site drainage structures, and onsite monitoring wells are maintained and functioning within the design standards. Advance notification of inspections will be made to NYSDEC at least 72 hours prior to commencement of inspection-related activities in the event NYSDEC attendance is desired. An example of the inspection checklist is provided in Appendix A. The quarterly landfill inspection reports will be submitted to NYSDEC, along with the quarterly ground-water monitoring event reports.

## 2.1 DRAINAGE STRUCTURES

The inspections will include visual checks of culverts, drainage swales, and berms/benches, if present; to ensure that erosion problems are not occurring. Any material defects and erosion occurrences discovered at the facility will be repaired immediately and restored to meet the design standard. Eroded soil or cover material will be replaced as soon as possible. Exposed or unvegetated soil will be re-seeded, fertilized, and mulched.

## 2.2 COVER SYSTEM

Areas of concern within the final landfill cover system could include erosion, exposure, loss of vegetative cover, settlement, gravity sliding, or cracking on the top or side slopes of the landfill. Each quarter, the cover system, including topsoil layer and barrier protection layer, will be inspected and records will be maintained.

In the event that major erosion, sloughing, or slumping is noted during an inspection, NYSDEC personnel will be notified within 48 hours of the problems observed. An action plan detailing the remedial measures to be taken to rectify the problem will be developed and submitted to NYSDEC for approval, prior to implementation of the remedy.

Minor repairs to the cover system will be performed by hand, utilizing materials from the original borrow source or newly approved borrow source. The areas of minor erosion, sloughing, or cracking will be excavated by hand to allow for a concise repair. Materials will be placed, compacted appropriately by hand, and re-seeded. Additional erosion control measures, such as straw or hay bales, will be used accordingly to prevent future damage to the repaired areas.

## 2.3 VECTORS

The vector inspection in December 2002 indicated that vectors do not appear to pose a threat to the proposed landfill cap section. However, it is recognized that the habitat will be significantly improved after closure has been completed. The presence of any vectors (e.g., rodents, flies, etc.) on the site will be evaluated during the quarterly inspections. If present, extermination or treatment that will remove the vecting population(s) will be implemented.

## 2.4 OTHER FACILITIES AND STRUCTURES

Monitoring well casings, casing locks, concrete aprons, and gas vents will be inspected to ensure that they are undamaged and functional. Identified damage will be repaired immediately and structures re-secured. Mowing of the cap system will occur twice during the 2008 growing season to allow for re-germination of the vegetative cover, and annually thereafter. Annual mowing will be performed after the 1st of September to allow for enhancement of avian wildlife habitat.

## 2.5 QUARTERLY MONITORING AND INSPECTION REPORTS

After each quarterly monitoring and inspection, a letter report will be prepared and submitted to the NYSDEC Division of Solid and Hazardous materials Region 3 office. The inspection report will include, at a minimum, the date, and time of the inspection; personnel conducting the inspection; visual observations of the inspectors; a list of items inspected; and a brief description of any repair work, if required, including the nature of the damage, the repairs completed, and the estimated cost of the repairs. The report will also describe any items that will need future attention or repairs not completed during the course of the inspection, along with any other pertinent comments.

## 2.6 ANNUAL MONITORING AND INSPECTION REPORTS

A summary report will be prepared and submitted annually outlining the previous year's monitoring and maintenance activities. The report will describe the previous year's trends with regards to constituents of concern in ground water, inspection report findings, and associated remedies, if required. Three copies of the annual monitoring and inspection report will be submitted to NYSDEC Region 3. One copy of the annual inspection report will also be provided to the Dutchess County Department of Public Works.

# 3.0 ENVIRONMENTAL MONITORING PLAN

## 3.1 GAS VENTING SYSTEM

The venting system includes seven six-inch diameter riser pipes with screened openings spaced across the landfill cap. These vents must be periodically maintained by replacing or repairing any vents that appear not to be functioning properly. 6 NYCRR Part 360 also indicates that DCDPW must conduct explosive gas monitoring described below on a quarterly basis for at least 2 ½ years (10 quarterly events) following cap completion, and at potentially reduced intervals thereafter upon petition to NYSDEC.

1. Explosive Gas Monitoring

   The following tasks are required during each monitoring session:

   a. Explosive gas monitoring will be performed at the seven proposed gas vent representing approximately one vent per acre of landfill. Gases requiring analysis include methane and hydrogen sulfide. Portable field instruments should be used for monitoring purposes and sampling should occur when the atmospheric pressure and wind velocity are low and ideally when the ground surface has been wet or frozen. No perimeter explosion gas monitoring is warranted because the site is surrounded by streams and a wetland, such that no effective gas migration through the vadose zone could occur.

   b. The landfill surface and perimeter toe of slope areas will be inspected for soil cracks or stressed vegetation potentially indicating escaping gas.

2. Corrective Action

   a. Where the final cover has been damaged by the escape of gas, additional vents may need to be installed to control further damage. Damaged areas must be fully repaired and restored.

   b. Where any single gas vent appears over successive quarters to release no explosive gas, then and assessment may be warranted to confirm that the gas vent remains in connection to an assessment

## 3.2 GROUNDWATER MONITORING

The long-term groundwater monitoring plan is summarized below and is suitable to meet requirements found in 6 NYCRR Part 360- Solid Waste Management Facilities for a long-term groundwater monitoring strategy for the site. The monitoring well network must be maintained with properly functioning monitoring wells for the duration of the monitoring period. The DCDPW must conduct the groundwater monitoring stipulated

below on a quarterly basis for at least 2 ½ years (10 quarterly rounds), and at potentially reduced intervals thereafter upon petition to NYSDEC.

The following three wells are part of the long-term monitoring well network. These three monitoring wells were installed in conformance with monitoring well specifications described in 6 NYCRR Parts 360-2.11(a)(9), (10), and (11).

MW-1S - This upgradient monitoring well will be used to monitor upgradient groundwater quality between the rest of the county's airport Facility and Balefill, serving as a sentinel well for any potential contaminants migrating towards the landfill.

MW-2 - The 2006 Closure Investigation Report identified a component of shallow groundwater flow migrating toward the existing leachate seep on the banks of the Wappinger Creek. This aspect of groundwater flow was interpreted to reflect preferential flow facilitated by a zone of sand and gravel extending between the Balefill and the Wappinger Creek in this area. Monitoring at MW-2 will serve to monitor changes in groundwater quality downgradient of the landfill in the direction of the seep. As a result MW-2 also served as an upgradient monitoring point for evaluating the quality of water emerging at the seep on the banks of Wappingers Creek. Groundwater samples collected from MW-2 will be most representative of future seep conditions because seep samples are subject to interferences due to atmospheric exposure and surface water runoff.

MW-3S - Shallow groundwater also migrates in a downgradient direction northwest of the Balefill, converging downstream with the Wappinger Creek. MW-3 will serve to assess changes in groundwater quality in this downgradient direction.

No monitoring of any deeply installed monitoring wells is warranted since the Closure Investigation Report confirmed that most groundwater impacts associated with the Balefill were confined to the shallow aquifer zone monitored by wells MW-1S, MW-2 and MW-3S

1. Groundwater Sampling and Analysis

Groundwater from each monitoring well listed above will be sampled and analyzed using appropriate purge, sampling, and sample custody protocols, and requiring sample analysis for parameters listed in 6 NYCRR Part 360-2.11(d)(6) according to the following schedule:

a. Once landfill closure is complete, wells MW-1S, MW-2 and MW-3S will initially be monitored quarterly for water levels and sampled for the baseline parameter once a year on a rotating basis and sampled for routine parameters in the remaining three quarters.

2. Contingency Sampling and Analysis

If contamination for one or more routine parameters is found to exceed pre-closure concentrations by 50% in a single event, analysis for baseline parameters will be required during the next quarterly sampling event. If NYSDEC determines that contamination detected by the baseline poses an immediate threat to public health or the environment, additional or more frequent sampling may be required.

## 3.3 LANDFILL SURACE MONITORING AND LEACHATE SEEP MONITORING

As required by 6 NYCRR Part 360 the DCDPW must provide the necessary surface and leachate monitoring on a quarterly basis for at least 2 ½ years (10 quarters), and at potentially reduced intervals thereafter upon petition to NYSDEC.

1. Landfill Surface Monitoring

Quarterly observations are required for the landfill cover, including monitoring for evidence of breakout of leachate on the landfill slope and along the toe of slope.

2. Leachate Seep Monitoring

A seep of leachate impacted water currently enters the Wappinger Creek at a point where the Balefill is nearest to the Wappinger Creek, approximately 200 feet to the north of the Balefill. As discussed in Section 3.2 of this plan, well MW-2S effectively serves to monitor groundwater quality upgradient of the seep location; therefore no direct sampling of the seep is warranted.

To document the aesthetic appearance at the seep, visual inspections of the seep will be photographically documented from a consistent vantage point (see site map) on a quarterly basis for a period of 2½ years (10 quarters) and at potentially reduced intervals thereafter upon petition to NYSDEC. Photographs will be included in the Annual Report discussed in Section D.

Since the closure plan proposes replacement of current soils at the seep area, visual documentation in conjunction with sampling data from MW-2 will help evaluate the effectiveness of the landfill closure plan.

3. Corrective Action

If leachate discharges cause new oxidation staining in the seep area, consultation will be necessary with NYSDEC on any corrective action required. Repeated soil replacement in this area may be warranted until discharges cease causing significant discoloration, or seep sampling may be required.

## 3.4 ANNUAL SUMMARY REPORT

As per 6 NYCRR Part 360 - Solid Waste Management Facilities annual summary reports must be submitted to the NYSDEC Division of Solid Waste. The report must include record of quarterly cap condition and vector inspections, describing the condition of the vegetative cover, location of any erosion or leachate observed, incidents of vandalism, the site mowing schedule, presence of vectors, a historic chronology of completed maintenance or repair activities and a copy of the Inspection reports discussed in Section II C.

The summary report must initially also include water level data and annual baseline and quarterly routine laboratory reports from groundwater and surface water sampling conducted at the site. The explosive gas monitoring data must also be included in this report.

Suggested revisions to the required extent of groundwater, surface water and explosive gas monitoring at the Balefill Landfill may be suggested at appropriate intervals to NYSEC as part of the annual report summaries.

## 3.5 SAMPLING PROCEDURES

Laboratory personnel shall carry out the procedures consistent with groundwater sampling taken at contracted facilities. Modification of protocols shall only be accomplished upon written approval of the director of the contracted laboratory and the NYSDEC, Division of Solid Waste, Region 3. The laboratory shall ensure that all personnel are technically competent and fully trained and certified for such work and shall ensure that all equipment required for these protocols is of the best available technology and appropriate for their task and properly maintained to the manufacturer's specifications.

1. Pre-Sampling Procedures

A Field Service Supervisor shall assign a sampling team to carry out the contracted work and establish a date and time agreeable with the NYSDEC Division of Solid Waste Region 3 and the DCDPW.

The sampling team shall be responsible for the following:

a. Assemble and inspect all field equipment necessary for sample collection and ensure that it is clean and free of contaminants and in good working order.

b. Calibrate all equipment to manufacturing specifications.

c. Establish a list and prepare bottles that will ensure the integrity of all groundwater samples for analysis. Sample shipping containers shall be clean and contaminant free and contain ice or freezer packs adequate to keep the samples at 4°C until the

samples reach the laboratory. All bottles will be packed to prevent breakage during transportation.

d. The exact location and proper identification of each well shall be known by the sampling team or established with a representative of NYSDEC.

e. Schedule travel, well evacuation and sampling for the day.

f. Arrange for proper collection of evacuated water and cleaning fluid if necessary.

2. Explosive Gas Monitoring

a. Landfill gas will be monitored at the seven gas vents using a MultiRAE Plus 4-gas Meter and a photoionization detector (PID).

b. All locations will be evaluated for the percent of the lower explosive limit (% LEL), carbon monoxide, hydrogen sulfide, and oxygen with the 4-gas Meter, and for volatile organic vapors with the PID. The explosive gas monitoring locations are shown on the Site Plan.

3. Groundwater Sample Collection

a. Well Opening:

Upon arrival, the sampling team shall examine the well for any damage or tampering. They shall report any problems to the Project Manager of the firm providing environmental services to the DCDPW, who will notify the NYSDEC, Division of Solid Waste, Region 3.

- Overgrowth of vegetation shall be removed or reported to the DCDPW. No anti-rust agents or chemicals shall be used on or near any part of the well.
- It is advised that well caps be tapped slightly before opening as a check for wasp or bee nesting. At no time shall the use of insecticides be permitted around or near any part of the well.
- The escaping gas from the well may be sampled with hazardous gas screening equipment such as Organic Vapor Analyzer or Combustible Gas meters, at the discretion of the sampling team or upon contracted agreement with the NYSDEC Division of Solid Waste Region 3.
- The need for respiratory equipment and evacuated water treatment shall be the responsibility of the sampling team.
- Any hazardous gas readings shall be reported to the lab director and noted in the field reports.

- All foreign matter such as rain water, dirt and debris shall be cleared to prevent anything from dropping into the well.
- Gloves appropriate for the protection of the sampling team shall be used and changed as needed and before sampling to prevent cross-contamination of the wells and samples.

b. Water Level Determination:

- All water level measurements shall be taken from the top of the well casing. Care shall be taken so as not to confuse the security casing with the well casing and accurate field notes shall be kept that reflect the upper level reference point.
- Water level meters with electronic indicators accurate to one hundredth of one foot (0.01 foot) shall be used to measure the distance between the top of the well casing and the top of the standing or static water level.
- The well shall be sounded and the volume of the water determined.
- The Water Level Indicator shall be decontaminated before it is used again.

c. Well Evacuation:

Each monitoring well shall be sampled using "low-flow" sampling methods drawing water from the well screen interval or fully evacuated and sampled using a dedicated bailer. Sampling shall be conducted from the up-gradient well to the down-gradient wells in order to minimize any potential cross-contamination.

Any free product or sheen of immiscible products shall be reported to the lab director and noted in field reports. The presence of these contaminants may alter analysis and stop further disposed of as previous test result quality warrants.

Under some conditions the evacuated waste may be returned to the groundwater as surface runoff, if prior samples indicate that the practice will not significantly alter the volume of composition of the surface runoff, or groundwater.

Under normal conditions the wells shall be evacuated for a minimum of three (3) volumes of standing water unless low-flow sampling methods are used in which case purging is continued only until field parameter stabilization is observed. Wells may be evacuated using disposable Teflon bailers, or submersible "low-flow" pumps. Wells that are less than twenty-five feet (25') in depth may be evacuated with peristaltic pumps and dedicated polyethylene tubing.

Wells which recover slowly and will not regenerate beyond the screen level in less that three (3) volumes of evacuated water are considered "Dry Wells". "Dry Wells" are sampled either by low-flow sampling methods or evacuated to screen level twice after regeneration to within one foot (1') of their original static water levels.

Wells evacuated under standard purge and sample techniques will be managed to avoid the agitation of the bottom sediments. Wells are checked for water column height before, during and after evacuation. Wells are evacuated well enough in advance of the sampling to ensure the full recovery of the well to within six inches (6") of the standing water level at the time of sampling. Wells are evacuated to below the screen level only if the analysis doesn't call for the sampling of the volatile compounds.

d. Sampling:

Sampling begins when the well has been properly evacuated and allowed to recover to within six inches (6") of its original static water level or low-flow field sampling parameters have fully stabilized. Sampling bottles are individually numbered and labeled for location, date, time, sampler's name, analysis intended, and preservations. Teflon bailers with Teflon coated wire, or "low-flow" pumps are used for sampling.

If bailers are used for sampling, then the first bailer full of water will be used for the sample vessel which will be subjected to turbidity analysis. The second bailer full of water is used for pH, temperature and conductivity readings. The pH, temperature and conductivity readings are checked again after all sampling is complete to evaluate changes of the analyte.

Volatile samples are collected next, followed by TOX organic samples, metals and the remainder of the containers are filled in an order that remains consistent for subsequent wells.

Samples are immediately sorted in coolers, packed with ice and returned to the laboratory without ever leaving the custody of the sampling team. Custody seals are used it shipping is needed.

e. Record Keeping:

The sampling team will keep written records of the following:

- Day of the week, date, times of evacuation and sampling.
- Weather conditions
- Conditions of the well (damage, foliage, outside interference, atmospheric, etc.)
- Readings of Air Monitoring Devices (if taken)
- Names of sampling teams members
- Methods of evacuation
- Water levels before, during and after evacuation

- Depth to bottom of well (soundings)
- Physical properties of evacuated water (immiscible layers, color, turbidity)
- Decontamination and cleaning procedures for well equipment used at more than one well
- Sample label information
- Complete Chain of Custody papers which contain all the information on the sample label and the samplers signature. The signature of anyone at the landfill involved with sampling, the time and condition of the bottles as they arrived at the laboratory and the signature of the person at the laboratory responsible for their custody.

4. Equipment Decontamination

Decontamination of equipment can be done in the laboratory and field. Although, with groundwater sampling equipment, decontamination should be done in the laboratory and dedicated to a sampling point for that day of sampling. Other equipment used shall be cleaned in the field, as necessary. The field sampling equipment cleaning and decontamination is as follows:

a. Non-phosphate detergent plus tap water wash to remove visible particulates and oils and grease.

b. Tap water rinse.

c. Distilled/de-ionized water rinse.

d. 10% Nitric acid rinse (diluted with DI Water) only if samples are being analyzed for metals.

e. De-ionized/distilled water rinse (if nitric acid rinse).

f. Total air dry or pure nitrogen blow out.

g. Distilled/de-ionized water rinse.

5. Equipment List

Groundwater Sampling: Equipment used for groundwater sampling generally falls into two categories; evacuation of well casing and collection of sample.

Equipment for evacuation can include:

- Teflon bailer (bottom fill) with Teflon wire or nylon rope.
- Stainless steel bottom fill bailer with Teflon wire

- Submersible pump
- Centrifugal/Diaphragm pump
- Bladder pump

Some evacuation equipment can also be used for sampling but must be dedicated to each well or have tubing dedicated for use in only one well.

Acceptable equipment for sample collection are included in the following list:

- *Teflon bottom fill bailer with Teflon wire or nylon rope.
- *Stainless steel bottom fill bailer with Teflon wire
- Peristaltic pump
- Syringe sampler
- Bladder pump

*Note:* *Most Often used for sampling.

In addition to evacuation and sampling equipment, other equipment is also necessary for a groundwater sapling project:

- Water level indicator (Electric depth meter)
- Preservatives as needed
- Ice and/or ice packs
- Field instrumentation (photo ionization detector (PID), OVA, NHa, etc.)
- Field and trip blanks
- Field notebook
- Chain of custodies, field sheets
- Custody seals
- Sample labels
- Tool box
- Keys to wells
- Appropriate personal safety attire and equipment

6. Sample Preservation and Chain of Custody

To ensure sample integrity during transportation from the facility to the laboratory, the guidelines for preservatives containers and maximum holding times should be observed.

The information below should be included on the chain of custody report which accompanies all samples:

- Project name
- Sample locations
- Number and type of containers
- Name of person(s) maintaining custody
- Dates of Possession

## 3.6 ROUTINE AND BASELINE ANALYSIS TABLE

The field and laboratory parameters for routine and baseline analyses are as per 6 NYCRR Part 360.

## 3.7 DATA REPORTING

The results of site monitoring shall consist of the field data sheet(s), chain of custody form(s) and the laboratory analysis results. Results shall be sent in report from as outlined by 6 NYCRR Part 360-2.11(c)(5)(iv) and 360-1.4 (c) to the regional office of the New York State Department of Environmental Conservation (NYSDEC) no later than sixty (60) days after the last day of the quarter in question.

An annual report shall be prepared that shall analyze the results, compare background and well sampling data and discuss which parameters, if any, are contravening water quality standards and their significance. This annual report shall be sent to the NYSDEC, Division of Solid Waste, Region 3.

# Appendix C:
# Design Specifications

## DIVISION 1 – GENERAL REQUIREMENTS


| Section Number and Description | | Number of Pages |
|---|---|---|
| 01100 | Summary | 2 |
| 01250 | Contract Modification Procedures | 3 |
| Form | EJCDC C-940 Change Directive | 1 |
| Form | EJCDC C-941 Change Order | 2 |
| Form | EJCDC C-942 Field Order | 1 |
| 01270 | Unit Prices | 14 |
| 01290 | Payment Procedures | 5 |
| Form | EJCDC C-620 Application for Payment | 3 |
| 01310 | Project Management and Coordination | 3 |
| 01320 | Construction Progress Documentation | 7 |
| 01330 | Submittal Procedures | 9 |
| Form | CSI 1.5A Subcontractors and Major Materials Suppliers List | 1 |
| Form | CSI 12.1A Submittal Transmittal | 1 |
| 01351 | Safety, Health, and Emergency Response | 5 |
| 01400 | Quality Requirements | 6 |
| 01410 | Testing Laboratory Services | 4 |
| 01420 | References | 3 |
| 01500 | Temporary Facilities and Controls | 5 |
| 01570 | Temporary Erosion and Sediment Control | 2 |
| 01600 | Product Requirements | 8 |
| 01700 | Execution Requirements | 4 |
| Form | CSI 13.2A Request for Interpretation | 1 |
| 01720 | Field Engineering | 3 |
| 01770 | Closeout Procedure | 5 |
| Form | CSI 14.1A Punch List | 1 |
| Form | EJCDC C-625 Substantial Completion Certification | 1 |
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## DIVISION 2 - SITEWORK


| Section Number and Description | | Number of Pages |
|---|---|---|
| 02230 | Site Clearing | 3 |
| 02300 | Earthwork | 11 |
| 02520 | Gas Venting Risers | 3 |
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| 02714 | Geotextiles | 4 |
| 02715 | Geocomposite Drain | 9 |
| 02920 | Site Restoration | 7 |

# SECTION 01100

# SUMMARY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

### 1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification:
   1. Project Location: The Dutchess County Balefill landfill is located at the east end of Citation Drive near the north end of the north/south runway at the Dutchess County Airport in the Town of Wappinger, New York.
   2. Owner: Dutchess County Department of Public Works (DCDPW), 22 Market Street, Poughkeepsie, New York, 12601.

B. Engineers Identification: The Contract Documents were prepared by Chazen Engineering & Land Surveying, P.C., 547 River Street, Troy, New York 12180, tel: (518) 273-0055.

C. The work includes the installation of the following: Clear and grub site, construct gravel perimeter road with swales and culverts, strip topsoil, relocate waste and add ash or select granular fill to prepare subgrade, install geotextile, install gas venting layer and gas vent risers, install geomembrane and geocomposite, install barrier protection layer, and install topsoil layer with seed and mulch. Perform all Construction Quality Assurance and Construction Quality Control requirements.

### 1.3 CONTRACT

A. Project will be constructed under a single general construction contract.

B. Items noted "NIC" (Not-In-Contract), will be furnished and installed by others.

### 1.4 WORK SEQUENCE

A. The Work shall be conducted in one phase. Coordinate construction schedule and operations with Owner and Engineer.

### 1.5 CONTRACTOR USE OF PREMISES

A. Limited use of premises for work and for construction operations, to allow for Owner occupancy, work by others and public access.

B. Coordinate use of premises under direction of Owner and Engineer.

## 1.6 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
   1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the Table of Contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
   2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
      a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION (Not Used)

END OF SECTION 01100

# SECTION 01250

# CONTRACT MODIFICATION PROCEDURES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Section 01270 - Unit Prices.

C. Section 01600 - Product Requirements.

### 1.3 MINOR CHANGES IN THE WORK

A. Engineer will issue through Project Representative supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, in the form of a written Field Order in accordance with Paragraph 9.04 of the General Conditions.

### 1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.

2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
   a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   c. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and

finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Engineer.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

5. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on EJCDC Document C-941 form included herein.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Work Change Directive: Engineer may issue a Work Change Directive on EJCDC Document C-940 form included herein. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01250

# Work Change Directive

## No. _____

Date of Issuance: _____ Effective Date: _____

| Project: | Owner: | Owner's Contract No.: |
|---|---|---|
| Contract: | | Date of Contract: |
| Contractor: | | Engineer's Project No.: |

**You are directed to proceed promptly with the following change(s):**

| Item No. | Description |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

**Attachments (list documents supporting change):**

_____

_____

**Purpose for Work Change Directive:**

☐ Authorization for Work described herein to proceed on the basis of Cost of the Work due to:

☐ Nonagreement on pricing of proposed change.

☐ Necessity to expedite Work described herein prior to agreeing to changes on Contract Price and Contract Time.

**Estimated change in Contract Price and Contract Times:**

Contract Price $ _____ (increase/decrease) Contract Time _____ (increase/decrease)
days

If the change involves an increase, the estimated amounts are not to be exceeded without further authorization.

| Recommended for Approval by Engineer: | Date |
|---|---|
| Authorized for Owner by: | Date |
| Accepted for Contractor by: | Date |
| Approved by Funding Agency (if applicable): | Date: |

# Change Order No. _____

Date of Issuance: _____ Effective Date: _____

| Project: | Owner: | Owner's Contract No.: |
|---|---|---|
| Contract: | | Date of Contract: |
| Contractor: | | Engineer's Project No.: |

**The Contract Documents are modified as follows upon execution of this Change Order:**

Description:

Attachments: (List documents supporting change):

| **CHANGE IN CONTRACT PRICE:** | **CHANGE IN CONTRACT TIMES:** |
|---|---|
| Original Contract Price:<br>$_____ | Original Contract Times: ☐ Working days ☐ Calendar days<br>Substantial completion (days or date): _____<br>Ready for final payment (days or date): _____ |
| [Increase] [Decrease] from previously approved Change Orders No._____ to No._____:<br>$_____ | [Increase] [Decrease] from previously approved Change Orders No._____ to No._____:<br>Substantial completion (days): _____<br>Ready for final payment (days): _____ |
| Contract Price prior to this Change Order:<br>$_____ | Contract Times prior to this Change Order:<br>Substantial completion (days or date): _____<br>Ready for final payment (days or date): _____ |
| [Increase] [Decrease] of this Change Order:<br>$_____ | [Increase] [Decrease] of this Change Order:<br>Substantial completion (days or date): _____<br>Ready for final payment (days or date): _____ |
| Contract Price incorporating this Change Order:<br>$_____ | Contract Times with all approved Change Orders:<br>Substantial completion (days or date): _____<br>Ready for final payment (days or date): _____ |

| RECOMMENDED: | ACCEPTED: | ACCEPTED: |
|---|---|---|
| By: _____ | By: _____ | By: _____ |
| Engineer (Authorized Signature) | Owner (Authorized Signature) | Contractor (Authorized Signature) |
| Date: _____ | Date: _____ | Date: _____ |

Approved by Funding Agency (if applicable): _____ Date: _____

# Change Order
## Instructions

### A. GENERAL INFORMATION

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Price or Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

### B. COMPLETING THE CHANGE ORDER FORM

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

# Field Order
# No. _____

Date of Issuance: _____ Effective Date: _____

| Project: | Owner: | Owner's Contract No.: |
|---|---|---|
| Contract: | | Date of Contract: |
| Contractor: | | Engineer's Project No.: |

**Attention:**
You are hereby directed to promptly execute this Field Order issued in accordance with General Conditions Paragraph 9.05A., for minor changes in the Work without changes in Contract Price or Contract Times. If you consider that a change in Contract Price or Contract Times is required, please notify the Engineer immediately and before proceeding with this Work.

Reference: _____ _____
(Specification Section(s)) (Drawing(s) / Detail(s))

Description:

Attachments:

| | |
|---|---|
| | Engineer: |
| **Receipt Acknowledged by (Contractor):** | Date: |

Copy to Owner

# SECTION 01270

# UNIT PRICES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for unit prices including descriptions and procedures for measurement and payment.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Section 01250 - Contract Modification Procedures.

C. Section 01400 - Quality Requirements.

### 1.3 DEFINITIONS

A. Unit price is an amount proposed by Bidder, stated on the Bid Form, as a price per unit of measurement for materials or services, which may be added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

### 1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment:

1. Payment Items are listed in this Section by Payment Item Number exactly as they appear on the Bid Form.

2. Subject to the provisions in GENERAL CONDITIONS, Article 10 – Changes in the Work and Article 12 – Change of Contract Price, all Work and payment for the Work of this Contract are represented by Payment Items and associated unit prices.

    a. Payment Items include all incidental costs and subsidiary obligations reasonably required to complete the Work.

b. Payment Items include all Work Units combined as specified in this Section.

3. Definitions:

a. PAYMENT ITEM: a specifically described unit of Work or a combination of described units of Work for which a price is provided in the Contract.

b. WORK UNIT: an element of work specifically described in one of the Specification Sections which may be:
1) Combined with other Work Units into a single Payment Item as specified in this Section; or,
2) Specified as a Payment Item in this Section. The Work unit may appear in the Contract as a discrete Payment Item, and may also be combined with other Work Units as a part of another Payment Item.

c. SUBSIDIARY OBLIGATIONS: all material, labor, supplies, equipment, and services not specifically described as Payment Items but which are reasonably required to complete the work.

C. PAYMENT

1. Subject to all other Contract requirements, the Contractor shall be paid for "as-built" and in place quantities of Payment Items.

2. Estimated Quantities on the Bid Form are for comparison in competitive bidding only and do not constitute a basis for payment or measurement of quantities.

3. Unless otherwise specified or further qualified in this Section, Estimated Quantities on the Bid Form are:

a. Accurate within +/– 15%.

b. "As-built" quantities of Payment Items failing to meet such accuracy are defined as significantly changed, and subject the provisions in GENERAL CONDITIONS, Article 11, Paragraph 11.03.

D. MEASUREMENT FOR PAYMENT

1. Payment Limit Lines:

a. Where payment limit lines are shown on the Contract Drawings, measurement of a Payment Item quantity will be made up to, but not beyond such lines.

b. Where the actual work of a Payment Item falls short of the payment limit line, measurement will be made to the line of the actual work.

c. No measurement for payment will be made for quantities outside the payment limit lines unless authorized in writing by the Engineer.

2. Methods of Measurement:

a. Measurements of lengths, widths, slope angles, and depths or elevations shall be made to determine "as built" quantities of lengths, areas, and volumes pertinent to Payment Items.
   1) Unless otherwise specified, all lengths shall be horizontal distances.
   2) Slope angles and elevations shall be measured using land surveying equipment appropriate to the situation.

b. Graphic representations of measured quantities shall be drafted to scale using the Contract Drawings where convenient and appropriate. Additional drawings shall be drafted if required.
   1) Irregular shapes representing areas and volumes shall be measured using a compensating polar planimeter or a computer digitizer.
   2) Regular shapes shall be scaled.

c. Use of Contract Drawings:
   1) Unless otherwise agreed upon between the Contractor and Engineer the Contract Drawings shall be used as the basis to establish existing grades and other existing topographic features prior to the start of work.

3. Payment Limits where payment Lines are not shown on the Contract Drawings:

a. Earthwork excavation and embankment grades:
   1) Original: Grade prior to stripping topsoil, clearing, and grubbing.
   2) Finished:Upper grade of the excavation or embankment Payment Item.

b. Trench excavation:
   1) Original top in existing paved areas: Grade after pavement removal.
   2) Original top in existing earth areas: Grade prior to stripping topsoil, clearing, and grubbing.
   3) Original top in proposed grade-change areas: Grade after making earthwork cuts or fills.
   4) Bottom: Grade of pipe zone bedding bottom.
   5) Bottom Width: Pipe outside diameter (OD) plus 12 inches on each side unless otherwise shown on Contract Drawings.
   6) Sides: Vertical (when supported) or per OSHA.

4. Other Measurements for Payment:

a. Pipe Lengths: Measurement of pipe shall be made along the top of pipe in place, taken as the laying length for the following: culverts excluding flared end sections.

b. Except as otherwise specified, measurement of Payment Item quantities of weights, lengths, areas, and volumes shall be made:
   1) On "as-built" and in-place completed work, during construction or at the time of Substantial Completion.
   2) If no other feasible and practical method of measurement is available, by delivery slips delivered to the Engineer.

c. Adjustments shall be made to eliminate overlaps in area and volume calculations.

d. Deductions shall be made for volume occupied by pipes built under this Contract.

5. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

## 1.5 UNIT PRICES ITEM DESCRIPTIONS

### A. BID ITEM 1 - MOBILIZATION

1. Scope of Work:

   a. Work under this item shall include the Contractor's general set up, including office and storage areas and such sanitary and other facilities required by local or state law or regulation. This item shall include the requirements of the Contract's General Conditions unless included under other work items. Under this work item, Contractor shall also include the cost of required permits, bonds and insurances. Mobilization shall not exceed 4% of the Base Bid.

2. Work Included:

   a. The work required to provide the above facilities and services for mobilization shall be done in a safe and workmanlike manner and shall conform to any pertinent local or state law or code. Good housekeeping consistent with safety shall be maintained.

3. Associated Work Not Included

   a. None

4. Method of Payment

   a. Payment for this item will be on a lump sum basis.

5. Method of Measurement

   a. Payment for this item shall be considered after Contractor has completed all work required by this bid item.

### B. BID ITEM 2 - RECORD DRAWINGS AND DOCUMENTATION

1. Scope of Work

   a. Under this item, the Contractor shall furnish record drawings for all completed work as well as all other required construction progress documentation as required by the Contract Documents.

2. Work Included

   a. Furnish two complete sets of record drawings on clean sets of prints.

b. Record drawings shall be kept current and include all information required by the Contract Documents.

c. Furnish schedules and reports.

d. Furnish color photographs.

3. Associated Work Not Included

a. None

4. Method of Payment

a. Payment for this item will be made on a lump sum basis.

5. Method of Measurement

a. Payment for this item shall be considered after Contractor has completed all work required by this bid item.

C. BID ITEM 3 – SITE CLEARING

1. Scope of Work

a. Under this item, the Contractor shall furnish all materials, labor and equipment required to complete the clearing, grubbing, topsoil stripping and stockpiling where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Remove existing trees.

d. Excavate earth material and ground vegetation.

e. Periodic and final clean-up.

3. Associated Work Not Included.

a. Site restoration.

b. Culvert pipe installation.

4. Method of Payment

a. Payment for this item will be made on a lump sum basis for the complete demolition, removal, and disposal as required by the Contract Documents.

5. Method of Measurement

a. The quantity for which payment will be made, shall be based on the completion of site clearing required by the Contract Documents.

D. BID ITEM 4 – EROSION AND SEDIMENT CONTROL

1. Scope of Work

a. Under this item, the Contractor shall furnish all materials, labor and equipment necessary to install and maintain the erosion and sediment control features where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Comply with the provisions of the SPDES General Permit for Stormwater Discharges.

d. Furnish and install silt fences.

e. Furnish and install rock check dams.

f. Furnish and install stabilized construction entrances.

g. Provide inspection and maintenance of all erosion and sediment control.

h. Periodic and final clean-up.

3. Associated Work Not Included.

a. Site restoration.

4. Method of Payment

a. Payment for this item will be made on a lump sum basis for furnishing, installing and maintaining all required erosion and sediment control features.

5. Method of Measurement

a. The method of measurement for payment for this item shall be based on the completion of the erosion and sediment control requirements of the Contract Documents.

E. BID ITEM 5 – SELECT GRANULAR FILL

BID ITEM 6 – SAND (GAS VENTING LAYER & PIPE ZONE BEDDING & BACKFILL)

BID ITEM 7 – SEMI-PERVIOUS FILL (BARRIER PROTECTION LAYER)

BID ITEM 8 – NYSDOT SUBBASE COURSE TYPE 2

BID ITEM 9 - PROCESSED GRAVEL (PIPE TRENCH BACKFILL)

BID ITEM 10 - NYSDOT NO. 1 & 2 CRUSHED STONE

BID ITEM 11 - NYSDOT LIGHT & MEDIUM STONE FILLING (RIP RAP)

BID ITEM 12 - RIP RAP BEDDING MATERIAL

1. Scope of Work

   a. Under these items, the Contractor shall furnish, place and compact these materials where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

   a. General provisions.

   b. Lines and grades.

   c. Furnish, spread and compact materials.

   d. Dust control.

   e. Periodic and final clean-up.

3. Associated Work Not Included.

   a. HDPE Culverts.

   b. Ash.

   c. Geotextiles.

   d. Geocomposite Drains.

   e. Geomembranes.

   f. Gas Vent Risers.

   g. Site Restoration.

4. Method of Payment

   a. Payment for this item will be made on a unit price basis for each cubic yard of material installed in accordance with the Contract Documents.

5. Method of Measurement

a. The quantity for which payment will be made, shall be the total cubic yards of material, measured in its compacted condition, placed in accordance with the Contract Documents.

F. BID ITEM 13 – GAS VENT RISERS

1. Scope of Work

a. Under these items, the Contractor shall furnish and install all gas vent risers where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Removal of surplus materials.

c. Furnish and install gas vent risers.

3. Associated Work Not Included.

a. Geotextile.

b. Sand.

c. Geomembrane Pipe Boots.

4. Method of Payment

a. Payment for this item will be made on a unit price for each gas vent riser completed in accordance with the Contract Documents.

5. Method of Measurement

a. The quantity for payment will be made, shall be the total number of gas vent risers completed in accordance with the Contract Documents.

G. BID ITEM 14 – GEOMEMBRANES

BID ITEM 15 – GEOTEXTILES

BID ITEM 16 – GEOCOMPOSITE DRAINS

1. Scope of Work

a. Under these items, the Contractor shall furnish and install geomembranes, geotextiles, and geocomposite drains where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Removal of surplus material.

d. Furnish and install geomembranes, geotextiles, and geocomposite drains.

e. Furnish and install geomembranes pipe boots for penetrations.

f. Periodic clean-up.

3. Associated Work Not Included

a. None

4. Method of Payment

a. Payment for this item will be made on a square yard basis for the area of geomembranes, geotextiles, and geocomposite drains.

5. Method of Measurement

The quantity for which payment will be made, shall be the total square yards of geomembranes, geotextiles, and geocomposite drains installed in accordance with the Contract Documents.

H. BID ITEM 17 – 15" DIAMETER HDPE CULVERT PIPE

BID ITEM 18 – 6" DIAMETER HDPE TOE DRAIN

1. Scope of Work

a. Under these items, the Contractor shall furnish and install HDPE culvert pipes and toe drains where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Trenching for utilities.

d. Vermin guards.

e. Removal of surplus materials.

f. Dewatering.

g. Shoring, sheeting and bracing.

h. Dust control.

i. Spread, compact and grade trench bedding and backfill material.

j. Periodic and final clean-up.

3. Associated Work Not Included.

a. Culvert flared end sections.

4. Method of Payment

a. Payment for this item will be made on a unit price basis for each linear foot of pipe installed in accordance with the Contract Documents.

5. Method of Measurement

a. The method of measurement for payment for this item shall be the total horizontal measurement in linear feet of pipe installed as measured along the centerline of the installed pipe.

I. BID ITEM 19 – 15" DIAMETER CULVERT FLARED END SECTION

1. Scope of Work

a. Under these items, the Contractor shall furnish and install culvert pipe flared end sections of the material where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Removal of surplus materials.

d. Furnish and install flared end sections.

3. Associated Work Not Included.

a. Culvert pipes.

4. Method of Payment

a. Payment for this item will be made on a unit price for each flared end section installed in accordance with the Contract Documents.

5. Method of Measurement

a. The quantity for payment will be made, shall be the total number of flared end sections installed in accordance with the Contract Documents.

J. BID ITEM 20 – WET SWALES

1. Scope of Work

a. Under this item, the Contractor shall furnish all materials, labor and equipment necessary to construct the wet swales along the landfill perimeter road where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Final clean-up and restoration.

d. Excavation and grading.

e. Prepare finished grades.

3. Associated Work Not Included.

a. Utility trench site restoration.

b. Erosion and sediment control.

4. Method of Payment

a. Payment for this item will be made on a unit price basis for each linear foot of wet swale completed in accordance with the Contract Documents.

5. Method of Measurement

a. The method of measurement for payment for this item shall be the total horizontal measurement in linear feet of wet swale completed as measured along the centerline of the channel.

K. BID ITEM 21 – SITE RESTORATION

1. Scope of Work

a. Under this item, the Contractor shall furnish all materials, labor and equipment necessary to restore vegetated surfaces disturbed by construction operations and where shown on the Contract Drawings or where ordered by the Engineer.

2. Work Included

a. General provisions.

b. Lines and grades.

c. Support and protect existing facilities.

d. Final clean-up and restoration.

e. Topsoil, limestone, fertilizer and other soil amendments.

f. Seed mixtures, mulch, and hydromulch.

g. Hydroseeding.

h. Erosion control blankets.

i. Topsoil, seed, mulch and install erosion control blankets in all areas shown on the Contract Drawings.

j. Prepare finished grades.

3. Associated Work Not Included.

a. None.

4. Method of Payment

a. Payment for this item will be made on a unit price basis for each square foot of restoration completed.

5. Method of Measurement

a. The quantity for which payment will be made, shall be the total square footage of site restoration. Payment for 50% of the unit item shall be made upon completion of topsoil, seeding, mulching, and placement of erosion control blankets. The remaining 50% of the unit item will be paid upon satisfactory establishment of new vegetation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01270

# SECTION 01290

# PAYMENT PROCEDURES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01270 - Unit Prices.

C. Section 01250 - Contract Modification Procedures.

D. Section 01320 - Construction Progress Documentation.

### 1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

### 1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:

   a. Application for Payment forms with Continuation Sheets.
   b. Submittals Schedule.

2. Submit the Schedule of Values to Engineer through Project Representative at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

   a. Project name and location.
   b. Name of Engineer.
   c. Engineer's project number.
   d. Contractor's name and address.
   e. Date of submittal.

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

   a. Related Specification Section or Division.
   b. Description of the Work.
   c. Name of subcontractor.
   d. Name of manufacturer or fabricator.
   e. Name of supplier.
   f. Change Orders (numbers) that affect value.
   g. Dollar value.

      1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100%.

3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

   a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.

6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.

9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

## 1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is the 15th day of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days before the date for each progress payment.

C. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets or EJCDC Document C-620 or other standard form as approved by Engineer for Applications for Payment.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

E. Transmittal: Submit 5 signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Delays: Submit each Application for Payment with Contractor's waiver of mechanic's lien for construction period covered by the application.

a. Submit final Application for Payment with, or preceded by, final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.

5. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.

G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Products list.
5. Schedule of unit prices.
6. Submittals Schedule (preliminary if not final).
7. List of Contractor's staff assignments.
8. List of Contractor's principal consultants.
9. Copies of building permits.
10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
11. Initial progress report.
12. Report of preconstruction conference.

H. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100% completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final, liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01290

# Contractor's Application For Payment No. _____

| | | |
|---|---|---|
| | Application Period: | Application Date: |
| To (Owner): | From (Contractor): | Via (Engineer) |
| Project: | Contract: | |
| Owner's Contract No.: | Contractor's Project No.: | Engineer's Project No.: |

## APPLICATION FOR PAYMENT

**Change Order Summary**

| Approved Change Orders | | |
|---|---|---|
| Number | Additions | Deductions |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| TOTALS | | |
| NET CHANGE BY CHANGE ORDERS | | |

| | | |
|---|---|---|
| **1. ORIGINAL CONTRACT PRICE** | $ | |
| **2. Net change by Change Orders** | $ | |
| **3. CURRENT CONTRACT PRICE (Line 1 ± 2)** | $ | |
| **4. TOTAL COMPLETED AND STORED TO DATE (Column F on Progress Estimate)** | $ | |
| **5. RETAINAGE:** | | |
| **a. _____ % x $_____ Work Completed** | $ | |
| **b. _____ % x $_____ Stored Material** | $ | |
| **c. Total Retainage (Line 5a + Line 5b)** | $ | |
| **6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c)** | $ | |
| **7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application)** | $ | |
| **8. AMOUNT DUE THIS APPLICATION** | $ | |
| **9. BALANCE TO FINISH, PLUS RETAINAGE (Column G on Progress Estimate + Line 5 above)** | $ | |

## CONTRACTOR'S CERTIFICATION

The undersigned Contractor certifies that: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

| By: | Date: |
|---|---|
| | |

Payment of: $_____
(Line 8 or other - attach explanation of other amount)

is recommended by: _____ _____
(Engineer) (Date)

Payment of: $_____
(Line 8 or other - attach explanation of other amount)

is approved by: _____ _____
(Owner) (Date)

Approved by: _____ _____
Funding Agency (if applicable) (Date)

## Progress Estimate

# Contractor's Application

| For (contract): | Application Number: |
|---|---|
| Application Period: | Application Date: |

| A | | | | B | C | D | E | F | | G |
|---|---|---|---|---|---|---|---|---|---|---|
| Item | | Bid Quantity | Unit Price | Bid Value | Estimated Quantity Installed | Value | Materials Presently Stored (not in C) | Total Completed and Stored to Date (D + E) | % (F) B | Balance to Finish (B - F) |
| Bid Item No. | Description | | | | | | | | | |
| | | | | | | | | | | |
| | Totals | | | | | | | | | |

# Stored Material Summary

# Contractor's Application

| For (contract): | | | | | | | Application Number: | | |
|---|---|---|---|---|---|---|---|---|---|
| Application Period: | | | | | | | Application Date: | | |
| A | B | C | D | | E | | F | | G |
| Invoice No. | Shop Drawing Transmittal No. | Materials Description | Stored Previously | | Stored this Month | | Incorporated in Work | | Materials Remaining in Storage ($) (D + E - F) |
| | | | Date (Month/Year) | Amount ($) | Amount ($) | Subtotal | Date (Month/Year) | Amount ($) | |
| | | | | | | | | | |
| | | Totals | | | | | | | |

# SECTION 01310

# PROJECT MANAGEMENT AND COORDINATION

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General project coordination procedures.
   2. Conservation.
   3. Coordination Drawings.
   4. Administrative and supervisory personnel.
   5. Project meetings.

### 1.2 RELATED REQUIREMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
2. Section 01320 - Construction Progress Documentation.
3. Section 01700 - Execution Requirements.
4. Section 01770 - Closeout Procedures.

### 1.3 COORDINATION

1. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
2. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   a. Preparation of Contractor's Construction Schedule.
   b. Preparation of the Schedule of Values.
   c. Installation and removal of temporary facilities and controls.
   d. Delivery and processing of submittals.
   e. Progress meetings.
   f. Pre-installation conferences.
   g. Project closeout activities.
   h. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
   i. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

### 1.4 SUBMITTALS

A. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
   1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

## 1.5 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
   1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
   2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
   3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within 3 days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
   1. Attendees: Authorized representatives of Owner Engineer, and their consultants; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   2. Agenda: Discuss items of significance that could affect progress, including the following:
      a. Tentative construction schedule.
      b. Phasing.
      c. Critical work sequencing.
      d. Designation of responsible personnel.
      e. Procedures for processing field decisions and Change Orders.
      f. Procedures for processing Applications for Payment.
      g. Distribution of the Contract Documents.
      h. Submittal procedures.
      i. Preparation of Record Documents.
      j. Use of the premises.
      k. Responsibility for temporary facilities and controls.
      l. Parking availability.
      m. Office, work, and storage areas.
      n. Equipment deliveries and priorities.
      o. First aid.
      p. Security.
      q. Progress cleaning.
      r. Working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310

# SECTION 01320

# CONSTRUCTION PROGRESS DOCUMENTATION

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Preliminary Construction Schedule.
2. Contractor's Construction Schedule.
3. Submittals Schedule.
4. Daily construction reports.
5. Material location reports.
6. Field condition reports.
7. Special reports.
8. Construction photographs.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01290 - Payment Procedures.

C. Section 01310 - Project Management and Coordination.

D. Section 01330 - Submittal Procedures.

E. Section 01400 - Quality Requirements.

F. Section 01770 - Closeout Procedures

### 1.3 SUBMITTALS

A. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:

1. Scheduled date for first submittal.
2. Specification Section number and title.
3. Submittal category (action or informational).
4. Name of subcontractor.
5. Description of the Work covered.
6. Scheduled date for Engineer's final release or approval.

B. Preliminary Construction Schedule: Submit two printed copies.

C. Contractor's Construction Schedule: Submit two printed copies of initial schedule, one a reproducible print and one a blue- or black-line print, large enough to show entire schedule for entire construction period.

1. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

D. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.

1. Format: smooth-surface matte prints on single-weight commercial-grade stock, enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:

a. Name of Project.
b. Name and address of photographer.
c. Name of Engineer and Project Representative.
d. Name of Contractor.
e. Date photograph was taken.
f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

3. Negatives: Submit a complete set of photographic negatives in protective envelopes with each submittal of prints. Identify date photographs were taken.

E. Daily Construction Reports: Submit two copies at weekly intervals.

F. Material Location Reports: Submit two copies at weekly intervals.

G. Field Condition Reports: Submit two copies at time of discovery of differing conditions.

H. Special Reports: Submit two copies at time of unusual event.

## 1.4 QUALITY ASSURANCE

A. Pre-scheduling Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Verify availability of qualified personnel needed to develop and update schedule.
2. Discuss constraints, including phasing, work stages, area separations and interim milestones.
3. Review delivery dates for Owner-furnished products.
4. Review schedule for work of Owner's separate contracts.
5. Review time required for review of submittals and re-submittals.

6. Review requirements for tests and inspections by independent testing and inspecting agencies.
7. Review time required for completion and startup procedures.
8. Review and finalize list of construction activities to be included in schedule.
9. Review submittal requirements and procedures.
10. Review procedures for updating schedule.

## 1.5 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from parties involved.
2. Coordinate each construction activity with other activities and schedule them in proper sequence.

# PART 2 - PRODUCTS

## 2.1 SUBMITTALS SCHEDULE

A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.

1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

    a. At Contractor's option, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

## 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice of Award to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
2. Submittal Review Time: Include review and re-submittal times indicated in Division 1 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
3. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Engineer's and Project Representative's administrative procedures necessary for certification of Substantial Completion.

B. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
3. Products Ordered in Advance: Include delivery date indicated in Division 1 Section 1100 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
4. Work Restrictions: Show the effect of the following items on the schedule:

    a. Uninterruptible services.
    b. Partial use before Substantial Completion.
    c. Seasonal variations.

5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

    a. Subcontract awards.
    b. Submittals.
    c. Purchases.
    d. Fabrication.
    e. Sample testing.
    f. Deliveries.
    g. Installation.
    h. Tests and inspections.
    i. Adjusting.
    j. Curing.
    k. Startup and placement into final use and operation.
    l. List critical work and subcontracts here if requirement to indicate stages of the Work is limited only to those elements.
    m. Substantial Completion.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

D. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the Work performed as of dates used for preparation of payment requests.

1. Refer to Division 1 Section 01290 "Payment Procedures" for cost reporting and payment procedures.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, demonstrate the effect of the proposed change on the overall project schedule.

## 2.3 PRELIMINARY CONSTRUCTION SCHEDULE

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

## 2.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. High and low temperatures and general weather conditions.
5. Accidents.
6. Meetings and significant decisions.
7. Unusual events (refer to special reports).
8. Stoppages, delays, shortages, and losses.
9. Meter readings and similar recordings.
10. Emergency procedures.
11. Orders and requests of authorities having jurisdiction.
12. Change Orders received and implemented.
13. Construction Change Directives received.
14. Services connected and disconnected.
15. Equipment or system tests and startups.
16. Partial Completions and use.
17. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information on CSI Form 13.2A. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

## 2.5 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, durations, actual starts and finishes.
3. As the Work progresses, indicate Actual Completion percentage for each item.

B. Distribution: Distribute copies of approved schedule to Engineer, Project Representative, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

### 3.2 CONSTRUCTION PHOTOGRAPHS

A. Photographic Film:

B. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

C. Preconstruction Photographs: Before starting construction, take color photographs of Project site and surrounding properties from different vantage points, as directed by Project Representative. Show existing conditions adjacent to property.

D. Periodic Construction Photographs: Take color photographs monthly, coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.

1. Field Office Prints: Retain one set of prints of periodic photographs in field office at Project site, available at all times for reference. Identify photographs the same as for those submitted to Engineer and Project Representative.

E. Final Completion Construction Photographs: Take color photographs after date of Substantial Completion for submission as Project Record Documents. Project Representative will direct photographer for desired vantage points.

END OF SECTION 01320

# SECTION 01330

# SUBMITTAL PROCEDURES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01290 - Payment Procedures.

C. Section 01310 - Project Management and Coordination.

D. Section 01320 - Construction Progress Documentation.

E. Section 01400 - Quality Requirements.

F. Section 01770 - Closeout Procedures.

G. Section 01781 - Project Record Documents

### 1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Engineer's and Project Representative's responsive action.

B. Informational Submittals: Written information that does not require Engineer's and Project Representative's approval.

### 1.4 SUBMITTAL PROCEDURES

A. General: Electronic copies of CAD Drawings of the Contract Drawings can be provided by Engineer for Contractor's use in preparing submittals. The Engineer does not assume any responsibility for accuracy of CAD documents provided.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
   a. Engineer and Project Representative reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Submittals Schedule: Comply with requirements in Division 1 Section "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.

D. Processing Time: Allow enough time for submittal review, including time for re-submittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.

2. Concurrent Review: Where concurrent review of submittals by Engineer's consultants, Owner, or other parties is required, allow 21 days for initial review of each submittal.

3. Direct Transmittal to Consultant: Where the Contract Documents indicate that submittals may be transmitted directly to Engineer's consultants, provide duplicate copy of transmittal to Engineer and Project Representative. Submittal will be returned to Engineer before being returned to Contractor.

4. If intermediate submittal is necessary, process it in same manner as initial submittal.

5. Allow 15 days for processing each re-submittal.

6. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

E. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.

3. Include the following information on label for processing and recording action taken:
   a. Project name.
   b. Date.
   c. Name and address of Engineer.
   d. Name and address of Contractor.
   e. Name and address of subcontractor.
   f. Name and address of supplier.

g. Name of manufacturer.
h. Unique identifier, including revision number.
i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.
k. Other necessary identification.

F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

G. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer or Project Representative observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer and Project Representative.

2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.

H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer and Project Representative will return submittals, without review, received from sources other than Contractor.

1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer and Project Representative on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.

2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
a. Project name.
b. Date.
c. Destination (To :).
d. Source (From :).
e. Names of subcontractor, manufacturer, and supplier.
f. Category and type of submittal.
g. Submittal purpose and description.
h. Submittal and transmittal distribution record.
i. Remarks.
j. Signature of transmitter.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, and installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

1. Number of Copies: Submit copies of each submittal, as follows, unless otherwise indicated:
   a. Initial Submittal: Submit a preliminary single copy of each submittal where selection of options, color, pattern, texture, or similar characteristics is required. Engineer will return submittal with options selected.
   b. Final Submittal: Submit three copies, unless copies are required for operation and maintenance manuals. Submit five copies where copies are required for operation and maintenance manuals. Engineer will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Document.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
   a. Manufacturer's written recommendations.
   b. Manufacturer's product specifications.
   c. Manufacturer's installation instructions.
   d. Manufacturer's catalog cuts.
   e. Compliance with recognized trade association standards.
   f. Compliance with recognized testing agency standards.
   g. Application of testing agency labels and seals.
   h. Notation of coordination requirements.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Include the following information, as applicable:
   a. Dimensions.
   b. Identification of products.
   c. Schedules.
   d. Design calculations.
   e. Compliance with specified standards.
   f. Notation of coordination requirements.
   g. Notation of dimensions established by field measurement.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 24 by 36 inches.

3. Number of Copies: Submit copies of each submittal, as follows:

a. Initial Submittal: Submit two blue or black-line prints. Engineer will return one print.
b. Final Submittal: Submit three blue or black-line prints, unless prints are required for operation and maintenance manuals. Submit five prints where prints are required for operation and maintenance manuals. Engineer will retain two prints; remainder will be returned. Mark up and retain one returned print as a Project Record Drawing.

D. Coordination Drawings: Comply with requirements in Division 1 Section 01310 "Project Management and Coordination."

E. Delegated-Design Submittal: Comply with requirements in Division 1 Section 01400 "Quality Requirements."

F. Contractor's Construction Schedule: Comply with requirements in Division 1 Section 01320 "Construction Progress Documentation" for Project Representative's action.

G. Submittals Schedule: Comply with requirements in Division 1 Section 01320 "Construction Progress Documentation."

H. Application for Payment: Comply with requirements in Division 1 Section 01290 "Payment Procedures."

I. Schedule of Values: Comply with requirements in Division 1 Section 01290 "Payment Procedures."

J. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.

2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.

## 2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.

1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Engineer will not return copies.

2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

3. Test and Inspection Reports: Comply with requirements in Division 1 Section 1400 "Quality Requirements."

B. Contractor's Construction Schedule: Comply with requirements in Division 1 Section 1320 "Construction Progress Documentation."

C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.

D. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

H. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

I. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

J. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

L. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section 01770 "Closeout Procedures."

M. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

N. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1. Preparation of substrates.

2. Required substrate tolerances.

3. Sequence of installation or erection.

4. Required installation tolerances.

5. Required adjustments.

6. Recommendations for cleaning and protection.

O. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.

2. Statement on condition of substrates and their acceptability for installation of product.

3. Statement that products at Project site comply with requirements.

4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.

7. Other required items indicated in individual Specification Sections.

P. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

Q. Construction Photographs and Videotapes: Comply with requirements in Division 1 Section 01320 "Construction Progress Documentation."

## PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.

C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 01330

Advancement
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# SUBCONTRACTORS AND MAJOR MATERIAL SUPPLIERS LIST

Project: _____

_____

To (A/E): _____

_____

From (Contractor): _____

Date: _____

A/E Project Number: _____

Contract For: _____

List Subcontractors and Major Material Suppliers proposed for use on this Project as required by the Construction Documents. Attach supplemental sheets if necessary.

| Section Number | Section Title | Firm | Address | Phone Number (Fax Number) | Contact |
|---|---|---|---|---|---|

☐ Attachments

Signed by: Date:

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

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July 1994
CSI Form 1.5A

Advancement of Construction Technology

# SUBMITTAL TRANSMITTAL

Project: _____ Date: _____

_____ A/E Project Number: _____

**TRANSMITTAL A**

To (Contractor): _____ Date: _____ Submittal No. _____

From (Subcontractor): _____ By: _____ ☐ Resubmission

| Qty. | Reference / Number | Title / Description / Manufacturer | Spec. Section Title and Paragraph / Drawing Detail Reference |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

☐ Submitted for review and approval
☐ Resubmitted for review and approval
☐ Complies with contract requirements
☐ Will be available to meet construction schedule
☐ A/E review time included in construction schedule

☐ Substitution involved - Substitution request attached
☐ If substitution involved, submission includes point-by-point comparative data or preliminary details
☐ Items included in submission will be ordered immediately upon receipt of approval

Other remarks on above submission:

☐ One copy retained by sender

**TRANSMITTAL B**

To (A/E): _____ Attn: _____ Date Rec'd by Contractor: _____

From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

☐ Approved
☐ Approved as noted

☐ Revise / Resubmit
☐ Rejected / Resubmit

Other remarks on above submission:

☐ One copy retained by sender

**TRANSMITTAL C**

To (Contractor): _____ Attn: _____ Date Rec'd by A/E: _____

From (A/E): _____ ☐ Other By: _____ Date Trnsmt'd by A/E: _____

☐ Approved
☐ Approved as noted
☐ Not subject to review
☐ No action required
☐ Revise / Resubmit
☐ Rejected / Resubmit
☐ Approved as noted / Resubmit

☐ Provide file copy with corrections identified
☐ Sepia copies only returned

☐ Point-by-point comparative data required to complete approval process

☐ Submission Incomplete / Resubmit

Other remarks on above submission:

☐ One copy retained by sender

**TRANSMITTAL D**

To (Subcontractor): _____ Attn: _____ Date Rec'd by Contractor: _____

From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ One copy retained by sender

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SECTION 01351

SAFETY, HEALTH, AND EMERGENCY RESPONSE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section specifies a Site Safety and Health Plan (SSHP) which shall apply to work performed at the landfill.

1.2 REGULATORY REQUIREMENTS

A. Work performed under this contract shall comply with Occupational Safety and Health Administration (OSHA) standards, 29 CFR 1910 and 29 CFR 1926.

1.3 SITE SAFETY AND HEALTH PLAN (SSHP)

A. SSHP shall be prepared by the Contractor covering on-site work to be performed by the Contractor and all subcontractors. The Safety and Health Manager shall be responsible for the development, implementation, and oversight of the SSHP. The SSHP shall establish, in detail, the protocols necessary for the anticipation, recognition, evaluation, and control of hazards associated with each task performed. The SSHP shall address site specific conditions. The level of detail provided in the SSHP shall be tailored to the type of work, complexity of operations to be performed, and hazards anticipated. Details about some activities may not be available when the initial SSHP is prepared and submitted. Therefore, the SSHP shall address, in as much detail as possible, anticipated tasks, their related hazards, and anticipated control measures.

1.4 SITE DESCRIPTIONS AND CONTAMINATION CHARACTERIZATION

A. Project/Site Conditions: Test pit logs, boring logs, and groundwater analytical results are included in the "Final Closure Plan". Refer to Supplementary Conditions 00810.

B. Plan Requirements: The SSHP shall include a site description and contamination characterization section that addresses the following elements:

1. Description of the site location, topography, size, and past uses of the site.

2. A list of contaminants, which may present occupational health and safety hazards.

1.5 SITE HAZARDS

A. The following potential hazards may be encountered during site work. These are not complete lists; therefore, they shall be expanded and/or revised as necessary during preparation of the SSHP.

1. Safety Hazards: The following hazards may be present: Excavations, slips, trips, and falls; electricity; construction equipment and machinery; trenching; debris handling; and underground lines.

2. Chemical Hazards: The SSHP shall describe the chemical, physical, and toxicological properties of contaminants, sources and pathways of employee exposures, anticipated on-site and off-site exposure level potentials, and regulatory (including Federal, state and local) or recommended protective exposure standards. The SSHP shall also address employee exposure to hazardous substances brought on-site, and shall comply with the requirements of 29 CFR 1910.1200 and 29 CFR 1926.59, Hazard Communication.

3. Physical Agents: The following hazards may be encountered: Noise, heat and cold stress, and vibration.

4. Biological Hazards: Poisonous plants, animals, and ticks (Lyme Disease) may be encountered.

1.6 ACTION LEVELS

A. General: Action levels shall be established for site operations. The action levels and required actions (engineering controls, changes in PPE, etc.) shall be presented in the SSHP.

1.7 STAFF ORGANIZATION, QUALIFICATIONS, AND RESPONSIBILITIES

A. An organizational structure shall be developed that sets forth lines of authority (chain of command), responsibilities, and communication procedures concerning site safety, health, and emergency response. This organizational structure shall cover management, supervisors, and employees of the Contractor and subcontractors.

B. Site Superintendent: A Site Superintendent, who has responsibilities to implement the SSHP, the authority to direct work performed under this contract and verify compliance, shall be designated.

C. Safety and Health Manager: The Safety and Health Manager shall:

1. Be responsible for the development, implementation, oversight, and enforcement of the SSHP.

2. Conduct initial site-specific training.

3. Be present on-site during the first day of remedial activities and at the startup of each new major phase.

4. Visit the site as needed to audit the effectiveness of the SSHP.

5. Be available for emergencies.

6. Provide on-site consultation as needed to ensure the SSHP is fully implemented.

7. Provide continued support for upgrading/downgrading of the level of personal protection.

8. Be responsible for evaluating air monitoring data and recommending changes to engineering controls, work practices, and PPE.

9. Review accident reports and results of daily inspections.

D. Site Safety and Health Officer (SSHO): The Site Safety and Health Officer shall:

1. Assist and represent the Safety and Health Manager in on-site training and the day-to-day on-site implementation and enforcement of the accepted SSHP.

2. Be assigned to the site on a full-time basis for the duration of field activities.

3. Have authority to stop work if unacceptable safety or health conditions exist, and take necessary action to re-establish and maintain safe working conditions.

4. Consult with and coordinate any modifications to the SSHP with the Safety and Health Manager and the Site Superintendent.

5. Conduct accident investigations and prepare accident reports.

6. Review results of daily quality control inspections and document safety and health findings into the Daily Safety Inspection Log.

7. In coordination with site management and Safety and Health Manager, recommend corrective actions for identified deficiencies and oversee the corrective actions. The Site Safety and Health Officer may also be the Site Superintendent

1.8 TRAINING

A. Personnel shall receive training in accordance with the Contractor's written safety and health training program and 29 CFR 1910.120, 29 CFR 1926.65, and 29 CFR 1926.21. The SSHP shall include a section describing training requirements.

1.9 PERSONAL PROTECTIVE EQUIPMENT

A. General: In accordance with 29 CFR 1910.120(g)(5) and 29 CFR 1926.65(g)(5), a written Personal Protective Equipment (PPE) program which addresses the elements listed in that regulation, and which complies with respiratory protection program requirements of 29 CFR 1910.134, is to be included in the Contractor's Safety and Health Program.

B. Levels of Protection: The Safety and Health Manager shall establish appropriate levels of protection for each work activity based on review of historical site information, existing data, an evaluation of the potential for exposure (inhalation, dermal, ingestion, and injection) during each task, past air monitoring results, and a continuing safety and health monitoring program. The Safety and Health Manager shall also establish action levels for upgrade or downgrade in levels of PPE from the following specified minimum levels of protection.

1.10 MEDICAL SURVEILLANCE

A. The SSHP shall detail the medical surveillance program that includes scheduling of examinations, certification of fitness for duty, compliance with OSHA requirements, and information provided to the physician.

## 1.11 SITE CONTROL MEASURES

A. In order to prevent the spread of contamination and control the flow of person, vehicles, and materials into and out of work areas, site control measures shall be established and described in the SSHP.

1. Site Control Log: A log of personnel visiting, entering, or working on the site shall be maintained. The log shall include the following: date, name, agency or company, and time entering and exiting site.

## 1.12 EQUIPMENT DECONTAMINATION

A. Vehicles and equipment used on-site shall be decontaminated prior to leaving the site. The procedures for decontaminated of vehicles and equipment shall be addressed in the SSHP.

## 1.13 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

A. The SSHP shall describe the emergency and first aid equipment to be available on-site. The following items, as a minimum, shall be maintained on-site and available for immediate use:

1. First aid equipment and supplies.

2. Emergency eyewashes, which comply with ANSI 2358.1.

3. Fire extinguishers with a minimum rating of 20-A:120-B.C shall be provided at site facilities.

## 1.14 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

A. An Emergency Response Plan, that meets the requirements of 29 CFR 1910.120(1) and 29 CFR 1926.65(1), shall be developed and implemented as a section of the SSHP. In the event of any emergency associated with remedial action, the Contractor shall, without delay, alert all on-site employees that there is an emergency situation; take action to remove or otherwise minimize the cause of the emergency; and institute measures necessary to prevent repetition of the conditions or actions leading to, or resulting in, the emergency. The following elements, as a minimum, shall be addressed in the plan:

1. Pre-emergency planning. The local emergency response agencies shall be contacted during preparation of the Emergency Response Plan.

2. Personnel roles, lines of authority, communication for emergencies.

3. Criteria and procedures for site evacuation (emergency alerting procedures, employee alarm system, emergency PPE and equipment, safe distances, places of refuge, evacuation routes, site security and control).

4. Specific procedures for decontamination and medical treatment of injured personnel.

5. Specific procedures for contacting and handling asbestos containing material should these materials be encountered during waste relocation.

6. Routes maps to nearest pre-notified medical facility.

7. Emergency alerting and response procedures including posted instructions and a list of names and telephone numbers of emergency contacts.

1.15 CERTIFICATE OF WORKER/VISITOR ACKNOWLEDGEMENT

A. A copy of a Contractor-generated certificate of worker/visitor acknowledgement shall be completed and submitted for each visitor and for each employee.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01351

# SECTION 01400

# QUALITY REQUIREMENTS

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-control services required by Engineer, Owner, Project Representative, or authorities having jurisdiction are not limited by provisions of this Section.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01320 - Construction Progress Documentation.

C. Division 2 Specification Sections for specific test and inspection requirements.

D. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer or Project Representative.

C. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

## 1.4 SUBMITTALS

A. Qualification Data: For testing agencies specified in Subsection 1.5 - Quality Assurance, to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

C. Reports: Prepare and submit certified written reports that include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

## 1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.

E. Professional Engineer Qualifications: A Professional Engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.

H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.
   1. Contractor responsibilities include the following:

      a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.

      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

      c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.

      d. When testing is complete, remove assemblies; do not reuse materials on Project.
   2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

## 1.6 QUALITY CONTROL

A. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
   1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
   2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

B. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

C. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
   5. Do not perform any duties of Contractor.

E. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field-curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspecting equipment at Project site.

F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

## 1.7 CONSTRUCTION QUALITY ASSURANCE AND CONSTRUCTION QUALITY CONTROL (CQA/CQC) PLAN

A. A Construction Quality Assurance and Construction Quality Control (CQA/CQC) Plan has been prepared for the Dutchess County Balefill Landfill Closure in Wappinger, New York. This Plan describes the necessary materials testing required under 6 NYCRR Part 360-2.8 and 2.13, (o), (p), (q), (r), and (t) and associated subparts. The purpose of this document is to specify the means of assuring construction quality.

The activities that require specific quality assurance procedures for the landfill closure construction include:

- Erosion and sediment control and stormwater management.
- Site clearing/grading/waste relocation.
- Bedding layer (subgrade) installation.
- Geotextile installation.
- Gas Venting Layer installation.
- Geomembrane installation.
- Geocomposite installation.
- Barrier Protection Layer installation.
- Topsoil Layer installation.

The project construction and installation require verification of specified materials, assurance of material placement, and laboratory and field testing of in-place materials to verify compliance with Contract Drawings and Specifications and good workmanship. The Contractor is required to comply with the CQA/CQC Plan. In the event that a conflict arises, the CQA/CQC Plan governs and the Contractor shall notify the Engineer immediately for clarification.

# PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

## 3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Sections of these Specifications. Restore patched areas and extend restoration into adjoining areas in a manner that eliminates evidence of patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01400

# SECTION 01410

# TESTING LABORATORY SERVICES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDES

A. Selection and payment.

B. Contractor submittals.

C. Laboratory responsibilities.

D. Laboratory reports.

E. Limits on testing laboratory authority.

F. Contractor responsibilities.

G. Schedule of inspections and tests.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01330 – Submittal Procedures.

C. Section 01770 – Closeout Procedures.

D. Division 2 Specification Sections for specific requirements and limitations applicable to testing and laboratory services individual parts of the work.

E. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.3 REFERENCES

A. ANSI/ASTM D3740 – Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

### 1.4 SELECTION AND PAYMENT

A. Contractor shall employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. Employment of testing laboratory shall in no way relive Contractor of obligation to perform work in accordance with requirements of Contract Documents.

## 1.5 QUALITY ASSURANCE

A. Comply with requirements of ANSI/ASTM D3740.

B. Laboratory: Authorized to operate in state in which Project is located.

C. Laboratory Staff: Maintain a full time registered Engineer on staff.

D. Testing Equipment: Calibrated at reasonable intervals with devices of an accuracy traceable to either National Bureau of Standards (NBS) Standards or accepted values of natural physical constants.

## 1.6 CONTRACTOR SUBMITTALS

A. Prior to start of work, submit testing laboratory name, address, and telephone number, and names of full time registered Engineer and responsible officer.

B. Submit copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards (NBS) during most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

## 1.7 LABORATORY RESPONSIBILITIES

A. Test samples of mixes submitted by Contractor.

B. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.

C. Perform specified inspection, sampling, and testing of Products in accordance with Contract Documents.

D. Ascertain compliance of materials and mixes with requirements of Contract Documents.

E. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or Products.

F. Perform additional inspections and tests required by Engineer.

## 1.8 LABORATORY REPORTS

A. After each inspection and test, promptly submit five copies of laboratory report to Engineer and to Contractor.

B. Include:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and Specifications Section.
   6. Location in the Project.
   7. Type of inspection or test.
   8. Date of test.
   9. Results of tests.
   10. Conformance with Contract Documents.

C. When requested by Engineer, provide interpretation of test results.

## 1.9 LIMITS ON TESTING LABORATORY AUTHORITY

A. Laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

B. Laboratory may not approve or accept any portion of the Work.

C. Laboratory may not assume any duties of Contractor.

D. Laboratory has no authority to stop the Work.

## 1.10 CONTRACTOR RESPONSIBILITES

A. Deliver to laboratory at designated location, adequate samples of materials proposed to be used which require testing.

B. Cooperate with laboratory personnel, and provide access to the Work (and to manufacturer's facilities).

C. Provide incidental labor and facilities to provide access to Work to be tested, to obtain and handle samples at the site or at source of products to be tested, to facilitate tests and inspections, storage and curing of test samples.

D. Notify Engineer and laboratory 24 hours prior to expected time for operations requiring inspection and testing services.

E. Arrange with laboratory and pay for additional samples and tests required by Contractor beyond specified requirements.

## 1.11 SCHEDULE OF INSPECTIONS AND TESTS

A. Section 02300 – Earthwork, Section 02713 – Geomembrane, Section 02714 – Geotextiles, Section 02715 – Geocomposite Drain, and Section 02920 – Site Restoration. See Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

B. Add additional items for inspection and tests.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01400

SECTION 01420

REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

1.2 DEFINITIONS

General: Basic Contract definitions are included in the Conditions of the Contract.

"Approved": The term "approved," when used to convey Engineer's action on Contractor's submittals, applications, and requests, is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

"Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by Engineer, requested by Engineer, and similar phrases.

"Indicated": The term "indicated" refers to graphic representations, notes, or schedules on Drawings or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference.

"Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

"Furnish": The term "furnish" means to supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

"Install": The term "install" describes operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, and protecting, cleaning, and similar operations.

"Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

"Installer": An installer is the Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

The term "experienced," when used with an entity, means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

"Project site" is the space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

## 1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

## 1.4 CONSTRUCTION QUALITY ASSURANCE AND CONSTRUCTION QUALITY CONTROL (CQA/CQC) PLAN

A. A Construction Quality Assurance and Construction Quality Control (CQA/CQC) Plan has been prepared for the Dutchess County Balefill Landfill Closure in Wappinger, New York. This Plan

describes the necessary materials testing required under 6 NYCRR Part 360-2.8 and 2.13, (o), (p), (q), (r), and (t) and associated subparts. The purpose of this document is to specify the means of assuring construction quality.

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- Geomembrane installation.
- Geocomposite installation.
- Barrier Protection Layer installation.
- Topsoil Layer installation.

The project construction and installation require verification of specified materials, assurance of material placement, and laboratory and field testing of in-place materials to verify compliance with Contract Drawings and Specifications and good workmanship. The Contractor is required to comply with the CQA/CQC Plan. In the event that a conflict arises, the CQA/CQC Plan governs and the Contractor shall notify the Engineer immediately for clarification.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01420

# SECTION 01500

# TEMPORARY FACILITIES AND CONTROLS

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.

B. Temporary utilities include, but are not limited to, the following:
   1. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.

C. Support facilities include, but are not limited to, the following:
   1. Temporary roads and paving.
   2. Dewatering facilities and drains.
   3. Project identification and temporary signs.
   4. Waste disposal facilities.
   5. Construction aids and miscellaneous services and facilities.

D. Security and protection facilities include, but are not limited to, the following:
   1. Environmental protection.
   2. Stormwater management.
   3. Wetland protection.
   4. Barricades and warning signs.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01330 - Submittal Procedures.

C. Section 01700 - Execution Requirements.

### 1.3 SUBMITTALS

A. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

B. Implementation and Termination Schedule: Within 15 days of date established for submittal of Contractor's Construction Schedule, submit a schedule indicating implementation and termination of each temporary utility.

1.4 PROJECT CONDITIONS

A. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:
   1. Keep temporary services and facilities clean and neat.
   2. Relocate temporary services and facilities as required by progress of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Engineer. Provide materials suitable for use intended.

B. Water: Potable.

2.2 EQUIPMENT

A. General: Provide equipment suitable for use intended.

B. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
   1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

C. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

D. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
   1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
   2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
   3. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled.
   4. Drinking-Water Facilities: Provide bottled-water, drinking-water units.

## 3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:
   1. Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access.
   2. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
   3. Maintain support facilities until Substantial Completion

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Locate temporary roads and paved areas within construction limits indicated on Drawings.
   1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

C. Traffic Controls: Provide temporary traffic controls at junction of temporary roads with public roads. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with requirements of authorities having jurisdiction.

D. Dewatering Facilities and Drains: Comply with requirements in applicable Division 2 Sections for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain Project site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.
   2. Before connection and operation of permanent drainage piping system, provide temporary drainage.
   3. Remove snow and ice as required to minimize accumulations.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 1 Section "Execution Requirements" for progress cleaning requirements.
   1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.
   2. Develop a waste management plan for Work performed on Project. Indicate types of waste materials Project will produce and estimate quantities of each type. Provide

detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.

F. Janitorial Services: Provide janitorial services on a daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas.

## 3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints from persons or firms near Project site.

B. Stormwater Management: Provide earthen embankments and similar barriers in and around excavations and sub-grade construction, sufficient to prevent flooding by runoff of stormwater from heavy rains.

C. Wetland Plant Protection: Provide orange construction fencing where indicated on the Contract Drawings.

## 3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, or no later than Substantial Completion.
   1. Materials and facilities that constitute temporary facilities are the property of Contractor.
   2. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
   3. At Substantial Completion, clean and renovate site used during construction period. Comply with final cleaning requirements in Division 1 Section "Closeout Procedures."

END OF SECTION 01500

# SECTION 01570

# TEMPORARY EROSION AND SEDIMENT CONTROL

## PART 1 - GENERAL

### 1.1 RESPONSIBILITY

A. Assume responsibility for the temporary control of soil erosion and water pollution resulting from performance of the work of this contract.

B. In the event of conflict between these specifications and the regulation of other Federal, State, or local jurisdictions, the more restrictive regulations shall apply.

### 1.2 DESCRIPTION

A. The Work shall consist of temporary control measures as required to provide temporary control of soil erosion or water pollution.

B. Temporary measures shall include berms, sedimentation basins, silt screens, mulches, grasses, or other erosion control devices or methods as required.

### 1.3 AUTHORITY

A. The Owner's Representative has the authority to limit the surface area of erodible earth exposed by earthwork operations and to direct the Contractor to provide immediate temporary or permanent erosion or pollution control measures to minimize damage to property and contamination of watercourses and water impoundments.

### 1.4 COORDINATION AND SCHEDULING

A. Schedule the work so as to minimize the time that raw earth areas will be exposed to erosive conditions.

B. Coordinate the use of temporary controls with the permanent erosion control features or finish materials shown.

C. Incorporate permanent control features into the work at the earliest practical time.

## PART 2 - MATERIALS

### 2.1 MATERIALS

A. Mulches: Hay, straw, wood cellulose, fiber mats, geotextiles, and other materials approved by the Engineer.

B. Grasses: Seed mixture as specified in Section 02920 or other species suitable for temporary cover which will not compete with the grasses sown later for permanent cover.

C. Erosion Control Blankets: Contractor to provide the Engineer with shop drawings for the specific application for review and approval prior to installation.

## PART 3 - EXECUTION

### 3.1 WORK AREAS

A. The Owner's Representative may limit the area of clearing and grubbing and earthwork operations in progress commensurate with the Contractor's demonstrated capability in protecting erodible earth surfaces with temporary or permanent erosion control measures.

B. Under no circumstances will the area of erodible earth material exposed at one time exceed 5 acres without prior written approval of the Owner's Representative.

C. The Owner's Representative may increase or decrease the area of erodible earth material exposed at one time as determined by his analysis of project, weather and other conditions.

END OF SECTION 01570

# SECTION 01600

# PRODUCT REQUIREMENTS

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDES

A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Section 01420 - References.

C. Section 01770 - Closeout Procedures.

### 1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, which is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service

performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

## 1.4 SUBMITTALS

A. Product List: Submit a list, in tabular from, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
   1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
   2. Form: Tabulate information for each product under the following column headings:
      1) Specification Section number and title.
      2) Generic name used in the Contract Documents.
      3) Proprietary name, model number, and similar designations.
      4) Manufacturer's name and address.
      5) Supplier's name and address.
      6) Installer's name and address.
      7) Projected delivery date or time span of delivery period.
      8) Identification of items that require early submittal approval for scheduled delivery date.
   3. Initial Submittal: Within 30 days after date of commencement of the Work, submit three copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
      1) At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
   4. Completed List: Within 60 days after date of commencement of the Work, submit three copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
   5. Engineer's Action: Engineer will respond in writing to Contractor within 15 days of receipt of completed product list. Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Engineer's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number, title, and Drawing numbers and titles.
   1. Substitution Request Form: Use CSI Form 13.1A.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      1) Statement indicating why specified material or product cannot be provided.

2) Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will be necessary to accommodate proposed substitution.
3) Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
4) Product Data, including drawings and descriptions of products and fabrication and installation procedures.
5) Samples, where applicable or requested.
6) List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and Owners.
7) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
8) Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
9) Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
10) Cost information, including a proposal of change, if any, in the Contract Sum.
11) Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
12) Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
   1) Form of Acceptance: Change Order.
   2) Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Submittal Procedures." Show compliance with requirements.

## 1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
   5. Store products to allow for inspection and measurement of quantity or counting of units.
   6. Store materials in a manner that will not endanger Project structure.
   7. Store products that are subject to damage by the elements, under cover in a weather-tight enclosure above ground, with ventilation adequate to prevent condensation.
   8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   9. Protect stored products from damage.

B. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

## 1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Refer to Divisions 2 Specification Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 1 Section 1770 "Closeout Procedures."

# PART 2 - PRODUCTS

## 2.1 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures: Procedures for product selection include the following:
1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
    1) Substitutions may be considered.
2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
    1) Substitutions may be considered.
3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with the requirements.
    1) Substitutions may be considered.
4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
    1) Substitutions may be considered.
5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.
8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

1) Substitutions may be considered.

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches satisfactorily.
    1) If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
    1) Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that does not include premium items.
    2) Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 PRODUCT SUBSTITUTIONS

A. Timing: Engineer will consider requests for substitution if received within 60 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Engineer.

B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
    1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
    2. Requested substitution does not require extensive revisions to the Contract Documents.
    3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    4. Substitution request is fully documented and properly submitted.
    5. Requested substitution will not adversely affect Contractor's Construction Schedule.
    6. Requested substitution has received necessary approvals of authorities having jurisdiction.
    7. Requested substitution is compatible with other portions of the Work.
    8. Requested substitution has been coordinated with other portions of the Work.
    9. Requested substitution provides specified warranty.
    10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

## 2.3 COMPARABLE PRODUCTS

A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
   1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
   2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   3. Evidence that proposed product provides specified warranty.
   4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
   5. Samples, if requested.

## PART 3 - EXECUTION (Not Used)

END OF SECTION 01600

# SECTION 01700

# EXECUTION REQUIREMENTS

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. Field engineering and surveying.
   3. General installation of products.
   4. Coordination of Owner-installed products.
   5. Progress cleaning.
   6. Starting and adjusting.
   7. Protection of installed construction.
   8. Correction of the Work.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01310 - Project Management and Coordination.

C. Section 01330 - Submittal Procedures.

D. Section 01770 - Closeout Procedures.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed.

B. Existing Utilities: The existence and location of underground utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
      a. Description of the Work.
      b. List of detrimental conditions, including substrates.
      c. List of unacceptable installation tolerances.
      d. Recommended corrections.
   2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   3. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

## 3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2A, "Request for Interpretation."

## 3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer and Project Representative promptly.

B. General: Lay out the Work using accepted surveying practices.
   1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
   2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
   3. Inform installers of lines and levels to which they must comply.
   4. Check the location, level and plumb, of every major element as the Work progresses.
   5. Notify Engineer and Project Representative when deviations from required lines and levels exceed allowable tolerances.
   6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer and Project Representative.

## 3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
   1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer and Project Representative before proceeding.
   2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
   1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
   2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
   3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

## 3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of use.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

## 3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg. F.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

D. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

## 3.7 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction.

END OF SECTION 01700

Advancement of Construction Technology

# REQUEST FOR INTERPRETATION

Project: _____ R.F.I. Number: _____

_____ From: _____

To: _____ Date: _____

_____ A/E Project Number: _____

Re: _____ Contract For: _____

Specification Section: Paragraph: Drawing Reference: Detail:

Request:

Signed by: Date:

Response:

☐ Attachments

Response From: To: Date Rec'd: Date Ret'd:

Signed by: Date:

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

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July 1994
CSI Form 13.2A

# SECTION 01720

# FIELD ENGINEERING

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01270 – Unit Prices.

C. Section 01770 – Closeout Procedures.

D. Section 02300 – Earthwork.

E. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.2 QUALITY ASSURANCE

A. Employ an independent Land Surveyor, licensed to practice in the State of New York, for the duration of the Work, to certify the accuracy of the survey work.
   1. The word "independent" as used above means a person not in the regular employment of the Contractor or having any vested interest in the Contractor's business.

### 1.3 SUBMITTALS

A. Submit the name, address, telephone number, and registration number of the Land Surveyor before starting the survey work.

B. On request, submit documentation verifying accuracy of survey work.

C. Upon completion of the Work, submit a certificate signed and sealed by the Land Surveyor, stating that the elevations and locations of the Work are in conformance with the Contract Documents.

### 1.4 PROJECT RECORD DOCUMENTS

A. Maintain a complete and accurate log of control and survey work as it progresses.

B. Record location data for control points in sketch form and turn over 6 copies of sketches and computations to the Engineer.

C. Submit Record Documents under provisions of Section 01770.

1.5 TOOLS, EQUIPMENT, AND MATERIALS

A. Furnish all tools, equipment, and materials required to perform the work of this Section.

1.6 EXAMINATION

A. Verify locations of control points prior to starting work.

B. Promptly notify Engineer of any discrepancies discovered.

1.7 CONTROL POINTS

A. Control datum for survey is indicated on the Contract Drawings.

B. Protect control points prior to starting site work; preserve control points during construction.

C. Promptly report to Engineer the loss or destruction of any control point or relocation required because of changes in grades or other reasons.

D. Replace dislocated control points based on original survey control. Make no changes without prior written notice to the Engineer.

1.8 SURVEY REQUIREMENTS

A. Utilize recognized engineering survey practices.

B. Establish a minimum of two permanent survey markers to be used as benchmarks for vertical control on the Site where indicated on the Contract Drawings and referenced to established control points. Record locations, with horizontal and vertical data to within one one-hundredth of a foot, on Project Record Documents.

C. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
   2. Grid or axis for structures.
   3. Building foundation, column locations, ground floor elevations.

D. Verify disturbed layouts by same means.

1.9 FIELD ENGINEERING FOR CULVERTS

A. Culverts: Provide stakes at each end marked with inverts.

1.10 FIELD ENGINEERING FOR SWALES

A. Swales: Provide stakes at centerline of swales along each side of roadway.

1.11 FIELD ENGINEERING FOR LANDFILL PERIMETER ROAD

A. Place two offset stakes at each centerline station (50-foot intervals) and at tangent points, radius points, abrupt changes in grade, super-elevation, and other locations necessary to maintain layout and grade control.

B. Mark each stake with the correct centerline station number, description, offset and cut or fill.

C. Restore faded or illegible markings.

D. Provide pins and hubs directly adjacent to the Work at a spacing of 25 feet. Mark pins and affix string lines to provide adequate horizontal and vertical control for work.

E. For points of curve and tangent points provide identifying markings at the outside edge of lane.

1.12 FIELD ENGINEERING FOR GAS VENTING LAYER, BARRIER PROTECTION, AND TOPSOIL LAYER

A. Refer to Section 5 – Surveying Construction Quality Assurance and Section 6 – Documentation of the Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan) and Specification Section 02300 – Earthwork for survey line and grade requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01720

# SECTION 01770

# CLOSEOUT PROCEDURES

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Inspection procedures.
2. Project Record Documents.
3. Warranties.
4. Final cleaning.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01290 - Payment Procedures.

C. Section 01320 - Construction Progress Documentation.

D. Section 01700 - Execution Requirements.

E. Section 01781 - Project Record Documents.

F. Division 2 Specification Sections for specific closeout and special cleaning requirements for products of those Sections.

### 1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.

3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

5. Prepare and submit Project Record Documents, Final Completion construction photographs and photographic negatives, damage or settlement surveys, and similar final record information.

6. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.

7. Submit changeover information related to Owner's use, operation, and maintenance.

8. Complete final cleaning requirements.

9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for Final Completion.

## 1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section 1290 "Payment Procedures."

2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

## 1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction. Use CSI Form 14.1A.

1. Include the following information at the top of each page:
   a. Project name.
   b. Date.
   c. Name of Engineer and Project Representative.
   d. Name of Contractor.
   e. Page number.

## 1.6 WARRANTIES

A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and used by Owner during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Remove debris and surface dust from limited access spaces, including trenches, vaults, manholes, and similar spaces.
   f. Remove labels that are not permanent.
   g. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

B. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01770

Advancement of Construction Technology

# PUNCH LIST

Project: _____

_____

To (Contractor): _____

_____

From (A/E): _____

Site Visit Date: _____

A/E Project Number: _____

Contract For: _____

The following items require the attention of the Contractor for completion or correction. This list may not be all-inclusive, and the failure to include any items on this list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

| Item Number | Room Number | Location (Area) | Description | Correction/Completion Date | Verification A/E Check |
|---|---|---|---|---|---|

☐ Attachments

Signed by: Date:

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

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601 Madison Street, Alexandria, VA 22314-1791



September 1996
CSI Form 14.1A

# Certificate of Substantial Completion

| Project: | Owner: | Owner's Contract No.: |
|---|---|---|
| Contract: | | Date of Contract: |
| Contractor: | | Engineer's Project No.: |

**This [tentative] [definitive] Certificate of Substantial Completion applies to:**

☐ All Work under the Contract Documents: ☐ The following specified portions:

_____

_____

_____

_____

_____
Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

A [tentative] [revised tentative] [definitive] list of items to be completed or corrected, is attached hereto. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

**The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:**

☐ Amended Responsibilities ☐ Not Amended

Owner's Amended Responsibilities:

_____

_____

_____

Contractor's Amended Responsibilities:

_____

_____

_____

The following documents are attached to and made part of this Certificate:

_____

_____

_____

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

_____ _____
Executed by Engineer Date

_____ _____
Accepted by Contractor Date

_____ _____
Accepted by Owner Date

# SECTION 01781

# PROJECT RECORD DOCUMENTATION

## PART 1 - GENERAL

### 1.1 REQUIREMENTS INCLUDED

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.

### 1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

B. Section 01770 - Closeout Procedures.

### 1.3 SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set of marked-up Record Prints.

B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one copy of each Product Data submittal.

## PART 2 - PRODUCTS

### 2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of blue or black-line white prints of the Contract Drawings and Shop Drawings.
   1. Preparation: Mark Record Prints to show the actual installation of all contract items. Contractor is required to prepare the record drawings.

      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

      b. Information submitted shall be recorded in an understandable fashion.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.

    b. Revisions to details shown on Drawings.

    c. Locations and depths of underground utilities.

    d. Actual equipment locations.

    e. Changes made by Change Order or Construction Change Directive.

    f. Changes made following Engineer's written orders.

    g. Details not on the original Contract Drawings.

    h. Field records for variable and concealed conditions.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
5. Contractor is required to submit on 8 ½" x 11" sheets at end of project all pertinent location information i.e., tie sketches to individual water services (3 ties each min.), valve clusters w/tie information, etc.

B. Newly Prepared Record Drawings:
1. New Drawings may be required when a Change Order is issued.
2. Consult with Engineer for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

    a. Project name.

    b. Date.

    c. Designation "PROJECT RECORD DRAWINGS."

    d. Name of Engineer and Project Representative.

    e. Name of Contractor.

## 2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
   1. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
   2. Record the name of the manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
   3. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.

## 2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
   1. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

# PART 3 - EXECUTION

## 3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss.

END OF SECTION 01781

# SECTION 02230

# SITE CLEARING

## PART 1 - GENERAL

### 1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants, and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Temporary erosion and sedimentation control measures.
6. Protect and maintain existing monitoring wells indicated to remain.
7. Remove existing piezometers.

### 1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

### 1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

D. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. Contractor shall minimize disturbance to the waste.

E. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

F. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

G. Contractor shall minimize disturbance to adjacent wetlands by controlling surface runoff.

PART 2 - PRODUCTS - (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

## 3.2 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
   1. Dispose of all materials off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

## 3.3 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

   1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust. Provide temporary erosion and sediment control measures as indicated on the Contract Drawings.

   1. Dispose of excess topsoil as specified for waste material disposal.

## 3.4 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 02230

# SECTION 02300

# EARTHWORK

## PART 1 - GENERAL

### 1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. Site Clearing: Section 02230.
C. Gas Venting Risers: Section 02520.
D. HDPE Storm Drain Pipe: Section 02635.
E. Geomembrane: Section 02713.
F. Geotextiles: Section 02714.
G. Geocomposite Drain: Section 02715.
H. Site Restoration: Section 02920.
I. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.2 DEFINITIONS

A. The following terms shall have the meanings ascribed to them in this Article, wherever they appear in this Section.

1. Earth Excavation: The removal of all surface and subsurface material not classified as rock (as defined below).
2. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cubic yard. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cubic yard shall be classified as rock.
   a. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation.
3. Subgrade Surface: Surface upon which roadway subbase, landfill cap components, or topsoil is placed.
4. Subbase Surface: Roadway surface above subgrade surface.
5. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D-1557 (Method C), and ASTM D-2922 (Method B) as modified by NYSDOT in Manual STM-10.
6. Lawn Areas: Areas not covered by structures, walks, roads, paving, or parking.
7. Unauthorized Excavation: The removal of material below required elevations indicated on the Contract Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Engineer.
8. NYSDOT: New York State Department of Transportation Standard Specifications for Construction and Materials, dated May 4, 2006 and all latest addenda.

### 1.3 SUBMITTALS

A. Quality Control Submittals:

1. Materials: Name and location of source, stockpile number, and latest NYSDOT test results and approval (if any).

1.4 PROJECT CONDITIONS

A. Cold Weather Requirements:

1. Do not backfill with any frozen soil materials between November 1 and April 1, except with written permission of the Engineer.

B. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

C. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

PART 2 - PRODUCTS

2.1 MATERIALS

A. NYSDOT Select Granular Fill (Subgrade Preparation): Material shall be a sand and gravel mixture substantially free from silt, clay, shale. The material shall not contain organic matter, frozen sections, slag, cinders, ashes, rubbish, other foreign material or deleterious matters. This soil material shall be used a general fill (embankment) where indicated on the Contract Drawings. The material shall be approved by the Engineer and conform to the following gradation:

| NYSDOT Select Granular Fill U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 4 inch | 100% |
| No. 40 | 0% - 70% |
| No. 200 | 0% - 15% |

1. Magnesium Sulfate Soundness Test: Materials exceeding 30% will be rejected.

Other approved equivalent materials (Subgrade Preparation): The Contractor may propose the use of other equivalent fill materials to prepare the subgrade. All substitute materials will be reviewed by the Owner and Engineer for approval.

B. Sand (Gas Venting Layer): Material shall be a sand or a mixture of crushed stone and gravel, free of soft, nondurable particles, elongated particles or other deleterious matters. Material shall not contain organic matter, frozen sections, slag, cinders, ashes, rubbish, or other foreign material. Material shall have a minimum coefficient of permeability of $1 \times 10^{-3}$ cm/sec after compaction. The material shall be approved by the Engineer and conform to the following gradation:

| Sand<br>U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 3/4 inch | 100% |
| No. 4 | 90% |
| No. 40 | 30% - 70% |
| No. 200 | 0% - 5% |

C. Semi-Pervious Fill (Barrier Protection Layer): Material shall consist of a sand and silt mixture. The Material shall not contain organic matter, frozen sections, slag, cinders, ashes, rubbish, other foreign material or deleterious matters. The material shall be approved by the Engineer and conform to the following gradation:

| Semi-Pervious Fill<br>U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 3/4 inch | 100% |
| No. 4 | 85% - 95% |
| No. 40 | 40% - 60% |
| No. 200 | 5% - 15% |

The Contractor may propose the use of other equivalent fill materials, which may have higher percentage of fines. All substitute materials will be reviewed by the Owner and Engineer for approval.

A written affirmation by a soil scientist, agronomist, or local soil and water conservation district should be submitted to the Owner and Engineer to affirm that the topsoil layer and the barrier protection layer will, acting together, continually support growth of the proposed vegetative cover. Refer to Specification Section 02920 – Site Restoration, for topsoil layer material requirements.

D. NYSDOT Subbase Course Type 2 per NYSDOT Standard Specification Section 304 (Landfill Perimeter Road, Pipe Trench Backfill): Crushed ledge rock approved for use as subbase material, approved by the Engineer and conforming to the following gradation:

| NYSDOT Subbase Course Type 2<br>U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 2 inch | 100% |
| 1/4 inch | 25% - 60% |
| No. 40 | 5% - 40% |
| No. 200 | 0% - 10% |

1. Magnesium Sulfate Soundness Test: 20% maximum loss by weight after 4 test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve shall not exceed 5.0.
3. Elongated Particles: Not more than 30%, by weight, of the particles retained on a 2-inch sieve shall consist of flat or elongated particles. A flat or elongated particle is defined as one,

which has its greatest dimension more than 3 times its least dimension.

E. NYSDOT No. 1 & 2 Crushed Stone per NYSDOT Standard Specification Table 703-4 (Pipe Trench Bedding and Backfill, Toe Anchor Trench): Crushed stone shall be washed and conform to a 1:1 mix ratio. Material shall be substantially free from silt, clay and organic matter. It shall not contain frozen sections, slag, cinders, ashes, rubbish, other foreign material and deleterious matters. The material shall be approved by the Engineer and conform to the following gradation:

| NYSDOT No. 1 Crushed Stone U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 1 inch | 100% |
| 1/2 inch | 90% - 100% |
| 1/4 inch | 0% - 15% |
| No. 200 | 0% - 1% |

| NYSDOT No. 2 Crushed Stone U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 1-1/2 inch | 100% |
| 1 inch | 90% - 100% |
| 1/2 inch | 0% - 15% |
| No. 200 | 0% - 1% |

F. NYSDOT Stone Filling (Rip Rap) per NYSDOT Standard Specification Figure 620-1: Provide sound, durable, stone complying with the following requirements:

1. Freeze-Thaw Test: A maximum of 10% loss, by weight, after 25 cycles of freezing and thawing.
2. Magnesium Sulfate Soundness Test: A maximum 10% loss, by weight, after 10 cycles of the magnesium sulfate soundness test.
3. Materials shall contain less 20% of stones with a ratio of maximum to minimum dimension greater than three.
4. Cobbles or gravel having at least one fractured face per particle are acceptable substitutes for stone under these items, provided that soundness and gradation requirements are met.
5. Materials shall contain a sufficient amount of stones smaller than the average stone size to fill the spaces between the larger stones.

| Rip Rap NYSDOT Fine Stone Filling Stone Size | % of total by weight |
|---|---|
| Smaller than 8 inches | 90% - 100% |
| Larger than 3 inches | 50% - 100% |
| Smaller than No. 10 sieve | 0% - 10% |

| Rip Rap NYSDOT Light Stone Filling Stone Size | % of total by weight |
|---|---|
| Lighter than 100 lbs. | 90% - 100% |
| Larger than 6 inches | 50% - 100% |
| Smaller than ½ inch | 0% - 10% |

| Rip Rap NYSDOT Medium Stone Filling Stone Size | % of total by weight |
|---|---|
| Heavier than 100 lbs. | 50% - 100% |
| Smaller than 4 inches | 0% - 10% |

Bedding material shall be composed of crushed stone or gravel, free of soft, nondurable particles, organic material, and thin or elongated particles. The material shall be approved by the Engineer and conform to the following gradation:

| Rip Rap Bedding Material U.S. Sieve Designation | % by weight passing square opening |
|---|---|
| 4 inch | 100% |
| 1 inch | 15% - 60% |
| 1/4 inch | 0% - 25% |
| No. 40 | 0% - 10% |

G. The following soils materials are deemed unsatisfactory and unacceptable for use, defined as those complying with ASTM D-2487 (USCS) soil classification groups GC, SC, ML, CL, CH, OL, OH, and PT.

H. Soil materials shall be screened with wire mesh screens instead of bar screens to ensure that all aggregates are screened to the specified sizes herein.

## PART 3 - EXECUTION

### 3.1 EROSION & SEDIMENT CONTROL MEASURES

A. Prior to any construction activities, install temporary erosion and sediment control barriers or measures as indicated on the Contract Drawings. Temporary structural practices are used during construction to prevent offsite sediment transport. The length of time that temporary practices are functional varies since the sediment control strategy may change as construction activity progresses.

B. The general locations of temporary erosion and sediment control measures as indicated on the Contract

Documents can be modified with approval by the Engineer. Additional materials may be needed in other locations not indicated, due to the Contractor's construction activities and for the maintenance and protection of his work. The Contractor is responsible for these additional materials

C. Staging of Earthwork Activities: All earthwork shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

D. The Contractor is fully responsible for maintaining, repairing, and protecting his work throughout the Project, at no additional cost to the Owner, until the Owner accepts the Work. The Contractor shall make all erosion repairs within three days after any rainfall event. The Contractor shall use the erosion and sediment control measures detailed in the Contract Documents, as well as measures defined in the NYS Standards & Specifications for Erosion & Sediment Control - August 2005 version (a.k.a., "Blue Book") to maintain and protect his work.

E. The measures are temporary, and shall be removed and the areas restored to its original condition when they are no longer required, at no additional cost to the Owner.

F. During the final site restoration, the Contractor shall remove all sediment and debris deposited in the temporary and permanent erosion and sediment control barriers or measures including but not limited to all culverts, stormwater ponds, and drainage swales, at no additional cost to the Owner.

## 3.2 DUST CONTROL

A. The release of dust from the site shall be controlled by the use of water spray on temporary access and haul roads and work areas. Dust generation is expected to be more prevalent during dry weather. It is the Contractor's responsibility to maintain control of nuisance dust.

## 3.3 EXCAVATION

A. Excavate earth as required for the Work.

B. Maintain sides and slopes of all excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).

C. Stockpile excavated materials classified as suitable material where directed, until required for fill. Place, grade, and shape stockpiles for proper drainage as approved by the Engineer. Stockpile soil materials without intermixing. Cover stockpiles to prevent wind-blown dust. Install erosion control measures around the base of the stockpile as indicated on the Contract Drawings.

D. Utility Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Unless otherwise indicated on the Contract Drawings, excavate trenches approximately 24 inches wide plus the outside pipe diameter, equally divided on each side of the pipe centerline. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe. Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

1. Utility Pipe Trenches in Rock: Excavate an additional 6 inches below bottom of pipe for bed

of Pipe Zone Bedding and Backfill material under the pipe.

E. Removal of Unsuitable Materials: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the Engineer. Have cross sections taken, under the supervision of an independent Land Surveyor, to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor, will be paid for in accordance with the Change Order procedures of the Contract Documents. Contractor shall remove all unexcavated and unsuitable materials, daily from the Site as it accumulates. All materials shall be disposed of at a proper licensed disposal facility, at the Contractor's expense.

F. Notify the Engineer upon completion of excavation operations. Do not proceed with the Work until the excavation is inspected and approved. Inspection of the excavation by the Engineer will be made on 3 working days notice.

## 3.4 DEWATERING

A. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

B. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

C. Convey clean water (i.e., water that does not contact solid waste) removed from excavations, and rain water, to a collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

D. Leachate (i.e., water that has been in contact with solid waste) cannot be conveyed since it will impact surface water.

E. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

## 3.5 CHEMICAL CONTAMINATION TESTING

A. All soil materials shall be free of contamination. Prior to importing the Sand (Gas Venting Layer), Semi-Pervious Fill (Barrier Protection Layer), and Topsoil, one composite sample shall be collected from each borrow source. The sample shall be sent to an approved laboratory and analyzed for the following:

| Sand (Gas Venting Layer)<br>Semi-Pervious Fill (Barrier Protection Layer)<br>Topsoil<br>Chemical Contamination Testing Requirements | |
|---|---|
| Test Method | Frequency |

| | |
|---|---|
| EPA 8260B for VOCs<br>EPA 8270C for SVOCs<br>EPA 8082 for PCBs<br>EPA 6010B/6020 for TAL metals<br>EPA 8081A for Pesticides<br>EPA 9012B for Cyanide<br>EPA 8151A for Chlorinated Herbicides | 1 sample per source, a composite of 5 samples |

B. The Engineer will review the results of the testing to determine if the soil is acceptable based upon the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) No. 4046 and NYCRR Part 375-6 for each compound. All test results, TAGM Standards and NYCRR Part 375-6 Standards, shall be summarized in columns in an electronic spreadsheet from the laboratory and submitted by the Contractor to the Engineer for comparison, prior to the delivery of any materials to the site. Once the source has been prescreened and approved, Quality Control testing will be performed on the soil material based upon the frequencies outlined in the Specifications.

## 3.6 PLACING FILL AND BACKFILL

A. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Prior to placement of fill, smooth out and compact areas where wheel rutting has occurred due to stripping or earthwork operations.

B. Excavations: Backfill as promptly as Work permits, but not until completion of the following:
   1. Acceptance by the Engineer of construction below finished grade including bearing capacity of supporting soil.

C. Place backfill materials in layers not more than 12 inches thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill material on surfaces that are muddy, frozen, or covered with ice.
   1. Place backfill in confined areas i.e., utility pipe trenches, not easily accessible by larger compaction equipment, in maximum 6 inch thick (loose depth) layers.
   2. For large fill areas, the layer thickness may be modified by the Engineer, at the Contractor's written request, if in the Engineer's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request shall include the type and specifications of compaction equipment intended for use.
   3. Place soil over geosynthetics starting from the toe of slope and working upwards. Any other method is subject to Engineer acceptance, including the construction of temporary roads to facilitate the Contractor's operations.

D. Utility Pipe Trenches: Place pipe zone bedding and backfill and trench backfill materials, as indicated on the Contract Drawings.

E. Lawn Areas: Place NYSDOT Select Granular Fill when required to complete fill or backfill areas up to subgrade surface elevation below topsoil layer, in areas outside of the landfill cap only.

F. Contractor shall survey lines and grades (Surveying Construction Quality Assurance) of the subgrade layer, gas venting layer, barrier protection layer, and topsoil layer upon construction completion, to verify that the compacted thicknesses of the soil materials are in accordance with the Contract

Documents. The following spacing and locations shall be provided, as a minimum, for survey points (spot checks):

1. Surfaces with slopes less than 10% shall be surveyed on a square grid not wider than 25 feet with additional locations at grade breaks.
2. On slopes greater than 10%, a square grid not wider than 25 feet shall be used; in any case, a line at the crest, midpoint, and toe of the slope shall be taken, as well as at grade breaks.
3. A line of survey points no farther than 25 feet apart shall be taken along any slope break (this shall include the inside edge and outside edge of any bench on a slope).
4. The survey grid shall be consistent and similar in location for each lift and layer, so that the survey points can be checked in the same location to compare and confirm thicknesses.

Thicknesses may also be field spot checked by the Owner and Engineer thru test pits. Field survey data shall be retained by the Contractor's chief surveyor. The results from the field surveys shall be documented on a set of survey record (as-built) drawings. These drawings should, at a minimum, show all elevations of the surfaces surveyed. Any deficiencies in thickness shall be corrected before placement of the subsequent layer.

G. Backfilling Excavation Resulting From Removal of Unsuitable Material: Backfill the excavation with compacted NYSDOT Select Granular Fill material. Such additional backfilling, will be paid for in accordance with the Change Order procedures of the Contract Documents.

## 3.7 ROUGH GRADING

A. Exterior Grading: Trim and grade area within the Project area and excavations outside the Project area, required by this Contract, to a level of 4 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide smooth uniform transition to adjacent areas.

1. Slope cut and fill in transition areas, outside of the project work limits, to meet corresponding levels of existing grades at a maximum slope of 1 vertical to 3 horizontal.
2. Lawn Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within 3 inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top 3 inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of 3 inches immediately prior to placing topsoil.

## 3.8 FINISHED GRADING

A. Uniformly grade rough graded areas within the project work limits, to the finished grade elevations indicated.

B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finished elevations are indicated or between such points and existing finished grade.

C. Finish surfaces shall be free from irregular surface changes and depressions, which will trap water.

D. Spread topsoil directly upon prepared subgrade surface to a depth measuring 6 inches after natural settlement of the topsoil has occurred in areas to be seeded or to receive sod. Place to greater depth

when necessary to adjust grades to required elevations.

1. Approved existing topsoil within the Project area may be used. Provide additional topsoil from outside sources as required.

## 3.9 COMPACTION

A. Compact each layer of soil material to a minimum 92% Modified Maximum Density and at a moisture content suitable to obtain the required densities, but at not less than 3% drier or more than 2% wetter than the optimum content as determined by ASTM D-1557.

B. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density, if necessary.

C. Moisture Control:
   1. Where backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
   2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value, which will permit compaction to the percentage of maximum density specified.

D. Compaction Testing: Notify the Engineer at least 3 working days in advance of all phases of backfilling operations. The Contractor is responsible for compaction testing to ascertain the compacted density of the backfill materials. Compaction testing will be performed on certain layers of the backfill as determined by the Engineer. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and will be retested. No additional material may be placed over a compacted layer until the specified density is achieved. Testing methods shall no damage installed work. Perform in-place field density tests in accordance to the Modified Proctor Maximum Density (ASTM D-1557), at the following test intervals:
   1. Utility Pipe Trenches: (1) test per compacted lift per 50 linear feet of pipe length.
   2. Select Granular Fill, Gas Venting Layer, & Barrier Protection Layer Materials:

| Test | Test Method | Frequency |
|---|---|---|
| Compaction Characteristics of Soil | ASTM D-1557 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Density of Soil In-Place by Nuclear Methods | ASTM D-2922 | 9 tests per acre per lift |
| Rapid Moisture Content | ASTM D-3017 | 9 tests per acre per lift |

## 3.10 QUALITY ASSURANCE TESTING REQUIREMENTS

A. The Contactor shall perform or direct the performance by qualified subcontractors of testing of the sand and semi-pervious fill. The sample collection and testing shall be performed at the direction and frequency shown in the Specifications and as shown in the Tables below.

The individual performing the testing or the testing oversight shall have demonstrated knowledge in the pertinent testing procedure, and shall be approved in writing by the Contractor. This written approval shall include documentation of the technician's qualifications. Test results shall be submitted to the Engineer when available.

| Sand (Gas Venting Layer)<br>Semi-Pervious Fill (Barrier Protection Layer)<br>Quality Assurance Testing Requirements | | |
|---|---|---|
| Test | Test Method | Frequency |
| Compaction Characteristics of Soil | ASTM D-1557 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Density of Soil In-Place by Nuclear Methods | ASTM D-2922 | 9 tests per acre per lift |
| Rapid Moisture Content | ASTM D-3017 | 9 tests per acre per lift |
| Particle Size Analysis | ASTM D-422 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Atterberg Limits | ASTM D-4318 | 1 test per 1,000 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Unified Soil Classification System | ASTM D-2487 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Moisture Content | ASTM D-2216 | 1 test per 1,000 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change |
| Hydraulic Conductivity (less than 1 x $10^{-3}$ cm/sec) | ASTM D-5084 | 1 test per 2,500 $yd^3$ of borrow, minimum of 2 tests per source, additional tests when material characteristics change. |

## 3.11 MAINTENANCE AND RESTORATION

A. Restore grades to indicated levels where settlement or damage due to performance of the Work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

B. Restore lawns and other exterior surfaces damaged during performance of the Work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

C. Topsoil and seed or sod damaged lawn areas outside the Project area, at no additional cost to the Owner. Topsoil and seed new lawn areas inside the Project area. Water as required until physical completion of the Work

## 3.12 PROTECTION

A. Protect graded areas from traffic and erosion, and keep them free of trash and debris.

END OF SECTION 02300

# SECTION 02520

# GAS VENTING RISERS

## PART 1 - GENERAL

### 1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

### 1.2 SUBMITTALS

A. Product Data: Manufacturer's specifications with detailed information regarding dimensions, pressure rating, fittings and installation instructions. Manufacturer's data must indicate compliance with the standards specified herein.

### 1.3 PROJECT CONDITIONS

A. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

B. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Each length of pipe shall be marked to identify size, material type and grade, pressure rating, ASTM Designation, manufacturer, and NSF approval.

### 2.2 POLYVINYL CHLORIDE (PVC) PIPE & FITTINGS

A. PVC Pipe & Fittings: ASTM D-3034 (SDR-26). Where required, perforations shall be 1/2 inch diameter, 5 inches center-to-center, 3 rows at 120 degrees apart.

B. Insect Screen: Stainless steel, Type 304, to fit over PVC gooseneck cap, Mozzi Stoppa Screen by Rain Harvesting, PO Box 311, Archerfield QLD 4108, Australia, or approved equivalent.

### 2.3 SOLVENT CEMENTS

A. Solvent cement used for joining plastic pipe and fittings shall meet ASTM D-2564.

2.4 FILTER SOCK

A. Filter sock shall be a polyester machine-knitted envelope that stretches to fit snugly over the pipe, while allowing water entry and preventing sediment intrusion in the pipe perforations. Material shall meet the following requirements:

| FILTER SOCK | | |
|---|---|---|
| Geotextile Property | Test Method | Property Required |
| Fiber Size [denier per filament] | N/A | 100 to 200 |
| Weight [oun./sy] | ASTM D-3776 | 2.5 – 3.5 |
| Air Permeability [cfm/sf] | ASTM D-737 | 700 |
| Burst Strength [psi] | ASTM D-3786 | 100 - 135 |
| Equivalent Opening Size | USACOE W02215 | 30 - 40 |

B. Acceptable Manufacturer: ADS Sock® Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe and fittings before installation. Remove defective materials from the Site.

B. Do not backfill before installation is inspected by the Engineer.

3.2 GENERAL

A. Install pipe in accordance with the manufacturer's recommendations and as specified in ASTM D-2321.

B. Join PVC pipe with solvent cemented joints as recommended by ASTM D-2855.

3.3 INSTALLATION

A. Joints:
1. Wipe inside of sockets and outside of pipe to be jointed, clean and dry.

B. Filter Sock: Install filter sock in accordance with the manufacturer's recommendations.

C. Insect Screen: Install insect screen over PVC gooseneck caps.

END OF SECTION 02520

SECTION 02635

HDPE STORM DRAIN PIPE

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Construction Quality Assurance and Construction Quality Control Plan (CQA/CQC Plan).

1.2 SUBMITTALS

A. Product Data: Manufacturer's specifications (AASHTO M-252 or AASHTO M-294), including dimensions, allowable height of cover information, and installation instructions.

1.3 PROJECT CONDITIONS

A. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

B. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

PART 2 - PRODUCTS

2.1 PIPE

A. Corrugated Polyethylene Pipe (HDPE, Dual Wall with Smooth Interior): Conform to AASHTO M-294 (12 to 36-inch diameter).
   1. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
   2. Classification: Soil-tight, integral bell and spigot joints. Joints shall be sealed with factory installed rubber O-ring gaskets that meet ASTM F-477.
   3. Minimum Pipe Stiffness Values:

| DIAMETER | PIPE STIFFNESS (PER ASTM D-2412) |
|---|---|
| 4" - 12" | 50 pii |
| 15" | 42 pii |
| 18" | 40 pii |

| | |
|---|---|
| 24" | 34 pii |
| 30" | 28 pii |
| 36" | 22 pii |

4. Joint Couplings (Soil-tight): Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F-477.
5. Fittings:
   a. High density polyethylene meeting the properties specified for the pipe.
   b. Either molded or fabricated.
   c. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
6. Acceptable Manufacturer: ProLink ST (N-12 IB ST), Smooth Interior Pipe & Fittings by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

B. High-Density Polyethylene (HDPE) Pipe for Toe Drains: Plain end pipe, slotted, dual wall, smooth interior and annular exterior corrugations: Conform to AASHTO M252, Type S.
1. Joint Couplings: HDPE coupling split coupler bands.
2. Fittings:
   a. HDPE meeting the properties specified for the pipe.
   b. Either molded or fabricated.
   c. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
3. Acceptable Manufacturer: ADS N-12® Plain End Pipe by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

## 2.2 FLARED END SECTION

A. Flared End Sections: Galvanized steel manufactured from material meeting the requirements of AASHTO M-218.
1. Conform to shape, dimensions, and thickness shown on the drawings.
2. Use only extra length rod and lug-type, galvanized coupling band connectors.

## 2.3 ANIMAL GUARD

A. Acceptable Manufacturer: Animal Guard by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

# PART 3 - EXECUTION

## 3.1 MAINTENANCE OF EXISTING STORMWATER FLOWS

A. Provide all temporary facilities required to safely and adequately bypass existing stormwater flows from the Work area during construction, to the satisfaction of the Owner.

B. The bypassing of such flows shall prevent any hazards to public health and welfare when the stormwater flows are bypassed from the Work area during construction.

C. The Contractor is fully responsible for any and all damages to construction, adjacent properties, utilities, and/or buildings in the area caused by these operations.

3.2 INSTALLATION

A. Laying: Lay pipe to indicated line and grade with a firm uniform bearing for the entire length of the pipe. Fill excess excavation with suitable materials and tamp.

B. Joints: Install coupling and fasten per manufacturer's instructions.

C. Install flared end section in accordance with the Contract Drawings and manufacturer's instructions.

D. Install animal guard in accordance with the manufacturer's instructions.

END OF SECTION 02635

# SECTION 02713

# GEOMEMBRANE

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. This Section includes geomembrane covers for landfill closure. Furnish and install Textured Linear Low Density Polyethylene (LLDPE) geomembrane as specified herein, as shown on the Contract Drawings, and in accordance with manufacturer's recommendations. LLDPE geomembrane shall be placed on the landfill and shall be textured on both sides.

B. Engage an independent qualified Geosynthetics testing agency (Quality Control Agency), accredited by the Geosynthetics Accreditation Institute, with at least 2 years' experience in the testing of geosynthetics to provide the quality control testing and inspection required by this section.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Geocomposite Drain: Section 02715.

D. Quality Assurance and Quality Control Plan.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide geomembrane cap/covers that prevent the passage of water.

### 1.4 SUBMITTALS

A. Product Data: For the following:
   1. Seaming adhesives, solvents, and extrusions.

B. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples for Verification: For each geomembrane panel, not less than one 12-inch seam length of factory-bonded sheets and one 12-inch seam length of field-bonded sheets.

D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

E. Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.

F. Qualification Data: For Installer and manufacturer.

G. Material Test Reports: For each geomembrane panel material.

H. Material Certificates: For each geomembrane panel material, signed by manufacturers.

I. Field quality-control test reports.

J. Maintenance Data: For geomembrane liner to include in maintenance manuals.

K. Warranty: Special warranty specified in this Section.

L. Record / As-Built Drawings

## 1.5 QUALIFICATIONS

A. An experienced installer who has specialized in installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to geomembrane manufacturer. The field crew foreman of the liner installer must have a documented minimum qualification of successful installation experience of at least 50 acres of previous landfill or comparable geosynthetic systems, on a minimum of 5 different projects. Installers experience shall be submitted to the Owner and Engineer in writing, prior to the commencement of work.

B. Manufacturer shall have at least 5 years continuous experience in manufacturing polyethylene geomembrane and/or experience totaling 10,000,000 square feet of manufactured polyethylene geomembrane and with a record of successful in-service performance.

C. Source Limitations: Obtain geomembrane liner panels, accessories, and required seaming materials, solvents, and adhesives through one source from a single manufacturer.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Specification Sections.

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
2. Review structural load limitations.
3. Review limitations on equipment and installer's personnel.
4. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
5. Review required testing, inspecting, and certifying procedures.
6. Review existing and forecasted weather conditions and procedures for unfavorable conditions.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane liners to be performed according to manufacturers' written instructions and warranty requirements.

B. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

C. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

1.7 WARRANTY

A. Provide a 5-year written warranty by the Geomembrane Manufacturer and Geosynthetics Installer to the benefit of the Owner against defects in materials and workmanship of the installed geomembrane, and in-ground durability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide 40-mil Textured Linear Low Density Polyethylene geomembrane (CX-T-LLDPE), as manufactured by Poly-Flex, Inc., or approved equivalent.

2.2 RESIN

A. The geomembrane shall be manufactured from virgin polyethylene resin, and shall be designed and manufactured specifically for use in geomembranes.

B. Reclaimed/recycled polymer shall not be added to the resin. However, the use of re-worked polymer during the manufacturing process shall be permitted if performed with appropriate cleanliness, and if the recycled polymer does not exceed 5% by weight of the total polymer weight.

C. Resin shall comply with the following specified properties:
   1. Specific Gravity: Linear low density, 0.915 to 0.926 g/cc, per ASTM D-1505,
   2. Melt Flow Index: Not more than 0.021 oz./10 minutes per ASTM D-1238, Condition E 190eC, 2.16 kg,
   3. Carbon Black Content: 2 to 3% per ASTM D-1603.

## 2.3 GEOMEMBRANE PROPERTIES

A. Geomembranes shall meet the following Specifications:

1. Nominal Thickness: 40-mil thick sheet per ASTM D-5994.
2. Carbon Black Dispersion: Per ASTM D-5596, Note 1.
3. Tensile Properties: Not less than indicated for each direction, per ASTM D-638.
    a. Strength at Break: 60 lbf/in.
    b. Elongation at Break: 250%.
4. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2% per ASTM D-1204.
5. Tearing Resistance: Not less than 22 lbf per ASTM D-1004.
6. Puncture Resistance: Not less than 45 lbf per ASTM D-4833.
7. Seam Properties: Not less than indicated for each direction, per ASTM D-6392.
    a. Shear Strength: 60 lbf/in.
    b. Peel Strength: 50 lbf/in. for hot wedge and 44 lbf/in. for extrusion fillet
8. Geomembranes shall:
    a. Contain a maximum of 1% by weight of additives, fillers, or extenders (not including carbon black);
    b. Not have striations, roughness (except in the case of textured geomembranes where a roughened surface is characteristic), pinholes, or bubbles on the surface/interior;
    c. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter; and
    d. Be manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness).
    e. Pass the required interface friction angle testing as per Subsection 2.7.
9. Shall be shipped on rolls, not folded.
10. Shall be shipped free of any factory seams.

## 2.4 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

## 2.5 MANUFACTURING QUALITY CONTROL

A. Manufacturer shall test each batch of base resin to ensure consistency and quality of the raw material. Tests shall include Density, Melt Flow Index, Volatiles Content and Oxidation Induction Time.

B. Each roll shall be continuously monitored across its full width to assure uniformity of thickness. At no point shall the thickness of the roll be more than 5% below the specified nominal thickness.

C. The geomembrane quality control testing shall meet the following frequency requirements:

| Property | Test Method | Testing Frequency (min.) |
|---|---|---|
| Thickness (textured sheet) | ASTM D-5994 | per roll |
| Asperity Height (textured sheet only)<br>Alternate the measurement side for double-sided textured sheet. | GRI GM12 | every second roll |
| Sheet Density | ASTM D-1505/D-792 | 200,000 lb |
| Tensile Properties<br>1. Break Strength<br>2. Break Elongation | ASTM D-6693 | 20,000 lb |
| 2% Modulus<br>(LLDPE only) | ASTM D-5323 | per each formulation |
| Tear Resistance | ASTM D-1004 | 45,000 lb |
| Puncture Resistance | ASTM D-4833 | 45,000 lb |
| Axi-Symetric Break Strain<br>(LLDPE only) | ASTM D-5617 | per each formulation |
| Carbon Black Content | ASTM D-1603 | 20,000 lb |
| Carbon Black Dispersion | ASTM D-5596 | 45,000 lb |
| Oxidative Induction Time (OIT)<br>Standard OIT | ASTM D-3895 | 200,000 lb |
| Oven Aging at 85°C<br>High Pressure OIT | ASTM D-5721<br>ASTM D-5885 | per each formulation |
| UV Resistance<br>High Pressure OIT | GRI GM11<br>ASTM D-5885 | per each formulation |

D. The welding rod shall be tested at the frequency of once per 25 rolls of welding rod. The following tests shall be performed on the sample.

1. Diameter ASTM D-5199
2. Density ASTM D-1505
3. Melt Index ASTM D-1238
4. Carbon Black Content ASTM D-1603

## 2.6 LABELING

A. Geomembrane rolls shall be wrapped in protective covers and labeled with the following information.
   1. Product identification
   2. Roll number
   3. Product thickness
   4. Length and Width dimensions
   5. Resin type
   6. Date of manufacture

## 2.7 CONFORMANCE TESTING

A. Interface strength tests shall be performed on the following interfaces:
   1. Geocomposite on Textured Geomembrane.
   2. Textured Geomembrane on compacted gas venting layer material.

B. Interface strength test reports shall include a minimum: sample size, summary of test methods and procedures employed, strain rates utilized during shear, shear stress-deflection plots, normal stress-shear plots, peak and residual interface strength values, and strength envelope plots.

C. The test procedure shall include:
   1. Retain the services of approved independent testing laboratory to perform interface strength testing.
   2. Provide representative samples of candidate materials in sufficient quantity for required testing. Material samples shall not be used for more than one test data point.
   3. Testing procedures shall be in accordance with ASTM D-5321 – Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
   4. The shear box shall be a minimum of 12 inches by 12 inches in size.
   5. Laboratory test samples shall be oriented to shear in the same direction, as they will be loaded in the field.
   6. Geosynthetic materials shall not be affixed to a substrate for the entire area of the sample and shall be allowed to strain during shearing. Where possible, "free shear" testing procedures shall be used.
   7. Soil/Geosynthetic interfaces shall be sheared at a strain rate, which will allow pore pressure to dissipate at the soil/geosynthetic interface. Provide evidence that pore pressures do not build up. Maximum strain rate for soil/geosynthetic interfaces shall be 0.04 inches per minute.
   8. All tests shall be performed so that both peak interface strength and residual interface strength values are determined. Determine residual shear values after at least 2 inches of displacement.

D. To be acceptable, the geocomposite to texture geomembrane interface shall exhibit effective friction angles of at least 25 degrees residual.

E. To be acceptable, the textured geomembrane to compacted gas venting layer material interface shall exhibit effective friction angles of at least 26 degrees residual.

F. Tests shall be conducted with the following conditions:
   1. Normal stresses shall be determined later for each interface strength test.
   2. Direct shear interface tests of textured geomembrane on compacted gas venting layer material shall be performed after compacting the granular material in the shear box at moisture conditions 2 to 3% wet of optimum moisture content and soaking the surcharged sample for 4 hours or until saturated, whichever is greater. Soil material shall be compacted to densities corresponding with the minimum density requirements for the constructed work.
   3. All interface direct shear tests shall be performed in a soaked condition.

G. Any interface, which fails to achieve the specified minimum effective friction angles, shall be retested at the Contractor's expense until specified results are obtained. This may involve the Contractor selecting different combinations of materials. Materials, which meet all other requirements of the Contract Documents but do not achieve acceptable interfacial friction angles relative to the adjacent layers will not be approved.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Transportation, Storage, and Handling:
   1. The geomembrane rolls shall be packaged and shipped by appropriate means so that no damage is caused. Transportation shall be the responsibility of the installer.
   2. Offloading and storage of the geomembrane is the responsibility of the installer. Rolls shall be stored off the ground and protected from direct sunlight, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall be stored in accordance with any additional requirements of the manufacturer.
   3. Handle geomembrane rolls only with manufacturer approved equipment and methods to minimize risk of damage to material.

B. Surface Preparation
   1. The Engineer shall inspect the subgrade preparation. Prior to liner installation, the subgrade shall be compacted in accordance with the Project Specifications. Weak or compressible areas, which cannot be satisfactorily compacted, should be removed and replaced with properly compacted gas venting layer material.
   2. All surfaces to be lined shall be smooth, free of all foreign and organic material, sharp objects, or debris of any kind.
   3. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade.
   4. Standing water or excessive moisture shall not be allowed.
   5. The installer, on a daily basis, shall approve the surface on which the geomembrane will be installed. After the supporting soil surface has been approved, it shall be the installer's responsibility to indicate to the inspector any changes to its condition that may require repair work.
   6. Excavate anchor trenches and prevent from sloughing.
   7. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Placement Conditions:
   1. Field panels shall be placed one at a time, and each field panel shall be seamed to adjacent panels the same day that it is placed. Install geomembranes in a relaxed condition and free of tension or stress. Stretching of geomembranes is prohibited.
   2. Geomembranes shall be placed when between ambient air temperatures of 32°F and 104°F.
   3. Geomembranes shall not be placed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of winds exceeding 20 miles per hour.
   4. No vehicular traffic shall be allowed on the geomembrane.
   5. Equipment shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.
   6. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
   7. Minimize wrinkles (especially differential wrinkles between adjacent panels).
   8. Temporary loads and/or anchors (e.g., sand bags, tires) not likely to damage the geomembrane should be placed on the geomembrane to prevent uplift by wind. In high wind conditions, continuous loading along the edge of the panels is recommended.
   9. Any field panel or portion thereof, which becomes damaged (torn, twisted, or crimped), shall be replaced with new material at no cost to the Owner. Less serious damage may be repaired at the Engineer's sole discretion and at no cost to the Owner. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area.

B. Exposure to UV
   1. All geomembranes shall be covered within 14 days. If a geomembrane will be left exposed for more than 14 days, the manufacturer shall provide field UV test data and written recommendations for the maximum time of UV exposure prior to material shipment.
   2. Geomembrane left exposed for more than 14 days may be sampled and tensile strength tests performed every 4 weeks. Sample areas shall be immediately repaired. If the tensile strength of the geomembrane falls below 90% of the original values within the recommended exposure period, the manufacturer will replace the defective material.

## 3.3 FIELD SEAMING

A. Approved seaming processes are double fusion and extrusion welding. Extrusion welding shall be the primary welding procedure. On side slopes, seams shall be oriented in the general direction 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. No base T-seam shall be closer than 5 feet from the 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.

B. All personnel performing seaming operations shall be qualified and trained in the operation of the specific seaming equipment being used.

C. Proceed with seaming at required temperatures for materials and ambient conditions. Field seaming is prohibited when either air or sheet temperature is below 32°F, when the air temperature is above 104°F, during periods of precipitation, or when winds are in excess of 20 miles per hour.

D. Form seams by lapping edges of panels 6 inches.

E. Prior to seaming, the seam area shall be cleaned and made free of moisture, dust, dirt, debris of any kind, and foreign material. Cleaning solvents may not be used unless the product is approved by the liner manufacturer.

F. Seaming equipment shall be operated in a manner that does not cause damage to the geomembrane. Only apparatus that the Engineer has specifically approved by make and model shall be used. Proposed alternate seaming procedures shall be documented and submitted to the Engineer for review.

G. Extrusion Equipment and Procedures:
   1. The Geosynthetics Installer shall maintain at least one spare operable extrusion seaming apparatus on site at all times.
   2. Extrusion welding apparatus shall be equipped with gauges giving temperature in the apparatus and at the nozzle.
   3. Prior to beginning a seam, the extruder shall be purged 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.
   4. The Geosynthetics Installer shall provide documentation regarding the extrudate to the Engineer and shall certify that the extrudate is compatible with the Specifications and consists of the same resins as the geomembrane.
   5. The electric generator used for power supply to the welding machines shall be placed outside the area to be lined or mounted on soft tires such that no damage occurs to the geomembrane. The electric generator shall be equipped with a grounding rod that is driven into the ground outside the lined area. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

H. Field Test Seams:
   1. Field test seams (textured to textured welds and textured to smooth welds) shall be conducted on the liner to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period and at least once every 4 hours, for each seaming apparatus, type seam (smooth/smooth, smooth/textured, textured/textured) and personnel used that day and when significant changes in geomembrane temperature are observed.
   2. All test seams shall be made in contact with the subgrade. Welding rod used for extrusion welding shall have the same properties as the resin used to manufacture the geomembrane. The test seam samples shall be 10 feet long for fusion welding and 3 feet long for extrusion welding with the seam centered lengthwise. Five specimens shall be cut from each end of the test seams by the inspector. The inspector shall use a tensiometer to test 5 specimens for both shear and peel. Four out of five specimens shall meet the strength requirements. Each specimen shall be 1-inch wide with a grip separation of 4 inches plus the width of the seam. The seam shall be centered between the clamps. The rate of grip separation shall be 2 inches per minute.

3. Field test seam testing shall be performed in accordance with ASTM D-6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods. For both smooth and textured seams, the strength of four out of five 1-inch wide strip specimens should meet or exceed values given in this Specification. The fifth specimen must meet or exceed 80% of the given values. The shear percent elongation should exceed 50%. The assumed gauge length is considered the unseamed sheet material on either side of the welded area. Elongation measurements should be omitted for field testing. In addition, the peel separation should not exceed 25% based on the proportion of area of separated bond to the area of the original bonding. Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in the ASTM D-6392. In this regard, SIP is an acceptable break code.
   a. Unacceptable Break Codes
      1) Hot Wedge: AD and AD-BRK > 25%
      2) Extrusion Fillet: AD1, AD2 and AD-WELD (unless strength is achieved)

I. Non-Destructive Seam Testing:
1. The Geosynthetics Installer shall nondestructively test all field seams over their full length using vacuum box testing, or other approved method. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. The installer shall complete any required repairs in accordance with Part 3.3K of this Section. The following shall apply to locations where seams cannot be non-destructively tested.
   a. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.
   b. If the seam cannot be tested prior to final installation, overlay all seams with the same geomembrane. The seaming and patching operation must be inspected by the project engineer for uniformity and completeness.
2. The Engineer must:
   a. Monitor all non-destructive testing.
   b. Record the location, date, test unit number, name of tester, and results of all testing.
   c. Inform the installer of any required repairs.
3. Vacuum Box Testing
   a. Shall be performed in accordance with ASTM D-5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
4. Air Pressure Testing
   a. Shall be performed in accordance with ASTM D-5820, Standard Practice for Pressurized Air Channel Evaluation by of Dual Seamed Geomembranes.

J. Destructive Seam Testing:
Destructive Seam Testing should be minimized to preserve the integrity of the liner. The installer shall provide the inspector with one destructive test location per 500 feet of seam length for each type of field seam (smooth to smooth welds, textured to textured welds and textured to smooth welds), and at a minimum of one test for each seaming machine operating on a given day. Test locations shall be determined by the inspector. Destructive seam testing shall be performed in accordance with ASTM D-6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

1. Sampling Procedure: In order to obtain test results prior to completion of liner installation, samples shall be cut by the installer as the seaming progresses. The installer shall also record the date, location, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately patched and vacuum tested.
2. Size and Dispositions of Samples: The samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into 3 equal-length pieces, one to be given to the inspector, one to be given to the Owner and one to the installer.
3. Field Laboratory Testing: The inspector shall test specimens from his sample for shear strength, adjacent geomembrane elongation and for peel strength.
4. Independent Laboratory Testing: The Owner must send seam samples to a laboratory for testing. The test method and procedures to be used by the independent laboratory shall be the same as used in field testing.
5. Procedure for Destructive Test Failure: The following procedures shall apply whenever a sample fails the field destructive test:
    a. The installer shall cap strip the seam between the failed location and any passed test locations.
    b. The installer can retrace the welding path to an intermediate location (usually 10 feet from the location of the failed test), and take a sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, then the process is repeated.
    c. All acceptable seams must lie between two locations where samples passed the test procedures found in subclause (b) of this clause and include one test location along the reconstructed seam.
    d. Over the length of seam failure, the installer shall either cut out the old seam, reposition the panel and reseam, or add a cap strip.

K. Defects and Repairs:
1. All seams and non-seam areas of the geomembrane shall be inspected by the inspector for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection.
2. Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the inspector. Each location that fails the non-destructive testing shall be marked by the inspector, and repaired accordingly.
3. When seaming of the geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the Engineer shall identify all excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested as any other seam.
4. Repair Procedures
    a. Defective seams shall be cap stripped or replaced.
    b. Small holes shall be repaired by extrusion welding a bead of extrudate over the hole. If the hole is larger than 1/4 inch, it shall be patched.
    c. Tears shall be repaired by patching. If the tear is on a slope or an area susceptible to stress and has a sharp end it must be rounded prior to patching.
    d. Blisters, large cuts and undispersed raw materials shall be repaired by patches.
    e. Patches shall be completed by extrusion welding. The weld area shall be ground no more than 10 minutes prior to welding. No more than 10% of the thickness shall be removed by grinding. 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. The welding shall restart by grinding the existing seam and rewelding a new seam. Patches shall be round or oval in shape, made of the same geomembrane, and extend to a minimum of 6 inches beyond the edge of defects.

5. Verification of Repairs:
   a. Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved.
   b. The inspector shall keep daily documentation of all non-destructive and destructive testing. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

## 3.4 PLACEMENT OF GEOSYNTHETIC MATERIALS

A. Unless otherwise specified by the Owner, equipment operating on soil material overlying the geomembrane and related geotextiles shall comply with the following:

| Maximum allowable equipment ground pressure (psi) | Thickness of overlying compacted fill (in) |
|---|---|
| < 5 | 8 |
| < 10 | 18 |
| < 20 | 24 |
| > 20 | 36 |

## 3.5 GEOMEMBRANE ACCEPTANCE

A. The Contractor shall retain all Ownership and responsibility for the geomembrane until accepted by the Owner.

B. The geomembrane will not be accepted by the Owner until all of the following conditions are met:
   1. The installation of all geosynthetic materials and the associated layers of geocomposite drainage, barrier protection layer and topsoil layer is finished;
   2. All documentation of installation is completed including the Contractor's Independent Quality Control Agency's and the Engineer's final report;
   3. Verification of the adequacy of all field seams and repairs, including associated testing, is complete;
   4. The warranties required by Subsection 1.7 are accepted by the Owner; and
   5. All documentation of the associated geosynthetic materials, written certification documents, including Contractor's record drawings, sealed by the Contractor's Surveyor have been received and accepted by the Owner.

## 3.6 FIELD QUALITY CONTROL

A. The handling and installation of the geomembranes materials shall be inspected and tested by the Contractor's Quality Control (QC) Agency as outlined in the Specifications. Contractor shall provide full-time inspection by its independent QC Agency during the geomembrane

handling and installation activities. The Contractor's QC Agency shall make and record observations and tests of the handling and installation of geomembrane materials and shall submit written reports of such observations and tests to the Engineer no later than the workday following the observations and tests.

B. The Contractor and the Geosynthetics Installer shall be aware of the required Quality Control and Quality Assurance activities in the Specifications and shall account for these activities in the installation schedule.

C. Owners Engineer will perform Quality Assurance Tests as required, observe the field observations, and review quality control data provided by the Contractor as deemed necessary to evaluate the effectiveness of Contractor Quality Control activities. The results of such tests and observations will be provided to the Contractor, but may not be used by the Contractor in substitution for the Quality Control Testing and inspection required herein.

## 3.7 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION 02713

# SECTION 02714

# GEOTEXTILES

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. Contactor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of the non-woven, needle-punched geotextile as specified herein, as shown on the Contact Drawings, and in accordance with the Specifications.

### 1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Quality Assurance and Quality Control Plan.

### 1.3 SUBMITTALS

A. Submit manufacturer's literature and certification that products comply with the Specifications. Also submit a 1 square foot sample of the product.

### 1.4 PROJECT CONDITIONS

A. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

B. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Geotextile shall be non-woven, needle-punched polyester or polypropylene product for use as filter fabric and stabilization fabric, GSE NW10 as manufactured by GSE Lining Technology, or approved equivalent.

B. The geotextile shall be manufactured from prime quality virgin polymer.

C. The geotextile shall be able to withstand direct exposure to ultraviolet radiations from the sun for up to (30) days without any noticeable effect on index or performance properties.

D. The physical properties of the geotextile shall meet the minimum requirements of Table 1. All geotextile properties are minimum average roll values (i.e., the test results for any sampled roll in a lot shall meet or exceed the minimum values Table 1 below).

| TABLE 1 | | |
|---|---|---|
| Geotextile Property | Test Method | Property Required |
| Apparent Opening Size [mm (U.S. Sieve)] | ASTM D-4751 | 0.150 maximum (No. 100 or large sieve number |
| Permittivity [1/second] | ASTM D-4491 | 1.2 minimum |
| Permeability [cm/sec] | ASTM D-4491 | 0.01 minimum |
| Grab Tensile Strength [N (lb.)] | ASTM D-4632 | 1,155 (260) minimum |
| Puncture Strength [N (lb)] | ASTM D-4833 | 725 (165) minimum |
| Trapezoid Tear [N (lb.)] | ASTM D-4533 | 445 (100) minimum |

E. At least 2 weeks prior to installation of the geotextile, the Contractor shall submit a certificate of compliance.

F. Each roll shall be clearly labeled so as to easily identify the product in the field. The label shall include as a minimum the manufacture's name, product name and number, and the contract name and number.

G. Staples or pins required to hold the geotextile prior to placing overlying materials shall be those prescribed by the manufacturer.

H. Approval of the geotextile shall be based on review of the certificate of compliance and, if directed by the Engineer, on the testing of geotextile samples. At the direction of the Engineer, samples of the geotextile shall be submitted directly to a testing agency approved by the Engineer at least 14 days prior to installation, so that the Engineer may perform independent tests to check material properties. The submitted samples shall be taken from actual rolls that will be delivered to the site and shall have the same manufacturer, manufacturing plant, and product code number as the rest of the geotextile to be used under this item. Any geotextile which is found to be in non-compliance with this Specification shall be rejected. The Engineer also reserves the right to collect samples periodically during installation for confirmation testing.

2.2 TRANSPORT

A. Transportation of the geotextile shall be the responsibility of the Contractor.

B. During shipment, the geotextile shall be protected form ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, or other damaging or deleterious conditions.

C. Upon delivery at the job site, the Contractor shall ensure that the geotextile rolls are handled and stored in accordance with the manufacturer's instructions as to prevent damage.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE

A. The Engineer shall examine the geotextile rolls upon delivery to the site and report any deviations from project specifications to the Contractor.

B. The Engineer may decide to arrange conformance testing of the rolls delivered to the job site. For this purpose, the Engineer shall take a sample 3 feet (along roll length) by roll width according to ASTM D-4354. The sample shall be properly marked, wrapped and sent to an independent laboratory for conformance testing.

C. The pass or fail of the conformance test results shall be determined according to ASTM D-4759.

3.2 INSTALLATION

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the Contractor damage the geotextile to the extent that it is no longer usable as determined by these Specifications or by the Engineer, the Contractor shall replace the geotextile at his own cost.

B. The geotextile shall be installed to the lines and grades as shown on the Contract Drawings and as described herein.

C. The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

D. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

E. The Contractor shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage to such material occur due to the fault of the Contractor, the latter shall repair the damaged materials at his own cost and to the satisfaction of the Engineer.

F. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the Engineer.

G. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 15 days after installation.

H. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the Engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.

I. The Contractor shall not use heavy equipment to traffic above the geotextile without approved protection.

J. The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

K. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

END OF SECTION 02714

SECTION 02715

GEOCOMPOSITE DRAIN

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Contractor shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geocomposite drainage as specified herein, as shown on the Contract Drawings, and in accordance with the Specifications.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Geomembrane: Section 02713.

D. Quality Assurance and Quality Control Plan.

1.3 WORK INCLUDED

A. Contractor shall install all geocomposites utilizing personnel, or subcontractor, thoroughly qualified and experienced in the installation of geocomposites.

B. Contractor shall engage an independent qualified geosynthetics testing agency (Quality Control Agency), accredited by Geosynthetics Accreditation Institute, to provide the quality control testing and inspection required by this Section.

C. Independent Geosynthetics QCA shall utilize National Institute for the Certification of Engineering Technicians (NICET) Certified Level II personnel to perform the tests required by this Section.

D. Contractor shall install the geocomposite drain in conjunction with the earthwork, trenching, and other components of the drainage control system as identified on the Contract Drawings.
   a. Geocomposite drain, with geotextile attached to both sides, shall be installed after the geomembrane is placed.

E. The work of this Section shall include, but not be limited to, the furnishing and installation of the geocomposite and assemblies in areas identified on the Contract Drawings.

1.4 WARRANTY

A. The Contractor shall obtain from the manufacturer and the Geocomposite installer, and provide same to the Owner, a written 1-year warranty to the benefit of the Owner, against defects in the material, in-ground durability, and in the workmanship of the installed geocomposite.

## 1.5 SUBMITTALS

A. Geosynthetics Work Plan

1. Prepare a Geosynthetics Work Plan describing how the Contractor will manage and conduct the procurement, acceptance, handling, installation and quality control testing and inspection for the geocomposite materials to be incorporated into the work.

2. At least 21 days prior to shipping any geocomposite to the site, the Contractor shall obtain from the geocomposite manufacturer, submit to the Engineer and have available for the Geosynthetics Installers' inspection, the following documentation on the raw materials used to manufacture the geocomposite.
   a. Manufacturing quality control certificates for each batch of resin and each shift's production. The certificates shall identify the origin of the resin and the manufacturer of the resin. The certificates shall be signed by responsible parties employed by the Manufacturer (such as the production manager). The quality control certificate shall include: Roll numbers and identification; sampling procedures; and results of quality control tests, including a description of the test methods used.
   b. The Geotextile Manufacturer quality control tests to be performed are outlined in Part 2.3 of this Section. Daily reports to Engineer and Contractor's QC Agency's previous day's inspection findings and field test results of geocomposite materials placed. Reports of off-site laboratory test results, delivered to Engineer at least 7 days prior to on-site utilization of the tested materials. Contractor shall submit, 30 days before installation, qualifications of Geocomposite Installer to Engineer in accordance with the requirements of this Specification. Contractor shall accept full responsibility for installed geocomposite materials until it has been accepted by the Owner.

## 1.6 PROJECT CONDITIONS

A. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

B. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

# PART 2 – PRODUCTS

## 2.1 MATERIALS

A. Geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure with a non-woven geotextile bonded to both sides, Model GSE FabriNet as manufactured by GSE Lining Technology, or approved equivalent.

## 2.2 GEOCOMPOSITE PROPERTIES:

A. The geocomposite specified shall have properties that meet or exceed the Minimum Average Roll Values (MARV) listed in the following tables below and pass the required interface friction angle testing as per Subsection 2.7.

TABLE 1

| Tested property | Test method | Frequency | MARV |
|---|---|---|---|
| Geocomposite | | | |
| Transmissivity, gal/min/ft ($m^2$/sec) | ASTM D-4716 | 1/540,000 $ft^2$ | 0.43 ($9x10^{-5}$) |
| Ply adhesion, lb/in (g/cm) | ASTM D-7005 | 1/540,000 $ft^2$ | 1.0 (178) |
| Roll width, ft (m) | | | 14.5 (4.4) |
| Roll length, ft (m) | | | 190 (58.0) |
| Roll area, $ft^2$ ($m^2$) | | | 2,755 (256) |
| Geonet core | | | |
| Transmissivity, gal/min/ft ($m^2$/sec) | ASTM D-4716 | | 9.66 ($2x10^{-3}$) |
| Thickness, mil (mm) | ASTM D-5199 | 1/50,000 $ft^2$ | 200 (5) |
| Density, $g/cm^3$ | ASTM D-1505 | 1/50,000 $ft^2$ | 0.94 |
| Tensile strength (MD), lb/in (N/mm) | ASTM D-5035 | 1/50,000 $ft^2$ | 45 (7.9) |
| Carbon black, % | ASTM D-1603 | 1/50,000 $ft^2$ | 2.0 |
| Geotextile | | | |
| Mass per unit area, oz/$yd^2$ ($g/m^2$) | ASTM D-5261 | 1/90,000 $ft^2$ | 10 (335) |
| Grab tensile, lb (N) | ASTM D-4632 | 1/90,000 $ft^2$ | 260 (1,155) |
| Puncture strength, lb (N) | ASTM D-4833 | 1/90,000 $ft^2$ | 165 (725) |
| AOS, US sieve (mm) | ASTM D-4751 | 1/540,000 $ft^2$ | 100 (0.150) |
| Permittivity, ($sec^{-1}$) | ASTM D-4491 | 1/540,000 $ft^2$ | 1.2 |
| Flow rate, gpm/$ft^2$ (lpm/$m^2$) | ASTM D-4491 | 1/540,000 $ft^2$ | 85 (3,460) |
| UV resistance, % retained | ASTM D-4355 | Once per formulation | 70 |

B. Resin

1. Resin shall be new first quality, compounded polyethylene resin.
2. Natural resin (without carbon black) shall meet the following additional minimum requirements:

| Property | Test Method [1] | Value |
|---|---|---|
| Density ($g/cm^3$) | ASTM D-1505 | > 0.94 |
| Melt Flow Index (g/10 min) | ASTM D-1238 | < 1.0 |

## 2.3 MANUFACTURING QUALITY CONTROL

A. The geocomposite shall be manufactured with quality control procedures that meet generally accepted industry standards.

B. The Contractor shall require the manufacturer to sample and test the geocomposite to demonstrate that the material complies with the Specifications.

C. Any geocomposite sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to the Owner.

D. If a geocomposite sample fails to meet the quality control requirements of this Section, the Contractor shall require that the Manufacturer sample and test each roll manufactured in the same lot or at the same time as the failing roll which is intended for use on the project. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

E. The Contractor may require the manufacturer to perform additional sample testing at its discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

F. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The Manufacturer shall sample and test the geocomposite material, at a minimum, once every 50,000 square feet to demonstrate that its properties conform to the values specified in the TABLE 1.

## 2.4 LABELING

A. Geocomposite materials shall be supplied in rolls wrapped in protective covers and labeled with the following information:
   1. Manufacturer's name;
   2. Product identification;
   3. Lot number;
   4. Roll number; and,
   5. Roll dimensions.

## 2.5 TRANSPORTATION

A. Geocomposite materials shall be delivered to the site at least 21 days before planned date of deployment to allow the Engineer and the Contractor's QC Agency time to inspect, sample, and/or test the delivered material.

## 2.6 HANDLING AND STORAGE

A. Handling, storage, and care of the geocomposite materials prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the engineered barrier system by the Owner.

B. The Contractor shall be responsible for storage of the geocomposite material at the site. The geocomposite material shall be stored off the ground and out of direct sunlight, and shall be protected from mud, dirt, and dust. Any additional storage procedures required by the Manufacturer shall be the Contractor's responsibility.

## 2.7 CONFORMANCE TESTING

A. Interface strength tests shall be performed on the compacted barrier protection layer (or the Drainage Layer if Bid Alternate No.1 is selected) above the geocomposite.

B. Interface strength test reports shall include a minimum: sample size, summary of test methods and procedures employed, strain rates utilized during shear, shear stress-deflection plots, normal stress-shear plots, peak and residual interface strength values, and strength envelope plots.

C. The test procedure shall include:
1. Retain the services of approved independent testing laboratory to perform interface strength testing.
2. Provide representative samples of candidate materials in sufficient quantity for required testing. Material samples shall not be used for more than (1) test data point.
3. Testing procedures shall be in accordance with ASTM D-5321 – Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
4. The shear box shall be a minimum of 12 inches by 12 inches in size.
5. Laboratory test samples shall be oriented to shear in the same direction, as they will be loaded in the field.
6. Geosynthetic materials shall not be affixed to a substrate for the entire area of the sample and shall be allowed to strain during shearing. Where possible, "free shear" testing procedures shall be used.
7. Soil/Geosynthetic interfaces shall be sheared at a strain rate, which will allow pore pressure to dissipate at the soil/geosynthetic interface. Provide evidence that pore pressures do not build up. Maximum strain rate for soil/geosynthetic interfaces shall be 0.04 inches per minute.
8. All tests shall be performed so that both peak interface strength and residual interface strength values are determined. Determine residual shear values after at least 2 inches of displacement.

D. To be acceptable, the barrier protection layer material to geocomposite interface shall exhibit effective friction angles of at least 28 degrees residual.

E. Tests shall be conducted with the following conditions:
1. Normal stresses shall be determined later for each interface strength test.
2. Direct shear interface tests of geocomposite on the barrier protection layer (or the Drainage Layer if Bid Alternate No.1 is selected) shall be performed after compacting the granular material in the shear box at moisture conditions 2 to 3% wet of optimum moisture content and soaking the surcharged sample for 4 hours or until saturated, whichever is greater. Soil material shall be compacted to densities corresponding with the minimum density requirements for the constructed work.
3. All interface direct shear tests shall be performed in a soaked condition.

F. Any interface, which fails to achieve the specified minimum effective friction angles, shall be retested at the Contractor's expense until specified results are obtained. This may involve the Contractor selecting different combinations of materials. Materials which meet all other requirements of the Contract Documents but do not achieve acceptable interfacial friction angles relative to the adjacent layers will not be approved.

## PART 3 - EXECUTION

### 3.1 SURFACE PREPARATION

A. Surface Preparation

1. The Contractor shall require the Geosynthetics Installer to inspect the surface supporting the geocomposite and certify in writing that the surface is acceptable. Installer shall provide certification of acceptance to the Engineer one day before starting geocomposite installation in the area.
2. Special care shall be taken not to damage the geomembrane. Any damage to the geomembrane caused by installation activities shall be repaired at the Contractor's expense.

## 3.2 MATERIAL PLACEMENT

A. The geocomposite shall be handled in such a manner as to ensure that it is not damaged in any way. Should the Contractor damage the geocomposite to the extent that it is no longer usable as determined by these Specifications or by the Engineer, the Contractor shall replace the geocomposite at his own cost.

B. The geocomposite shall be installed to the lines and grades as shown on the Contract Drawings and as described herein.

C. The geocomposite shall be rolled down the slope in such a manner as to continuously keep the geocomposite in tension by self-weight. The geocomposite shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

D. If the project contains long, steep slopes, special care should be taken so that only full-length rolls are used at the top of the slope.

E. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

F. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

G. During placement of the geocomposite, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geocomposite as judged by the Engineer.

H. In applying fill material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

I. Unless otherwise specified by the Owner, equipment operating on soil material overlying the geocomposite, geomembrane and related geotextiles shall comply with the following:

| Maximum allowable equipment ground pressure (psi) | Thickness of overlying compacted fill (in) |
|---|---|
| < 5 | 8 |
| < 10 | 18 |
| < 20 | 24 |
| > 20 | 36 |

J. The cover soil shall be placed in the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

K. The geocomposite shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 15 days after installation.

3.3 SEAMS AND OVERLAPS

A. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

B. Geonet Components
1. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.
2. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length.
3. Adjoining geocomposite rolls (end to end) across the roll width shall be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.
4. The geonet portion shall be tied every 6 inches in the anchor trench or as specified by the Engineer.

3.4 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50% of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.4.

3.5 PRODUCT PROTECTION

A. The Contractor shall use all means necessary to protect all prior work, and all materials and completed work of other Sections.

B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the Engineer, and at no additional cost to the Owner.

3.6 FIELD QUALITY CONTROL

A. The handling and installation of the geocomposite materials shall be inspected and tested by the Contractor's Quality Control Agency and Engineer as outlined in the Specifications. Contractor shall provide full-time inspection by its independent QC Agency during all geocomposite handling and installation activities. The Contractor's QC Agency shall make and record observations and tests of the handling and installation of geocomposite materials and shall submit

written reports of such observations and tests to Engineer no later than the workday following the observations and tests.

B. The Contractor shall be aware of the activities outlined in the Specifications and shall account for these activities in the construction schedule.

C. The Engineer will perform quality assurance tests, and/or observations of the plant and field operations and reviews of quality control data provided by the Contractor it deems necessary to evaluate the effectiveness of Contractor's quality control activities. The results of such tests and observations will be provided to the Contractor, but may not be used by the Contractor in substitution for the quality control testing and inspection required herein.

END OF SECTION 02715

SECTION 02920

SITE RESTORATION

PART 1 - GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Earthwork: Section 02300.

C. Quality Assurance and Quality Control Plan.

1.2 QUALITY ASSURANCE

A. Provide prepackaged seed readily available to the public with quality and purity equal to product of Scotts Miracle-Gro, Marysville, OH, 43041, (937) 644-0011, or approved equivalent. On-the-job or made-to-order mixes will not be accepted.

1.3 DELIVERY STORAGE AND HANDLING

A. Deliver fertilizer in manufacturer's standard size bags or cartons showing weight, analysis, and the name of the manufacturer. Store as approved by Landscape Architect and/or Engineer.

B. Store all seed at the site in a cool dry place, not in conjunction or proximity to any gasoline or petroleum based products, as approved by the Landscape Architect and/or Engineer. Replace any seed damaged during storage.

1.4 SCHEDULING

A. Time For Seeding: Sow grass seed between March 15$^{th}$ and June 15$^{th}$ or between August 15$^{th}$ and October 15$^{th}$, except as otherwise approved in writing by the Landscape Architect and/or Engineer. If seeding is done between May 15$^{th}$ and August 15$^{th}$, irrigation will be required to ensure a successful seeding.

B. No seeding shall occur on frozen ground, highly muddy soils, or during extreme heat or drought conditions.

1.5 SUBMITTALS

A. Product Data:
   1. Topsoil.
   2. Limestone.
   3. Fertilizer.
   4. Seed Mixtures.
   5. Mulch.

6. Hydro Mulch.
7. Erosion Control Blankets and Fasteners.
8. Silt Fence.

1.6 PROJECT CONDITIONS

A. During the performance of the Work, the Contractor will encounter waste and the potential for seeps. The existing waste consists of bundled (baled) commercial/municipal waste. Contractor shall minimize disturbance to the waste. Contractor to communicate with Owner and Engineer when waste or seeps are encountered.

B. Contractor to include appropriate notice, protection measures, and control measures associated with potential exposure to waste and/or seeps in Contractor's Health & Safety Plan.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Source: Provide topsoil from existing stockpiles stripped from the project site and approved by the Landscape Architect and/or Engineer. See Specification Section 02300 – Earthwork for Chemical Contamination Testing requirements.

B. If required, provide additional imported topsoil conforming to the following:
1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.
2. Containing not less than 5% nor more than 20% organic matter in that portion of a sample passing a 1/4-inch sieve when determined by the wet combustion method on a sample dried at 105 degrees C.
3. Containing a pH value within the range of 6.5 to 7 on that portion of the sample that passes a 1/4-inch sieve.
4. Containing the following gradations:

| SIEVE DESIGNATION | PERCENT PASSING |
|---|---|
| 2 inch | 100% |
| 1 inch | 85% - 100% |
| 1/4 inch | 65% - 100% |
| No. 200 | 20% - 80%<br>(of the 1/4 inch sieve) |

C. A written affirmation by a soil scientist, agronomist, or local soil and water conservation district should be submitted to the Owner and Engineer to affirm that the topsoil layer and the barrier protection layer will, acting together, continually support growth of the proposed vegetative cover. Refer to Specification Section 02300 – Earthwork, for barrier protection layer material requirements.

2.2 LIMESTONE

A. Provide ground limestone in the producer's standard bags containing not less than 90% of calcium and magnesium carbonates equivalent to not less than 45% of the mixed oxides of calcium and magnesium and conforming to the following gradations:

| SIEVE DESIGNATION | PERCENT PASSING |
|---|---|
| No. 100 | 50% - 100% |
| No. 20 | 100% |

2.3 FERTILIZER

A. Mixed commercial fertilizers shall contain total nitrogen, available phosphoric acid and soluble potash in the ratio of 19-19-19 (NPK, 50% N/UF). 50% of total nitrogen shall be derived from ureaform furnishing a minimum of 3.5% water insoluble nitrogen (3.5% WIN). The balance of the nitrogen shall be present as methylene urea, water-soluble urea, nitrate and ammoniacal compounds.

B. Other fertilizers meeting NYSDOT Specification Section 713-03 Fertilizer can be used.

2.4 SEED MIXTURE

A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety, and conforming to Federal and State Standards.

B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1% by weight.

C. All seed will be rejected if the label indicates any noxious weed seeds.

D. The seed mixture for temporary vegetative cover during construction shall be comprised of the following:

| SEED MIXTURE (TEMPORARY COVER DURING CONSTRUCTION) | | | |
|---|---|---|---|
| AMOUNT BY WEIGHT IN MIXTURE | SPECIES OR VARIETY * | PERCENTAGE | |
| | | PURITY | GERMINATION |
| 100% | ANNUAL RYEGRASS | 98% | 90% |
| 100% TOTAL | Application Rate: 3 – 4 lbs. per 1,000 SF | | |

E. The seed mixture for permanent vegetative cover after construction shall be comprised of the following:

| SEED MIXTURE (PERMANENT COVER AFTER CONSTRUCTION) | | | |
|---|---|---|---|
| AMOUNT BY WEIGHT IN MIXTURE | SPECIES OR VARIETY * | PERCENTAGE | |
| | | PURITY | GERMINATION |
| 60% | TETRAPLOID PERENNIAL RYEGRASS | 98% | 90% |
| 25% | PENNLAWN RED FESCUE | 98% | 90% |
| 10% | CHEWINGS RED FESCUE | 98% | 90% |
| 2.5% | NEW ZEALAND WHITE CLOVER | 98% | 90% |
| 2.5% | EMPIRE BIRDSFOOT TREFOIL | 98% | 90% |
| 100% TOTAL | Application Rate: Conform to manufacturer's recommendations. | | |

*Variety may be altered depending on availability of seed from manufacturer.

2.5 MULCH

A. Straw (Cereal Grain) Mulch: Stalks of oats, wheat, rye or other approved crops that are free of noxious weed seeds. Weight shall be based on a 15% moisture content.

B. Anchoring Material (Hydromulch): Colored (green dye), wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch to anchor straw mulch, by Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC., or approved equivalent.

2.6 EROSION CONTROL BLANKET

A. Erosion Control Blanket: Consisting of 70% agricultural straw (0.35 lbs./SY) and 30% coconut fiber (0.15 lbs./SY) matrix stitched with degradable thread between a UV stabilized top netting and a standard polypropylene bottom netting, with the manufacturer's "DOT" Staple System and 6 inch BioSTAKE's biodegradable plastic blanket pin fasteners. Use Extended-Term Degradable Double Net Straw-Coconut Blanket, Product No. SC150 by North American Green, 14649 Highway 41 North, Evansville, Indiana, 47725, (800) 772-2040, or approved equivalent.

2.7 SILT FENCE

A. Prefabricated silt fence with hardwood posts, wire woven fence, and woven geotextile for sediment control applications, as shown on the Contract Drawings. Filter X, TC Mirafi, Inc. 100X Silt Fence, Stabilinka T140N, or approved equivalent.

PART 3 - EXECUTION

3.1 GRADING

A. Rough Grading: Trim and grade lawn areas and swales within the project work limits to a level of 6 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide smooth uniform transition to adjacent areas.

B. Finish Grading: Finish surfaces free from irregular surface changes, and as follows:

1. Lawn Areas and Swales: Finish areas to receive topsoil to within 1 inch above or below the required subgrade surface elevations.

3.2 SPREADING TOPSOIL

A. Perform topsoil spreading operations only during dry weather.

B. To insure a proper bond with the topsoil, harrow or otherwise loosen the subgrade to a depth of 3 inches before spreading topsoil.

C. Spread topsoil directly upon prepared subgrade to a minimum depth measuring 6 inches after natural settlement in areas to be seeded. Scarify topsoil to a depth of 2 inches in compacted areas. Smooth out unsightly variations, bumps, ridges, and depressions that will hold water. Remove stones, litter, or other objectionable material. The seedbed must be prepared to allow good soil to seed contact, with the soil not too soft and compact. Finished surfaces shall conform to the contour lines and elevations indicated on the Contract Drawings or fixed by the Landscape Architect and/or Engineer.

3.3 SPREADING LIMESTONE

A. Spread ground limestone evenly over the topsoiled surface. Incorporate limestone within the top 2 inches of the topsoil prior to finish raking.

B. Apply limestone at the following rate per 1,000 SF of topsoil area, corresponding to the hydrogen ion concentration (pH) shown by the soil chemical analysis:

| pH | RATE (pounds/1,000 SF) |
|---|---|
| 4.5 to 5.0 | 150 |
| 5.0 to 5.5 | 100 |
| 5.5 to 6.0 | 50 |
| 6.0 to 6.8 | 25 |
| over 6.8 | 0 |

3.4 FERTILIZING

A. Apply fertilizer evenly at the rate of 300 lbs./acre, or as required according to the soil test analysis.

3.5 SEEDING

A. It is recommended that seeding occur within (1) day after final grading with the proper soil moisture conditions. Apply seed for temporary and permanent cover, including grass swales, evenly at the rate of 5 lbs./1,000 square feet. Apply seed for wet swales evenly at the rate of 1 lb./2,500 square feet.

B. Assume all risks when seed is sowed before approval of seed analysis.

C. Do not seed when the wind velocity exceeds 5 miles per hour.

D. Method of Seeding: Sow seed evenly by broadcasting/spreading, drillings, cultipack type, or hydroseeding on dry or moderately dry soil.

E. Hydroseeding:
   1. Apply seeding materials with an approved hydroseeder.
   2. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogeneous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
   3. Distribute uniformly a slurry mixture of water, seed, fertilizer, and mulch at a minimum rate of 57 gallons per 1,000 square feet (2,500 gallons per acre). The Landscape Architect and/or Engineer may order the amount of water increased if distribution of seeding materials is not uniform.

3.6 MULCHING

A. Within (1) day after seeding, cover the seeded areas with a uniform blanket of straw mulch at the application rate of 2 tons/acre. Then immediately apply wood cellulose fiber hydromulch to anchor straw mulch for wind blowing at the application rate of 500 – 750 lbs./acre, according to the manufacturer's written instructions.

B. Do not apply mulch in areas where erosion control blankets are required.

3.7 EROSION CONTROL BLANKET

A. Within (1) day after seeding, install erosion control blankets and fasteners, perpendicular to the seeded slope using the fastener pattern according to the manufacturer's instructions. Erosion Control Blankets replace the need for mulch. Contractor shall be field trained by the manufacturer's representative for the proper installation, seam overlap, and fastening procedures of the erosion control blankets. The Contractor shall not install any erosion control blanket without this initial training. See Contract Drawings for locations requiring the use of the erosion control blankets.

3.8 LAWN ESTABLISHMENT

A. Maintain the grass at heights between 2-1/2 inches and 3-1/2 inches and include (1) mowing.

B. Water and protect all seeded areas until final acceptance of the lawn.

3.9 FINAL ACCEPTANCE

A. Final acceptance of seeded areas will be granted when a uniform stand of acceptable grass is obtained, with a minimum of 95% coverage. Portions of the seeded areas may be accepted at various times at the discretion of the Landscape Architect and/or Engineer.

B. Unacceptable seeded areas, dry application: Reseed as specified and fertilized at one-half the specified rate.

C. Unacceptable seeded areas, hydro application: Reseed, fertilize, and mulch at one-half the specified rate, use full water rate.

D. Once accepted, the Owner will assume all maintenance responsibilities.

END OF SECTION 02920

# Appendix D:
# Design Calculations

**THE CHAZEN ENGINEERING & LAND SURVEYING CO., P.C.**
547 River Street
TROY, NEW YORK 12180
(518) 273-0055 Fax (518) 273-8391

JOB 40313.01 DC Balefill
SHEET NO. 1 OF
CALCULATED BY MAK DATE 2/12/07
CHECKED BY KSP DATE 3/27/07
~~SCALE~~ Soil Properties

Introduction: Previous collected site data and various references will be evaluated to determine the appropriate soil parameters to be used for slope stability analyses and settlement

Soil Properties: $\gamma_T$ = total unit weight (pounds per cubic foot)
$\phi$ = internal friction angle (degrees)
$c$ = cohesion (pounds per square foot)

Soil Types: Glaciolacustrine (from report, till on logs)
Alluvium Sandy Silt
Alluvium Sand and Gravel (clean)
MSW
Existing Cover

Soils:

Glaciolacustrine; clay w/silt few to little of sand
$N_{avg}$ = 9 (casing) El. 110 msl
$\gamma_T$ = 120 pcf ; $\phi$ = 0° ; c = 1,000 psf

---

Alluvium Sandy Silt w/ some gravel
Corrected $\bar{N}$ = 24
$\gamma_T$ = 120 pcf , $\phi$ = 33° ; c = 0 pcf

---

Alluvium Sand & Gravel
no blow counts ~ clean Sand and gravel, cobbles
$\gamma_T$ = 125 pcf ; $\phi$ = 38° ; c = 0 psf

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& LAND SURVEYING CO., P.C.
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JOB 40313.01 DC Balefill
SHEET NO. 2 OF
CALCULATED BY MAK DATE 2/12/07
CHECKED BY CKSP DATE 3/27/07
~~SCALE~~ Soil Properties

Soils (cont.):

Municipal Solid Waste (MSW)
- waste consists of bundled commercial and municipal
- bales of compressed municipal waste and cardboard were stacked in the landfill area

Ref: Geotechnology of Waste Management
$\gamma_T$ = 37 - 67 pcf bale
$\gamma_T$ = 30 - 45 pcf mod. compacted
avg of mids = 45 pcf

From attached figure $\phi = 28^\circ$
$c = 340$ psf
Jessberger and Kockel (1991) $\phi = 32$ $c = 200$
Singh and Murphy (1990) = $\phi$ 26 $c = 250$
$\phi = 29 < \phi = 30$
$c = 263$

---

Existing Cover: Silty Sand

N values = 12 and 2 for first 1' dry

$\gamma_T = 115$ $\phi = 30^\circ$ $c = 0$ psf

Table A.8 Typical values of $(N_1)_{60}$ for cohesive soil (after Das, 1994)

| $(N_1)_{60}$ (blows/ft) | Consistency | $q_u$ (tsf) |
|---|---|---|
| 0 – 2 | Very soft | 0 – 0.25 |
| 2 – 4 | Soft | 0.25 – 0.5 |
| 4 – 8 | Medium stiff | 0.5 – 1.0 |
| 8 – 16 | Stiff | 1.0 – 2.0 |
| 16 – 32 | Very stiff | 2.0 – 4.0 |
| > 32 | Hard | > 4.0 |

(Note: $q_u$ = unconfined compression strength)

→ Assume stiff consistency for clay (N = 9)

$(N_1)_{60} = C_n N_{60}$

↑ correction factor for overburden

elevation of water = El. 117 msl (avg MW-4 & 5)

elevation of clay = El. 113 msl (avg MW-4 & 5)

$(N_1)_{60} \rightarrow 8 \Rightarrow$ 1.0 tsf = $q_u$

$\frac{2000 \text{ lbs}}{1 \text{ ton}} \times 1.0 \text{ tsf} = X \text{ psf} = 2000 \text{ psf} = q_u$

$q_u = 2 S_u$

↑ cohesion value

$S_u = 1000$ psf

# EFFECTIVE STRESS / PILE DESIGN WORKSHEET

Based on a Single, Non-Cohesive Stratum

$\gamma_{total}$ 120 pcf $\gamma_{water}$ 62.4 pcf $\gamma'$ 57.6 pcf

$H_2O$ Depth 26 feet ***Cohesion, c = 0 psf***

| Depth | $\sigma_{Total}$ (psf) | u (psf) | $\sigma'$ (psf) | Raw Avg N-Value[1] | $C_{N\ avg}$ | Corrected N-Value[2] | φ (degrees) | τ (psf) | Ko (1-sin φ) | Kp (Rankine) | Nq (Vesic) | $\sigma_o$ (psf) | $q_p$ (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | | | | | | | | | | |
| 1 | 120 | 0 | 120 | | | | | | | | | | |
| 2 | 240 | 0 | 240 | | | | | | | | | | |
| 3 | 360 | 0 | 360 | | | | | | | | | | |
| 4 | 480 | 0 | 480 | | | | | | | | | | |
| 5 | 600 | 0 | 600 | | | | | | | | | | |
| 6 | 720 | 0 | 720 | | | | | | | | | | |
| 7 | 840 | 0 | 840 | | | | | | | | | | |
| 8 | 960 | 0 | 960 | | | | | | | | | | |
| 9 | 1,080 | 0 | 1,080 | | | | | | | | | | |
| 10 | 1,200 | 0 | 1,200 | | | | | | | | | | |
| 11 | 1,320 | 0 | 1,320 | | | | | | | | | | |
| 12 | 1,440 | 0 | 1,440 | | | | | | | | | | |
| 13 | 1,560 | 0 | 1,560 | | | | | | | | | | |
| 14 | 1,680 | 0 | 1,680 | | | | | | | | | | |
| 15 | 1,800 | 0 | 1,800 | | | | | | | | | | |
| 16 | 1,920 | 0 | 1,920 | | | | | | | | | | |
| 17 | 2,040 | 0 | 2,040 | | | | | | | | | | |
| 18 | 2,160 | 0 | 2,160 | | | | | | | | | | |
| 19 | 2,280 | 0 | 2,280 | | | | | | | | | | |
| 20 | 2,400 | 0 | 2,400 | | | | | | | | | | |
| 21 | 2,520 | 0 | 2,520 | 29.5 | 0.908 | 27 | | 1,637 | 0.455 | 3.39 | 43 | 1,605 | 35 |
| 22 | 2,640 | 0 | 2,640 | | | | | | | | | | |
| 23 | 2,760 | 0 | 2,760 | 38.5 | 0.873 | 34 | | 2,005 | 0.412 | 3.85 | 65 | 1,678 | 55 |
| 24 | 2,880 | 0 | 2,880 | | | | | | | | | | |
| 25 | 3,000 | 0 | 3,000 | 15.5 | 0.841 | 13 | | 1,803 | 0.485 | 3.12 | 33 | 1,970 | 33 |
| 26 | 3,120 | 0 | 3,120 | | | | | | | | | | |
| 27 | 3,240 | 62 | 3,178 | 11.5 | 0.820 | 9 | | 1,947 | 0.485 | 3.12 | 33 | 2,087 | 34 |
| 28 | 3,360 | 125 | 3,235 | | | | | | | | | | |
| 29 | 3,480 | 187 | 3,293 | | | | | | | | | | |
| 30 | 3,600 | 250 | 3,350 | | | | | | | | | | |
| 31 | 3,720 | 312 | 3,408 | | | | | | | | | | |
| 32 | 3,840 | 374 | 3,466 | | | | | | | | | | |
| 33 | 3,960 | 437 | 3,523 | | | | | | | | | | |
| 34 | 4,080 | 499 | 3,581 | | | | | | | | | | |
| 35 | 4,200 | 562 | 3,638 | | | | | | | | | | |
| 36 | 4,320 | 624 | 3,696 | | | | | | | | | | |
| 37 | 4,440 | 686 | 3,754 | | | | | | | | | | |
| 38 | 4,560 | 749 | 3,811 | | | | | | | | | | |
| 39 | 4,680 | 811 | 3,869 | | | | | | | | | | |
| 40 | 4,800 | 874 | 3,926 | | | | | | | | | | |
| 41 | 4,920 | 936 | 3,984 | | | | | | | | | | |
| 42 | 5,040 | 998 | 4,042 | | | | | | | | | | |
| 43 | 5,160 | 1,061 | 4,099 | | | | | | | | | | |
| 44 | 5,280 | 1,123 | 4,157 | | | | | | | | | | |
| 45 | 5,400 | 1,186 | 4,214 | | | | | | | | | | |
| 46 | 5,520 | 1,248 | 4,272 | | | | | | | | | | |
| 47 | 5,640 | 1,310 | 4,330 | | | | | | | | | | |
| 48 | 5,760 | 1,373 | 4,387 | | | | | | | | | | |
| 49 | 5,880 | 1,435 | 4,445 | | | | | | | | | | |

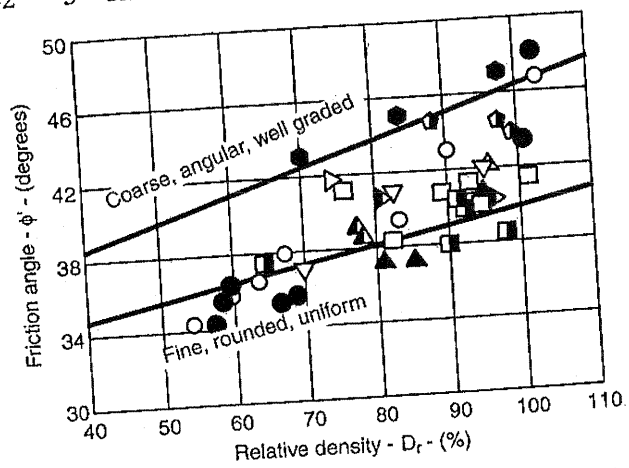



**Figure 5.9** Correlation between friction angle and relative density for sands. (Data from Schmertmann, 1975, and Lunne and Kleven, 1982.)

**Table 5.4 Correlation Among Relative Density, CPT Cone Resistance, and Angle of Internal Friction for Clean Sands**

| State of packing | Relative density, $D_r$ (%) | $q_c$ (tons/ft² or kgf/cm²) | $\phi'$ (deg) |
|---|---|---|---|
| Very loose | < 20 | < 20 | < 32 |
| Loose | 20–40 | 20–50 | 32–35 |
| Medium | 40–60 | 50–150 | 35–38 |
| Dense | 60–80 | 150–250 | 38–41 |
| Very dense | > 80 | 250–400 | 41–45 |

*Source:* Meyerhof (1976).

**Table 5.3 Relationship Among Relative Density, SPT Blow Count, and Angle of Internal Friction for Clean Sands**

| State of packing | Relative density, $D_r$ (%) | SPT blow count, $N^a$ (blows/ft) | Angle of internal friction $\phi'^b$ (deg) |
|---|---|---|---|
| Very loose | < 20 | < 4 | < 30 |
| Loose | 20–40 | 4–10 | 30–35 |
| Compact | 40–60 | 10–30 | 35–40 |
| Dense | 60–80 | 30–50 | 40–45 |
| Very dense | > 80 | > 50 | > 45 |

*Source:* Meyerhof (1956).

[a] $N = 15 + (N' - 15)/2$ for $N' > 15$ in saturated very fine or silty sand, where $N$ is the blow count corrected for dynamic pore pressure effects during the SPT, and $N'$ is the measured blow count.

[b] Reduce $\phi'$ by 5° for clayey sand; increase $\phi'$ by 5° for gravelly sand.

= undisturbed strength/remoulded strength), they are very easily disturbed. In a study of a silt from the Alaskan arctic (Fleming and Duncan, 1990), it was found that disturbance reduced the undrained strengths measured in unconsolidated–undrained tests by as much as 40%, and increased the undrained strengths measured in consolidated–undrained tests by as much as 40%. Although silts can usually be sampled using the same techniques as those used for clays, the quality of samples should not be expected to be as good.

### Cavitation

Unlike clays, nonplastic silts almost always tend to dilate when sheared, even if they are normally consolidated. In undrained tests, pore pressures decrease as a result of this tendency to dilate, and pore pressures can become negative. When pore pressures are negative, dissolved air or gas may come out of solution, forming bubbles within test specimens that greatly affect their behavior.

Figure 5.10 shows stress–strain and pore pressure–strain curves for consolidated–undrained triaxial tests on nonplastic silt from the Yazoo River valley. As the specimens were loaded, they tended to dilate, and the pore pressures decreased. As the pore pressures decreased, the effective confining pressures increased. The effective stresses stopped increasing when cavitation occurred, because from that point on the volume of the specimens increased as the cavitation bubbles expanded. The value of the maximum deviator stress for each sample was determined by the initial pore pressure (the back pressure), which determined how much negative change in pore pressure took place before cavitation occurred. The higher the back pressure, the greater was the undrained strength. These effects can be noted in Figure 5.10.

### Drained or Undrained Strength?

Values of $c_v$ for nonplastic silts are often in the range 100 to 10,000 cm²/h (1000 to 100,000 ft²/yr). It is often difficult to determine whether silts will be drained or undrained under field loading conditions

**Table 2.8** Range of unit weight of uncompacted and compacted refuse components

| Waste component | Uncompacted unit weight (lb/ft³) | Water content | RATIO OF COMPACTED TO UNCOMPACTED WEIGHT | |
|---|---|---|---|---|
| | | | Normal compaction | Well compacted |
| Food waste | 8–30 | 50–80 | 2.9 | 3.0 |
| Paper and paper board | 2–8 | 4–10 | 4.5 | 6.2 |
| Plastics | 2–8 | 1–4 | 6.7 | 10 |
| Textiles | 2–6 | 6–15 | 5.6 | 6.7 |
| Rubber and leather | 6–16 | 1–12 | 3.3 | 3.3 |
| Yard waste | 4–14 | 30–80 | 4 | 5 |
| Wood | 8–20 | 15–40 | 3.3 | 3.3 |
| Glass | 10–30 | 1–4 | 1.7 | 2.5 |
| Metals | 3–70 | 2–6 | 4.3 | 5.3 |
| Ash, brick, dirt | 20–60 | 6–12 | 1.2 | 1.3 |

*Source:* After Tchobanoglous et al., 1977

**Table 2.9** Field values of unit weight of individual waste components in municipal landfills (EPA, 1992)

| Component | Unit weight (lb/ft³) | Unit weight (kN/m³) |
|---|---|---|
| DURABLE GOODS | 19.26 | 2.80 |
| NONDURABLE GOODS | | |
| Nondurable paper | 29.63 | 4.31 |
| Nondurable plastic | 11.67 | 1.70 |
| Disposable diapers | | |
| Diaper materials | 29.44 | 4.28 |
| Urine and feces | 50.00 | 7.28 |
| Rubber | 12.78 | 1.86 |
| Textiles | 16.11 | 2.34 |
| Miscellaneous nondurables (mostly plastics) | 14.44 | 2.10 |
| PACKAGING | | |
| Glass containers | | |
| Beer and soft drink bottles | 103.70 | 15.09 |
| Other containers | 103.70 | 15.09 |
| Steel containers | | |
| Beer and soft drink cans | 20.74 | 3.02 |
| Food cans | 20.74 | 3.02 |
| Other packaging | 20.74 | 3.02 |
| Aluminum | | |
| Beer and soft drink cans | 9.26 | 1.35 |
| Other packaging | 20.37 | 2.96 |
| Paper and paperboard | | |
| Corrugated | 27.78 | 4.04 |
| Other paperboard | 30.37 | 4.42 |
| Paper packaging | 27.41 | 3.99 |
| Plastics | | |
| Film | 24.81 | 3.61 |
| Rigid containers | 13.15 | 1.91 |
| Other packaging | 6.85 | 1.00 |
| Wood packaging | 29.63 | 4.31 |
| Other miscellaneous packaging | 37.59 | 5.47 |
| BIODEGRADABLE | | |
| Food waste | 74.07 | 10.78 |
| Yard trimmings | 55.56 | 8.08 |

**Table 2.10** Unit weights for different types of landfill materials

| Description and state | TOTAL UNIT WEIGHT lb/ft³ | kN/m³ |
|---|---|---|
| MUNICIPAL WASTE | | |
| Poor compaction | 18–30 | 2.8–4.7 |
| Moderate to good compaction | 30–45 | 4.7–7.1 |
| Good to excellent compaction | 45–60 | 7.1–9.4 |
| Baled waste | 37–67 | 5.5–10.5 |
| Shredded and compacted | 41–67 | 6.4–10.5 |
| In situ density | 35–44 | 5.5–6.9 |
| Municipal waste from Canada | 43–89 | 6.8–14 |
| Active landfill with leachate mound | 42 | 6.6 |
| Northeast U.S. active landfill | 30–40 | 4.6–6.3 |
| INCINERATOR RESIDUE | | |
| Poorly burnt | 46 | 7.2 |
| Intermediately burnt | 75 | 11.8 |
| Well burnt | 81 | 12.6 |
| Ashes | 41–52 | 6.4–8.2 |
| HAZARDOUS WASTE LANDFILL SITE | | |
| 75-ft deep waste with soil cover | 101 | 15.9 |
| 40- to 50-ft deep dry dust and soil | 30–110 | 4.6–17.3 |
| 62-ft deep waste average | | |
| Kiln dust, sludge tar, creosote, and soil (average) | 73 | 11.5 |
| Dusts | 46 | 7.2 |
| Tars | 104 | 16.3 |
| Contaminated soils | 69 | 10.8 |
| 75-ft deep chemical solutions and scrap metals mixed with contaminated soil | 63–74 | 9.9–11.6 |
| 30- to 40-ft deep landfill with 90 to 95% waste in metal drums | 90 | 14.1 |

*Source:* Bromwell, 1978; Collins, 1977; Landva and Clark, 1990; Oweis and Khera, 1986; Peirce and Witter, 1986; Sargunan et al., 1986; Shoemaker, 1972; Sowers, 1973; Tchobanoglous et al., 1977

### 2.3.1 *Unit Weight Determination*

Municipal waste is a multiphase material. Its unit weight can be determined using a phase diagram, as shown in Figure 2.5. Let the weights of various components be represented by $W_1, W_2, \ldots, W_i, \ldots, W_n$, and the corresponding unit weights be given by $\gamma_1, \gamma_2, \ldots, \gamma_i, \ldots, \gamma_n$. The volume of each of the components will then be $V_1 = \frac{W_1}{\gamma_1}, V_2 = \frac{W_2}{\gamma_2}, \ldots, V_i = \frac{W_i}{\gamma_i}, \ldots, V_n = \frac{W_n}{\gamma_n}$.

Total unit weight
$$\gamma = \frac{W_1 + W_2 + \cdots + W_n}{V_1 + V_2 + \cdots + V_n} = \frac{W}{\frac{W_1}{\gamma_1} + \frac{W_2}{\gamma_2} + \cdots + \frac{W_n}{\gamma_n}}$$

$$\gamma = \frac{1}{\sum_1^n \frac{W_i}{W \cdot \gamma_i}} \tag{2.16}$$

# "SLIDES HAPPEN - LANDFILL STABILITY ANALYSIS"

## PRESENTED TO

## CIVIL ENGINEERING DEPARTMENT
## NORTH CAROLINA STATE UNIVERSITY
## RALEIGH, NC
## APRIL 20, 2004

**ALSO GIVEN AS**
**THE 2002 ALEKSANDAR VESIC MEMORIAL LECTURE**

**PRESENTED TO**

**NORTH CAROLINA SECTION**
**AMERICAN SOCIETY OF CIVIL ENGINEERS**

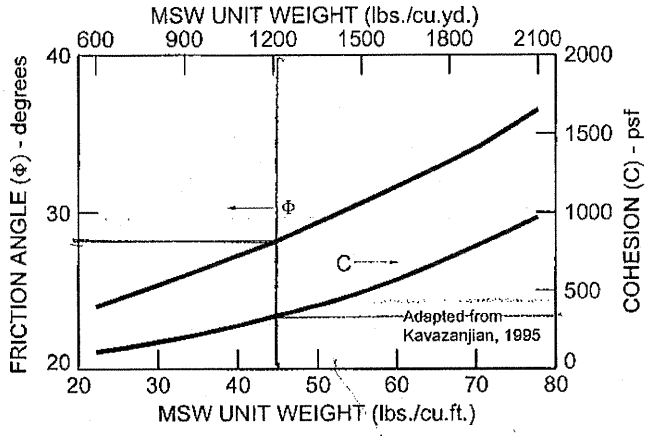
**WRIGHTSVILLE BEACH, NC**
**OCTOBER 3, 2002**

**BY**

DR. GORDON P. BOUTWELL, P.E.
SOIL TESTING ENGINEERS, INC.
BATON ROUGE, LA - NEW ORLEANS, LA - BILOXI, MS

$\gamma_T = 45$ pcf =






$\phi = 28^0$

$C = 340$ psf

**FIGURE 11 - MSW STRENGTH PARAMETERS vs DENSITY**

So we have increasing density causing increases in both the driving forces and the resisting forces. What is the overall effect on stability? Let us take a simple example as given below, and take both effects of self-weight compression into account in the stability analyses. We have assumed that the MSW was compacted to initial (surface) densities corresponding to poor practice (600 lb./cu.yd.) through excellent practice (1500 lb./cu.yd.). The results are illustrated on Figure 12.

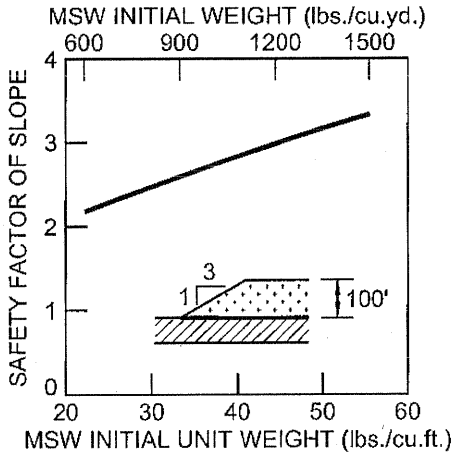


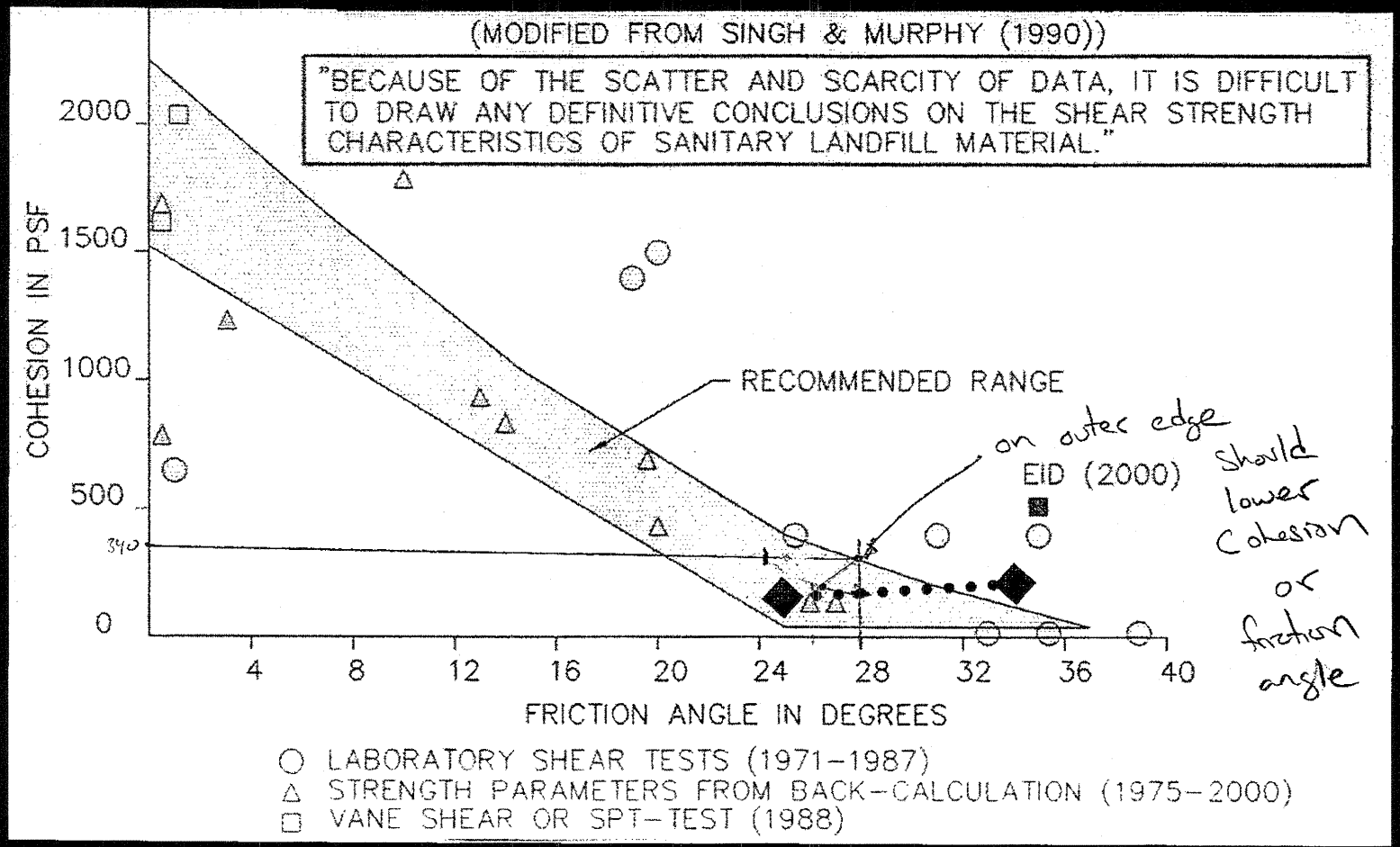

**FIGURE 12 - EFFECT OF DENSITY ON STABILITY**

Clearly, increasing the initial density increases the stability of the MSW landfill at a given slope. This could also mean increasing the side slope (and thus airspace) at a given safety factor.

From: "Slides Happen - Landfill Stability Analysis"
by Dr. Gordon P. Bartwell, P.E

# MSW Strength- Method 1

## (Based on Published Lab and Field Testing)




**Example:**

**Assume MSW peak shear strength**
**Ø=34° and C=200 psf**
**Design for FS=1.5**

**Equilibrium ("stability"):**
**Ø= atan[(tan34°)/(1.5)] )= 24.2°**
**C= 200/1.5 =133 psf**

As reported by Singh and Murphy (1990), back-calculated strength data has also been obtained from observing the satisfactory performance of many landfills in southern California during earthquakes. Since the landfill elopes survived the events, back-calculated values of c and $ obtained by assuming a factor of eafety equal to 1.0, repreeent minimum available strength and therefore were assumed to be conservative.

Earth Technology (1989) evaluated the ehear strength of MSW at Puente Hills Landfill in southern California using in-situ techniques such as blowcounte from standard penetration testing (SPT) or California drive samplers, ae well as with vane shear testing. Cone penetration teets (CPT) on landfills have also been used to determine strength as well as compressibility of waste (Hinkle, 1990; Oakley, 1990; Jeseberger & Kockel, 1991).

When strength values are obtained by direct measurements (i.e. direct shear teets), the data can be presented in terms of shear strength versus normal etrees. However, back-calculated values of shear strength from failures and load tests are often reported as cohesion (c) and friction angle ($\phi$) pairs that satisfy equilibrium. This is the result of using one known (the factor of safety = 1.0) to determine two unknowns (c and $\phi$).

The data summarized by Singh and Murphy (1990) are presented separately as pairs of c and $\phi$ determined from laboratory tests, from back-calculations, and from in-situ testing. All of the results are then presented on a single figure, reproduced here as Figure 5.

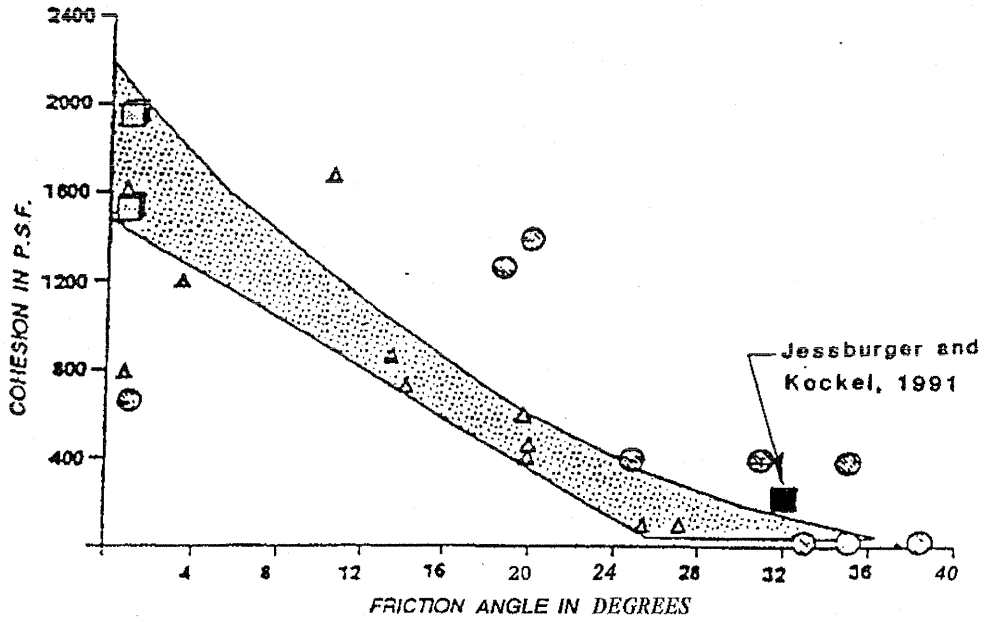



FIGURE 5. Summary of MSW Strength Data (after Singh and Murphy, 1990)

The shaded zone is the range of strength parameters Singh recommends for use in stability analyses. Jessberger and Kockel (1991) suggested using $\phi$ = 32°, c = 200 psf for stability analysis of typical MSW landfills.

Using a different approach, Howland and Landva (1992), presented strength data from five case studies by plotting shear strength

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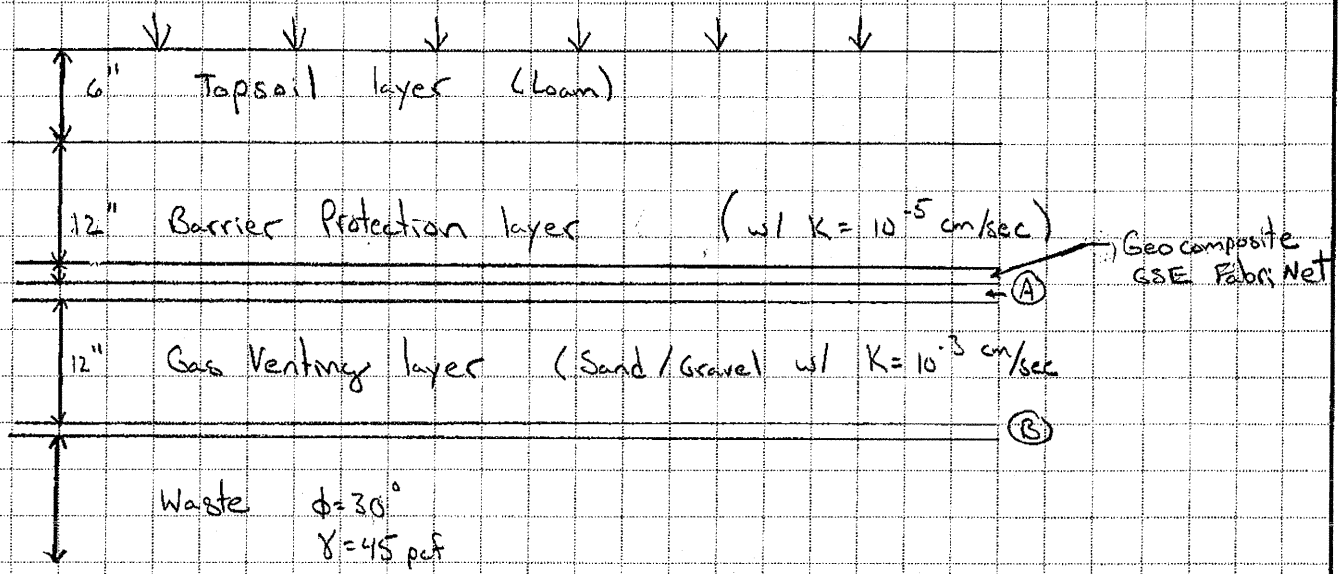
TROY, NEW YORK 12180
(518) 273-0055 Fax (518) 273-8391

JOB 40313.01 DC Balefill
SHEET NO. _____ OF _____
CALCULATED BY MAK DATE 2/26/07
CHECKED BY KSP DATE 3/27/07
SCALE Typical Section




## Soil Properties:

Topsoil: unit weight = $\gamma_{Tp}$ = 105 pcf
internal friction angle = $\phi_{Tp}$ = 28°
cohesion = $c_{Tp}$ = 0 psf

Barrier Protection: unit weight = $\gamma_{Br}$ = 115 pcf Silty Sand
(assuming 92% Mod. compaction)
internal friction angle $\phi_{Br}$ = 32°
cohesion = $c_{Br}$ = 0 psf

(A) Geomembrane Cover

Poly-Flex LLDPE - Textured 40 mil

Gas Venting Layer: unit weight = $\gamma_{ga}$ = 100 pcf
(assuming minimal compaction) max 10% <#200
internal friction angle $\phi_{ga}$ = 36°

(B) Geotextile filter - GSE NW10

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JOB 4031.3.01 DC Balefill
SHEET NO. ____ OF ____
CALCULATED BY MAK DATE 2/27/07
CHECKED BY TSP DATE 3/27/07
SCALE NTS

# Geomembrane Design

**Purpose:** To determine the strength parameters required for the impermeable membrane

**Calculation:**

unit weight $_{avg}$ = $\gamma_{avg\ cover}$

$\phi = 32°$
$\phi = 28°$

1 feet barrier layer $\gamma = 115$ % of cover = $\frac{1}{1.5} = 67\%$
0.5 feet topsoil $\gamma = 105$ % of cover = $\frac{.5}{1.5} = 33\%$
1.5 total depth

$\phi_{avg} = 31°$

$$\gamma_{avg\ cover} = (\gamma_{layer\ n})(\%) + \gamma_{layer\ n+1}(\%) + \ldots$$

$$\gamma_{avg\ cover} = (115\ pcf)(67\%) + (105\ pcf)(33\%)$$

$$\gamma_{avg\ cover} \approx 112\ pcf$$

friction $T_w = K_o \sigma_v \tan\phi\ (D)$

$$= [1 - \sin 31][\tfrac{1}{2}(112)(1.5)][\tan(31)][1.5]$$

$T_w = 36.7\ ^{lb}/_{ft}$ based on 1.5' cover

Typical Section is 40'

Net $W_{fill\ slp} = [\tfrac{1}{2}(\text{width})(\text{depth})(\text{unit wt.}) - T_w$

$$= [\tfrac{1}{2}(40')(1.5')(112\ pcf)] - 36.7\ ^{lb}/_{ft}$$

$$= 3323\ ^{lb}/_{ft} = 3.3\ ^{K}/_{ft}$$

assume slope 3:1 with $\beta = 18.4°$

$W \cos\beta = 3.3\ ^{K}/_{ft} \cos 18.4° = 3.1\ ^{K}/_{ft}$

$W \sin\beta = 3.3\ ^{K}/_{ft} \sin 18.4° = 1.0\ ^{K}/_{ft}$

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JOB 40313.01 DC Backfill
SHEET NO. ____ OF ____
CALCULATED BY MAK DATE 2/27/07
CHECKED BY KSP DATE 3/27/07
SCALE ____

Calcs (cont.):

Shear Forces

$F_1 = W \cos\beta \tan\delta_1$

$\delta_1$ = interface friction angle between drainage layer and geomembrane = 25° (geonet)

$F_1 = 3.1\ ^k/_{ft} \tan(25) = 1.4\ ^k/_{ft}$

$F_2 = W \cos\beta \tan\delta_2$

$\delta_2$ = interface friction angle between geomembrane and Gas Venting layer = 29°

$F_2 = 3.1\ ^k/_{ft} \tan(29°) = 1.7\ ^k/_{ft}$

Since $F_1 < F_2$ membrane is not in tension

Choose membrane that meets min NYSDEC reqs. 40 mils

- check to make sure break strength is adequate for constructing anchor trench.

# GEOMEMBRANES | POLYETHYLENE | non-HDPE

| Product Name | Base Polymer [1] | Dimensional Properties: Roll Width/Length m (ft) | Dimensional Properties: [2] Thickness ASTM 5199 mm (mils) | Dimensional Properties: [2] Thickness ASTM D5994 mm (mils) | Density ASTM D1505 (g/cm³)s | Tensile Properties ASTM D6693: Strength Yield kN/m (lb/in) | Tensile Properties ASTM D6693: Strength Break kN/m (lb/in) | Tensile Properties ASTM D6693: Elongation Yield/Break % | Puncture Resistance ASTM D4833 kN (lb) | Tear Resistance ASTM D1004 kN (lb) | Low Temperature Brittleness ASTM D746 °C (°F) [3] | Carbon Black Content ASTM D1603 (%) | Carbon Black Dispersion ASTM D5596 [4] | Manufacturer's Suggested Applications [5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Layfield Geosynthetics and Industral Fabrics Ltd.** | | | | | | | | | | | | | www.geomembranes.com | |
| Enviro Liner 4030 | LLDPE | 3,15/457 (10.3/1500) | 0.76 (30) | NA | 0.939 | NA | 20 (114) | 8 | 0.186 (42) | 0.071 (16) | -70 | 2–3 | Pass | CL, LPL, SIC, RP, |
| Enviro Liner 4040 | LLDPE | 3.15/457 (10.3/1500) | 1.0 (40) | NA | 0.939 | NA | 26.6 (152) | 8 | 0.250 (56) | 0.098 (22) | -70 | 2–3 | Pass | CL, LPL, SIC, LC |
| Enviro Liner 6030 | O/C | 3.15/457 (10.3/1500) | 0.76 (30) | NA | NA | NA | 20.1 (115) | 8 | 0.213 (48) | 0.071 (16) | -70 | 2–3 | Pass | CL, LPL, SIC, RP, |
| Enviro Liner 6040 | O/C | 3.15/457 (10.3/1500) | 1.0 (40) | NA | NA | NA | 26.6 (152) | 8 | 0.271 (61) | 0.098 (22) | -70 | 2–3 | Pass | CL, LPL, SIC, RP, |
| **Poly-Flex Inc.** | | | | | | | | | | | | | www.poly-flex.com | |
| Poly-Flex | LLDPE | 7/305 (23/1000) | 0.75 (30) | NA | 0.93 | NA | 20 (114) | NA/800 | 0.190 (42) | 0.07 (16) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | LLDPE | 7/229 (23/750) | 1.0 (40) | NA | 0.93 | NA | 27 (152) | NA/800 | 0.250 (56) | 0.10 (22) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | LLDPE | 7/152 (23/500) | 1.5 (60) | NA | 0.93 | NA | 40 (228) | NA/800 | 0.370 (84) | 0.15 (33) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | LLDPE | 7/114 (23/375) | 2.0 (80) | NA | 0.93 | NA | 53 (304) | NA/800 | 0.500 (112) | 0.20 (44) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | CX-T | 7/229 (23/750) | NA | 0.95 (38) | 0.93 | NA | 11 (60) | NA/250 | 0.20 (44) | 0.10 (22) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | CX-T | 7/152 (23/500) | NA | 1.425 (57) | 0.93 | NA | 16 (90) | NA/250 | 0.30 (66) | 0.15 (33) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex | CX-T | 7/114 (23/375) | NA | 1.9 (76) | 0.93 | NA | 21 (120) | NA/250 | 0.40 (88) | 0.20 (44) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-LLDPE | 7/229 (23/750) | 1.0 (40) | NA | 0.93 | NA | 27 (152) | NA/800 | 0.25 (56) | 0.10 (22) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-LLDPE | 7/152 (23/500) | 1.5 (60) | NA | 0.93 | NA | 40 (228) | NA/800 | 0.37 (84) | 0.15 (33) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-LLDPE | 7/114 (23/375) | 2.0 (80) | NA | 0.93 | NA | 53 (304) | NA/800 | 0.50 (112) | 0.20 (44) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-T LLDPE | 7/229 (23/750) | NA | 0.95 (38) | 0.93 | NA | 11 (60) | NA/250 | 0.20 (44) | 0.10 (22) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-T LLDPE | 7/152 (23/500) | NA | 1.425 (57) | 0.93 | NA | 16 (90) | NA/250 | 0.30 (66) | 0.15 (33) | -70 (-94) | 2–3 | [4] | all |
| Poly-Flex White | CX-T LLDPE | 7/114 (23/375) | NA | 1.9 (76) | 0.93 | NA | 21 (120) | NA/250 | 0.40 (88) | 0.20 (44) | -70 (-94) | 2–3 | [4] | all |
| **Raven Industries** | | | | | | | | | | | | | www.ravenind.com | |
| Rufco 2000B | LLDPE | 4600 (50,000) | 0.50 (20) | NA | ≤0.939 | NA | 13 (76) | NA/ 800 | 0.13 (30) | 0.05 (11) | -70 (-94) | 2.0 | Note [4] | CL, LPL, LC, TL, RP, DL, SIC, DP, SIL |

[1] LLDPE = Linear low density polyethylene
LLDPE-T = Linear low density polyethylene, textured
CX = Coextruded
CX-T = Coextruded, textured
O/C = Other or combination
EDPM = Ethylene Propylene Diene Monomer
EIA = Ethylene interpolmer alloy

[2] ASTM D 5199: Nominal thickness of geosynthetics
ASTM D 5994: Core thickness of textured geomembrane

[3] No failures at this temperature.

[4] Carbon black dispersion for 10 different views:
- minimum of 9 of 10 in categories 1 or 2
- all 10 in categories 1, 2, or 3

[5] CL = Canal liner
LPL= Leach pad liner
LC = Landfill cover
TL = Tunnel liner
RP = Reserve pit
DL = Dam liner
SIC = Surface impoundment cover
LL = Landfill liner
DP = Decorative pond
SIL = Surface impoundment liner

NP = Not provided by manufacturer
NA = Not applicable, per manufacturer

GFR recommends you contact the manufacturers before making any specifying/purchasing decisions.

# TEXTURED LLDPE GEOMEMBRANE
# ENGLISH UNITS

| Property | Test Method | Minimum Average Values 40 Mil | 60 Mil | 80 Mil |
|---|---|---|---|---|
| Thickness, mils | ASTM D 5994 | | | |
| minimum average | | 38 | 57 | 76 |
| lowest individual of 8 of 10 readings | | 36 | 54 | 72 |
| lowest individual of 10 readings | | 34 | 51 | 68 |
| Asperity Height[1], mils | GRI GM12 | 10 | 10 | 10 |
| Sheet Density, g/cc (max.) | ASTM D 1505/D 792 | 0.939 | 0.939 | 0.939 |
| **Tensile Properties**[2] | ASTM D 6693 | | | |
| 1. Break Strength, lb/in | | 60 | 90 | 120 |
| 2. Break Elongation, % | | 250 | 250 | 250 |
| 2% Modulus, lb/in$^2$ (max.) | ASTM D 5323 | 60,000 | 60,000 | 60,000 |
| Tear Resistance, lb | ASTM D 1004 | 22 | 33 | 44 |
| Puncture Resistance, lb | ASTM D 4833 | 44 | 66 | 88 |
| Axi-Symetric Break Strain, % | ASTM D 5617 | 30 | 30 | 30 |
| Carbon Black Content[3], % | ASTM D 1603 | 2.0 - 3.0 | 2.0 - 3.0 | 2.0 - 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | | --Note 4-- | |
| Oxidative Induction Time (OIT) Standard OIT, minutes | ASTM D 3895 | 100 | 100 | 100 |
| Oven Aging at 85°C High Pressure OIT - % retained after 90 days | ASTM D 5721 ASTM D 5885 | 60 | 60 | 60 |
| UV Resistance[5] High Pressure OIT[6] - % retained after 1600 hrs | GRI GM11 ASTM D 5885 | 35 | 35 | 35 |
| **Seam Properties** | ASTM D 6392 (@ 2 in/min) | | | |
| 1. Shear Strength, lb/in | | 60 | 90 | 120 |
| 2. Peel Strength, lb/in - Hot Wedge | | 50 | 75 | 100 |
| - Extrusion Fillet | | 44 | 66 | 88 |
| **Roll Dimensions** | | | | |
| 1. Width (feet): | | 23 | 23 | 23 |
| 2. Length (feet): | | 750 | 500 | 375 |
| 3. Area (square feet): | | 17,250 | 11,500 | 8,625 |
| 4. Gross weight (pounds, approx.): | | 3,465 | 3,465 | 3,435 |

1 Of 10 readings; 8 must be ≥ 7 mils and lowest individual reading must be ≥ 5 mils.
2 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.
3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3
5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

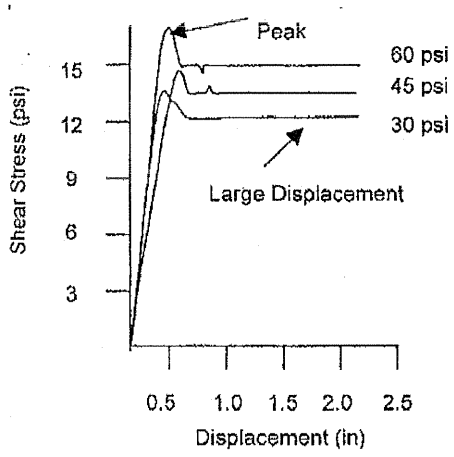
This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV. 11/06

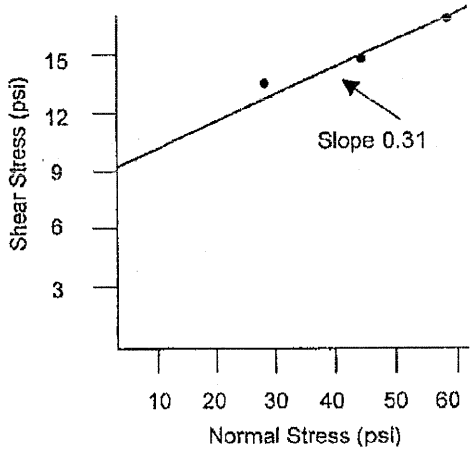
# Technical Note

## Direct Shear & Friction Angle Testing For GSE Geomembranes

Potential sources of failure of geosynthetic lined slopes are the interfaces of geosynthetic components, geosynthetic and the subgrade or a geosynthetic with the cover soil. Direct shear testing is often performed to determine this critical combination of loading and angle. The most common test performed to make this determination is ASTM D 5321. In order to make this test and the ensuing results meaningful, it is important that the testing be performed with site-specific interfaces (geosynthetics and soils) and site specific loading conditions. Furthermore, the soil must be conditioned such that it is not only the same basic type but also that the compaction and the moisture content are the same as actual field conditions. The last component that must be selected is the shear rate. ASTM D 5321 stipulates default rate of 0.2 in/min for geosynthetic/geosynthetic interfaces and 0.04 in/min for geosynthetic/soil interfaces. However, slower rates will give a better picture of the peak curve and will better simulate actual field conditions. Conversely, the slower rates take longer to complete and are thus more costly to run. The designer must weigh the importance of slope stability with the costs associated with a slower and potentially more accurate test. By specifying these site-specific conditions, the test becomes a more meaningful performance test rather than a standard index test[1].

A typical direct shear test consists of a minimum of three tests run at three different normal pressures as shown in the sample below:




The first graph shows a plot of shear stress versus displacement. The lines begin to flatten out after the initial rise and fall. This area where the line becomes flat, that is, the stress required to shear the interface is constant, is the large displacement strength (residual). The peak stress corresponds to the peak friction angle.

The second graph shows a plot of peak shear stress versus normal stress. The friction angle is derived from the slope of this line. In the previous example, the slope is 0.31. The friction angle is thus tan-1 (0.31) = 17°. A similar graph could be plotted showing large displacement stress versus normal stress. Determination of the slope of this line would give the large displacement friction angle.

Again, friction testing can be performed for a variety of interfaces, normal pressures and seat times. The materials can be run dry or, for worst case scenarios, can be run with saturated conditions. No manufacturer can guarantee a specific friction angle for a given set of site-specific conditions. Testing must be performed to ensure that the particular interfaces will meet the needs for the particular application. That being said, the tables on the back of this page list representative results from tests that have been performed on various materials. These values are intended as a guide only, not a guarantee.

- Continued -

Table 1. Geosynthetic vs. Geosynthetic Normal stress 50, 400, 800 psf

| Interface | Peak | | Large Displacement | |
|---|---|---|---|---|
| | Angle (degrees) | Adhesion (psf) | Angle (degrees) | Adhesion (psf) |
| Smooth geomembrane/geocomposite | 12 | 10 | 10 | 10 |
| Co-extruded textured geomembrane/geocomposite | 26 | 60 | 21 | 40 |
| Woven GCL/geocomposite | 25 | 15 | 22 | 5 |

Table 2. Geosynthetic vs. Geosynthetic Normal stress 4000, 8000, 15000 psf

| Interface | Peak | | Large Displacement | |
|---|---|---|---|---|
| | Angle (degrees) | Adhesion (psf) | Angle (degrees) | Adhesion (psf) |
| Smooth geomembrane/geocomposite | 12 | 80 | 10 | 25 |
| Co-extruded textured geomembrane/geocomposite | 24 | 520 | 19 | 20 |
| Woven GCL/geocomposite | 21 | 365 | 19 | 50 |

References:

[1] GSE Technical Note TN017 - Index Testing vs. Performance Testing.



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JOB 46313.01 DC Landfill
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# Geonet Design

Purpose: Determine volume of water flow through cover soils and strength parameters required for the geonet

Calculations: $\gamma_{avg\ cover} = 112$ pcf
(refer to "Geomembrane Design calc"

Strength

normal stress acting on Geonet (ASTM D1621)

$\sigma_{n\,act} = \gamma H_{max}$ $H_{max}$ = height of cover soils
$= (112)(1.5)$ $= 1.5'$
$= 168$ psf $\approx 1.2$ psi

if F.S. = 1.5 then $\sigma_{n\,act}(FS) = \sigma_{allow}$
$1.2$ psi $(1.5) = 1.8$ psi

Shear (tensile) stress

$$\tau_{act} = \frac{F_1 - F_2}{t}$$

$W \cos\beta = 3.1$ K/ft
(see Geomembrane Design)

$F_1 = W \cos\beta \tan\delta_1$

$\delta_1$ = interface of soil to geotextile (geonet) cover = 28°

$F_1 = 3.1$ K/ft $\tan(28°) = 1.6$ K/ft

$F_2 = N \cos\beta \tan\delta_2$

$\delta_2$ = interface of geotextile to geomembrane = 25°

$F_2 = 3.1$ K/ft $\tan 25° = 1.45$ K/ft

PRODUCT 204-1 (Single Sheet) 205-1 (Parklan)

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Calcs (cont.)

$$\tau_{act} = \frac{1.6 - 1.4}{0.20}\left(\frac{1}{12}\right) \quad \text{assume } t = 0.20 \text{ in}$$

$$\tau_{act} = 0.083\ ^{K}/_{in^2} = 83.\ ^{lbs}/_{in^2}$$

$$\tau_{allow} = \tau_{act}(FS) \quad \text{assume } FS = 1.5$$

$$= 83\ ^{lbs}/_{in^2}(1.5)$$

$$\tau_{allow} = 125\ ^{lbs}/_{in^2}$$

- check amount of flow anticipated

PRODUCT 204-1 (Single Sheets) 205-1 (Bound)

# GEONETS

| Product Name | Structure [1] | Core/Net/Mesh Polymer Composition [2] | Geotextile Attached (Y/N) [3] | Width/Length m (ft) | Core/Net/Mesh [4] Thickness ASTM D5199 mm (mil) | Compressive Strength at yield ASTM D1621 kPa (psi) | Transmissivity ASTM D4716-87 [5] | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Gradient = 0.1 Pressure = 10kPa 209 lb/ft² | Gradient = 1.0 Pressure = 479kPa 10,000 lb/ft² |
| | | | | | | | $m^2/s$ (gal/min/ft) | $m^2/s$ (gal/min/ft) |
| **CETCO** | | | | | | | | **www.cetco.com** |
| TexDrain 200 | GN | PE | N | 4.27/106.7 (14/350) | 5 (200) | NP | NP | $1 \times 10^{-3}$ (4.8) |
| TexDrain 250 | GN | PE | N | 4.27/83.8 (14/275) | 6.35 (250) | NP | NP | $1.5 \times 10^{-3}$ (7.2) |
| TexDrain 200-DS4 | O/C | PP/PE/PP | Y, nonwoven | 4.1/76.2 (13.5/250) | NP | NP | NP | $2 \times 10^{-4}$ (1.0) |
| TexDrain 200-DS6 | O/C | PP/PE/PP | Y, nonwoven | 4.1/76.2 (13.5/250) | NP | NP | NP | $0.8 \times 10^{-4}$ (0.4) |
| TexDrain 200-DS8 | O/C | PP/PE/PP | Y, nonwoven | 4.1/61 (13.5/200) | NP | NP | NP | $4 \times 10^{-5}$ (0.2) |
| TexDrain 250-DS6 | O/C | PP/PE/PP | Y, nonwoven | 4.1/53.4 (13.5/175) | NP | NP | NP | $2 \times 10^{-4}$ (1.0) |
| TexDrain 250-DS8 | O/C | PP/PE/PP | Y nonwoven | 4.1/45.7 (13.5/150) | NP | NP | NP | $1.0 \times 10^{-4}$ (0.5) |
| **GSE Lining Technology Inc.** | | | | | | | | **www.gseworld.com** |
| GSE HyperNet | GN-HDPE | PE | N | 4.6 (15) / 91 (300) | 5 (200) | NP | $3 \times 10^{-3}$ (14) | $8 \times 10^{-4}$ (4) |
| GSE HyperNet UF | GN-HDPE | PE | N | 4.6 (15) / 60 (200) | 7.6 (300) | NP | $9 \times 10^{-3}$ (44) | $2 \times 10^{-3}$ (10) |
| GSE FabriNet | O/C | O/C | Y | 4.4 (14.5) / 70.1 (230) | 5 (200) | NP | $5 \times 10^{-4}$ (2) | $1 \times 10^{-4}$ (0.5) |
| GSE FabriNet UF | O/C | O/C | Y | 4.5 (15) / 48 (160) | 7.6 (300) | NP | $2 \times 10^{-3}$ (10) | $5 \times 10^{-4}$ (2) |
| GSE DuraNet Geonet | GN-HDPE | PE | N | 4.6 (15) / 60 (200) | NP | NP | NP | $4 \times 10^{-3}$ (20) |
| GSE DuraNet Geocomposite | O/C | O/C | Y | 4.5 (15) / 48 (160) | NP | NP | NP | $1 \times 10^{-3}$ (4) |
| **PAVCO - Amanco** | | | | | | | | **www.pavco.com.co** |
| PAVCO Geocomposite Drainage | O/C | PP / PE / PP | Y, Nonwoven | 2.0 / 50 (6.6 / 164) | 5.0 (200) | 1020 (146) | $3.0 \times 10^{-4}$ | NP |
| **Poly-Flex Inc.** | | | | | | | | **www.poly-flex.com** |
| GN-200 | GN | PE | N | 4.27/106.7 (14/350) | 5.1 (200) | NP | $4 \times 10^{-3}$ (19.3) | $0.8 \times 10^{-3}$ (3.9) |
| GN-250 | GN | PE | N | 4.27/83.8 (14/275) | 6.3 (250) | NP | $5 \times 10^{-3}$ (24.1) | $1.2 \times 10^{-3}$ (5.8) |
| GC-06S-2.0 | O/C | PP/PE | Y nonwoven | 4.1/91.4 (13.5/300) | NP | NP | $2 \times 10^{-3}$ (9.7) | $2 \times 10^{-4}$ (0.97) |
| GC-08S-2.0 | O/C | PP/PE | Y nonwoven | 4.1/76.2 (13.5/250) | NP | NP | $1.5 \times 10^{-3}$ (7.2) | $1 \times 10^{-4}$ (0.48) |
| GC-06S-2.5 | O/C | PP/PE | Y nonwoven | 4.1/68.6 (13.5/225) | NP | NP | $2.8 \times 10^{-3}$ (13.5) | $4.5 \times 10^{-4}$ (2.2) |

[1] GN = Geonet
O/C = Other or combination

[2] HDPE = High Density polyethylene
PP = Polypropylene
NP = Not provided by manufacturer
PE = Polyethylene
PS = Polystyrene
O/C = Other or combination

[3] If "Y", specify woven or nonwoven.

[4] Thickness includes attached geotextile, when applicable

[5] Seating time is 15 min. and flat-plate environment.

NP = Data not provided by manufacturer
NA = Not applicable, per manufacturer

GFR recommends you contact the manufacturers before making any specifying/purchasing decisions.

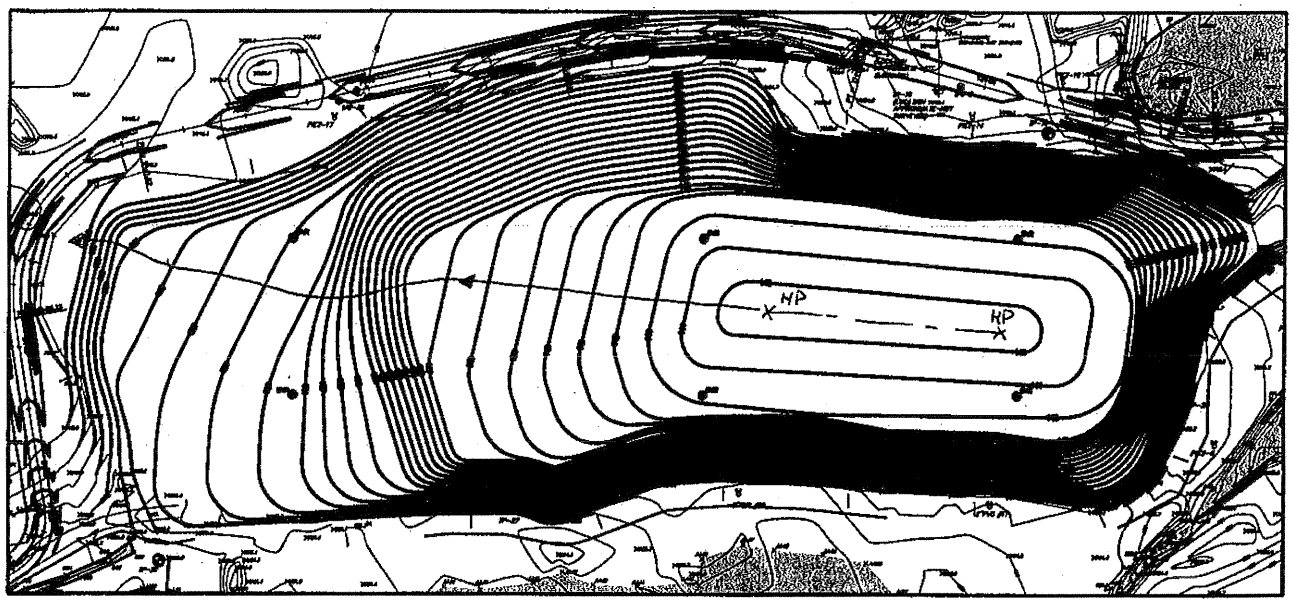
# GSE FabriNet

| TESTED PROPERTY | TEST METHOD | FREQUENCY | MINIMUM AVERAGE ROLL VALUE[a] | | |
|---|---|---|---|---|---|
| **Geocomposite** | | | 6 oz/yd² | 8 oz/yd² | 10 oz/yd² |
| Product Code | | | F420600605 | F420800805 | F421001005 |
| Transmissivity[b], gal/min/ft (m²/sec) | ASTM D 4716 | 1/540,000 ft² | 0.48 (1 x $10^{-4}$) | 0.48 (1 x $10^{-4}$) | 0.43 (9 x $10^{-5}$) |
| Ply Adhesion, lb/in (g/cm) | ASTM D 7005 | 1/50,000 ft² | 1.0 (178) | 1.0 (178) | 1.0 (178) |
| Roll Width[c], ft (m) | | | 14.5 (4.4) | 14.5 (4.4) | 14.5 (4.4) |
| Roll Length[c], ft (m) | | | 230 (70.1) | 200 (60.9) | 190 (58.0) |
| Roll Area, ft² (m²) | | | 3,335 (310) | 2,900 (269) | 2,755 (256) |
| **Geonet core[d]** | | | | | |
| Transmissivity,[b] gal/min/ft (m²/sec) | ASTM D 4716 | | 9.66 (2 x $10^{-3}$) | 9.66 (2 x $10^{-3}$) | 9.66 (2 x $10^{-3}$) |
| Thickness, mil (mm) | ASTM D 5199 | 1/50,000 ft² | 200 (5) | 200 (5) | 200 (5) |
| Density, g/cm³ | ASTM D 1505 | 1/50,000 ft² | 0.94 | 0.94 | 0.94 |
| Tensile Strength (MD), lb/in (N/mm) | ASTM D 5035 | 1/50,000 ft² | 45 (7.9) | 45 (7.9) | 45 (7.9) |
| Carbon Black Content, % | ASTM D 1603 | 1/50,000 ft² | 2.0 | 2.0 | 2.0 |
| **Geotextile (prior to lamination)[d,e]** | | | | | |
| Mass per Unit Area, oz/yd² (g/m²) | ASTM D 5261 | 1/90,000 ft² | 6 (200) | 8 (270) | 10 (335) |
| Grab Tensile, lb (N) | ASTM D 4632 | 1/90,000 ft² | 170 (755) | 220 (975) | 260 (1,155) |
| Puncture Strength, lb (N) | ASTM D 4833 | 1/90,000 ft² | 90 (395) | 120 (525) | 165 (725) |
| AOS, US sieve (mm) | ASTM D 4751 | 1/540,000 ft² | 70 (0.212) | 80 (0.180) | 100 (0.150) |
| Permittivity, (sec⁻¹) | ASTM D 4491 | 1/540,000 ft² | 1.5 | 1.5 | 1.2 |
| Flow Rate, gpm/ft² (lpm/m²) | ASTM D 4491 | 1/540,000 ft² | 110 (4,480) | 110 (4,480) | 85 (3,460) |
| UV Resistance, % retained | ASTM D 4355 (after 500 hours) | once per formulation | 70 | 70 | 70 |

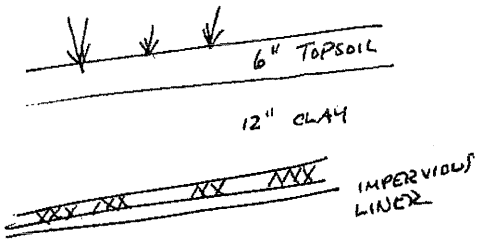
**NOTES:**

- [a]These are MARV values that are based on the cumulative results of specimens tested and determined by GSE. AOS in mm is a maximum average roll value.
- [b]Gradient of 0.1, normal load of 10,000 psf, water at 70° F between steel plates for 15 minutes.
- [c]Roll widths and lengths have a tolerance of ±1%.
- [d]Component properties prior to lamination.
- [e]Refer to geotextile product data sheet for additional specifications.

1" = 500'




LENGTH LONGEST FLOW PATH ≅ 500'




CLAY SOIL LAYER (DARCY'S LAW)

$K = 10^{-5}$ cm/s

$K = 3.281 \times 10^{-7}$ ft/s

$V = Ki \qquad i = 1$

$V = K = 3.281 \times 10^{-7}$ ft/s

$Q = KA$

$Q = 3.281 \times 10^{-7} (500) =$

$Q = 1.64 \times 10^{-4}$ ft³/s

96% CHECK

1 HR RAINFALL, DUTCHESS COUNTY = 2.8 in

$2.8/24 = 0.1167$ in/hr

$V = 2.80 \times 10^{-6}$ ft/s

$Q = VA = 2.8 \times 10^{-6} (500) =$

$Q = 1.35 \times 10^{-3}$ ft³/s

## *Appendix D - Minimum Testing Frequencies and Properties for GSE Nonwoven Geotextile*

| TESTED PROPERTY | TEST METHOD | FREQUENCY | NW4 | NW6 | NW8 | NW10 | NW12 | NW16 |
|---|---|---|---|---|---|---|---|---|
| Product Code | | | GEO 0408002 | GEO 0608002 | GEO 0808002 | GEO 1008002 | GEO 1208002 | GEO 1608002 |
| AASHTO M288 Class | | | 3 | 2 | 1 | >1 | >>1 | >>>1 |
| Mass per Unit Area, oz/yd² (g/m²) | ASTM D 5261 | 90,000 ft² | 4 (135) | 6 (200) | 8 (270) | 10 (335) | 12 (405) | 16 (540) |
| Thickness | ASTM D 5199 | 1/90,000 ft² | 45 mil | 70 mil | 80 mil | 100 mil | 110 mil | 155 mil |
| Grab Tensile Strength, lb (N) | ASTM D 4632 | 90,000 ft² | 120 (530) | 170 (755) | 220 (975) | 260 (1,155) | 320 (1,420) | 390 (1,735) |
| Grab Elongation, % | ASTM D 4632 | 90,000 ft² | 50 | 50 | 50 | 50 | 50 | 50 |
| Puncture Strength, lb (N) | ASTM D 4833 | 90,000 ft² | 60 (265) | 90 (395) | 120 (525) | 165 (725) | 190 (835) | 240 (1,055) |
| Trapezoidal Tear Strength, lb (N) | ASTM D 4533 | 90,000 ft² | 50 (220) | 70 (310) | 95 (420) | 100 (445) | 125 (555) | 150 (665) |
| Apparent Opening Size, Sieve No. (mm) | ASTM D 4751 | 540,000 ft² | 70 (0.212) | 70 (0.212) | 80 (0.180) | 100 (0.150) | 100 (0.150) | 100 (0.150) |
| Permittivity, sec⁻¹ | ASTM D 4491 | 540,000 ft² | 1.50 | 1.50 | 1.50 | 1.20 | 0.80 | 0.70 |
| Permeability, cm/sec | ASTM D 4491 | 540,000 ft² | 0.22 | 0.30 | 0.30 | 0.30 | 0.29 | 0.27 |
| Water Flow Rate, gpm/ft² (l/min/m²) | ASTM D 4491 | 540,000 ft² | 120 (4,885) | 110 (4,480) | 110 (4,480) | 85 (3,460) | 60 (2,440) | 50 (2,035) |
| UV Resistance (% retained after 500 hours) | ASTM D 4355 | per formulation | 70 | 70 | 70 | 70 | 70 | 70 |
| Roll Length[1], ft (m) | | | 600 (182) | 600 (182) | 600 (182) | 300 ( 91) | 300 ( 91) | 300 (91) |
| Roll Width[1], ft (m) | | | 15 (4.6) | 15 (4.6) | 15 (4.6) | 15 (4.6) | 15 (4.6) | 15 (4.6) |
| Roll Area, ft² (m²) | | | 9,000 (836) | 9,000 ( 836) | 9,000 ( 836) | 4,500 (418) | 4,500 (418) | 4,500 (418) |

**NOTES:**

- The property values listed are in weaker principal direction. All values listed are Minimum Average Roll Values (MARV) except apparent opening size in mm and UV resistance. Apparent opening size (mm) is a Maximum Average Roll Value. UV is a typical value.
- [1]Roll lengths and widths have a tolerance of ±1%.



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JOB 40313.01 DC Landfill
SHEET NO. 1 OF 2
CALCULATED BY MAK DATE 2/27/07
CHECKED BY KSP DATE 3/27/07
SCALE

# Stability of Landfill Cap

- Check drainage layer against Geomembrane
  calculate using finite Slope without reinforcement
  "Designing with Geosynthetics" Robert Koerner

Properties are from before

Cap will be constructed at 3H:1V $\Rightarrow \beta = 18.4^\circ$
Interface between drainage layer (geonet ~ geotextile) and Geomembrane = $\delta_u = 25^\circ$
Cover above Geomembrane = 1' of barrier with $\gamma_{Br} = 115$ pcf
0.5' of Topsoil with $\gamma_{Tp} = 105$ pcf

Total height = 1.5' Total avg $\gamma = 67\%(115) + 33\%(105)$
$\gamma_{avg} = 112$ pcf

length of slope $= L = \frac{\Delta \text{Elev.}}{\sin\beta} = \frac{1.5}{\sin 18.4} = 4.7.5'$

calcs: • $W_A = \gamma_{avg} h_T^2 \left( \frac{L}{h_T} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2} \right)$

$= (112 \text{ pcf})(1.5 \text{ ft})^2 \left[ \frac{47.5}{1.5} - \frac{1}{\sin(18.4)} - \frac{\tan(18.4)}{2} \right]$

$W_A = 17,140$ lbs

• $N_A = W_A \cos\beta$

$= 17,140 \cos(18.4)$

$N_A = 16,775$ lbs

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Cals (cont.)

- $W_p = \frac{\gamma h^2}{\sin 2\beta}$

$= \frac{112\,(1.5)^2}{\sin 2(18.4)}$

$W_p = 421$ lbs

$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$

$a = (W_A - N_A \cos\beta)\cos\beta$

$[7140 - 6775 \cos(18.4)]\cos 18.4$

$a = 675$ lbs

cohesion = 0
adhesion = 0

$b = -[(W_A - N_A \cos\beta)\sin\beta \tan\phi + (N_A \tan\delta)\sin\beta\cos\beta + \sin\beta\,(W_p \tan\phi)$

$(7140 - 6775 \cos 18.4)\sin 18.4^\circ \tan 31^\circ + (16{,}775 \tan 25)\sin 18.4 \cos 18.4$

$+ \sin 18.4\,(421 \tan 31)]$

139.92
946.23
79.85

$b = -1161$ lbs

$c = (N_A \tan\delta)\sin^2\beta \tan\phi$

$(6{,}775 \tan 25)\sin^2 18.4^\circ \tan 31^\circ$

$c = 189$ lbs

$FS = \frac{+1{,}161 + \sqrt{(1161)^2 - 4(675)(189)}}{2(675)}$

$FS = 1.5$ ✓

PRODUCT 204-1 (Blank Sheets 216-1 (Padded)

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JOB 40313.01 DC Balefill
SHEET NO. 1 OF 2
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# Global Stability

Purpose: determine the overall stability of the final closure design under worst case conditions.

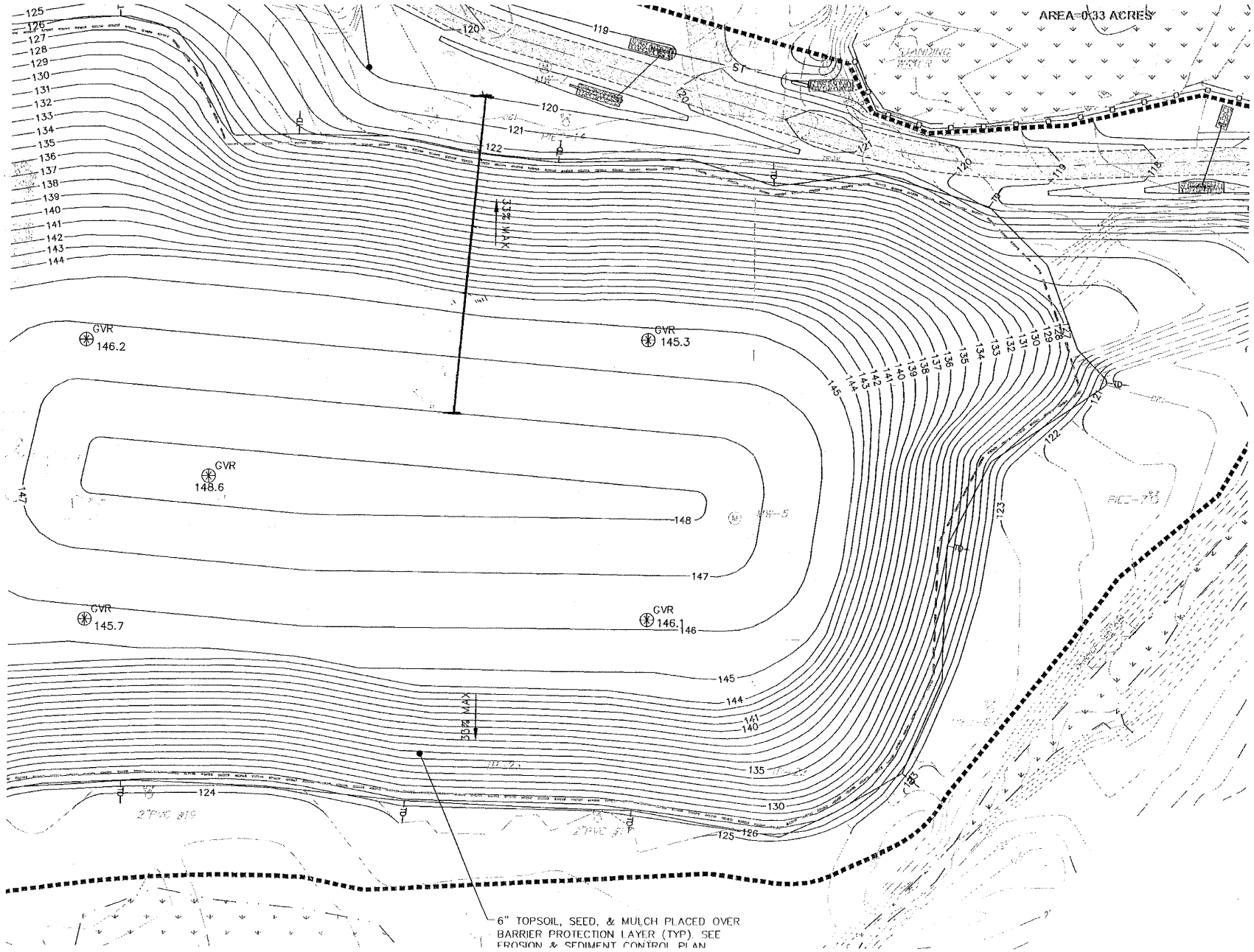
- Based on Topsoil Grading Plan and using a section of the proposed final conditions with the maximum 3H:1V length a cross section was modeled and analyzed with Galena v. 4.02
- All values were determined from "Soil Properties" or "Typical Section"
- Trial 1 ran an analysis using non-circular Spencer-Wright with a search for the critical failure plain through the proposed Cover design

  Result: Critical FOS = 1.57 see attached

- Trial 2 ran a circular analysis using Spencer-Wright with the search for the Critical failure plain through the MSW

  Result: Critical FOS = 1.9

Note:
Minimal requirements require that 12 inches of ash or select granular fill be placed over exposed MSW. Since calculations were performed prior to this knowledge, the cover design was placed directly over the waste. However our analysis is still valid because ash has soil properties similar to those assigned to the MSW. Therefore adding a layer of ash while removing MSW will not effect the overall global stability.




Scale
1:40

Topsoil Grades

N

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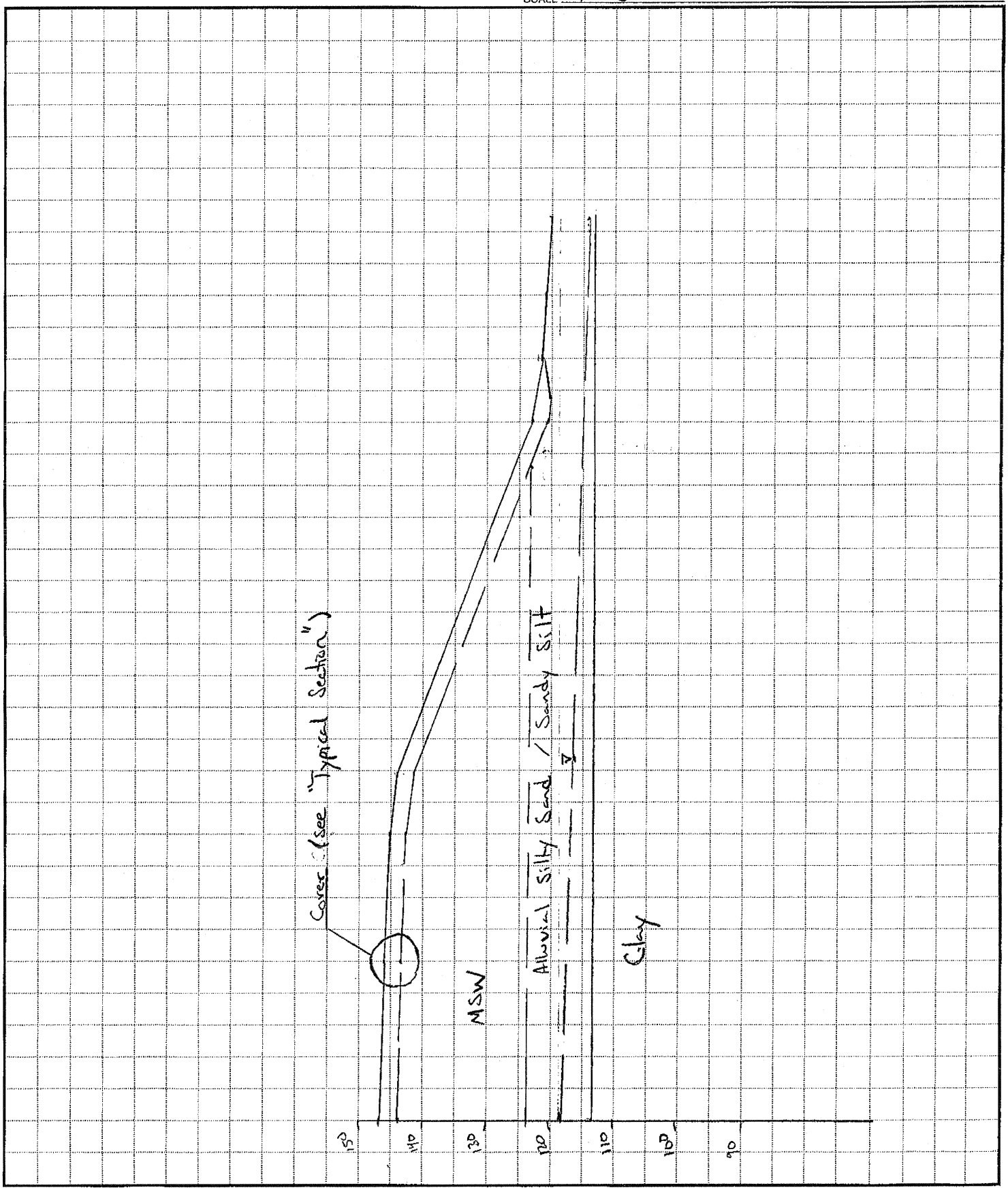
JOB 40313.01 DC Refill

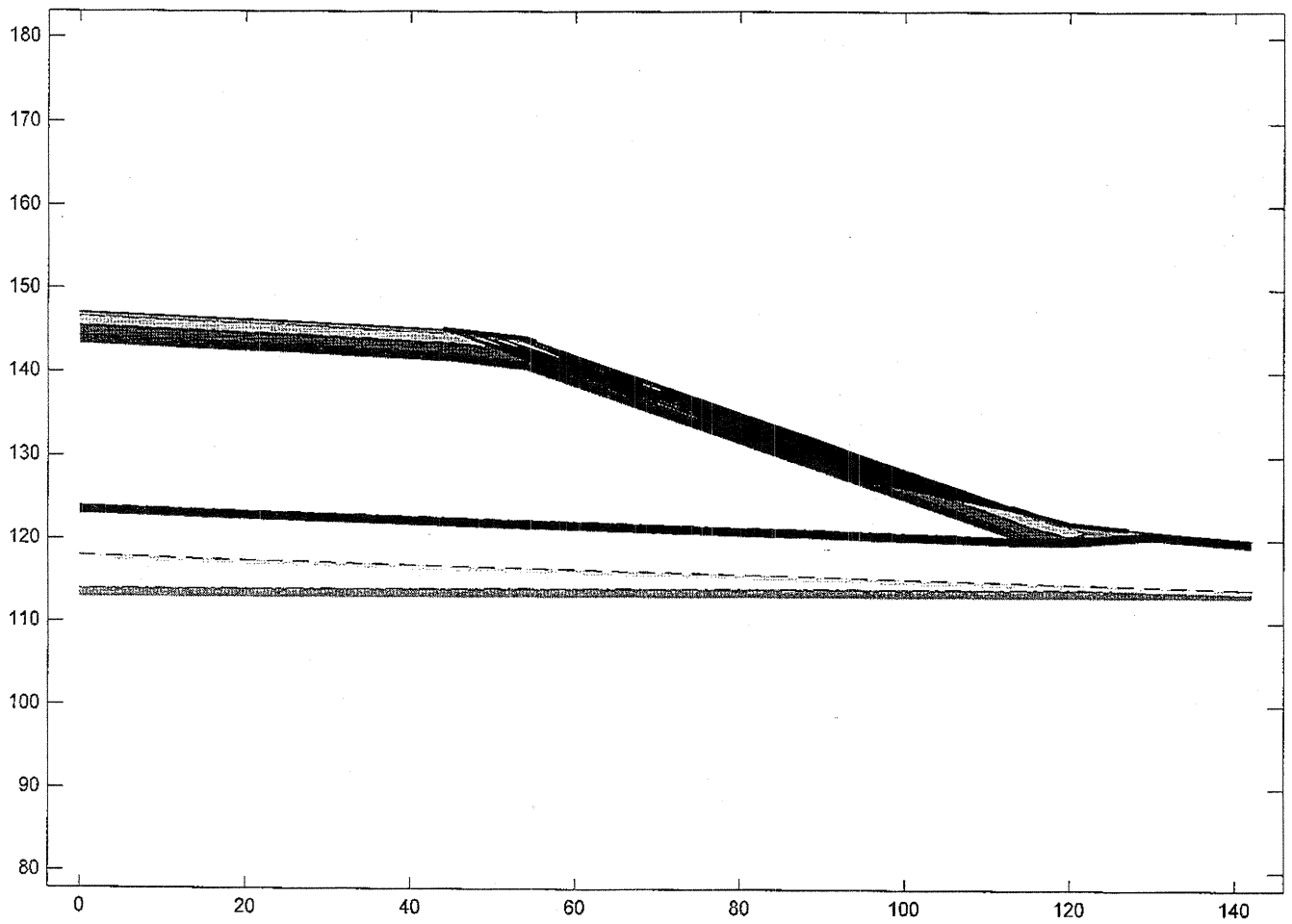
SHEET NO. 2 OF 2

CALCULATED BY MAK DATE 3/20/07

CHECKED BY KSP DATE 3/27/07

SCALE 1:20






**GALENA** Version 4.02

*Analysis:* 1
Multiple Stability Analysis
*Method:* Spencer-Wright
*Surface:* Non-Circular

*Results*
*Critical (minimum)*
*Factor of Safety:* 1.57
*Final Angle of*
*Interslice Forces:* 18.7°

*Edited:* 20 Mar 2007 *Processed:* 20 Mar 2007

*Project:* DC Balefill
Final Conditions
*File:* S:\4\40300-40399\40313_01\ENG\Geotech\Final Conditions.gmf

**The Chazen Companies**

Galena 4.02 Analysis Results — Licensee: The Chazen Companies

Project: DC Balefill
File: S:\4\40300-40399\40313_01\ENG\Geotech\Final Conditions.gmf — Processed: 13:23:57 20 Mar 2007

DATA: Analysis 1 - Final Conditions

Material and Water Properties (7 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Topsoil

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 28.0 | 105.00 | 0.00 |

Material: 2 (Mohr-Coulomb Isotropic) - Barrier Layer

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 32.0 | 115.00 | 0.00 |

Material: 3 (Mohr-Coulomb Isotropic) - GeoComposite/Geomembrane

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 25.0 | 50.00 | 0.00 |

Material: 4 (Mohr-Coulomb Isotropic) - Gas Venting Layer

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 36.0 | 110.00 | 0.00 |

Material: 5 (Mohr-Coulomb Isotropic) - MSW

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 30.0 | 45.00 | 0.00 |

Material: 6 (Mohr-Coulomb Isotropic) - Alluvium Deposits

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 0.00 | 33.0 | 120.00 | 0.00 |

Material: 7 (Mohr-Coulomb Isotropic) - Clay

| Cohesion | Phi | UnitWeight | Ru |
|---|---|---|---|
| 1000.00 | 0.0 | 120.00 | 0.00 |

Unit weight of water: 62.400 Unit weight of water/medium above ground: 0.000

Material Profiles (7 profiles)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Profile: 1 (7 points) | Material beneath: 1 - Topsoil | | | | | | | | |
| 0.00 | 147.00 | 25.00 | 146.00 | 45.00 | 145.00 | 54.00 | 144.00 | 116.00 | 123.00 |
| 120.00 | 122.00 | 130.00 | 121.00 | | | | | | |
| Profile: 2 (7 points) | Material beneath: 2 - Barrier Layer | | | | | | | | |
| 0.00 | 146.50 | 25.00 | 145.50 | 45.00 | 144.50 | 54.00 | 143.50 | 116.00 | 122.50 |
| 120.00 | 121.50 | 122.00 | 121.00 | | | | | | |
| Profile: 3 (7 points) | Material beneath: 3 - GeoComposite/Geomembrane | | | | | | | | |
| 0.00 | 145.50 | 25.00 | 144.50 | 45.00 | 143.50 | 54.00 | 142.50 | 116.00 | 121.50 |
| 120.00 | 120.50 | 122.00 | 121.00 | | | | | | |
| Profile: 4 (6 points) | Material beneath: 4 - Gas Venting Layer | | | | | | | | |
| 0.00 | 145.30 | 25.00 | 144.30 | 45.00 | 143.30 | 54.00 | 142.30 | 116.00 | 121.30 |
| 120.00 | 120.30 | | | | | | | | |
| Profile: 5 (5 points) | Material beneath: 5 - MSW | | | | | | | | |
| 0.00 | 144.30 | 25.00 | 143.30 | 45.00 | 142.30 | 54.00 | 141.30 | 116.00 | 120.30 |
| Profile: 6 (5 points) | Material beneath: 6 - Alluvium Deposits | | | | | | | | |
| 0.00 | 124.00 | 116.00 | 120.30 | 120.00 | 120.30 | 130.00 | 121.00 | 142.00 | 120.00 |
| Profile: 7 (2 points) | Material beneath: 7 - Clay | | | | | | | | |
| 0.00 | 114.00 | 142.00 | 114.00 | | | | | | |

Slope Surface (8 points)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 147.00 | 25.00 | 146.00 | 45.00 | 145.00 | 54.00 | 144.00 | 116.00 | 123.00 |
| 120.00 | 122.00 | 130.00 | 121.00 | 142.00 | 120.00 | | | | |

Phreatic Surface (2 points)

| | | | |
|---|---|---|---|
| 0.00 | 118.00 | 142.00 | 114.00 |

Failure Surface

Initial non-circular surface for critical search (3 points)

| | | | | | |
|---|---|---|---|---|---|
| 55.12 | 143.62 | 88.51 | 132.12 | 107.35 | 125.93 |

Variable Restraints

| | | | |
|---|---|---|---|
| Horizontal range around X-Left: | 11.00 | Trial positions within range: | 5 |
| Horizontal range around X-Right: | 14.00 | Trial positions within range: | 5 |
| Vertical range around Mid-Point: | 3.00 | Trial positions within range: | 5 |

---

RESULTS: Analysis 1 - Final Conditions

Spencer-Wright Method of Analysis - Non-Circular Failure Surface

Critical Failure Surface Search using Multiple Surface Generation Techniques

Factor of Safety for initial failure surface approximation: 1.88
There were 73 successful analyses from a total of 125 trial surfaces
52 analyses were aborted due to unacceptable geometry

Critical (minimum) Factor of Safety: 1.57

Final Angle of Interslice Forces: 18.7 degrees

Negative interslice forces exist on one or more slices - examine slice data and consult the Galena Users' Guide

Effective stress line of thrust for one or more slices is not within middle third of slice
Examine slice data and consult the Galena Users' Guide

Surface and Results Summary (Lowest 73 Factor of Safety surfaces)

| Surface | X-Left | Y-Left | X-Right | Y-Right | Y-Deflection | FoS |
|---|---|---|---|---|---|---|
| 1 | 55.12 | 143.62 | 107.35 | 125.93 | 0.75 | 1.570 |
| 2 | 55.12 | 143.62 | 110.85 | 124.74 | 0.75 | 1.570 |
| 3 | 55.12 | 143.62 | 114.35 | 123.56 | 0.75 | 1.570 |
| 4 | 46.87 | 144.79 | 110.85 | 124.74 | 0.00 | 1.576 |
| 5 | 52.37 | 144.18 | 114.35 | 123.56 | 0.75 | 1.585 |
| 6 | 52.37 | 144.18 | 110.85 | 124.74 | 0.75 | 1.587 |
| 7 | 46.87 | 144.79 | 107.35 | 125.93 | 0.00 | 1.590 |
| 8 | 52.37 | 144.18 | 107.35 | 125.93 | 0.75 | 1.590 |
| 9 | 46.87 | 144.79 | 114.35 | 123.56 | 0.00 | 1.637 |
| 10 | 55.12 | 143.62 | 107.35 | 125.93 | -0.75 | 1.739 |
| 11 | 55.12 | 143.62 | 110.85 | 124.74 | -0.75 | 1.756 |
| 12 | 55.12 | 143.62 | 107.35 | 125.93 | 0.00 | 1.773 |
| 13 | 55.12 | 143.62 | 114.35 | 123.56 | -0.75 | 1.782 |
| 14 | 55.12 | 143.62 | 110.85 | 124.74 | 0.00 | 1.782 |
| 15 | 55.12 | 143.62 | 114.35 | 123.56 | 0.00 | 1.790 |
| 16 | 52.37 | 144.18 | 107.35 | 125.93 | -0.75 | 1.811 |
| 17 | 52.37 | 144.18 | 107.35 | 125.93 | 0.00 | 1.825 |
| 18 | 52.37 | 144.18 | 110.85 | 124.74 | 0.00 | 1.828 |
| 19 | 52.37 | 144.18 | 114.35 | 123.56 | 0.00 | 1.830 |
| 20 | 52.37 | 144.18 | 110.85 | 124.74 | -0.75 | 1.833 |
| 21 | 52.37 | 144.18 | 114.35 | 123.56 | -0.75 | 1.853 |
| 22 | 49.62 | 144.49 | 110.85 | 124.74 | 0.75 | 1.881 |
| 23 | 49.62 | 144.49 | 114.35 | 123.56 | 0.00 | 1.881 |
| 24 | 49.62 | 144.49 | 107.35 | 125.93 | 0.75 | 1.883 |
| 25 | 49.62 | 144.49 | 110.85 | 124.74 | 0.00 | 1.884 |
| 26 | 49.62 | 144.49 | 107.35 | 125.93 | 0.00 | 1.888 |
| 27 | 49.62 | 144.49 | 107.35 | 125.93 | -0.75 | 1.931 |
| 28 | 46.87 | 144.79 | 114.35 | 123.56 | 0.75 | 1.931 |
| 29 | 44.12 | 145.04 | 114.35 | 123.56 | -1.50 | 1.942 |
| 30 | 44.12 | 145.04 | 117.85 | 122.54 | -1.50 | 1.944 |
| 31 | 49.62 | 144.49 | 117.85 | 122.54 | -0.75 | 1.944 |
| 32 | 49.62 | 144.49 | 110.85 | 124.74 | -0.75 | 1.946 |
| 33 | 46.87 | 144.79 | 110.85 | 124.74 | 0.75 | 1.951 |
| 34 | 44.12 | 145.04 | 110.85 | 124.74 | -1.50 | 1.957 |
| 35 | 49.62 | 144.49 | 114.35 | 123.56 | -0.75 | 1.959 |
| 36 | 46.87 | 144.79 | 107.35 | 125.93 | 0.75 | 1.961 |
| 37 | 55.12 | 143.62 | 107.35 | 125.93 | -1.50 | 1.969 |
| 38 | 55.12 | 143.62 | 117.85 | 122.54 | -1.50 | 1.974 |
| 39 | 44.12 | 145.04 | 107.35 | 125.93 | -1.50 | 1.974 |
| 40 | 55.12 | 143.62 | 110.85 | 124.74 | -1.50 | 1.977 |
| 41 | 46.87 | 144.79 | 114.35 | 123.56 | 1.50 | 1.981 |
| 42 | 55.12 | 143.62 | 114.35 | 123.56 | -1.50 | 1.985 |
| 43 | 49.62 | 144.49 | 114.35 | 123.56 | -1.50 | 1.998 |
| 44 | 46.87 | 144.79 | 110.85 | 124.74 | 1.50 | 2.004 |
| 45 | 49.62 | 144.49 | 117.85 | 122.54 | -1.50 | 2.004 |
| 46 | 52.37 | 144.18 | 107.35 | 125.93 | -1.50 | 2.005 |
| 47 | 52.37 | 144.18 | 117.85 | 122.54 | -1.50 | 2.007 |
| 48 | 52.37 | 144.18 | 110.85 | 124.74 | -1.50 | 2.010 |
| 49 | 52.37 | 144.18 | 114.35 | 123.56 | -1.50 | 2.011 |
| 50 | 49.62 | 144.49 | 110.85 | 124.74 | -1.50 | 2.013 |
| 51 | 46.87 | 144.79 | 114.35 | 123.56 | -1.50 | 2.018 |
| 52 | 44.12 | 145.04 | 114.35 | 123.56 | 1.50 | 2.019 |
| 53 | 46.87 | 144.79 | 117.85 | 122.54 | -1.50 | 2.026 |
| 54 | 44.12 | 145.04 | 110.85 | 124.74 | 1.50 | 2.027 |
| 55 | 49.62 | 144.49 | 107.35 | 125.93 | -1.50 | 2.031 |
| 56 | 46.87 | 144.79 | 107.35 | 125.93 | 1.50 | 2.033 |
| 57 | 44.12 | 145.04 | 114.35 | 123.56 | 0.75 | 2.035 |
| 58 | 46.87 | 144.79 | 110.85 | 124.74 | -1.50 | 2.036 |
| 59 | 44.12 | 145.04 | 107.35 | 125.93 | 1.50 | 2.038 |
| 60 | 44.12 | 145.04 | 110.85 | 124.74 | 0.75 | 2.038 |
| 61 | 44.12 | 145.04 | 107.35 | 125.93 | 0.75 | 2.041 |
| 62 | 46.87 | 144.79 | 107.35 | 125.93 | -1.50 | 2.056 |
| 63 | 46.87 | 144.79 | 117.85 | 122.54 | -0.75 | 2.156 |
| 64 | 46.87 | 144.79 | 114.35 | 123.56 | -0.75 | 2.158 |
| 65 | 46.87 | 144.79 | 110.85 | 124.74 | -0.75 | 2.160 |
| 66 | 46.87 | 144.79 | 107.35 | 125.93 | -0.75 | 2.163 |
| 67 | 44.12 | 145.04 | 114.35 | 123.56 | 0.00 | 2.200 |
| 68 | 44.12 | 145.04 | 110.85 | 124.74 | 0.00 | 2.204 |
| 69 | 44.12 | 145.04 | 114.35 | 123.56 | -0.75 | 2.207 |
| 70 | 44.12 | 145.04 | 107.35 | 125.93 | 0.00 | 2.209 |
| 71 | 44.12 | 145.04 | 117.85 | 122.54 | -0.75 | 2.221 |
| 72 | 44.12 | 145.04 | 110.85 | 124.74 | -0.75 | 2.231 |
| 73 | 44.12 | 145.04 | 107.35 | 125.93 | -0.75 | 2.239 |

Note: Y-Deflection values are failure surface mid-point vertical distances from the mid-point of the initial failure surface used for this analysis

Critical Failure Surface ( 3 points)

| | | | | | |
|---|---|---|---|---|---|
| 55.12 | 143.62 | 88.51 | 132.12 | 107.35 | 125.93 |

Slice Geometry and Properties (31 slices)

| Slice | X-Left | Width | Y-Top | Y-Base | Base Angle | Base Matl | Base Cohesion | Total Weight | PoreWater Force | Side Force (LHS) | l/h (LHS) | l'/h (LHS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 55.12 | 1.67 | 143.34 | 143.33 | 19.0 | 1 | 0.00 | 0.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 56.79 | 1.67 | 142.77 | 142.76 | 19.0 | 1 | 0.00 | 2.46 | 0.00 | 0.00 | 0.50 | -0.50 |
| 3 | 58.46 | 1.67 | 142.21 | 142.18 | 19.0 | 1 | 0.00 | 4.08 | 0.00 | 0.02 | 0.37 | -0.37 |
| 4 | 60.13 | 1.67 | 141.64 | 141.61 | 19.0 | 1 | 0.00 | 5.75 | 0.00 | 0.04 | 0.35 | -0.35 |
| 5 | 61.80 | 1.67 | 141.08 | 141.03 | 19.0 | 1 | 0.00 | 7.36 | 0.00 | 0.07 | 0.34 | -0.34 |
| 6 | 63.47 | 1.67 | 140.51 | 140.46 | 19.0 | 1 | 0.00 | 9.04 | 0.00 | 0.11 | 0.34 | -0.34 |
| 7 | 65.14 | 1.67 | 139.95 | 139.88 | 19.0 | 1 | 0.00 | 10.64 | 0.00 | 0.16 | 0.34 | -0.34 |
| 8 | 66.81 | 1.67 | 139.38 | 139.31 | 19.0 | 1 | 0.00 | 12.32 | 0.00 | 0.21 | 0.34 | -0.34 |
| 9 | 68.48 | 1.67 | 138.81 | 138.73 | 19.0 | 1 | 0.00 | 13.91 | 0.00 | 0.28 | 0.34 | -0.34 |
| 10 | 70.14 | 1.67 | 138.25 | 138.16 | 19.0 | 1 | 0.00 | 15.61 | 0.00 | 0.35 | 0.34 | -0.34 |
| 11 | 71.81 | 1.67 | 137.68 | 137.58 | 19.0 | 1 | 0.00 | 17.19 | 0.00 | 0.44 | 0.34 | -0.34 |
| 12 | 73.48 | 1.67 | 137.12 | 137.01 | 19.0 | 1 | 0.00 | 18.89 | 0.00 | 0.53 | 0.34 | -0.34 |
| 13 | 75.15 | 1.67 | 136.55 | 136.44 | 19.0 | 1 | 0.00 | 20.47 | 0.00 | 0.63 | 0.34 | -0.34 |
| 14 | 76.82 | 1.67 | 135.99 | 135.86 | 19.0 | 1 | 0.00 | 22.18 | 0.00 | 0.74 | 0.34 | -0.34 |
| 15 | 78.49 | 1.67 | 135.42 | 135.29 | 19.0 | 1 | 0.00 | 23.75 | 0.00 | 0.86 | 0.34 | -0.34 |
| 16 | 80.16 | 1.67 | 134.86 | 134.71 | 19.0 | 1 | 0.00 | 25.46 | 0.00 | 0.99 | 0.34 | -0.34 |
| 17 | 81.83 | 1.67 | 134.29 | 134.14 | 19.0 | 1 | 0.00 | 27.03 | 0.00 | 1.12 | 0.34 | -0.34 |
| 18 | 83.50 | 1.67 | 133.72 | 133.56 | 19.0 | 1 | 0.00 | 28.75 | 0.00 | 1.27 | 0.34 | -0.34 |
| 19 | 85.17 | 1.67 | 133.16 | 132.99 | 19.0 | 1 | 0.00 | 30.39 | 0.00 | 1.42 | 0.34 | -0.34 |
| 20 | 86.84 | 1.67 | 132.59 | 132.41 | 19.0 | 1 | 0.00 | 32.03 | 0.00 | 1.58 | 0.34 | -0.34 |
| 21 | 88.51 | 1.71 | 132.02 | 131.84 | 18.2 | 1 | 0.00 | 32.15 | 0.00 | 1.75 | 0.34 | -0.34 |
| 22 | 90.22 | 1.71 | 131.44 | 131.28 | 18.2 | 1 | 0.00 | 29.12 | 0.00 | 1.45 | 0.34 | -0.34 |
| 23 | 91.94 | 1.71 | 130.86 | 130.72 | 18.2 | 1 | 0.00 | 26.05 | 0.00 | 1.18 | 0.34 | -0.34 |
| 24 | 93.65 | 1.71 | 130.28 | 130.15 | 18.2 | 1 | 0.00 | 22.92 | 0.00 | 0.93 | 0.34 | -0.34 |
| 25 | 95.36 | 1.71 | 129.70 | 129.59 | 18.2 | 1 | 0.00 | 19.90 | 0.00 | 0.71 | 0.34 | -0.34 |
| 26 | 97.08 | 1.71 | 129.12 | 129.03 | 18.2 | 1 | 0.00 | 16.86 | 0.00 | 0.53 | 0.34 | -0.34 |
| 27 | 98.79 | 1.71 | 128.54 | 128.46 | 18.2 | 1 | 0.00 | 13.79 | 0.00 | 0.37 | 0.35 | -0.35 |
| 28 | 100.50 | 1.71 | 127.96 | 127.90 | 18.2 | 1 | 0.00 | 10.66 | 0.00 | 0.24 | 0.36 | -0.36 |
| 29 | 102.21 | 1.71 | 127.38 | 127.34 | 18.2 | 1 | 0.00 | 7.64 | 0.00 | 0.14 | 0.37 | -0.37 |
| 30 | 103.93 | 1.71 | 126.80 | 126.77 | 18.2 | 1 | 0.00 | 4.60 | 0.00 | 0.06 | 0.41 | -0.41 |
| 31 | 105.64 | 1.71 | 126.22 | 126.21 | 18.2 | 1 | 0.00 | 1.53 | 0.00 | 0.02 | 0.50 | -0.50 |
| RHS | 107.35 | | | | | | | | | -0.01 | 0.00 | 0.00 |

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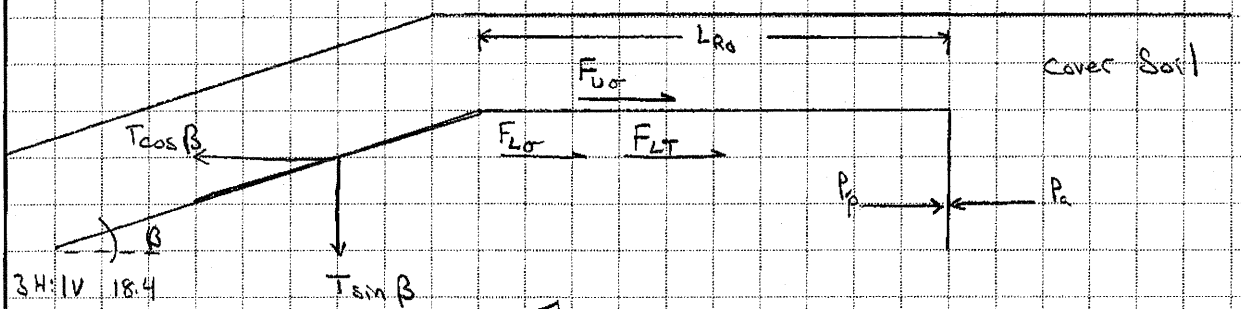
SHEET NO. 1 OF 2
CALCULATED BY MAK DATE 2/27/07
CHECKED BY KSP DATE 3/27/07
SCALE NTS

# Anchor Trench




$$\sum F_x = 0$$

$$T_{allow}\cos\beta = F_{UO} + F_{LO} + F_{LT} - P_a + P_p$$

$$F_{UO} = \sigma_n \tan\delta_U (L_{RO})$$

$$F_{LO} = \sigma_n \tan\delta_L (L_{RO})$$

$$F_{LT} = T_{allow}\sin\beta \tan\delta_L$$

$$P_A = (.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT} \qquad K_A = \tan^2(45 - \phi/2)$$

$$P_p = (.5\gamma_{AT} d_{AT} + \sigma_n) K_p d_{AT} \qquad K_p = \tan^2(45 + \phi/2)$$

- Assume depth of anchor trench ($d_{AT}$) = 0

- $T_{allow} = 11 \text{ KN/m}\ (60\ ^{lb}/_{in})$ ← Tensile strength break

$60\ ^{lb}/_{in}\left(\frac{12 in}{ft}\right)\left(\frac{1}{1.5}\right) = 480\ ^{lb}/_{ft}$

assume FS = 1.5 because designing with break

Max $L_{RO} = \dfrac{T_{allow}(\cos\beta - \sin\beta\tan\delta_L)}{\sigma_n(\tan\delta_U + \tan\delta_L}$ "Designing with Geosynthetics" Robert Koerner

ignore

$$L_{RO} = \frac{480\ ^{lb}/_{ft}[\cos(18.4) - \sin(18.4)\tan(29)]}{[(112\ ^{lb}/_{ft^3})(1.5\ ft)][\tan(0) + \tan(29)]} = 4.0\ ft$$

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JOB 40313.01 DC Landfill
SHEET NO. 2 OF 2
CALCULATED BY MAK DATE 3/2/07
CHECKED BY KSP DATE 3/27/07
SCALE NTS

Since need over 3 ft of $L_{RO}$ design a trench so that

$L_{RO} = 3$ ft ∴ solve for $d_{AT}$ min.

$F_{US}$ = Since cover soil is thin, tensile cracking will occur, therefore this value is negligible (Koerner "Designing with Geosynthetics" p.491)

$$F_{LS} = (1.5\text{ ft})(112\ ^{lb}/_{ft^3})\tan 29^\circ (3\text{ ft}) = 279.4\ ^{lb}/_{ft}$$

$$F_{LT} = 480\ ^{lb}/_{ft} \sin 18.4^\circ \tan 29^\circ = 84.0\ ^{lb}/_{ft}$$

$$P_A = [0.5(115\ ^{lb}/_{ft^3})(d_{AT}) + (1.5\text{ ft})(112\ ^{lb}/_{ft^3})][\tan^2(45^\circ - 32^\circ/2)\, d_{AT}]$$
$$= [57.5\ ^{lb}/_{ft^3}(d_{AT}) + 168\ ^{lb}/_{ft^2}][0.31(d_{AT})]$$
$$= 17.8\ ^{lb}/_{ft^3}(d_{AT})^2 + 52.1\ ^{lb}/_{ft^2}(d_{AT})$$

$$P_P = [0.5(115\ ^{lb}/_{ft^3})(d_{AT}) + (1.5\text{ ft})(112\ ^{lb}/_{ft^3})][\tan^2(45^\circ + 32^\circ/2)\, d_{AT}]$$
$$= [57.5\ ^{lb}/_{ft^3}(d_{AT}) + 168\ ^{lb}/_{ft^2}][3.3(d_{AT})]$$
$$= 189.8\ ^{lb}/_{ft^3}(d_{AT})^2 + 554.4\ ^{lb}/_{ft^2}(d_{AT})$$

$$480\ ^{lb}/_{ft}\cos 18.4^\circ = 0 + 279.4\ ^{lb}/_{ft} + 84\ ^{lb}/_{ft} - 17.8\ ^{lb}/_{ft^3}(d_{AT})^2 - 52.1\ ^{lb}/_{ft^2}(d_{AT}) + 189.8\ ^{lb}/_{ft^3}(d_{AT})^2 + 554.4\ ^{lb}/_{ft^2}(d_{AT})$$

$$455.5\ ^{lb}/_{ft} = 363.4\ ^{lb}/_{ft} + 172\ ^{lb}/_{ft^3}(d_{AT})^2 + 502.3\ ^{lb}/_{ft^2}(d_{AT})$$

$$0 = 172\ ^{lb}/_{ft^3}(d_{AT})^2 + 502.3\ ^{lb}/_{ft^2}(d_{AT}) - 92.1$$

$$d_{AT} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-502.3 \pm \sqrt{(502.3)^2 - 4(172)(-92.1)}}{2(172)}$$

$d_{AT} = 0.17$ ft min trench = 1 ft for constructability

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SHEET NO. 1 OF 1
CALCULATED BY MAK DATE 3/13/07
CHECKED BY KSP DATE 3/27/07
SCALE Seismic Analysis

Purpose: Determine whether or not a seismic analysis study is required for this Landfill Cap Design. If so, perform analysis.

Approach: Read through NYSDEC Regulations
Subpart 360
- Section 360-2.7 Engineering report (b)(7) see attached

Based on information in this section and after confirming with Doug McClure (VP of Environmental Services at Chazen) a seismic analysis study is not needed for this landfill cap design.

landfill design shall achieve the following factors of safety under static conditions, unless otherwise approved by the department:

(i) a minimum factor of safety of 2.00 for the bearing capacity and settlement of the landfill's subbase at full load conditions;

(ii) a minimum factor of safety of 1.25 for the structural design of the facility liner and leachate collection and removal system components; and

(iii) a minimum factor of safety of 1.50 for the final cover system;

(7) a seismic analysis for new landfills, lateral expansions of existing landfills, and subsequent development of any landfill permitted pursuant to these provisions located in a seismic impact zone, as defined in subparagraph (i) of this paragraph. Such analysis must use reasonable judgement that addresses the serviceable life of the landfill, its internal components and its related appurtenances. At a minimum, the analysis must demonstrate that all long-term containment structures including liners, leachate collection and removal systems, and surface water control systems, are designed to retain a minimum factor of safety of 1.0, unless otherwise approved by the department, to resist the maximum horizontal acceleration for the site as defined in subparagraph (ii) of this paragraph:

(i) seismic impact zone means an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years as delineated on the most current version of the United States Geological Survey Map - MF 2120 entitled Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico by S. T. Algermissen, D. M. Perkins, P.C. Thenhaus, S. L. Hanson, and B. L. Bender - 1990 or other equivalent seismic impact zone map approved by the department;

(ii) maximum horizontal acceleration in lithified earth material means the maximum expected horizontal acceleration depicted on a seismic hazard map, with a 90 percent or greater probability that the acceleration will not be exceeded

THE CHAZEN ENGINEERING
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JOB 40313.01 DC Balefill
SHEET NO. 1 OF 2
CALCULATED BY MAK DATE 3/15/07
CHECKED BY KSP DATE 3/27/07
SCALE

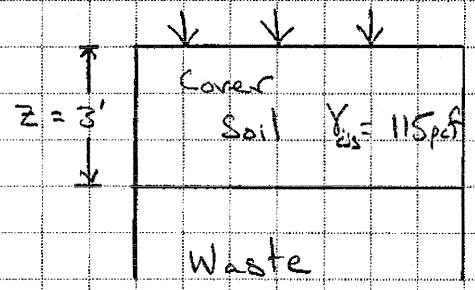
# Settlement Calculations:

Step 1: determine the change in load above the waste over a unit of waste

Existing Soil Cover was determined to be 3' thick and a unit weight of 115 pcf (from Soil Properties)

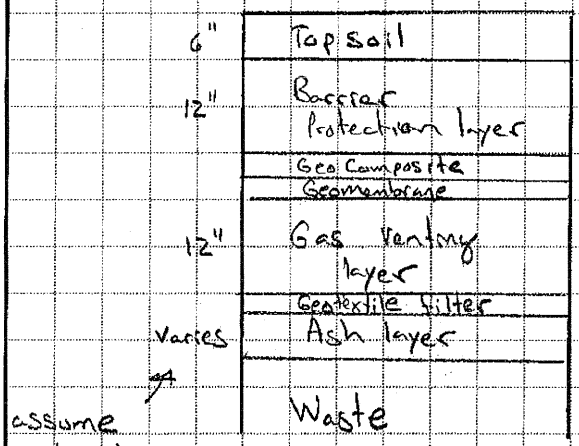
the Soil Cover thickness of 3' is taken from "Closure Investigation Report" by TCC June 2006 for this project.

Typical Existing Cross Section




Weight on Waste = $\sigma_v = \gamma_{cs}(z)$
$= 115 pcf (3 ft)$
$\sigma_{v_{existing}} = 345 psf$

Proposed Landfill Cap Design




$\gamma_{tp} = 105 pcf$
$\gamma_{BL} = 115 pcf$ → negligible
→ negligible
$\gamma_{gv} = 110 pcf$
→ negligible
$\gamma_{ash} = 80 pcf$

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JOB 40313.01 DC Balefill
SHEET NO. 2 OF 2
CALCULATED BY MAK DATE 3/19/07
CHECKED BY KSP DATE 3/27/07
SCALE

New weight on Waste =

$$\sigma_{v_{new}} = \gamma_{TP}(z_{TP}) + \gamma_{BR}(z_{BR}) + \gamma_{gc}(z_{gc}) + \gamma_{gm}(z_{gm}) + \gamma_{ga}(z_{ga}) + \gamma_{gs}(z_{gs}) + \gamma_{ash}(z_{ash})$$

$$= 105\ \frac{lbs}{ft^2}(0.5\ ft) + 115\ \frac{lbs}{ft^3}(1\ ft) + 110\ \frac{lbs}{ft^3}(1\ ft) + 80\ \frac{lbs}{ft^3}(3\ ft)$$

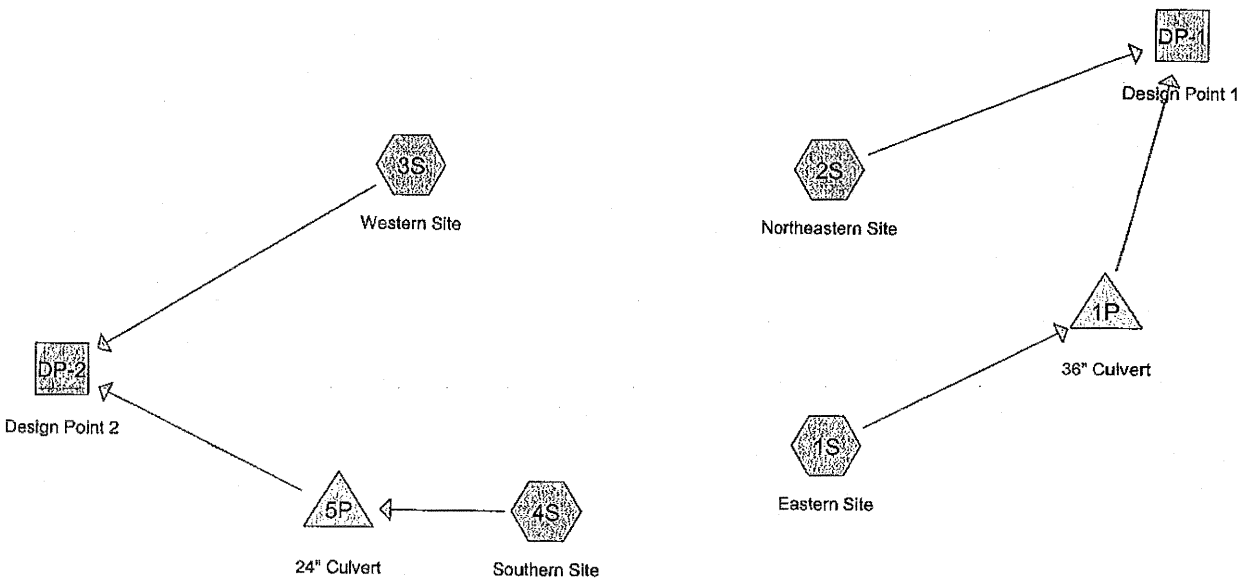
$$\sigma_{v_{new}} = 52.5\ psf + 115\ psf + 110\ psf + 240\ psf$$

$\Delta\sigma_{v_{new}} = \underline{517.5\ psf}$ if 3' of ash if required
if existing cover used then $(115-80) = 35\ psf \times 2 = 70$
give $\Delta\sigma_{v_{new}} = \underline{587.5\ psf}$

least change would occur if need to remove 3' of existing cover
$\Delta\sigma_{vnew} - \gamma_{ash}(z_{ash}) = 277.5\ psf$
* less than existing

Settlement will vary across the landfill depending on the amount of ash required to provide a level surface and to meet the required 3H:1V slope

assuming MSW will behave like a granular material
~2 inches of settlement could occur if assume greatest load applied (3-feet additional fill + cover system) on level surface.




Subcat Reach Pond Link

**Drainage Diagram for EX CONDITIONS ANALYSIS**
Prepared by Chazen Companies (Troy, NY) 4/24/2007
HydroCAD® 8.00 s/n 000927 © 2006 HydroCAD Software Solutions LLC

# Pre-Development Conditions
# 1 year 24 hour Storm Event
# Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Eastern Site

Runoff = 0.47 cfs @ 12.18 hrs, Volume= 0.049 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.772 | 65 | Woods/grass comb., Fair, HSG B |
| 0.274 | 79 | <50% Grass cover, Poor, HSG B |
| 1.046 | 69 | Weighted Average |
| 1.046 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 50 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 10.6 | 420 | Total | | | |

## Subcatchment 2S: Northeastern Site

Runoff = 1.63 cfs @ 12.22 hrs, Volume= 0.184 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 2.678 | 65 | Woods/grass comb., Fair, HSG B |
| 1.233 | 79 | <50% Grass cover, Poor, HSG B |
| 3.911 | 69 | Weighted Average |
| 3.911 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 4.3 | 225 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.1 | 40 | 0.2000 | 4.47 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 13.4 | 410 | Total | | | |

## Subcatchment 3S: Western Site

Runoff = 2.94 cfs @ 12.40 hrs, Volume= 0.393 af, Depth= 0.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 3.972 | 65 | Woods/grass comb., Fair, HSG B |
| 3.308 | 79 | <50% Grass cover, Poor, HSG B |
| 7.280 | 71 | Weighted Average |
| 7.280 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 4.5 | 330 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 3.4 | 250 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 50 | 0.1000 | 1.58 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 4.7 | 200 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.0 | 210 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 24.5 | 1,170 | Total | | | |

## Subcatchment 4S: Southern Site

Runoff = 2.15 cfs @ 12.79 hrs, Volume= 0.385 af, Depth= 0.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.874 | 65 | Woods/grass comb., Fair, HSG B |
| 2.900 | 79 | <50% Grass cover, Poor, HSG B |
| 1.170 | 79 | <50% Grass cover, Poor, HSG B |
| 4.944 | 77 | Weighted Average |
| 4.944 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 40 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,120 | Total | | | |

## Reach DP-1: Design Point 1

Inflow Area = 4.957 ac, Inflow Depth = 0.57" for 1-Yr event
Inflow = 2.10 cfs @ 12.22 hrs, Volume= 0.234 af
Outflow = 2.10 cfs @ 12.22 hrs, Volume= 0.234 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Reach DP-2: Design Point 2

Inflow Area = 12.224 ac, Inflow Depth = 0.76" for 1-Yr event
Inflow = 4.34 cfs @ 12.53 hrs, Volume= 0.778 af
Outflow = 4.34 cfs @ 12.53 hrs, Volume= 0.778 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.046 ac, Inflow Depth = 0.57" for 1-Yr event
Inflow = 0.47 cfs @ 12.18 hrs, Volume= 0.049 af
Outflow = 0.47 cfs @ 12.19 hrs, Volume= 0.049 af, Atten= 0%, Lag= 1.0 min
Primary = 0.47 cfs @ 12.19 hrs, Volume= 0.049 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 114.18' @ 12.19 hrs Surf.Area= 136 sf Storage= 10 cf

Plug-Flow detention time= 0.1 min calculated for 0.049 af (100% of inflow)
Center-of-Mass det. time= 0.1 min ( 895.2 - 895.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=0.47 cfs @ 12.19 hrs HW=114.18' (Free Discharge)
↑**1=Culvert** (Inlet Controls 0.47 cfs @ 1.42 fps)

## Pond 5P: 24" Culvert

| | | | | | |
|---|---|---|---|---|---|
| Inflow Area = | 4.944 ac, | Inflow Depth = | 0.93" | for 1-Yr event | |
| Inflow = | 2.15 cfs @ | 12.79 hrs, | Volume= | 0.385 af | |
| Outflow = | 2.15 cfs @ | 12.79 hrs, | Volume= | 0.385 af, | Atten= 0%, Lag= 0.4 min |
| Primary = | 2.15 cfs @ | 12.79 hrs, | Volume= | 0.385 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, | Volume= | 0.000 af | |

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 116.39' @ 12.79 hrs Surf.Area= 176 sf Storage= 69 cf

Plug-Flow detention time= 0.6 min calculated for 0.385 af (100% of inflow)
Center-of-Mass det. time= 0.7 min ( 905.1 - 904.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=2.15 cfs @ 12.79 hrs HW=116.39' (Free Discharge)
↑**1=Culvert** (Inlet Controls 2.15 cfs @ 2.23 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' (Free Discharge)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

# Pre-Development Conditions
# 10 year 24 hour Storm Event
# Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Eastern Site

Runoff = 1.99 cfs @ 12.16 hrs, Volume= 0.171 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.772 | 65 | Woods/grass comb., Fair, HSG B |
| 0.274 | 79 | <50% Grass cover, Poor, HSG B |
| 1.046 | 69 | Weighted Average |
| 1.046 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 50 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 10.6 | 420 | Total | | | |

## Subcatchment 2S: Northeastern Site

Runoff = 6.84 cfs @ 12.20 hrs, Volume= 0.638 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 2.678 | 65 | Woods/grass comb., Fair, HSG B |
| 1.233 | 79 | <50% Grass cover, Poor, HSG B |
| 3.911 | 69 | Weighted Average |
| 3.911 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 4.3 | 225 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.1 | 40 | 0.2000 | 4.47 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 13.4 | 410 | Total | | | |

## Subcatchment 3S: Western Site

Runoff = 10.97 cfs @ 12.36 hrs, Volume= 1.284 af, Depth= 2.12"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 3.972 | 65 | Woods/grass comb., Fair, HSG B |
| 3.308 | 79 | <50% Grass cover, Poor, HSG B |
| 7.280 | 71 | Weighted Average |
| 7.280 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 4.5 | 330 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 3.4 | 250 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 50 | 0.1000 | 1.58 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 4.7 | 200 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.0 | 210 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 24.5 | 1,170 | Total | | | |

## Subcatchment 4S: Southern Site

Runoff = 6.36 cfs @ 12.73 hrs, Volume= 1.081 af, Depth= 2.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.874 | 65 | Woods/grass comb., Fair, HSG B |
| 2.900 | 79 | <50% Grass cover, Poor, HSG B |
| 1.170 | 79 | <50% Grass cover, Poor, HSG B |
| 4.944 | 77 | Weighted Average |
| 4.944 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 40 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,120 | Total | | | |

## Reach DP-1: Design Point 1

Inflow Area = 4.957 ac, Inflow Depth = 1.96" for 10-Yr event
Inflow = 8.76 cfs @ 12.20 hrs, Volume= 0.809 af
Outflow = 8.76 cfs @ 12.20 hrs, Volume= 0.809 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Reach DP-2: Design Point 2

Inflow Area = 12.224 ac, Inflow Depth = 2.32" for 10-Yr event
Inflow = 14.91 cfs @ 12.42 hrs, Volume= 2.365 af
Outflow = 14.91 cfs @ 12.42 hrs, Volume= 2.365 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.046 ac, Inflow Depth = 1.96" for 10-Yr event
Inflow = 1.99 cfs @ 12.16 hrs, Volume= 0.171 af
Outflow = 1.92 cfs @ 12.19 hrs, Volume= 0.171 af, Atten= 4%, Lag= 1.9 min
Primary = 1.92 cfs @ 12.19 hrs, Volume= 0.171 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 114.47' @ 12.19 hrs Surf.Area= 719 sf Storage= 125 cf

Plug-Flow detention time= 0.4 min calculated for 0.170 af (100% of inflow)
Center-of-Mass det. time= 0.4 min ( 854.9 - 854.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=1.90 cfs @ 12.19 hrs HW=114.47' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 1.90 cfs @ 2.03 fps)

## Pond 5P: 24" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 4.944 ac, | Inflow Depth = | 2.62" | for 10-Yr event |
| Inflow = | 6.36 cfs @ | 12.73 hrs, Volume= | 1.081 af | |
| Outflow = | 6.37 cfs @ | 12.75 hrs, Volume= | 1.081 af, | Atten= 0%, Lag= 0.8 min |
| Primary = | 6.37 cfs @ | 12.75 hrs, Volume= | 1.081 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, Volume= | 0.000 af | |

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 116.97' @ 12.75 hrs Surf.Area= 303 sf Storage= 207 cf

Plug-Flow detention time= 0.6 min calculated for 1.080 af (100% of inflow)
Center-of-Mass det. time= 0.6 min ( 874.4 - 873.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=6.36 cfs @ 12.75 hrs HW=116.97' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 6.36 cfs @ 3.03 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

# Pre-Development Conditions
# 100 year 24 hour Storm Event
# Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Eastern Site

Runoff = 4.53 cfs @ 12.15 hrs, Volume= 0.379 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.772 | 65 | Woods/grass comb., Fair, HSG B |
| 0.274 | 79 | <50% Grass cover, Poor, HSG B |
| 1.046 | 69 | Weighted Average |
| 1.046 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 50 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 10.6 | 420 | Total | | | |

## Subcatchment 2S: Northeastern Site

Runoff = 15.61 cfs @ 12.19 hrs, Volume= 1.418 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 2.678 | 65 | Woods/grass comb., Fair, HSG B |
| 1.233 | 79 | <50% Grass cover, Poor, HSG B |
| 3.911 | 69 | Weighted Average |
| 3.911 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 4.3 | 225 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.1 | 40 | 0.2000 | 4.47 | | **Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps |
| 13.4 | 410 | Total | | | |

## Subcatchment 3S: Western Site

Runoff = 24.14 cfs @ 12.34 hrs, Volume= 2.778 af, Depth= 4.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 3.972 | 65 | Woods/grass comb., Fair, HSG B |
| 3.308 | 79 | <50% Grass cover, Poor, HSG B |
| 7.280 | 71 | Weighted Average |
| 7.280 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 4.5 | 330 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.1 | 30 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 3.4 | 250 | 0.0300 | 1.21 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 50 | 0.1000 | 1.58 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 4.7 | 200 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.0 | 210 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 24.5 | 1,170 | Total | | | |

## Subcatchment 4S: Southern Site

Runoff = 12.80 cfs @ 12.71 hrs, Volume= 2.173 af, Depth= 5.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.874 | 65 | Woods/grass comb., Fair, HSG B |
| 2.900 | 79 | <50% Grass cover, Poor, HSG B |
| 1.170 | 79 | <50% Grass cover, Poor, HSG B |
| 4.944 | 77 | Weighted Average |
| 4.944 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 40 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,120 | Total | | | |

## Reach DP-1: Design Point 1

Inflow Area = 4.957 ac, Inflow Depth = 4.35" for 100-Yr event
Inflow = 19.82 cfs @ 12.19 hrs, Volume= 1.797 af
Outflow = 19.82 cfs @ 12.19 hrs, Volume= 1.797 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Reach DP-2: Design Point 2

Inflow Area = 12.224 ac, Inflow Depth = 4.86" for 100-Yr event
Inflow = 31.80 cfs @ 12.39 hrs, Volume= 4.951 af
Outflow = 31.80 cfs @ 12.39 hrs, Volume= 4.951 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.046 ac, Inflow Depth = 4.35" for 100-Yr event
Inflow = 4.53 cfs @ 12.15 hrs, Volume= 0.379 af
Outflow = 4.22 cfs @ 12.20 hrs, Volume= 0.379 af, Atten= 7%, Lag= 2.8 min
Primary = 4.22 cfs @ 12.20 hrs, Volume= 0.379 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 114.76' @ 12.20 hrs Surf.Area= 1,752 sf Storage= 474 cf

Plug-Flow detention time= 0.7 min calculated for 0.379 af (100% of inflow)
Center-of-Mass det. time= 0.7 min ( 831.9 - 831.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=4.21 cfs @ 12.20 hrs HW=114.76' (Free Discharge)
└**1=Culvert** (Inlet Controls 4.21 cfs @ 2.50 fps)

## Pond 5P: 24" Culvert

Inflow Area = 4.944 ac, Inflow Depth = 5.27" for 100-Yr event
Inflow = 12.80 cfs @ 12.71 hrs, Volume= 2.173 af
Outflow = 12.47 cfs @ 12.81 hrs, Volume= 2.173 af, Atten= 3%, Lag= 6.0 min
Primary = 12.47 cfs @ 12.81 hrs, Volume= 2.173 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 117.79' @ 12.81 hrs Surf.Area= 2,434 sf Storage= 1,300 cf

Plug-Flow detention time= 0.8 min calculated for 2.171 af (100% of inflow)
Center-of-Mass det. time= 0.8 min ( 854.7 - 853.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

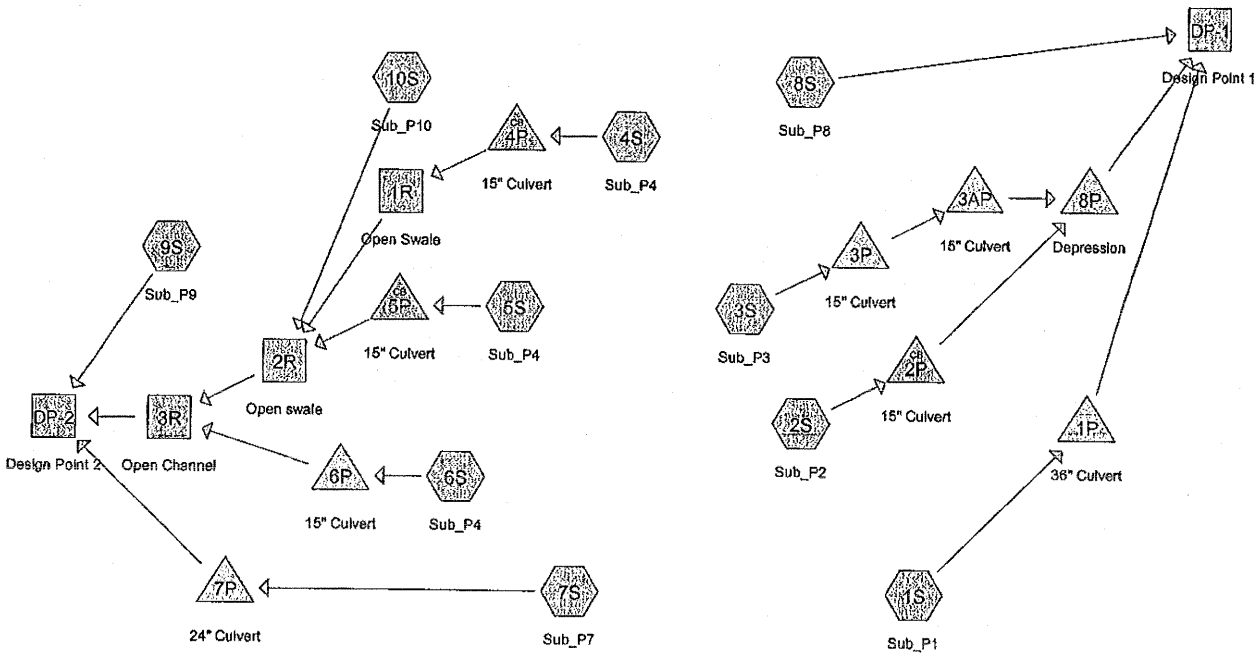
**Primary OutFlow** Max=12.45 cfs @ 12.81 hrs HW=117.79' (Free Discharge)
└**1=Culvert** (Inlet Controls 12.45 cfs @ 3.96 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

# Appendix K: Post-Development Watershed Conditions Modeling

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*




Subcat Reach Pond Link

**Drainage Diagram for POST CONDITIONS ANALYSIS**
Prepared by Chazen Companies (Troy, NY) 4/24/2007
HydroCAD® 8.00 s/n 000927 © 2006 HydroCAD Software Solutions LLC

# Post-Development Conditions
# 1 year 24 hour Storm Event
# Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Sub_P1

Runoff = 0.24 cfs @ 12.30 hrs, Volume= 0.036 af, Depth= 0.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.674 | 65 | Woods/grass comb., Fair, HSG B |
| 0.551 | 61 | >75% Grass cover, Good, HSG B |
| 1.225 | 63 | Weighted Average |
| 1.225 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.0 | 70 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 11.1 | 475 | Total | | | |

## Subcatchment 2S: Sub_P2

Runoff = 0.17 cfs @ 12.23 hrs, Volume= 0.019 af, Depth= 0.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.200 | 65 | Woods/grass comb., Fair, HSG B |
| 0.060 | 98 | Paved parking & roofs |
| 0.140 | 61 | >75% Grass cover, Good, HSG B |
| 0.400 | 69 | Weighted Average |
| 0.340 | | Pervious Area |
| 0.060 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.4 | 100 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 110 | 0.0400 | 3.00 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 9.7 | 290 | Total | | | |

## Subcatchment 3S: Sub_P3

Runoff = 0.36 cfs @ 12.30 hrs, Volume= 0.051 af, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.471 | 65 | Woods/grass comb., Fair, HSG B |
| 0.070 | 98 | Paved parking & roofs |
| 1.065 | 61 | >75% Grass cover, Good, HSG B |
| 1.606 | 64 | Weighted Average |
| 1.536 | | Pervious Area |
| 0.070 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 55 | 0.0700 | 1.32 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.7 | 90 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.0 | 310 | Total | | | |

## Subcatchment 4S: Sub_P4

Runoff = 0.26 cfs @ 12.32 hrs, Volume= 0.041 af, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.295 | 65 | Woods/grass comb., Fair, HSG B |
| 0.077 | 98 | Paved parking & roofs |
| 0.909 | 61 | >75% Grass cover, Good, HSG B |
| 1.281 | 64 | Weighted Average |
| 1.204 | | Pervious Area |
| 0.077 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.9 | 150 | 0.1730 | 2.91 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.7 | 220 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.9 | 470 | Total | | | |

## Subcatchment 5S: Sub_P4

Runoff = 0.26 cfs @ 12.32 hrs, Volume= 0.039 af, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.161 | 65 | Woods/grass comb., Fair, HSG B |
| 0.110 | 98 | Paved parking & roofs |
| 0.863 | 61 | >75% Grass cover, Good, HSG B |
| 1.134 | 65 | Weighted Average |
| 1.024 | | Pervious Area |
| 0.110 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.4 | 130 | 0.0500 | 1.57 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.8 | 140 | 0.1700 | 2.89 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 40 | 0.0250 | 1.11 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 120 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 13.7 | 530 | Total | | | |

## Subcatchment 6S: Sub_P4

Runoff = 0.31 cfs @ 12.40 hrs, Volume= 0.052 af, Depth= 0.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.193 | 65 | Woods/grass comb., Fair, HSG B |
| 0.059 | 98 | Paved parking & roofs |
| 1.506 | 61 | >75% Grass cover, Good, HSG B |
| 1.758 | 63 | Weighted Average |
| 1.699 | | Pervious Area |
| 0.059 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.3 | 110 | 0.0400 | 1.40 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 60 | 0.1500 | 2.71 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.4 | 210 | 0.0430 | 1.45 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.3 | 40 | 0.1250 | 2.47 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 110 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 15.2 | 630 | Total | | | |

## Subcatchment 7S: Sub_P7

Runoff = 1.54 cfs @ 12.83 hrs, Volume= 0.299 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 1.048 | 65 | Woods/grass comb., Fair, HSG B |
| 2.881 | 79 | <50% Grass cover, Poor, HSG B |
| 1.262 | 61 | >75% Grass cover, Good, HSG B |
| 5.191 | 72 | Weighted Average |
| 5.191 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 50 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,130 | Total | | | |

## Subcatchment 8S: Sub_P8

Runoff = 0.56 cfs @ 12.44 hrs, Volume= 0.088 af, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 2.529 | 65 | Woods/grass comb., Fair, HSG B |
| 2.529 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.8 | 130 | 0.0200 | 0.13 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 3.3 | 140 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.3 | 60 | 0.3300 | 2.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 20.4 | 330 | Total | | | |

## Subcatchment 9S: Sub_P9

Runoff = 0.25 cfs @ 12.75 hrs, Volume= 0.054 af, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 1.543 | 65 | Woods/grass comb., Fair, HSG B |
| 1.543 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 37.5 | 150 | 0.0100 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.5 | 120 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 41.5 | 420 | Total | | | |

## Subcatchment 10S: Sub_P10

Runoff = 0.11 cfs @ 12.77 hrs, Volume= 0.025 af, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 1-Yr Rainfall=2.80"

| Area (ac) | CN | Description |
|---|---|---|
| 0.705 | 65 | Woods/grass comb., Fair, HSG B |
| 0.705 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.6 | 60 | 0.0200 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 25.9 | 550 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 43.0 | 760 | Total | | | |

## Reach 1R: Open Swale

Inflow Area = 1.281 ac, Inflow Depth = 0.38" for 1-Yr event
Inflow = 0.26 cfs @ 12.32 hrs, Volume= 0.041 af
Outflow = 0.28 cfs @ 12.41 hrs, Volume= 0.041 af, Atten= 0%, Lag= 5.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 1.06 fps, Min. Travel Time= 3.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 8.5 min

Peak Storage= 64 cf @ 12.41 hrs, Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 240.0' Slope= 0.0100 '/'
Inlet Invert= 117.60', Outlet Invert= 115.20'

‡

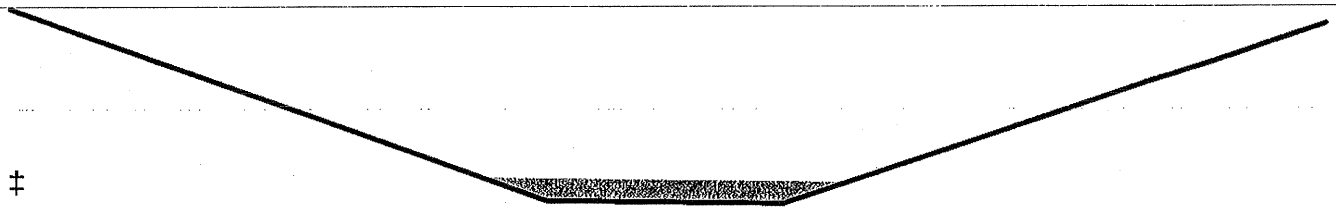
## Reach 2R: Open swale

Inflow Area = 3.120 ac, Inflow Depth = 0.40" for 1-Yr event
Inflow = 0.60 cfs @ 12.41 hrs, Volume= 0.105 af
Outflow = 0.62 cfs @ 12.43 hrs, Volume= 0.105 af, Atten= 0%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 1.36 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.63 fps, Avg. Travel Time= 4.2 min

Peak Storage= 73 cf @ 12.44 hrs, Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 160.0' Slope= 0.0100 '/'
Inlet Invert= 115.20', Outlet Invert= 113.60'



‡

## Reach 3R: Open Channel

Inflow Area = 4.878 ac, Inflow Depth = 0.39" for 1-Yr event
Inflow = 0.95 cfs @ 12.43 hrs, Volume= 0.157 af
Outflow = 0.94 cfs @ 12.47 hrs, Volume= 0.157 af, Atten= 0%, Lag= 2.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 1.90 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 7.8 min

Peak Storage= 197 cf @ 12.47 hrs, Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 122.18 cfs

4.50' x 1.50' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 13.50'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 114.00', Outlet Invert= 100.00'

‡

## Reach DP-1: Design Point 1

Inflow Area = 5.760 ac, Inflow Depth = 0.40" for 1-Yr event
Inflow = 1.24 cfs @ 12.41 hrs, Volume= 0.194 af
Outflow = 1.24 cfs @ 12.41 hrs, Volume= 0.194 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Reach DP-2: Design Point 2

Inflow Area = 11.612 ac, Inflow Depth = 0.53" for 1-Yr event
Inflow = 2.35 cfs @ 12.71 hrs, Volume= 0.510 af
Outflow = 2.35 cfs @ 12.71 hrs, Volume= 0.510 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.225 ac, Inflow Depth = 0.35" for 1-Yr event
Inflow = 0.24 cfs @ 12.30 hrs, Volume= 0.036 af
Outflow = 0.23 cfs @ 12.32 hrs, Volume= 0.036 af, Atten= 5%, Lag= 1.3 min
Primary = 0.23 cfs @ 12.32 hrs, Volume= 0.036 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 114.09' @ 12.32 hrs Surf.Area= 53 sf Storage= 2 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.3 min ( 926.3 - 926.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=0.21 cfs @ 12.32 hrs HW=114.09' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.21 cfs @ 1.16 fps)

## Pond 2P: 15" Culvert

Inflow Area = 0.400 ac, Inflow Depth = 0.57" for 1-Yr event
Inflow = 0.17 cfs @ 12.23 hrs, Volume= 0.019 af
Outflow = 0.17 cfs @ 12.23 hrs, Volume= 0.019 af, Atten= 0%, Lag= 0.0 min
Primary = 0.17 cfs @ 12.23 hrs, Volume= 0.019 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 117.11' @ 12.24 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 116.90' | **15.0" x 27.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 116.63' S= 0.0100 '/' Cc= 0.900 |

n= 0.012 Concrete pipe, finished

**Primary OutFlow** Max=0.16 cfs @ 12.23 hrs HW=117.10' TW=115.06' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.16 cfs @ 1.22 fps)

## Pond 3AP: 15" Culvert

Inflow Area = 1.606 ac, Inflow Depth = 0.38" for 1-Yr event
Inflow = 0.34 cfs @ 12.41 hrs, Volume= 0.051 af
Outflow = 0.34 cfs @ 12.43 hrs, Volume= 0.051 af, Atten= 0%, Lag= 1.4 min
Primary = 0.34 cfs @ 12.43 hrs, Volume= 0.051 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 118.36' @ 12.43 hrs Surf.Area= 156 sf Storage= 31 cf

Plug-Flow detention time= 1.9 min calculated for 0.051 af (100% of inflow)
Center-of-Mass det. time= 2.0 min ( 929.5 - 927.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.00' | 572 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.00 | 16 | 0 | 0 |
| 119.00 | 408 | 212 | 212 |
| 119.50 | 1,030 | 360 | 572 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.00' | **15.0" x 81.3' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.80' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |

**Primary OutFlow** Max=0.33 cfs @ 12.43 hrs HW=118.35' TW=115.07' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.33 cfs @ 1.76 fps)

## Pond 3P: 15" Culvert

Inflow Area = 1.606 ac, Inflow Depth = 0.38" for 1-Yr event
Inflow = 0.36 cfs @ 12.30 hrs, Volume= 0.051 af
Outflow = 0.34 cfs @ 12.41 hrs, Volume= 0.051 af, Atten= 3%, Lag= 6.6 min
Primary = 0.34 cfs @ 12.41 hrs, Volume= 0.051 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 118.56' @ 12.43 hrs Surf.Area= 496 sf Storage= 91 cf

Plug-Flow detention time= 6.3 min calculated for 0.051 af (100% of inflow)
Center-of-Mass det. time= 6.4 min ( 927.5 - 921.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.25' | 3,473 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.25 | 100 | 0 | 0 |
| 119.00 | 1,069 | 438 | 438 |
| 120.00 | 5,000 | 3,035 | 3,473 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.25' | **15.0" x 25.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 118.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 120.00' | **50.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=0.30 cfs @ 12.41 hrs HW=118.55' TW=118.35' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 0.30 cfs @ 1.96 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=118.25' TW=118.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 4P: 15" Culvert

Inflow Area = 1.281 ac, Inflow Depth = 0.38" for 1-Yr event
Inflow = 0.26 cfs @ 12.32 hrs, Volume= 0.041 af
Outflow = 0.26 cfs @ 12.32 hrs, Volume= 0.041 af, Atten= 0%, Lag= 0.0 min
Primary = 0.26 cfs @ 12.32 hrs, Volume= 0.041 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 118.22' @ 12.32 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 117.95' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.60' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=0.25 cfs @ 12.32 hrs HW=118.21' TW=117.70' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.25 cfs @ 1.37 fps)

## Pond 5P: 15" Culvert

Inflow Area = 1.134 ac, Inflow Depth = 0.42" for 1-Yr event
Inflow = 0.26 cfs @ 12.32 hrs, Volume= 0.039 af
Outflow = 0.26 cfs @ 12.32 hrs, Volume= 0.039 af, Atten= 0%, Lag= 0.0 min
Primary = 0.26 cfs @ 12.32 hrs, Volume= 0.039 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

Peak Elev= 116.07' @ 12.32 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.80' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 115.45' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=0.25 cfs @ 12.32 hrs HW=116.06' TW=115.36' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.25 cfs @ 1.37 fps)

## Pond 6P: 15" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 1.758 ac, | Inflow Depth = | 0.35" | for 1-Yr event |
| Inflow = | 0.31 cfs @ | 12.40 hrs, Volume= | 0.052 af | |
| Outflow = | 0.33 cfs @ | 12.42 hrs, Volume= | 0.052 af, | Atten= 0%, Lag= 1.1 min |
| Primary = | 0.33 cfs @ | 12.42 hrs, Volume= | 0.052 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, Volume= | 0.000 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 114.46' @ 12.42 hrs Surf.Area= 146 sf Storage= 29 cf

Plug-Flow detention time= 2.6 min calculated for 0.051 af (100% of inflow)
Center-of-Mass det. time= 2.6 min ( 932.5 - 929.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.16' | 3,174 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 114.16 | 50 | 0 | 0 |
| 115.00 | 321 | 156 | 156 |
| 116.00 | 2,143 | 1,232 | 1,388 |
| 116.50 | 5,000 | 1,786 | 3,174 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 114.16' | **15.0" x 36.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 113.80' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |
| #2 | Secondary | 116.50' | **30.0' long x 11.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64 |

**Primary OutFlow** Max=0.32 cfs @ 12.42 hrs HW=114.45' TW=114.10' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.32 cfs @ 1.45 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=114.16' TW=114.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 7P: 24" Culvert

Inflow Area = 5.191 ac, Inflow Depth = 0.69" for 1-Yr event
Inflow = 1.54 cfs @ 12.83 hrs, Volume= 0.299 af
Outflow = 1.54 cfs @ 12.84 hrs, Volume= 0.299 af, Atten= 0%, Lag= 0.5 min
Primary = 1.54 cfs @ 12.84 hrs, Volume= 0.299 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 116.28' @ 12.84 hrs Surf.Area= 151 sf Storage= 50 cf

Plug-Flow detention time= 3.3 min calculated for 0.299 af (100% of inflow)
Center-of-Mass det. time= 0.7 min ( 923.3 - 922.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=1.51 cfs @ 12.84 hrs HW=116.27' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.51 cfs @ 2.03 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' TW=0.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 8P: Depression

Inflow Area = 2.006 ac, Inflow Depth = 0.42" for 1-Yr event
Inflow = 0.46 cfs @ 12.39 hrs, Volume= 0.070 af
Outflow = 0.46 cfs @ 12.41 hrs, Volume= 0.070 af, Atten= 0%, Lag= 1.1 min
Primary = 0.46 cfs @ 12.41 hrs, Volume= 0.070 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 115.07' @ 12.41 hrs Surf.Area= 648 sf Storage= 34 cf

Plug-Flow detention time= 1.8 min calculated for 0.070 af (100% of inflow)
Center-of-Mass det. time= 1.7 min ( 921.7 - 920.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.00' | 5,640 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 115.00 | 335 | 83.4 | 0 | 0 | 335 |
| 116.00 | 14,389 | 574.7 | 5,640 | 5,640 | 26,066 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.00' | **10.0' long x 10.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=0.46 cfs @ 12.41 hrs HW=115.07' TW=0.00' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 0.46 cfs @ 0.66 fps)

# Post-Development Conditions
# 10 year 24 hour Storm Event
# Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Sub_P1

Runoff = 1.54 cfs @ 12.22 hrs, Volume= 0.154 af, Depth= 1.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.674 | 65 | Woods/grass comb., Fair, HSG B |
| 0.551 | 61 | >75% Grass cover, Good, HSG B |
| 1.225 | 63 | Weighted Average |
| 1.225 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.0 | 70 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 11.1 | 475 | Total | | | |

## Subcatchment 2S: Sub_P2

Runoff = 0.67 cfs @ 12.20 hrs, Volume= 0.065 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.200 | 65 | Woods/grass comb., Fair, HSG B |
| 0.060 | 98 | Paved parking & roofs |
| 0.140 | 61 | >75% Grass cover, Good, HSG B |
| 0.400 | 69 | Weighted Average |
| 0.340 | | Pervious Area |
| 0.060 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.4 | 100 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 110 | 0.0400 | 3.00 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 9.7 | 290 | Total | | | |

## Subcatchment 3S: Sub_P3

Runoff = 2.10 cfs @ 12.23 hrs, Volume= 0.212 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.471 | 65 | Woods/grass comb., Fair, HSG B |
| 0.070 | 98 | Paved parking & roofs |
| 1.065 | 61 | >75% Grass cover, Good, HSG B |
| 1.606 | 64 | Weighted Average |
| 1.536 | | Pervious Area |
| 0.070 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 55 | 0.0700 | 1.32 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.7 | 90 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.0 | 310 | Total | | | |

## Subcatchment 4S: Sub_P4

Runoff = 1.65 cfs @ 12.23 hrs, Volume= 0.169 af, Depth= 1.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.295 | 65 | Woods/grass comb., Fair, HSG B |
| 0.077 | 98 | Paved parking & roofs |
| 0.909 | 61 | >75% Grass cover, Good, HSG B |
| 1.281 | 64 | Weighted Average |
| 1.204 | | Pervious Area |
| 0.077 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.9 | 150 | 0.1730 | 2.91 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.7 | 220 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.9 | 470 | Total | | | |

## Subcatchment 5S: Sub_P4

Runoff = 1.52 cfs @ 12.24 hrs, Volume= 0.156 af, Depth= 1.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.161 | 65 | Woods/grass comb., Fair, HSG B |
| 0.110 | 98 | Paved parking & roofs |
| 0.863 | 61 | >75% Grass cover, Good, HSG B |
| 1.134 | 65 | Weighted Average |
| 1.024 | | Pervious Area |
| 0.110 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.4 | 130 | 0.0500 | 1.57 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.8 | 140 | 0.1700 | 2.89 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 40 | 0.0250 | 1.11 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 120 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 13.7 | 530 | Total | | | |

## Subcatchment 6S: Sub_P4

Runoff = 2.03 cfs @ 12.26 hrs, Volume= 0.221 af, Depth= 1.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.193 | 65 | Woods/grass comb., Fair, HSG B |
| 0.059 | 98 | Paved parking & roofs |
| 1.506 | 61 | >75% Grass cover, Good, HSG B |
| 1.758 | 63 | Weighted Average |
| 1.699 | | Pervious Area |
| 0.059 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.3 | 110 | 0.0400 | 1.40 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 60 | 0.1500 | 2.71 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.4 | 210 | 0.0430 | 1.45 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.3 | 40 | 0.1250 | 2.47 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 110 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 15.2 | 630 | Total | | | |

## Subcatchment 7S: Sub_P7

Runoff = 5.46 cfs @ 12.77 hrs, Volume= 0.951 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 1.048 | 65 | Woods/grass comb., Fair, HSG B |
| 2.881 | 79 | <50% Grass cover, Poor, HSG B |
| 1.262 | 61 | >75% Grass cover, Good, HSG B |
| 5.191 | 72 | Weighted Average |
| 5.191 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 50 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,130 | Total | | | |

## Subcatchment 8S: Sub_P8

Runoff = 2.84 cfs @ 12.35 hrs, Volume= 0.348 af, Depth= 1.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 2.529 | 65 | Woods/grass comb., Fair, HSG B |
| 2.529 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.8 | 130 | 0.0200 | 0.13 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 3.3 | 140 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.3 | 60 | 0.3300 | 2.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 20.4 | 330 | Total | | | |

## Subcatchment 9S: Sub_P9

Runoff = 1.35 cfs @ 12.63 hrs, Volume= 0.213 af, Depth= 1.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 1.543 | 65 | Woods/grass comb., Fair, HSG B |
| 1.543 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 37.5 | 150 | 0.0100 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.5 | 120 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 41.5 | 420 | Total | | | |

## Subcatchment 10S: Sub_P10

Runoff = 0.61 cfs @ 12.65 hrs, Volume= 0.097 af, Depth= 1.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 10-Yr Rainfall=5.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.705 | 65 | Woods/grass comb., Fair, HSG B |
| 0.705 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.6 | 60 | 0.0200 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 25.9 | 550 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 43.0 | 760 | Total | | | |

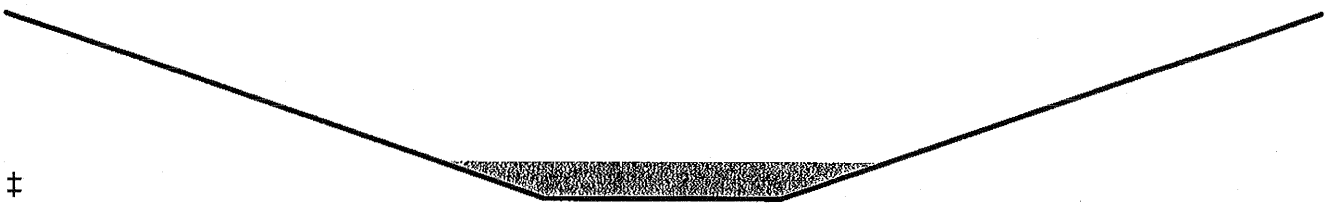
## Reach 1R: Open Swale

Inflow Area = 1.281 ac, Inflow Depth = 1.58" for 10-Yr event
Inflow = 1.65 cfs @ 12.23 hrs, Volume= 0.169 af
Outflow = 1.55 cfs @ 12.28 hrs, Volume= 0.169 af, Atten= 6%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 1.79 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.69 fps, Avg. Travel Time= 5.8 min

Peak Storage= 207 cf @ 12.28 hrs, Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 240.0' Slope= 0.0100 '/'
Inlet Invert= 117.60', Outlet Invert= 115.20'



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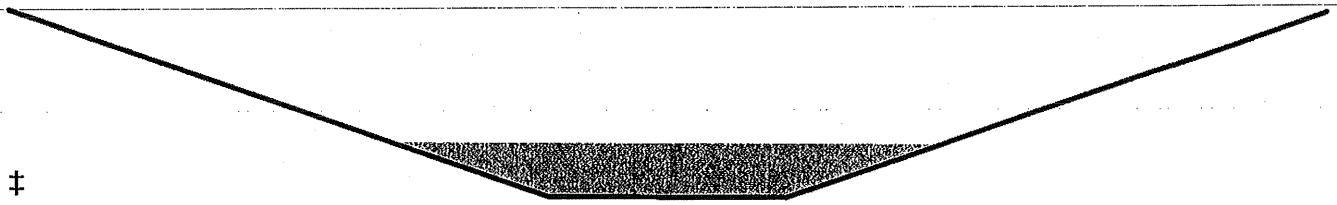
## Reach 2R: Open swale

Inflow Area = 3.120 ac, Inflow Depth = 1.62" for 10-Yr event
Inflow = 3.35 cfs @ 12.28 hrs, Volume= 0.422 af
Outflow = 3.21 cfs @ 12.31 hrs, Volume= 0.422 af, Atten= 4%, Lag= 2.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 2.21 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 2.9 min

Peak Storage= 231 cf @ 12.31 hrs, Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 160.0' Slope= 0.0100 '/'
Inlet Invert= 115.20', Outlet Invert= 113.60'



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## Reach 3R: Open Channel

Inflow Area = 4.878 ac, Inflow Depth = 1.58" for 10-Yr event
Inflow = 5.11 cfs @ 12.31 hrs, Volume= 0.643 af
Outflow = 5.23 cfs @ 12.36 hrs, Volume= 0.643 af, Atten= 0%, Lag= 2.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 3.53 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.25 fps, Avg. Travel Time= 5.3 min

Peak Storage= 591 cf @ 12.35 hrs, Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 122.18 cfs

4.50' x 1.50' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 13.50'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 114.00', Outlet Invert= 100.00'

‡

## Reach DP-1: Design Point 1

Inflow Area = 5.760 ac, Inflow Depth = 1.62" for 10-Yr event
Inflow = 6.41 cfs @ 12.32 hrs, Volume= 0.779 af
Outflow = 6.41 cfs @ 12.32 hrs, Volume= 0.779 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Reach DP-2: Design Point 2

Inflow Area = 11.612 ac, Inflow Depth = 1.87" for 10-Yr event
Inflow = 9.94 cfs @ 12.49 hrs, Volume= 1.807 af
Outflow = 9.94 cfs @ 12.49 hrs, Volume= 1.807 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.225 ac, Inflow Depth = 1.51" for 10-Yr event
Inflow = 1.54 cfs @ 12.22 hrs, Volume= 0.154 af
Outflow = 1.45 cfs @ 12.25 hrs, Volume= 0.154 af, Atten= 6%, Lag= 1.7 min
Primary = 1.45 cfs @ 12.25 hrs, Volume= 0.154 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 114.40' @ 12.26 hrs Surf.Area= 528 sf Storage= 78 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.6 min ( 871.8 - 871.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=1.35 cfs @ 12.25 hrs HW=114.38' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.35 cfs @ 1.86 fps)

## Pond 2P: 15" Culvert

Inflow Area = 0.400 ac, Inflow Depth = 1.96" for 10-Yr event
Inflow = 0.67 cfs @ 12.20 hrs, Volume= 0.065 af
Outflow = 0.67 cfs @ 12.20 hrs, Volume= 0.065 af, Atten= 0%, Lag= 0.0 min
Primary = 0.67 cfs @ 12.20 hrs, Volume= 0.065 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 117.34' @ 12.20 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 116.90' | **15.0" x 27.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 116.63' S= 0.0100 '/' Cc= 0.900 |

n= 0.012 Concrete pipe, finished

**Primary OutFlow** Max=0.67 cfs @ 12.20 hrs HW=117.33' TW=115.19' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.67 cfs @ 1.77 fps)

## Pond 3AP: 15" Culvert

Inflow Area = 1.606 ac, Inflow Depth = 1.58" for 10-Yr event
Inflow = 1.76 cfs @ 12.28 hrs, Volume= 0.212 af
Outflow = 1.72 cfs @ 12.34 hrs, Volume= 0.212 af, Atten= 2%, Lag= 3.3 min
Primary = 1.72 cfs @ 12.34 hrs, Volume= 0.212 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 118.85' @ 12.34 hrs Surf.Area= 348 sf Storage= 154 cf

Plug-Flow detention time= 2.2 min calculated for 0.212 af (100% of inflow)
Center-of-Mass det. time= 1.6 min ( 876.2 - 874.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.00' | 572 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.00 | 16 | 0 | 0 |
| 119.00 | 408 | 212 | 212 |
| 119.50 | 1,030 | 360 | 572 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.00' | **15.0" x 81.3' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.80' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |

**Primary OutFlow** Max=1.63 cfs @ 12.34 hrs HW=118.82' TW=115.19' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 1.63 cfs @ 2.71 fps)

## Pond 3P: 15" Culvert

Inflow Area = 1.606 ac, Inflow Depth = 1.58" for 10-Yr event
Inflow = 2.10 cfs @ 12.23 hrs, Volume= 0.212 af
Outflow = 1.76 cfs @ 12.28 hrs, Volume= 0.212 af, Atten= 17%, Lag= 3.3 min
Primary = 1.76 cfs @ 12.28 hrs, Volume= 0.212 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 119.06' @ 12.40 hrs Surf.Area= 1,287 sf Storage= 504 cf

Plug-Flow detention time= 8.2 min calculated for 0.212 af (100% of inflow)
Center-of-Mass det. time= 5.4 min ( 874.6 - 869.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.25' | 3,473 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.25 | 100 | 0 | 0 |
| 119.00 | 1,069 | 438 | 438 |
| 120.00 | 5,000 | 3,035 | 3,473 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.25' | **15.0" x 25.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 118.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 120.00' | **50.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=1.24 cfs @ 12.28 hrs HW=119.00' TW=118.81' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 1.24 cfs @ 2.29 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=118.25' TW=118.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 4P: 15" Culvert

Inflow Area = 1.281 ac, Inflow Depth = 1.58" for 10-Yr event
Inflow = 1.65 cfs @ 12.23 hrs, Volume= 0.169 af
Outflow = 1.65 cfs @ 12.23 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Primary = 1.65 cfs @ 12.23 hrs, Volume= 0.169 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 118.67' @ 12.24 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 117.95' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.60' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=1.55 cfs @ 12.23 hrs HW=118.64' TW=117.89' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.55 cfs @ 2.23 fps)

## Pond 5P: 15" Culvert

Inflow Area = 1.134 ac, Inflow Depth = 1.65" for 10-Yr event
Inflow = 1.52 cfs @ 12.24 hrs, Volume= 0.156 af
Outflow = 1.52 cfs @ 12.24 hrs, Volume= 0.156 af, Atten= 0%, Lag= 0.0 min
Primary = 1.52 cfs @ 12.24 hrs, Volume= 0.156 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

Peak Elev= 116.48' @ 12.24 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.80' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 115.45' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=1.42 cfs @ 12.24 hrs HW=116.46' TW=115.62' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.42 cfs @ 2.18 fps)

## Pond 6P: 15" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 1.758 ac, | Inflow Depth = | 1.51" | for 10-Yr event |
| Inflow = | 2.03 cfs @ | 12.26 hrs, Volume= | 0.221 af | |
| Outflow = | 1.95 cfs @ | 12.30 hrs, Volume= | 0.221 af, | Atten= 4%, Lag= 2.3 min |
| Primary = | 1.95 cfs @ | 12.30 hrs, Volume= | 0.221 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, Volume= | 0.000 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 114.95' @ 12.30 hrs Surf.Area= 306 sf Storage= 141 cf

Plug-Flow detention time= 1.6 min calculated for 0.220 af (100% of inflow)
Center-of-Mass det. time= 1.6 min ( 876.6 - 875.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.16' | 3,174 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 114.16 | 50 | 0 | 0 |
| 115.00 | 321 | 156 | 156 |
| 116.00 | 2,143 | 1,232 | 1,388 |
| 116.50 | 5,000 | 1,786 | 3,174 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 114.16' | **15.0" x 36.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 113.80' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |
| #2 | Secondary | 116.50' | **30.0' long x 11.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64 |

**Primary OutFlow** Max=1.80 cfs @ 12.30 hrs HW=114.91' TW=114.26' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 1.80 cfs @ 2.33 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=114.16' TW=114.00' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 7P: 24" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 5.191 ac, | Inflow Depth = | 2.20" | for 10-Yr event |
| Inflow = | 5.46 cfs @ | 12.77 hrs, | Volume= | 0.951 af |
| Outflow = | 5.47 cfs @ | 12.78 hrs, | Volume= | 0.951 af, Atten= 0%, Lag= 0.6 min |
| Primary = | 5.47 cfs @ | 12.78 hrs, | Volume= | 0.951 af |
| Secondary = | 0.00 cfs @ | 0.00 hrs, | Volume= | 0.000 af |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 116.86' @ 12.78 hrs Surf.Area= 279 sf Storage= 175 cf

Plug-Flow detention time= 3.2 min calculated for 0.951 af (100% of inflow)
Center-of-Mass det. time= 0.6 min ( 887.3 - 886.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=5.42 cfs @ 12.78 hrs HW=116.85' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 5.42 cfs @ 2.89 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' TW=0.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 8P: Depression

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 2.006 ac, | Inflow Depth = | 1.66" | for 10-Yr event |
| Inflow = | 2.30 cfs @ | 12.28 hrs, | Volume= | 0.277 af |
| Outflow = | 2.26 cfs @ | 12.33 hrs, | Volume= | 0.277 af, Atten= 2%, Lag= 2.9 min |
| Primary = | 2.26 cfs @ | 12.33 hrs, | Volume= | 0.277 af |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 115.20' @ 12.33 hrs Surf.Area= 1,510 sf Storage= 172 cf

Plug-Flow detention time= 1.5 min calculated for 0.277 af (100% of inflow)
Center-of-Mass det. time= 1.4 min ( 872.2 - 870.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.00' | 5,640 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 115.00 | 335 | 83.4 | 0 | 0 | 335 |
| 116.00 | 14,389 | 574.7 | 5,640 | 5,640 | 26,066 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.00' | **10.0' long x 10.0' breadth Broad-Crested Rectangular Weir** |
| | | | Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 |
| | | | Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=2.14 cfs @ 12.33 hrs HW=115.19' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.14 cfs @ 1.10 fps)

# Post-Development Conditions 100 year 24 hour Storm Event Model Computations

*TCC Job Number: 40313.01*

*The Chazen Companies*
*April, 2007*

## Subcatchment 1S: Sub_P1

Runoff = 3.91 cfs @ 12.21 hrs, Volume= 0.375 af, Depth= 3.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.674 | 65 | Woods/grass comb., Fair, HSG B |
| 0.551 | 61 | >75% Grass cover, Good, HSG B |
| 1.225 | 63 | Weighted Average |
| 1.225 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.0 | 70 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.1 | 260 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 11.1 | 475 | Total | | | |

## Subcatchment 2S: Sub_P2

Runoff = 1.51 cfs @ 12.19 hrs, Volume= 0.145 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.200 | 65 | Woods/grass comb., Fair, HSG B |
| 0.060 | 98 | Paved parking & roofs |
| 0.140 | 61 | >75% Grass cover, Good, HSG B |
| 0.400 | 69 | Weighted Average |
| 0.340 | | Pervious Area |
| 0.060 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 8.7 | 80 | 0.0400 | 0.15 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.4 | 100 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 110 | 0.0400 | 3.00 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 9.7 | 290 | Total | | | |

## Subcatchment 3S: Sub_P3

Runoff = 5.25 cfs @ 12.21 hrs, Volume= 0.506 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.471 | 65 | Woods/grass comb., Fair, HSG B |
| 0.070 | 98 | Paved parking & roofs |
| 1.065 | 61 | >75% Grass cover, Good, HSG B |
| 1.606 | 64 | Weighted Average |
| 1.536 | | Pervious Area |
| 0.070 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.3 | 65 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.7 | 55 | 0.0700 | 1.32 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.7 | 90 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.0 | 310 | Total | | | |

## Subcatchment 4S: Sub_P4

Runoff = 4.15 cfs @ 12.22 hrs, Volume= 0.404 af, Depth= 3.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.295 | 65 | Woods/grass comb., Fair, HSG B |
| 0.077 | 98 | Paved parking & roofs |
| 0.909 | 61 | >75% Grass cover, Good, HSG B |
| 1.281 | 64 | Weighted Average |
| 1.204 | | Pervious Area |
| 0.077 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.9 | 150 | 0.1730 | 2.91 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 1.7 | 220 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 12.9 | 470 | Total | | | |

## Subcatchment 5S: Sub_P4

Runoff = 3.74 cfs @ 12.22 hrs, Volume= 0.368 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.161 | 65 | Woods/grass comb., Fair, HSG B |
| 0.110 | 98 | Paved parking & roofs |
| 0.863 | 61 | >75% Grass cover, Good, HSG B |
| 1.134 | 65 | Weighted Average |
| 1.024 | | Pervious Area |
| 0.110 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.4 | 130 | 0.0500 | 1.57 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.8 | 140 | 0.1700 | 2.89 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 40 | 0.0250 | 1.11 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.6 | 120 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 13.7 | 530 | Total | | | |

## Subcatchment 6S: Sub_P4

Runoff = 5.27 cfs @ 12.24 hrs, Volume= 0.537 af, Depth= 3.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.193 | 65 | Woods/grass comb., Fair, HSG B |
| 0.059 | 98 | Paved parking & roofs |
| 1.506 | 61 | >75% Grass cover, Good, HSG B |
| 1.758 | 63 | Weighted Average |
| 1.699 | | Pervious Area |
| 0.059 | | Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 1.3 | 110 | 0.0400 | 1.40 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.4 | 60 | 0.1500 | 2.71 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.4 | 210 | 0.0430 | 1.45 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.3 | 40 | 0.1250 | 2.47 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 0.5 | 110 | 0.0500 | 3.35 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 15.2 | 630 | Total | | | |

## Subcatchment 7S: Sub_P7

Runoff = 11.83 cfs @ 12.74 hrs, Volume= 2.031 af, Depth= 4.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 1.048 | 65 | Woods/grass comb., Fair, HSG B |
| 2.881 | 79 | <50% Grass cover, Poor, HSG B |
| 1.262 | 61 | >75% Grass cover, Good, HSG B |
| 5.191 | 72 | Weighted Average |
| 5.191 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.3 | 100 | 0.0400 | 0.16 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 0.2 | 50 | 0.3300 | 4.02 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 2.1 | 110 | 0.0300 | 0.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 41.0 | 870 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 53.6 | 1,130 | Total | | | |

## Subcatchment 8S: Sub_P8

Runoff = 6.94 cfs @ 12.31 hrs, Volume= 0.821 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 2.529 | 65 | Woods/grass comb., Fair, HSG B |
| 2.529 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.8 | 130 | 0.0200 | 0.13 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.50" |
| 3.3 | 140 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.3 | 60 | 0.3300 | 2.87 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 20.4 | 330 | Total | | | |

## Subcatchment 9S: Sub_P9

Runoff = 3.34 cfs @ 12.60 hrs, Volume= 0.501 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 1.543 | 65 | Woods/grass comb., Fair, HSG B |
| 1.543 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 37.5 | 150 | 0.0100 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.5 | 120 | 0.0700 | 3.97 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 41.5 | 420 | Total | | | |

## Subcatchment 10S: Sub_P10

Runoff = 1.50 cfs @ 12.62 hrs, Volume= 0.229 af, Depth= 3.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Type III 24-hr 100-Yr Rainfall=8.00"

| Area (ac) | CN | Description |
|---|---|---|
| 0.705 | 65 | Woods/grass comb., Fair, HSG B |
| 0.705 | | Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.6 | 60 | 0.0200 | 0.07 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.50" |
| 3.5 | 150 | 0.0200 | 0.71 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 25.9 | 550 | 0.0050 | 0.35 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 43.0 | 760 | Total | | | |

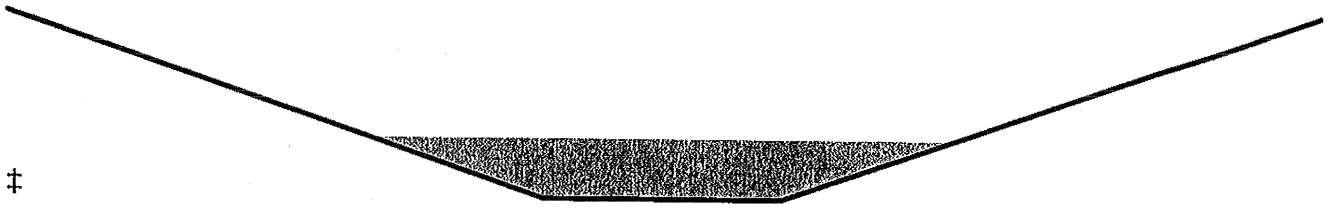
## Reach 1R: Open Swale

Inflow Area = 1.281 ac, Inflow Depth = 3.78" for 100-Yr event
Inflow = 4.15 cfs @ 12.22 hrs, Volume= 0.404 af
Outflow = 3.96 cfs @ 12.25 hrs, Volume= 0.404 af, Atten= 5%, Lag= 1.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 2.35 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 4.6 min

Peak Storage= 402 cf @ 12.25 hrs, Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 240.0' Slope= 0.0100 '/'
Inlet Invert= 117.60', Outlet Invert= 115.20'



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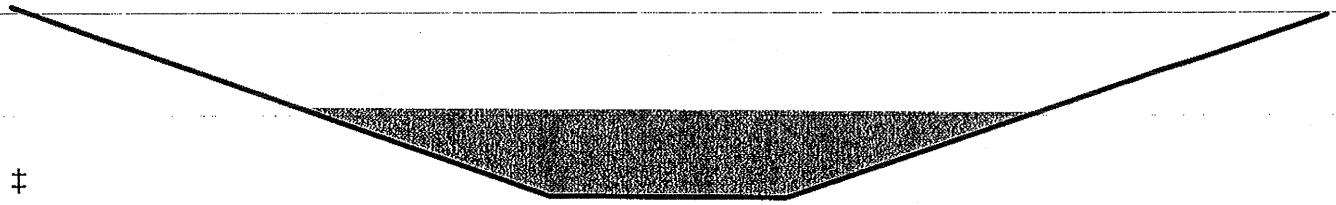
## Reach 2R: Open swale

Inflow Area = 3.120 ac, Inflow Depth = 3.85" for 100-Yr event
Inflow = 8.45 cfs @ 12.25 hrs, Volume= 1.000 af
Outflow = 8.28 cfs @ 12.27 hrs, Volume= 1.000 af, Atten= 2%, Lag= 1.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 2.86 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 2.4 min

Peak Storage= 460 cf @ 12.27 hrs, Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 43.30 cfs

2.00' x 1.50' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 3.0 '/' Top Width= 11.00'
Length= 160.0' Slope= 0.0100 '/'
Inlet Invert= 115.20', Outlet Invert= 113.60'



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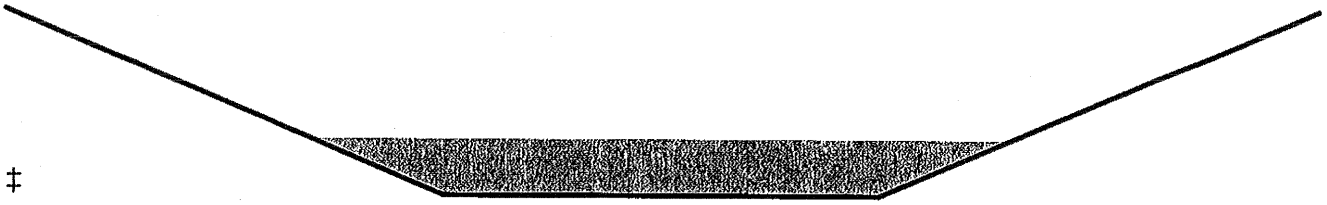
## Reach 3R: Open Channel

Inflow Area = 4.878 ac, Inflow Depth = 3.78" for 100-Yr event
Inflow = 12.71 cfs @ 12.29 hrs, Volume= 1.538 af
Outflow = 12.53 cfs @ 12.33 hrs, Volume= 1.538 af, Atten= 1%, Lag= 2.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Max. Velocity= 4.66 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 1.60 fps, Avg. Travel Time= 4.2 min

Peak Storage= 1,068 cf @ 12.33 hrs, Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 122.18 cfs

4.50' x 1.50' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 13.50'
Length= 400.0' Slope= 0.0350 '/'
Inlet Invert= 114.00', Outlet Invert= 100.00'



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## Reach DP-1: Design Point 1

Inflow Area = 5.760 ac, Inflow Depth = 3.85" for 100-Yr event
Inflow = 15.24 cfs @ 12.29 hrs, Volume= 1.846 af
Outflow = 15.24 cfs @ 12.29 hrs, Volume= 1.846 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Reach DP-2: Design Point 2

Inflow Area = 11.612 ac, Inflow Depth = 4.21" for 100-Yr event
Inflow = 23.23 cfs @ 12.47 hrs, Volume= 4.069 af
Outflow = 23.23 cfs @ 12.47 hrs, Volume= 4.069 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

## Pond 1P: 36" Culvert

Inflow Area = 1.225 ac, Inflow Depth = 3.67" for 100-Yr event
Inflow = 3.91 cfs @ 12.21 hrs, Volume= 0.375 af
Outflow = 3.57 cfs @ 12.25 hrs, Volume= 0.375 af, Atten= 8%, Lag= 2.6 min
Primary = 3.57 cfs @ 12.25 hrs, Volume= 0.375 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 114.69' @ 12.25 hrs Surf.Area= 1,464 sf Storage= 362 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.7 min ( 845.1 - 844.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.00' | 1,018 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 114.00 | 6 | 19.6 | 0 | 0 | 6 |
| 115.00 | 2,915 | 365.6 | 1,018 | 1,018 | 10,614 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 113.90' | **36.0" x 60.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 112.50' S= 0.0233 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=3.37 cfs @ 12.25 hrs HW=114.67' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 3.37 cfs @ 2.36 fps)

## Pond 2P: 15" Culvert

Inflow Area = 0.400 ac, Inflow Depth = 4.35" for 100-Yr event
Inflow = 1.51 cfs @ 12.19 hrs, Volume= 0.145 af
Outflow = 1.51 cfs @ 12.19 hrs, Volume= 0.145 af, Atten= 0%, Lag= 0.0 min
Primary = 1.51 cfs @ 12.19 hrs, Volume= 0.145 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 117.58' @ 12.19 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 116.90' | **15.0" x 27.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 116.63' S= 0.0100 '/' Cc= 0.900 |

n= 0.012 Concrete pipe, finished

**Primary OutFlow** Max=1.47 cfs @ 12.19 hrs HW=117.57' TW=115.31' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.47 cfs @ 2.20 fps)

## Pond 3AP: 15" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 1.606 ac, | Inflow Depth = | 3.78" | for 100-Yr event |
| Inflow = | 3.59 cfs @ | 12.25 hrs, Volume= | 0.506 af | |
| Outflow = | 3.35 cfs @ | 12.33 hrs, Volume= | 0.506 af, | Atten= 7%, Lag= 4.6 min |
| Primary = | 3.35 cfs @ | 12.33 hrs, Volume= | 0.506 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 119.29' @ 12.33 hrs Surf.Area= 775 sf Storage= 386 cf

Plug-Flow detention time= 2.3 min calculated for 0.506 af (100% of inflow)
Center-of-Mass det. time= 1.6 min ( 851.4 - 849.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.00' | 572 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.00 | 16 | 0 | 0 |
| 119.00 | 408 | 212 | 212 |
| 119.50 | 1,030 | 360 | 572 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.00' | **15.0" x 81.3' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.80' S= 0.0025 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |

**Primary OutFlow** Max=3.27 cfs @ 12.33 hrs HW=119.27' TW=115.31' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 3.27 cfs @ 3.25 fps)

## Pond 3P: 15" Culvert

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 1.606 ac, | Inflow Depth = | 3.78" | for 100-Yr event |
| Inflow = | 5.25 cfs @ | 12.21 hrs, Volume= | 0.506 af | |
| Outflow = | 3.59 cfs @ | 12.25 hrs, Volume= | 0.506 af, | Atten= 32%, Lag= 2.2 min |
| Primary = | 3.59 cfs @ | 12.25 hrs, Volume= | 0.506 af | |
| Secondary = | 0.00 cfs @ | 0.00 hrs, Volume= | 0.000 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 119.69' @ 12.45 hrs Surf.Area= 3,794 sf Storage= 2,124 cf

Plug-Flow detention time= 9.6 min calculated for 0.506 af (100% of inflow)
Center-of-Mass det. time= 6.8 min ( 849.8 - 843.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 118.25' | 3,473 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 118.25 | 100 | 0 | 0 |
| 119.00 | 1,069 | 438 | 438 |
| 120.00 | 5,000 | 3,035 | 3,473 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 118.25' | **15.0" x 25.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 118.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 120.00' | **50.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=2.39 cfs @ 12.25 hrs HW=119.52' TW=119.26' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.39 cfs @ 1.94 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=118.25' TW=118.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 4P: 15" Culvert

Inflow Area = 1.281 ac, Inflow Depth = 3.78" for 100-Yr event
Inflow = 4.15 cfs @ 12.22 hrs, Volume= 0.404 af
Outflow = 4.15 cfs @ 12.22 hrs, Volume= 0.404 af, Atten= 0%, Lag= 0.0 min
Primary = 4.15 cfs @ 12.22 hrs, Volume= 0.404 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 119.36' @ 12.22 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 117.95' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 117.60' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=4.02 cfs @ 12.22 hrs HW=119.32' TW=118.07' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 4.02 cfs @ 3.28 fps)

## Pond 5P: 15" Culvert

Inflow Area = 1.134 ac, Inflow Depth = 3.89" for 100-Yr event
Inflow = 3.74 cfs @ 12.22 hrs, Volume= 0.368 af
Outflow = 3.74 cfs @ 12.22 hrs, Volume= 0.368 af, Atten= 0%, Lag= 0.0 min
Primary = 3.74 cfs @ 12.22 hrs, Volume= 0.368 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs

Peak Elev= 117.06' @ 12.22 hrs

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.80' | **15.0" x 35.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 115.45' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |

**Primary OutFlow** Max=3.62 cfs @ 12.22 hrs HW=117.02' TW=115.88' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.62 cfs @ 2.97 fps)

## Pond 6P: 15" Culvert

Inflow Area = 1.758 ac, Inflow Depth = 3.67" for 100-Yr event
Inflow = 5.27 cfs @ 12.24 hrs, Volume= 0.537 af
Outflow = 4.52 cfs @ 12.35 hrs, Volume= 0.537 af, Atten= 14%, Lag= 6.4 min
Primary = 4.52 cfs @ 12.35 hrs, Volume= 0.537 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 115.72' @ 12.35 hrs Surf.Area= 1,627 sf Storage= 854 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.9 min ( 850.0 - 848.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 114.16' | 3,174 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 114.16 | 50 | 0 | 0 |
| 115.00 | 321 | 156 | 156 |
| 116.00 | 2,143 | 1,232 | 1,388 |
| 116.50 | 5,000 | 1,786 | 3,174 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 114.16' | **15.0" x 36.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 113.80' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior |
| #2 | Secondary | 116.50' | **30.0' long x 11.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64 |

**Primary OutFlow** Max=4.36 cfs @ 12.35 hrs HW=115.66' TW=114.44' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 4.36 cfs @ 3.55 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=114.16' TW=114.00' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 7P: 24" Culvert

Inflow Area = 5.191 ac, Inflow Depth = 4.69" for 100-Yr event
Inflow = 11.83 cfs @ 12.74 hrs, Volume= 2.031 af
Outflow = 11.65 cfs @ 12.81 hrs, Volume= 2.031 af, Atten= 2%, Lag= 4.1 min
Primary = 11.65 cfs @ 12.81 hrs, Volume= 2.031 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 117.64' @ 12.81 hrs Surf.Area= 2,025 sf Storage= 961 cf

Plug-Flow detention time= 3.4 min calculated for 2.031 af (100% of inflow)
Center-of-Mass det. time= 0.7 min ( 865.5 - 864.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.70' | 6,371 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 115.70 | 23 | 0 | 0 |
| 117.00 | 310 | 216 | 216 |
| 118.00 | 3,000 | 1,655 | 1,871 |
| 119.00 | 6,000 | 4,500 | 6,371 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.70' | **24.0" x 42.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900<br>Outlet Invert= 114.30' S= 0.0333 '/' Cc= 0.900<br>n= 0.012 Concrete pipe, finished |
| #2 | Secondary | 117.80' | **5.0' long x 20.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |

**Primary OutFlow** Max=11.61 cfs @ 12.81 hrs HW=117.63' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 11.61 cfs @ 3.73 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=115.70' TW=0.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 8P: Depression

Inflow Area = 2.006 ac, Inflow Depth = 3.89" for 100-Yr event
Inflow = 4.80 cfs @ 12.25 hrs, Volume= 0.651 af
Outflow = 4.67 cfs @ 12.30 hrs, Volume= 0.651 af, Atten= 3%, Lag= 2.7 min
Primary = 4.67 cfs @ 12.30 hrs, Volume= 0.651 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.20 hrs
Peak Elev= 115.32' @ 12.30 hrs Surf.Area= 2,634 sf Storage= 423 cf

Plug-Flow detention time= 1.5 min calculated for 0.651 af (100% of inflow)
Center-of-Mass det. time= 1.3 min ( 848.1 - 846.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 115.00' | 5,640 cf | **Custom Stage Data (Irregular)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 115.00 | 335 | 83.4 | 0 | 0 | 335 |
| 116.00 | 14,389 | 574.7 | 5,640 | 5,640 | 26,066 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.00' | **10.0' long x 10.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64 |

**Primary OutFlow** Max=4.43 cfs @ 12.30 hrs HW=115.31' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 4.43 cfs @ 1.42 fps)

# Appendix L:
# Design Calculations

Date: 04.09.2007
Chazen Project # 40313.01
Calculated By: Jason Jin
Checked By: Paul Guillet

## WATER QUALITY VOLUME CALCULATION

**Balefill Landfill**
Town of Wappinger, NY

$$WQv = ( (P) * (Rv) *(A) ) / 12$$

WQv = water quality volume (acre-feet)

P = 90% rainfall event number
(See Fig 4.1 in NYS Stormwater Management Design Manual)

Rv = runoff volume = 0.05 + .009 (I) , where I is the percent impervious cover

A = site area (acres)

$$Rv = 0.05 + 0.009 * \boxed{I \over 100}$$

| | | P | * | Rv | * | A | | |
|---|---|---|---|---|---|---|---|---|
| WQv | = | 0.95 | * | 0.95 | * | 0.60 | / | 12 |

WQv = 0.045 acre-feet

**WQv = 1953 CF**

**10% WQv = 195 CF**

**20% WQv = 391 CF**

**25% WQv = 488 CF**

**50% WQv = 976 CF**

**75% WQv = 1464 CF**

Notes: 1624.2 linear feet roadway has 16' wide gravel cover, which will add total 0.60 acres impervious area in the calculation. The WQv of each linear foot roadway is about 1.2 cu.fts. To provide 100% WQv storage in the channel, the 9" high check dams need to be spaced as followings to provide average 1.5 cu.fts each linear foot channel.

9" high check dam spacing 75 feet for 1% slope channel

9" high check dam spacing 37.5 feet for 2% slope channel

9" high check dam spacing 25 feet for 3% slope channel

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Chazen Project: 40313.01 | | |
| | | | **MANNING'S EQUATION** | | | | | | Calculated By: Jason Jin | | |
| | | | (Trapezoidal) | | | | | | Checked by: Paul Guillet | | |
| | | | | | | | | | Date: April 9th, 2007 | | |
| | | Q = (1.486 / n) * ( A ) * ( R ^ 0.6666) * ( S ^ 0.5) | | | | | | | | | |
| | | | n = | 0.03 | | | | | | | |
| | Bottom Width (ft) | | B= | 6.5 | ft | | | | | | |
| | Side Slope X | | X= | 3 | | | | | | | |
| | Flow Area (sqft) | | A = | 4.00 | sq ft | | | | | | |
| | Depth (ft) | | d= | 0.5 | ft | | | | | | |
| | Wetted Perimeter (ft) | | | Wp = | 6.5 | + | 3.16 | = | 9.66 | ft | |
| | | | | | Bottom width | | Sides | | | | |
| | Hydraulic Radius (ft.) | | R = | A / Wp = | 0.414 | ft | | | | | |
| | Slope (ft/ft) | | S = | 0.01 | ft / ft | | | | | | |
| | | | **Q =** | 11.0 | cfs | | | | | | |
| | | | **V=** | 2.75 | fps | | | | | | |
| | Note: | | | | | | | | | | |

# Appendix E:
# Variance Request Forms

New York State
Department of Environmental Conservation

**APPLICATION FOR VARIANCE FROM 6 NYCRR 360**

| FOR STATE USE ONLY | |
|---|---|
| PROJECT NO. | DATE RECEIVED |
| DEPARTMENT ACTION<br>□ Approved □ Disapproved | DATE |

SEE APPLICATION INSTRUCTIONS ON REVERSE SIDE

| | | |
|---|---|---|
| 1. OWNER'S NAME<br>**Dutchess County Department of Public Works**<br>**Charles Traver (Acting Commissioner)** | 2. ADDRESS (Street, City, State, Zip Code)<br>**22 Market Street, Poughkeepsie, New York, 12601** | 3. TELEPHONE NO.<br>**(845) 486-2121** |
| 4. OPERATOR'S NAME<br>**Dutchess County Department of Public Works**<br>**Charles Traver (Acting Commissioner)** | 5. ADDRESS (Street, City, State, Zip Code)<br>**22 Market Street, Poughkeepsie, New York, 12601** | 6. TELEPHONE NO.<br>**(845) 486-2121** |
| 7. ENGINEER'S NAME<br>**The Chazen Companies** | 8. ADDRESS (Street, City, State, Zip Code)<br>**547 River Street, Troy, New York, 12180** | 9. TELEPHONE NO.<br>**(518) 273-0055** |

10. PROJECT/FACILITY NAME
**Dutchess County Balefill Landfill, Wappinger, New York**

| | | |
|---|---|---|
| 11. PROJECT STATUS<br>■ Public □ Private □ Proposed □ Existing | 12. COUNTY IN WHICH FACILITY IS LOCATED<br>**Dutchess** | 13. ENVIRONMENTAL CONSERVATION REGION<br>**Region 3** |

14. DESCRIBE SPECIFIC LOCATION OF FACILITY
**The Dutchess County Balefill Landfill is located at the east end of Citation Drive, near the north end of the north/south runway of the Dutchess County Airport in the Town of Wappinger, New York. The landfill comprises a small fraction of a large County-owned property situated east of the Wappinger Creek, which also includes the Airport.**

15. TYPE OF PROJECT FACILITIES: □ Composting □ Transfer □ Shredding □ Bailing □ Sanitary Landfill □ Incineration □ Pyrolysis
□ Resource Recovery-Energy □ Resource Recovery-Materials ■ Other **Bundled commercial and municipal solid waste**

16. BRIEFLY DESCRIBE THE PROJECT INCLUDING THE BASIC PROCESS AND MAJOR COMPONENTS
**The project includes the closing of the landfill operated by the Dutchess County Department of Public Works, in accordance with 6 NYCRR 360.**

| 17. SPECIFIC PROVISION OF 6 NYCRR 360 FROM WHICH A VARIANCE IS REQUESTED | Section | Paragraphs | Variance Request No. |
|---|---|---|---|
| **Section 360-2.13 Landfill construction requirements, Geomembrane covers** | **2.13** | **(r)(2)(iii)** | **1 of 1** |

18. BRIEFLY DESCRIBE PROPOSED VARIANCE
**Requesting that the minimum 24-inch barrier protection layer be reduced to 12 inches, for the geomembrane barrier layer cap. The soil under geomembrane will be well-drained to prevent frost heave damage to the geomembrane. There is also written affirmation (see attachment) that the topsoil and barrier protection layer will, acting together, continually support growth of the proposed vegetative cover and not result in root damage to the geomembrane barrier layer.**

19. IMPACTS OF VARIANCE APPROVAL OR DISAPPROVAL:

a. Environmental Impact:
**This Variance Request will not result in any significant adverse effects upon the environment, considering factors such as health, safety, natural resources, aesthetics, and site usability. It is consistent with the provisions of the Environmental Conservation Law and the performance expected from application of 6 NYCRR 360.**

b. Economic Impact:
**This Variance Request will substantially "reduce" the financial burdens imposed on the Dutchess County Department of Public Works by:**
**5.99 Acres ± x 12 inch reduction in soil material = 9,700 CY ±**
**9,700 CY ± x $35/CY ± = $339,500 ± (Savings)**

20. CERTIFICATION
I hereby affirm under penalty of perjury that information provided on this form and attached statements and exhibits is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law

July 10, 2008
Date

Charles F Traver ACTING COMM OF PUBLIC WORKS
Signature and Title

# Appendix F:
# Design Drawing Set
# (Rolled Separately)