*prepared for:*

Delaware Solid Waste Authority
1128 S. Bradford Street
Dover, Delaware 19903

# Volume 11: Design Report: Appendices J through M

## Cherry Island Landfill Expansion Project Wilmington, Delaware

*prepared by:*

GEOSYNTEC CONSULTANTS
10015 Old Columbia Road
Columbia, Maryland 21046

Project No. ME0250
April 2003 -
Revised September 2003
Revised June 2004

# APPENDIX VIb-J

# EROSION AND SEDIMENT CONTROL PLAN

*Prepared for*

**DELAWARE SOLID WASTE AUTHORITY**
1128 South Bradford Street
Dover, Delaware 19903

# EROSION AND SEDIMENT CONTROL PLAN

***for***

# CHERRY ISLAND LANDFILL EXPANSION PROJECT

## Wilmington, Delaware

*Prepared by*

**GEOSYNTEC CONSULTANTS**
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046

Project No. ME0250

May 2005

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# 1. INTRODUCTION

## 1.1 Terms of Reference

GeoSyntec Consultants (GeoSyntec) prepared this Erosion and Sediment Control Plan (ESCP) for the Cherry Island Landfill (CIL) Expansion Project located in New Castle County, Delaware. The ESCP was prepared to fulfill the requirements of the Delaware Sediment and Stormwater Regulations, §10.2, pursuant to Delaware Erosion and Sediment Control Law, Chapter 40, Title 7 of the Delaware Code. In general, the ESCP describes the approach to minimize soil erosion and control sedimentation during the construction activities, waste placement operations, and closure construction associated with the CIL Expansion Project.

## 1.2 Site and Project Description

The CIL is located near the intersection of 12th Street and Interstate 495 (I-495) in Wilmington, Delaware. The location of the site is identified on Figure 1. The CIL site was initially permitted for solid waste management in 1982, and has been used for disposal of solid waste since 1985. The facility encompasses multiple solid waste management features, including five waste disposal cells, identified as Phase I through Phase V, which have a combined area of approximately 240 acres. Adjoining properties to the CIL site include: the Wilmington, Delaware wastewater treatment facility to the northeast; open wetland areas to I-495 to the northwest; the U.S. Army Corps of Engineers, Wilmington Harbor North Dredge Disposal Area to the southwest; the Christina River to the south; and the Delaware River to the east. The existing sediment and stormwater management features at the CIL include perimeter drainage channels, two erosion and sediment control ponds, and associated outfalls.

The CIL Expansion Project will incorporate an approximately 60-ft. high mechanically stabilized earth (MSE) berm around Phases III, IV, and V. Construction of the MSE berm will displace the existing perimeter drainage channels adjacent to Phases III, IV, and V, as well as the two sediment ponds. The size of the MSE berm necessitates that landfill expansion construction proceed in a defined sequential manner; thereby providing ample time to establish interim erosion controls and upgraded permanent stormwater management features.

## 1.3 Organization of ESCP

The remainder of the ESCP is organized as indicated below:

- a description of the anticipated sequence of construction and related erosion and sediment control measures to be implemented during construction of the expansion project are provided in Section 2;
- a description of the erosion and sediment control measures to be implemented during waste placement operations and closure operations is provided in Section 3;
- a description of the post-construction care requirements is provided in Section 4;
- project contacts are provided in Section 5; and
- references are provided in Section 6.

# 2. LANDFILL EXPANSION CONSTRUCTION

## 2.1 Introduction

The Delaware Solid Waste Authority (DSWA), site owner and operator, may employ multiple contractors to complete the expansion project. Contractors will be required to establish and maintain erosion and sediment control features throughout construction in accordance with the latest version of *"Delaware Erosion and Sediment Control Handbook"*. Erosion and sediment control features will remain in place until vegetation has been sufficiently established in disturbed or re-disturbed areas.

The CIL Expansion Project presents a unique construction challenge in that the MSE berm will be constructed on relatively soft, compressible soils that need to be improved. As such, gain of the underlying soil will be achieved by using a combination of surcharge loading and "wick" draining. The length of time for the foundation improvement will govern the rate of MSE berm construction, which directly impacts the implementation of erosion and sediment controls. Accordingly, construction of the MSE berm will progress laterally prior to vertically. At any time, the active construction site is anticipated encompass an area approximately 300-ft. wide by 8,000-ft. long, and due to the linear nature of the project, several of the construction

elements described in the following section may occur simultaneously at different areas of the construction site.

The erosion and sediment control features selected for this project are intended to minimize the potential for soil erosion and control sedimentation, while not adversely affecting construction progress. To that end, the establishment and maintenance of the erosion and sediment control features is directly tied to the sequence of construction. The sequence of construction and primary erosion and sediment features associated with each component of the construction are described below.

## 2.2 Sequence of Construction

The CIL Expansion Project incorporates three primary construction components: (i) installation of prefabricated vertical drains (PVDs) ("wick drains") for foundation improvement; (ii) construction of an approximately 60-ft. high MSE berm; and (iii) construction of five stormwater outlet culverts along to the Delaware and Christina Rivers. Construction of the entire expansion is anticipated to occur over a period of about two years, and as such, the specific measures required to control erosion and sediment will vary throughout the project. The following bulleted list presents the anticipated sequence of construction including approximate durations, and descriptions of the various erosion and sediment control features to be employed during construction. A timeline summary of the anticipated construction sequence is provided in Figure 2. Note that the Phase Va area will be used to manage sediment and stormwater during and in accordance with the sequence of construction described herewith and on Drawings 5, 6, 7, and 69. In order to preserve the Phase Va area for use as a sediment pond in this way, installation of PVDs and subsequent placement of fill in the Phase Va area will be performed in stages.

- *Establish Perimeter Erosion and Sediment Controls* – Perimeter erosion and sediment controls (i.e., silt fence) will be established in open spaces surrounding the existing landfill footprint with only minimal clearing required. It is anticipated that approximately 8,000 linear ft. of site fence will be installed around the Phase III, IV, and V as shown on Figure 3, over a period of three weeks.

- *Install PVDs* – PVD installation will occur around the perimeter of landfill Phases II, III, IV, and V. Prior to installation, areas where PVDs will be

installed will be cleared and grubbed; and a level working pad constructed. The area of disturbance required for PVD installation is approximately, 34 acres. PVD installation is anticipated to occur over a period of six months. The primary erosion and sediment control features to be employed include: temporary dike/swales, perimeter diversions, dust suppression, and silt fence.

- *Establish Soil Stock Pile Area* – A soil stockpile area will be established in the southeast corner of the landfill site. Prior to stockpiling imported soil borrow; the stockpile area will be surrounded with silt fence or temporary diversions, as necessary, to prevent release of sediment from the area. The soil stockpile area will encompass approximately 5.1 acres at the south end of the site, as shown on Figure 4. The primary erosion and sediment control features to be employed include: temporary dike/swales, temporary vegetation, dust suppression, and silt fence.

- *Stabilize PVD Area Beyond MSE Berm Face* – Following PVD installation, disturbed areas beyond the face of the MSE Berm will be permanently stabilized using vegetation. Application of permanent vegetation is anticipated to occur over a period of three weeks.

- *Establish MSE Berm Construction Area Runon Controls* – Runon controls will be established to protect the inside slope of the MSE berm. Runon controls will only be required when the MSE berm construction eliminates the existing landfill perimeter drainage channels. As much as 8,000 linear ft. of temporary earth dike may by required for the project. Implementation of the runon control is anticipated to occur simultaneously with MSE berm construction. The locations of runon controls to be employed are presented on Figure 4.

- *Construct MSE Berm* – The MSE berm construction will occur around the perimeter of landfill Phases II, III, IV, and V. Due to engineering requirements, construction of the MSE berm will proceed laterally over the entire berm footprint in limited vertical increments. The lateral extent of the MSE berm construction area will vary at any one time depending on construction conditions. However the area will be divided in to multiple, 5-acre subareas for erosion and sediment control purposes. Construction of the berm to full height is anticipated to occur over a period of about two years. The primary erosion and sediment control features to be employed during MSE berm construction are illustrated on Figure 4, and include:

- temporary perimeter dike/swales set along the face of the MSE berm;
- lined temporary sediment traps located along the rear edge of the MSE berm;
- temporary swales to direct runoff to sediment traps;
- rock check dams within temporary swales;
- temporary vegetation;
- dust suppression; and
- perimeter silt fence.

- *Vegetate MSE Berm Face* – The MSE berm face will be stabilized using permanent vegetation. Vegetation will be established on the berm face as the construction progresses.

- *Construct Stormwater Outlets* – A total of five stormwater outlets will be constructed around landfill Phases III, IV, and V. Due to engineering requirements, construction of the stormwater outlets will occur only after the MSE berm has been constructed to its full height. Construction of the outlets is anticipated occur over a period of two months. Stormwater flow through the outlets is not anticipated to occur until such time as the landfill is high enough to direct runoff to the perimeter berm. The primary erosion and sediment control features to be employed during construction of the stormwater outlets include: (i) rock outlet protection; (ii) erosion control mat; (iii) temporary and permanent vegetation; and (iv) silt fence.

- *Remove Perimeter Erosion and Sediments* – Removal of the aforementioned erosion and sediment control features will occur following establishment of permanent vegetation on the MSE berm face and at the stormwater outlets.

## 2.3 Erosion and Sediment Control Implementation

Material requirements, specifications, and general placement locations for erosion and sediment control features are provide on the landfill expansion project drawings and construction specifications. Erosion and sediment control features identified in this ESCP are intended to provide general guidance for placement and use of the erosion and sediment control features. The contractor will be responsible for specific placement of the various erosion and sediment control features based on actual field conditions.

# 3. LANDFILL WASTE PLACEMENT OPERATIONS

## 3.1 Introduction

DSWA will be required to establish and maintain erosion and sediment features to protect activities directly related to landfill operations in accordance with the latest version of *"Delaware Erosion and Sediment Control Handbook"*. Erosion and sediment features will remain in place until vegetation has been sufficiently established in disturbed or re-disturbed areas. In general, the completed MSE berm will provide complete stormwater containment until such time that the waste elevation is greater than the height of the MSE berm. The sequence of waste placement activities and the use of erosion and sediment control features for this phase of the project are described below.

## 3.2 Sequence of Operations

The sequence of waste placement operations will be based on filling sequence presented in the landfill expansion drawings. Conceptually, the proposed filling plan provides a sequence of filling that maximizes the use of existing erosion and sediment control and stormwater management features at the site. Existing features incorporated into the plan include the sediment basin located at the southeastern corner of the site, (previously used as temporary soil stockpile area) temporary swales, and sediment traps installed during MSE berm construction. The CIL Expansion Project design-life for waste disposal activities is about 30 years. The following presents an overview of the sequence of waste filling, and descriptions of the various erosion and sediment control features to be employed during waste filling.

- *Initial Development Stage* – During this stage, waste grades will be below the MSE berm, and stormwater from non-waste areas will be conveyed via temporary swales to the existing sediment basin at the southeastern corner of the site. The primary erosion and sediment control features will include temporary swales, rock check dams, temporary diversions, and temporary vegetation.

- *Intermediate Development Stage* – During this stage, waste grades along the perimeter of the MSE berm will be just above the MSE berm crest. Stormwater runoff from non-waste areas (i.e., non-contact stormwater) is conveyed via existing temporary swales to the existing sediment basin at the

southeastern corner of the site. Runoff from intermediate cover and final cover along perimeter slopes will be collected in temporary sediment traps located at the base of the waste slope. Sediment traps will discharge into stormwater drop inlet structures by gravity or pumping. Surface drain inlets within the perimeter drainage channel and stormwater drop inlets will be protected using erosion and sediment control features. The primary erosion and sediment control features will include: temporary swales, rock check dams, temporary diversions, pipe slope drains, storm drain inlet protection, silt fence, and temporary vegetation.

- *Final Development Sequence* – During this last stage, the sediment pond located at the southern corner of the site will be decommissioned and the area will be filled with waste. Non-contact stormwater runoff will be segregated using temporary dike/swales, and conveyed to temporary sediment traps. Sediment traps will discharge via pumps to the perimeter drainage channel. Runoff from intermediate cover and final cover along perimeter slopes will be collected in temporary sediment traps located at the base of the waste slope. Sediment traps will discharge into stormwater drop inlet structures by gravity or pumping. Surface drain inlets within the perimeter drainage channel and stormwater drop inlets will be protected using erosion and sediment control feature such as temporary diversions, storm drain inlet protection, and temporary vegetation.

### 3.3 Erosion and Sediment Control Implementation

Material requirements, specifications, and general placement locations for erosion and sediment control features are provide on the landfill expansion project drawings and construction specifications. Erosion and sediment control features identified in this ESCP are intended to provide general guidance for placement and use of the erosion and sediment control features. The site operator will be responsible for specific placement of the various erosion and sediment control features based on actual field conditions.

## 4. LANDFILL CLOSURE CONSTRUCTION

Closure construction will occur in multiple phases as various portions of the site are filled to the final waste grade. Each phase of closure construction will require

preparation of specific construction documents, and individual erosion and sediment control plan. Closure construction contractors will be required to adhere to the requirements of the closure construction specific erosion and sediment control plans.

Maintenance of the final cover system is described in the CIL Expansion Project Operation and Maintenance Plan. In general, erosion and sediment control feature care during post closure will include maintenance of stormwater drainage features and the cover system top and sideslopes.

## 5. SEDIMENT AND STORMWATER PLAN APPLICATION

The completed application for Sediment and Stormwater Management Plan Approval is provided in Appendix A. An annotated copy of the Delaware Sediment and Stormwater Plan Review Checklist is provided in Appendix B. The annotated checklist provides explanations of how each requirement is met and description of where the information is located in the CIL Expansion Permit Application. The following is a list of the project contacts:

**Owner:**

Delaware Solid Waste Authority
1128 South Bradford Street
Dover, Delaware 19903

Phone: 302)-739-5361

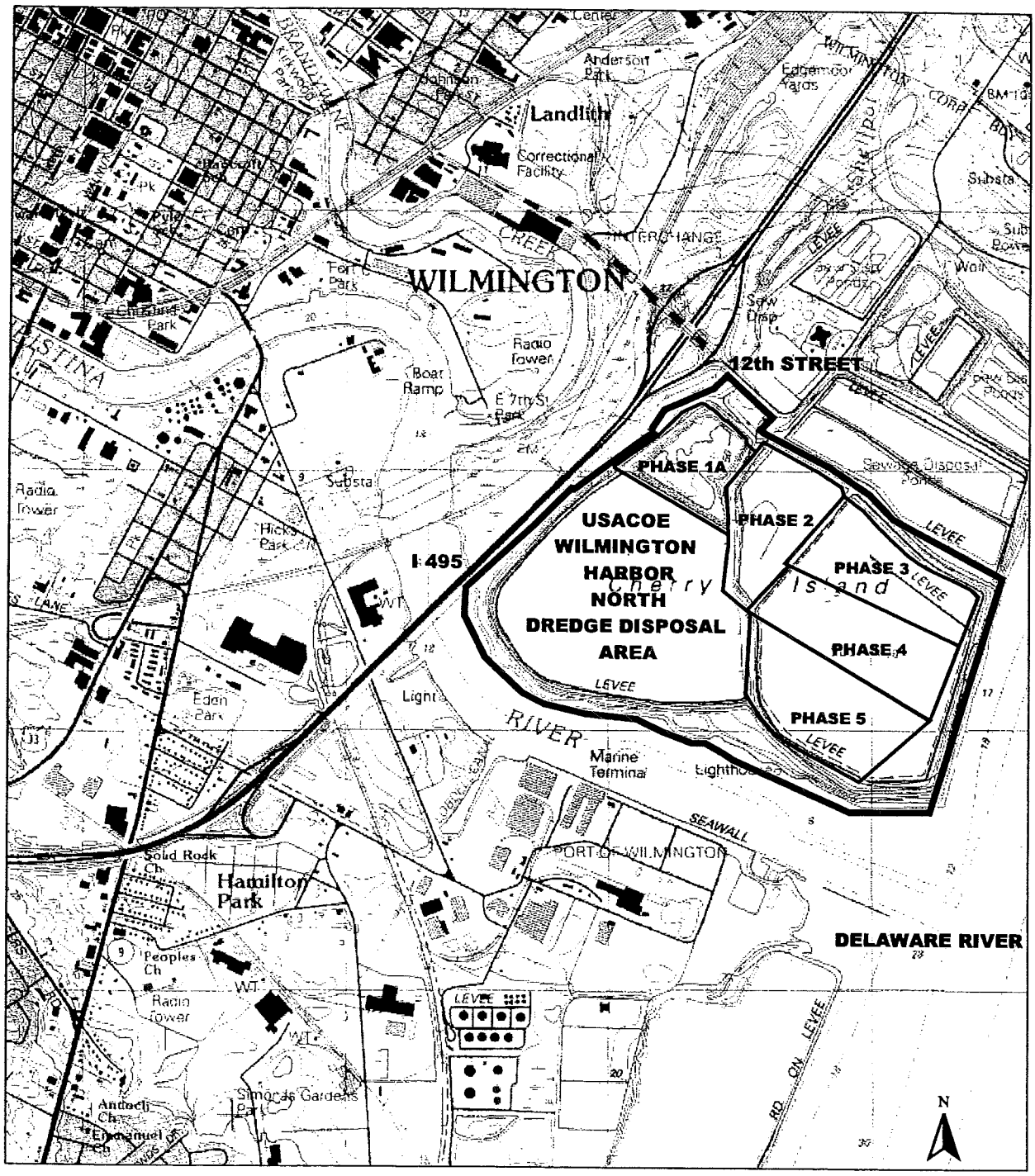
**Engineer:**

GeoSyntec Consultants
10015 Old Columbia Road
Suite A-200
Columbia, Maryland 21046

Phone: (410)-381-4333

## 6. REFERENCES

Delaware Department of Natural Resources, *Delaware Erosion and Sediment Control Handbook*, Dover, Delaware, 1989.




2000 0 2000 Feet

**LEGEND**

PHASE BOUNDARY
PROPERTY BOUNDARY

SOURCE: USGS 7.5-Minute Topographic Map
Wilmington, DE-NJ Quadrangle
1993

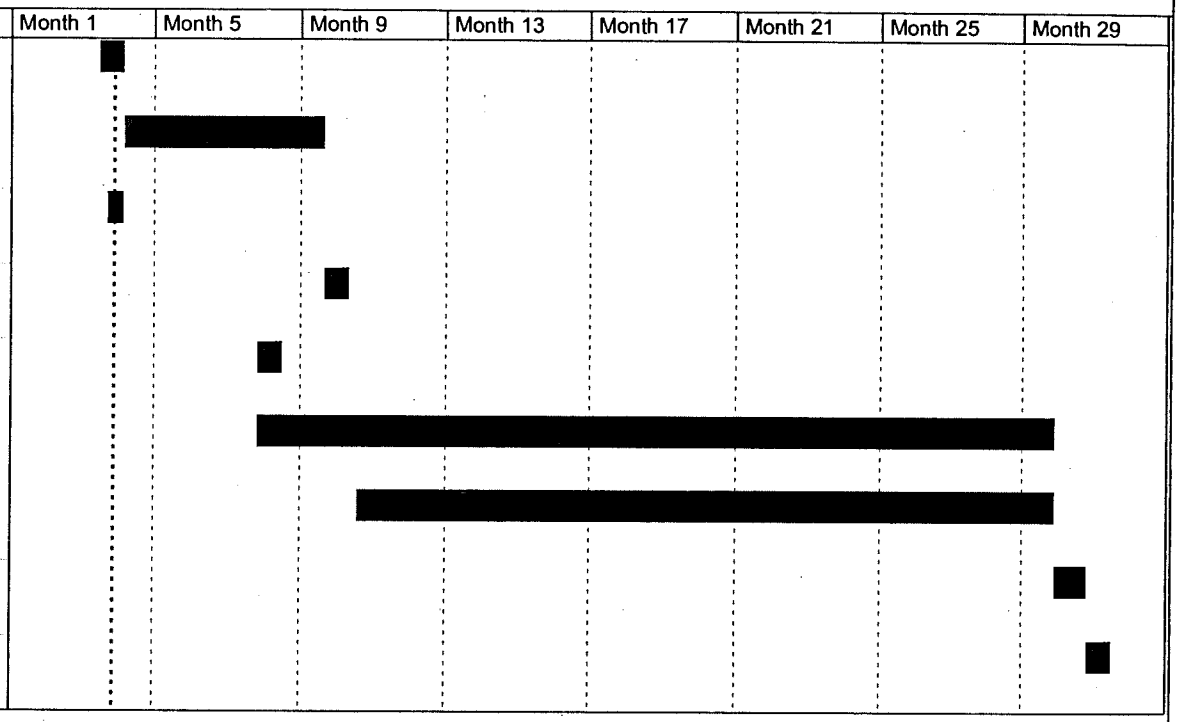
| | | |
|---|---|---|
| GEOSYNTEC CONSULTANTS<br>10015 Old Columbia Road, Suite A-200<br>Columbia, Maryland 21046 | GENERAL SITE PLAN<br>CHERRY ISLAND LANDFILL<br>WILMINGTON, DELAWARE | FIGURE 1<br>PROJECT- ME0250 |

# ANTICIPATED CONSTRUCTION SEQUENCE

GeoSyntec Consultants

## DELAWARE SOLID WSATE AUTHORITY
## CHERRY ISLAND LANDFILL EXPANSION PROJECT WILMINGTON, DELAWARE

| ID | ID | Task Name |
|---|---|---|
| 1 | 1 | Establish Perimeter Erosion and Sediment Controls |
| 2 | 2 | Install PVDs |
| 3 | 3 | Establish Soil Stockpile Area |
| 4 | 4 | Stabilize PVD Area Beyond MSE Berm Face |
| 5 | 5 | Establish MSE Berm Construction Area Runon Controls |
| 6 | 6 | Construct MSE Berm |
| 7 | 7 | Vegetate MSE Berm Face |
| 8 | 8 | Construct Stormwater Outlets |
| 9 | 9 | Remove Perimeter Erosion and Sediment Controls |

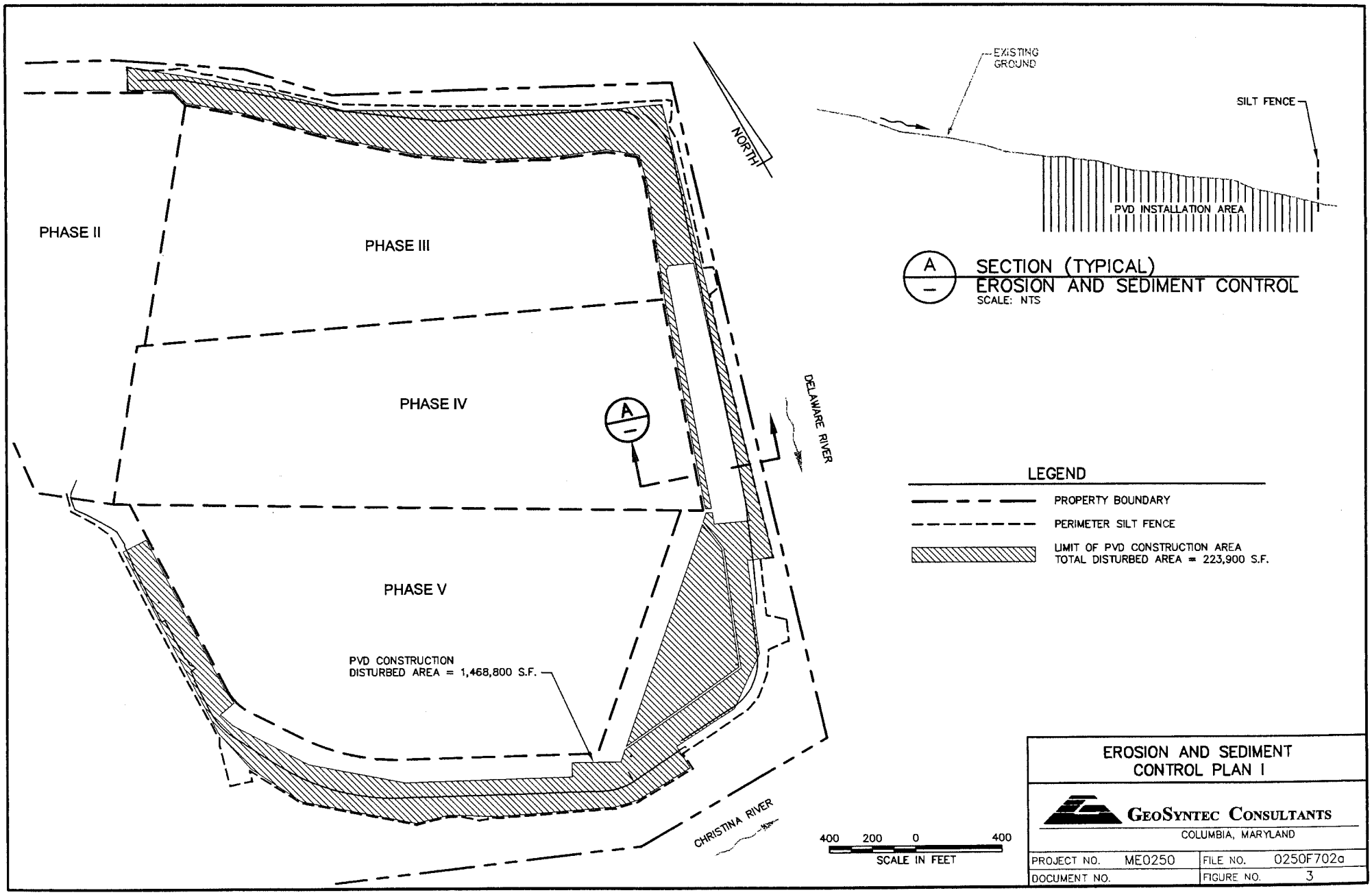


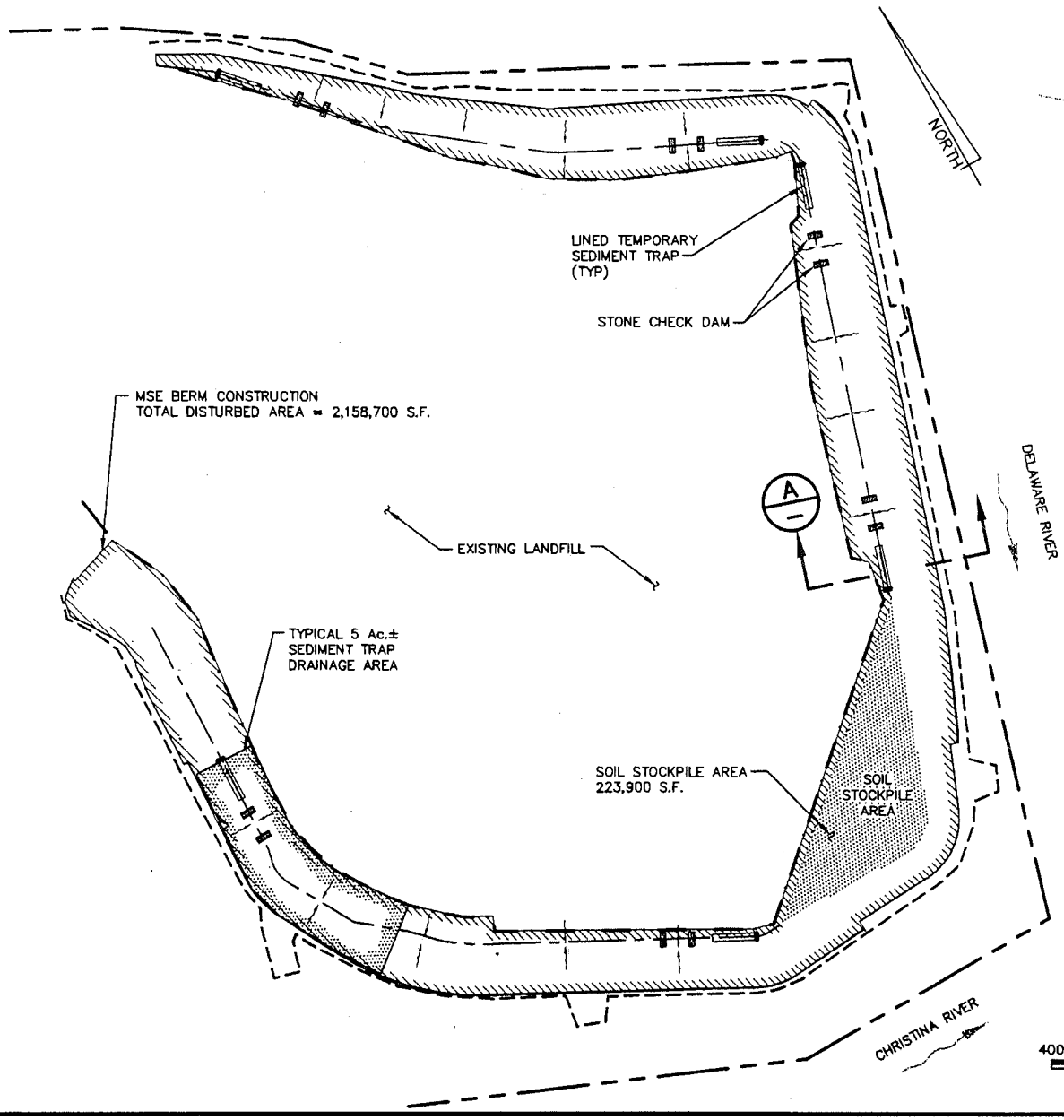

Project: E&STimeline
Date: 3/28/03

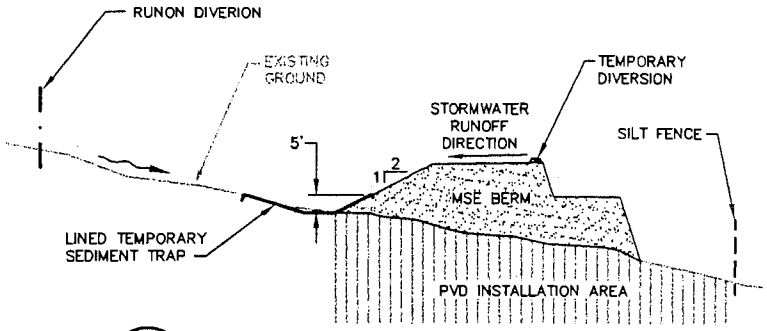
Task

ME0250\E&STimeline.mpp

**FIGURE 2**


PHASE II
PHASE III
PHASE IV
PHASE V
NORTH
DELAWARE RIVER
CHRISTINA RIVER
A
PVD CONSTRUCTION
DISTURBED AREA = 1,468,800 S.F.
EXISTING GROUND
SILT FENCE
PVD INSTALLATION AREA
A
SECTION (TYPICAL)
EROSION AND SEDIMENT CONTROL
SCALE: NTS
LEGEND
PROPERTY BOUNDARY
PERIMETER SILT FENCE
LIMIT OF PVD CONSTRUCTION AREA
TOTAL DISTURBED AREA = 223,900 S.F.
400 200 0 400
SCALE IN FEET
EROSION AND SEDIMENT
CONTROL PLAN I
GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND
PROJECT NO. ME0250
FILE NO. 0250F702a
DOCUMENT NO.
FIGURE NO. 3




A — SECTION (TYPICAL) EROSION AND SEDIMENT CONTROL
SCALE: NTS

## LEGEND

- PROPERTY BOUNDARY
- PERIMETER SILT FENCE
- FACE OF MSE BERM
- TOE OF MSE BERM
- TEMPORARY RUNON DIVERSION
- STORMWATER RUNOFF DIRECTION
- LINED TEMPORARY SEDIMENT TRAP
- SOIL STOCKPILE AREA
- LIMIT OF MSE BERM CONSTRUCTION

400 200 0 400
SCALE IN FEET

# EROSION AND SEDIMENT CONTROL PLAN II

GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

| | | | |
|---|---|---|---|
| PROJECT NO. | ME0250 | FILE NO. | 0250F702 |
| DOCUMENT NO. | | FIGURE NO. | 4 |

# ATTACHMENT A

# Application for Sediment and Stormwater Management Plan Approval

Delaware DNREC
Div. of Soil & Water Conservation
89 Kings Hwy.
Dover, DE 19901
Phone: (302) 739-4411
FAX: (302) 739-6724

DELAWARE SEDIMENT & STORMWATER PROGRAM

# APPLICATION FOR SEDIMENT AND STORMWATER MANAGEMENT PLAN APPROVAL

PROJECT OR CONTRACT NUMBER: Cherry Island Landfill Expansion

PROJECT DESCRIPTION: Landfill Expansion

PROJECT LOCATION: Wilmington (town/city) New Castle (county) (hundred/tax parcel #)

PROJECT DISTURBED AREA IN ACRES: 49.6
*expressed as acres and tenths of acres (i.e. 4.2 acres)*

OWNER/DEVELOPER NAME: Delaware Solid Waste Authority

OWNER/DEVELOPER ADDRESS: 1128 South Bradford Street, (street) Dover, DE (city) 19903 (zip)

OWNER/DEVELOPER PHONE #: ( 302 ) 739-5361 FAX #: ( 302 ) 739-4287

CONSULTANT/ENGINEER NAME: GeoSyntec Consultants

CONTACT PERSON/PROJECT ENGINEER: Michael Houlihan, PE

CONSULTANT/ENGINEER ADDRESS: 10015 Old Columbia Road, Ste A-200, (street) Columbia, MD (city) 21046 (zip)

CONSULTANT/ENGINEER PHONE #: ( 410 ) 381-4333 FAX#: ( 410 ) 381-4499

*FOR OFFICE USE ONLY*

☐ DESIGN REPORT

☐ PLAN

☐ CHECKLIST

FEE PAID $ _____

PERMIT # _____

**STATE OF DELAWARE**
**DNREC**
**SEDIMENT AND STORMWATER MANAGEMENT PLAN**

APPROVED BY _____

DATE _____ TITLE _____

Please submit this application with the Sediment and Stormwater Management Plan Checklist, owner/developer certification, design certification, agent's authorization, and plans, to the DNREC, Division of Soil and Water Conservation, Sediment and Stormwater Management Program, 89 Kings Highway, Dover DE, 19901.

## OWNER/DEVELOPER CERTIFICATION

"I/We certify that the information on this form and the attached plans is true and accurate to the best of my/our knowledge."

"I/We understand that DNREC may request information in addition to that set forth herein as may be deemed appropriate in considering this application."

"I/We will abide by the conditions of this approval as issued."

"I/We hereby certify that all clearing, grading, construction and/or development will be done pursuant to the approved plan, and that all responsible personnel involved in the land disturbing activities will have a Sediment and Stormwater Management Certification from the Delaware Department of Natural Resources and Environmental Control."

"I/We hereby authorize the right of entry for periodic on site inspections by State of Delaware, Department of Natural Resource and Environmental Control compliance personnel and/or authorized agents."

Pasquale S. Canzano 4/4/03

Owner/Developer Signature Date

Pasquale S. Canzano, EE COO

Owner/Developer Name and Title (Printed or typed)

## DESIGNER CERTIFICATION

"I hereby certify that, to the best of my knowledge, information, and belief, this plan has been designed in accordance with the current Delaware Erosion and Sediment Control Handbook and the Delaware Sediment and Stormwater Regulations.

Designer Signature Date

P.E. 9433

Delaware Reg. No. (if applicable)

Michael F. Houlihan, Vice President

Designer Name and Title (Printed or typed)

P. E.

Type (P.E., P.L.S., R.A., or R.L.A.)

## AGENT AUTHORIZATION*

(* If this authorization form is completed with the application, all future correspondence may be signed by the duly authorized agent.)

I,_____, hereby designate and authorize the following identified agent to act on my behalf in the processing of this application and to furnish any information that is requested.

AGENT NAME: _____

AGENT ADDRESS: _____

street city zip

AGENT PHONE #: ( )_____ FAX#: ( )_____

Owner/Developer Signature Date

Agent Signature Date

# ATTACHMENT B

# Sediment and Stormwater Plan Review Checklist

# SEDIMENT AND STORMWATER PLAN REVIEW CHECKLIST

**Cherry Island Landfill**
**Wilmington, Delaware**

## SECTION G: GENERAL INFORMATION

| Status | No. | Checklist Requirements | Notes / Location Reference |
|---|---|---|---|
| ✓ | 1 | Completed application signed by the owner, one set of plans, and the checklist must be submitted for review. | Application is in Attachment A to the Erosion and Sediment Control Plan. Drawings are submitted. |
| ✓ | 2 | Provide the name, mailing address, and phone number of the owner of the property, the land developer, the engineer or consultant and the applicant. Provide names of adjacent property owners on the plan. | See Section 5 of Erosion and Sediment Control Plan for contact information. |
| ✓ | 3 | Provide a legend on the Sediment and Stormwater Management Plan. | See Drawing 69 of 89. |
| ✓ | 4 | Provide a "limit of disturbance" line and the disturbed area in acres on the plan. | See Drawing 12 of 89 for overview of limit of disturbance and Drawing 69 of 89 for area of disturbance |
| ✓ | 5 | Provide a vicinity map with a scale no smaller than 1 in. = 1 mile. | See Drawing 1 of 89. |
| ✓ | 6 | Provide a north arrow on plan. | |
| ✓ | 7 | Maximum plan scale of 1 in. = 100 ft. | 50 Scale plans are provided on Drawings 15-21of 89. |
| ✓ | 8 | Plans should be submitted on 24 in. × 36 in. (minimum) sheets unless otherwise approved. | |
| ✓ | 9 | When two (2) or more sheets are used to illustrate the plan view, an index sheet is required, illustrating the entire project on one (1) 24 in. × 36 in. (minimum) sheet. | See Drawing 13 of 89 for index sheet. |
| ✓ | 10 | Provide existing and proposed contours based on mean sea level datum provided at one (1) foot intervals. Total contributing drainage are must be shown regardless of being located on or off-site. | Contributing drainage area is variable due to ongoing waste placement operations at the project site. No offsite areas contribute to the proposed erosion and sediment control features. |
| NA | 11 | Provide existing and proposed spot elevations based on mean sea level datum provided on a fifty foot grid system. Include high and low points. (This is for small projects only). | This is a large project. |
| ✓ | 12 | State and Federal wetlands must be accurately delineated. | See Drawing 3 of 89. |
| ✓ | 13 | The National Flood Insurance Program 100 Year Flood Zone must be delineated. | See Drawing 3 of 89. |
| ✓ | 14 | Provide soils mapping on plan with a general description of each soil. | Contributing drainage areas consist of daily and intermediate landfill cover soil or dredge material. |
| ✓ | 15 | All streams and drainage ways must be delineated. | See Drawing 3 of 89. |
| ✓ | 16 | All sediment and stormwater management practices must be located on the plan. | See Drawing 69 of 89 and Drawings 14 – 22 of 89. |
| NA | 17 | Provide corner and lowest floor elevations for all buildings. | |
| ✓ | 18 | Provide the volume of any spoil or borrow material. | Approximate off-site borrow volume required for project construction is 1.5 million cubic yards. |
| ✓ | 19 | Show project benchmark and identify elevation and date. | Site survey controls are to be determined. |

✓ = Checklist requirement included in the permit application.
NA = Checklist requirement not applicable to permit application.

# SEDIMENT AND STORMWATER PLAN REVIEW CHECKLIST

**Cherry Island Landfill**
**Wilmington, Delaware**

## SECTION N: NOTES

| Status | No. | Checklist Requirements | Notes / Location Reference |
|---|---|---|---|
| ✓ | 1 | Include a note that specifies that the DNREC, Sediment and Stormwater Management Program must be notified in writing five (5) days prior to commencing with construction. Failure to do so constitutes a violation of the approved sediment and stormwater management plan. | See Drawing 69 of 89. |
| ✓ | 2 | Include the following statement *"Review and or approval of the Sediment and Stormwater Management Plan shall not relieve the contractor from his or her responsibilities for compliance with the requirements of the Sediment and Stormwater Regulations, nor shall it relieve the contractor from errors or omissions in the approved plan."* | See Drawing 69 of 89. |
| ✓ | 3 | Include a signed Owner's Certification that states *"I, the undersigned, certify that all land clearing, construction and development shall be done pursuant to the approved plan."* This must be signed in ink on each plan submitted or on an original reproducible. | See Drawing 69 of 89. |
| ✓ | 4 | Include the following note. *"If the approved plan needs to be modified, additional sediment and stormwater control measures may be required as deemed necessary by the DNREC."* | See Drawing 69 of 89. |
| ✓ | 5 | Provide details of temporary and permanent stabilization measures including placement of the following statement on all plans. *"Following soil disturbance or re-disturbance, permanent or temporary stabilization shall be completed within 14 calendar days as to the surface of all perimeter sediment controls, soil stockpiles, and all other disturbed or graded areas on the project site."* | See Drawing 69 of 89. |
| ✓ | 6 | Provide a detailed sequence of construction, at a minimum, include the following activities: clearing and grubbing for those areas necessary for installation of perimeter controls, construction of perimeter controls, remaining clearing and grubbing, road grading, grading for the remainder of the site, utility installation and whether storm drains will be used or blocked until after completion of construction, final grading, landscaping or stabilization, and removal of sediment control practices. | See Drawings 5 – 7 of 89; detailed sequence of construction and approximate time-line for implementation is presented in the Erosion and Sediment Control Plan, Section 2.2. |
| ✓ | 7 | Specify whose responsibility it will be to maintain and repair all erosion and sediment control and stormwater management practices during utility installation. | Responsibilities are identified on the Drawing 5 – 7 of 89. |
| ✓ | 8 | A clear statement of defined maintenance responsibility shall be established during the plan review and approval process. | |

✓ = Checklist requirement included in the permit application.
NA = Checklist requirement not applicable to permit application.

# SEDIMENT AND STORMWATER PLAN REVIEW CHECKLIST

**Cherry Island Landfill**
**Wilmington, Delaware**

## SECTION E: EROSION AND SEDIMENT CONTROL

| | | Checklist Requirements | Notes / Location Reference |
|---|---|---|---|
| ✓ | 1 | Provide details and specifications for all erosion and sediment control management practices used. | See Drawing 70 of 89 and Construction Specifications. |
| ✓ | 2 | Stone check dams are required in all swales, ditches and channels. Provide details, cross-sections and specifications, including check dam station locations. Check dam depth must be such that a maximum stone depth is achieved while ensuring that flow continues over the center of the dam. A minimum 6" depth from the weir to the top of the structure is required. | See Drawings 15 – 21 of 89 and 70 of 89. |
| ✓ | 3 | All stone, with the exception of check dams, must be underlain with a geotextile fabric. Geotextile fabric specifications must be provided for various applications. | |
| ✓ | 4 | Outlet protection is required at all points of discharge from pipes, channels and spillways. Provide details, cross-sections and specification, including $d_{50}$ stone size, stone depth, outlet dimensions and type of geotextile fabric. | See Drawings 63 – 65 of 89. |
| ✓ | 5 | Erosion control matting is required on slopes of 3:1 or greater. | |
| ✓ | 6 | Specify what stabilization measures shall be initiated if dust control becomes a problem. | See Erosion and Sediment Control Plan Section 2.2 and Construction Specifications. |
| ✓ | 7 | Specify details of any unusual practices required. | Lined temporary sediment traps are used for protection of site areas situated above the existing landfill. See Drawing 70 of 89. |
| ✓ | 8 | Sediment traps and basins shall be utilized and sized to accommodate 3,600 cubic feet of storage per acre of contributing drainage area until project stabilization is complete. These structures must be located at the base of the drainage area. The following information is required: top of slope elevation, bottom elevation, outlet elevation, dimensions, proposed volume, required volume, type of trap or basin, and contributing drainage area. Include details, cross-sections and specifications; a minimum 2:1 length to width ratio is required. | Because various stages of construction will occur over different areas simultaneously, the contractor will be responsible for providing sediment traps as necessary to prevent release of sediment. Typical drainage area and sediment trap configuration are shown on Drawing 69. |
| ✓ | 9 | Diversions must be used to direct run-off into traps. When sediment laden stormwater is directed to traps and basins by closed pipe systems, temporary diversions must be used to direct stormwater to traps and basins until closed pipe systems are operations. | |
| ✓ | 10 | Soil stockpile areas must be delineated. Locate stockpiles on areas with little or no slope. Stockpiles must be surrounded with silt fence or a stabilized earthen berm. | See Drawing 69 of 70. |

✓ = Checklist requirement included in the permit application.
NA = Checklist requirement not applicable to permit application.

# SEDIMENT AND STORMWATER PLAN REVIEW CHECKLIST

**Cherry Island Landfill**
**Wilmington, Delaware**

## SECTION S: STORMWATER MANAGEMENT

| Status | No. | Checklist Requirements | Notes / Location Reference |
|---|---|---|---|
| ✓ | 1 | Sub-watershed areas must be delineated on the plan for both the pre- and post-development conditions. Provide the area in acres of each sub watershed. | Pre-development drainage areas are continually variable due to waste placement operations at the project site. Delineation of post-development sub-watershed areas are provided in Appendix VIb-I.2 of the Engineering Report. |
| ✓ | 2 | Provide directional stormwater flow arrows for all existing and proposed channels, pipes, etc. | |
| ✓ | 3 | Show drainage calculations considering off-site contributing drainage. Provide pre- and post-development velocities, peak rates of discharge, and inflow and outflow hydrographs of stormwater runoff at all existing and proposed points of discharge from the site for the two (2) year and the ten (10) year (and the 100 year frequency storm for projects in New Castle County north of the Chesapeake and Delaware Canal) frequency storm. Show site conditions around points of all surface water discharge including vegetation and method of flow conveyance from the land disturbing activity and design details for structural controls. | Post-development stormwater calculations are presented in Appendix VIb-I.1 through VIb-I.11 of the Engineering Report. |
| ✓ | 4 | Provide details, cross-sections and specifications (including appropriate channel lining) for diversions, ditches, ponds, swales, infiltration structures, etc. | Design details, cross sections are provided on Drawing 68 and 66 of 89. |
| ✓ | 5 | Provide inlet and outlet invert elevations for all drainage structures and facilities. | See Drawings 64 – 65 of 89. |
| ✓ | 6 | Provide profiles for all outfall pipes and channels. | See Drawing 65 – 65 of 89. |
| ✓ | 7 | All hydrologic computations shall be accomplished using the most recent version of USDA, Soil Conservation Service TR-20 or TR-55. The storm duration for computational purposes shall be the 24-hour rainfall event. For projects south of the C and D Canal, the Delmarva Unit Hydrograph shall be used. The pre-development peak discharge rate shall be computed assuming that all land uses in the site to be developed are in good hydrologic conditions. | Post-development stormwater calculations prepared using TR-20 and TR-55 are presented in Stormwater Calculations presented in Appendix VIb-I.1 through VIb-I.11 of the Engineering Report. |
| NA | 8 | All ponds constructed for stormwater management shall be designed and constructed in accordance with USDA Soil Conservation Service Small Pond Code 378, dated September 1990, as approved for use in Delaware. | Stormwater management ponds are not included in the design. |
| NA | 9 | Water quality ponds having a permanent pool shall be designed to release the first 1/2 inch of runoff from the site over a 24-hour period. Water quality ponds not having a permanent pool shall be designed to release the first inch of runoff from the site over a 24-hour period. | Stormwater management ponds are not included in the design. |
| NA | 10 | Post-development peak rates of discharge for the two (2) year and the ten (10) year (and the 100 year frequency storm events for projects in New Castle County north of the C and D Canal) shall not exceed the pre-development peak rates of discharge for the two (2) year and the ten (10) year (and the 100 year frequency storm events for projects in New Castle County north of the C and D Canal) frequency storm events. | Pre-development peak discharges are not calculated because the project site discharges directly to the tidally influenced Delaware and Christina Rivers. |
| NA | 11 | Infiltration practices, when used, shall be designed to accept, at least, the first inch of runoff from all streets, roadways, and parking lots, (including all contributing drainage areas). | Infiltration practices are not included in the design. |
| ✓ | 12 | All stormwater designs shall be in accordance with standards developed and/or approved by the DNREC. | |

# SEDIMENT AND STORMWATER PLAN REVIEW CHECKLIST
(continued)

| Status | No. | Checklist Requirements | Notes / Location Reference |
|---|---|---|---|
| NA | 13 | Maintenance set aside areas for disposal of sediments removed from stormwater management facilities must be provided. Set aside areas shall accommodate at least 2% of the stormwater management facility volume to the elevation of the 2 year storage volume elevation, maximum depth of the set aside volume shall be one foot, and the slope of the set aside area shall not exceed 5%. | Permanent stormwater management facilities are not included in the design. |
| NA | 14 | All ponds shall have a forebay or other design feature to act as a sediment trap; a ten (10) foot reverse slope bench must be provided one foot above the normal pool elevation for safety purposes; a ten (10) foot level bench one foot below the normal pool elevation, and all embankment ponds having a permanent pool shall have a means to drain the pool. | Stormwater management ponds are not included in the design. |
| NA | 15 | Infiltration practices shall be used only when the following criteria can be met or exceeded: | Infiltration practices are not included in the design. |
| NA | a. | Areas draining to these practices must be stabilized and vegetative filters established prior to runoff entering the system. | |
| NA | b. | A suspended solids filter accompanies the practice; when vegetation is used, there shall be at least a 20-foot length of vegetative filter. | |
| NA | c. | The bottom of the infiltration practice is at least three feet above the seasonal high water table. | |
| NA | d. | The infiltration practice shall be designed to drain completely within 48 hours. | |
| NA | e. | Infiltration practices are limited to soils having an infiltration rate of at least 1.02 inches per hour. On site soil borings and textural classifications must be done to verify site conditions and seasonal high water table, this information must be submitted with the plan. | |
| NA | f. | Infiltration practices greater than three feet deep shall be located at least 20 feet from basement walls. | |
| NA | g. | Infiltration practices designed to handle runoff from impervious parking areas shall be a minimum of 150 feet from any public or private water supply well. | |
| NA | h. | Infiltration practices shall have overflow systems with measures to provide a non-erosive velocity of flow along its length and at the outfall. | |
| NA | i. | The slope of the bottom of the infiltration practice shall not exceed five percent. | |
| NA | j. | Infiltration practices shall not be installed on or atop a slope whose natural angle of incline exceeds 20%. | |
| NA | k. | Infiltration practices shall not be installed in fill material. | |
| NA | l. | Unless allowed on a specific project, infiltration practices will only be permitted for the primary purpose of water quality enhancement. | |

✓ = Checklist requirement included in the permit application.
NA = Checklist requirement not applicable to permit application.

# APPENDIX VIb-K

# CAP SYSTEM CALCULATIONS

# Appendix VIb-K.1

# Geomembrane Puncture Resistance - Cover

# GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

**Client:** DSWA **Project:** Cherry Island Landfill **Project/Proposal #:** ME0250 **Task #:** ____

**TITLE OF COMPUTATIONS** GEOMEMBRANE PUNCTURE RESISTANCE - COVER

COMPUTATIONS BY:
Signature Carrie H. Pendleton — DATE 03/28/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature [signature] — DATE 3/28/03
Printed Name and Title: R. David Espinoza, Senior Engineer

COMPUTATIONS CHECKED BY:
Signature Douglas T. Mandeville — DATE 3/28/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Carrie H. Pendleton — DATE 03/28/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

APPROVED BY:
(PM or Designate)
Signature [signature] — DATE 3/30/03
Printed Name and Title: R. David Espinoza, Senior Engineer

APPROVAL NOTES: ____

REVISIONS (Number and initial all revisions)

| NO. | SHEET | DATE | BY | CHECKED BY | APPROVAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

Written by: C. Pendleton Date: 03/28/03 Reviewed by: R. Espinoza Date: 03/28/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: _____

# GEOMEMBRANE PUNCTURE RESISTANCE - COVER

## PURPOSE

The purpose of this analysis is to evaluate the puncture resistance of a 40-mil geomembrane. A 40-mil geomembrane material will be used as a cover component and will be in contact with subgrade soils and intermediate cover soils below the cap system. In order for the geomembrane to work efficiently as a barrier layer, puncturing of the geomembrane should be minimized. Also presented in this calculation package is a bearing capacity calculation for failure of the overlying soil due to construction equipment.

## METHOD

Figure 1 shows the cover system details. The puncture resistance will be evaluated for construction equipment working above the 40 mil geomembrane.

### Geomembrane Allowable Pressures

The allowable vertical stresses on geomembranes are based on typical manufacturer puncture resistance [Geosynthetics Research Institute, 1999] and modified by factors presented by Narejo et at. [1996]. Modification factors are applied in the following manner to compute the allowable pressure on the geomembrane.

$$P_{allow} = \frac{P_{lab}}{MF_s \times MF_{pd} \times MF_a \times FS_{cr} \times FS_{cbd}}$$

Where:

| | | |
|---|---|---|
| $P_{allow}$ | = | Allowable vertical stress on geomembrane |
| $P_{lab}$ | = | Ultimate vertical stress from controlled laboratory tests |
| $MF_s$ | = | Modification factor for protrusions |
| $MF_{pd}$ | = | Modification factor for packing density |
| $MF_a$ | = | Modification factor for arching |
| $FS_{cr}$ | = | Factor of safety for creep |
| $FS_{cbd}$ | = | Factor of safety against chemical and biological degradation |

Values of the modification factors (MF) and factors of safety (FS) are taken from Tables 1 through 4 at the end of this calculation package. The modification factors are used to modify the laboratory puncture resistance according to how the expected field condition is modeled in the laboratory. Field conditions which are less harmful to the geomembrane than

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laboratory testing conditions are conservatively assumed to have a modification factor of 1. The modification factors used in this calculation are shown in the following table:

| | Cover System 40 mil HDPE Geomembrane | |
|---|---|---|
| | Factor | Comments |
| $MF_s$ | 1 | Intermediate cover assumed angular |
| $MF_{pd}$ | 1 | Protrusions possible (conservative) |
| $MF_a$ | 1 | No arching effects assumed |
| $FS_{cr}$ | 2 | Assume 6 mm protrusions with no geotextile |
| $FS_{cbd}$ | 1.5 | Suggested value from Narejo et al. |

Based on the factors listed in the previous table, the laboratory puncture resistances are modified to represent the allowable pressure used for design.

| | Cover System (40 mil textured HDPE) |
|---|---|
| Puncture resistance(1) (lb.) | 60 |
| Puncture resistance(2) ,$P_{lab}$ (psi) | 4889 |
| Puncture resistance, $P_{allow}$ (psi) | 1413 |

NOTES:
(1) Based on test method ASTM D 4833. (GRI, 1999)
(2) Test probe diameter of 1/8 inch (0.125 in) used to convert puncture resistance from lb. to psi.

## Design Pressures

The total vertical stress on the geomembrane is calculated as the sum of the overlying soil pressure and the pressure exerted by the construction equipment.

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$$p_{act} = (\gamma_{ave} \times T) + q_{eqp}$$

Where:

$p_{act}$ = vertical stress on the geomembrane
$\gamma_{ave}$ = average unit weight of the material above geomembrane
$T$ = thickness of the soil material above geomembrane
$q_{eqp}$ = equipment ground pressure

To evaluate the maximum pressure of a construction vehicle above the geomembrane, two typical dozers are assumed: (i) a CAT D6H, Series II, LGP; and (ii) a CAT D6H, Series II. For this evaluation, a minimum lift thickness of 1 foot of soil will be evaluated as the most conservative case. As the amount of soil above the geomembrane increases the allowable ground pressure of construction traffic increases. The following table lists the required information about the assumed construction equipment and the calculated design pressures.

| Load Type | Contact Area($in^2$) | Ground pressure $q_{eqp}$ (psi) | Design pressure (2) $p_{act}$ (psi) |
|---|---|---|---|
| CAT D6H, Series II(1) | 4564 | 8.56 | 9.32 |
| CAT D6H, Series II, LGP(1) | 9255 | 4.71 | 5.47 |

**NOTES:**
(1) Equipment data taken from Caterpillar Performance Handbook, 23 edition, Oct, 1992
(2) including 1 foot of overlying soil with a unit weight 110 pcf.
(3) Assume waste thickness and unit weight of 210 ft and 70 pcf, respectively.

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## Factor of Safety against Puncture Failure

The factor of safety against puncture resistance for the load above the geomembrane is defined as:

$$FS = \frac{p_{allow}\ (psi)}{p_{act}\ (psi)}$$

Based on the pressures calculated, the factors of safety against puncture resistance for the cap system geomembrane are:

| Load | 40 mil Geomembrane Cap |
|---|---|
| CAT D6H, Series II | >100 |
| CAT D6H, Series II, LGP | >100 |

## Bearing Capacity

A factor of safety against bearing capacity failure of the soils overlying the geomembrane during construction is calculated. The construction equipments are the same as the ones in the previous section. The bearing capacity equation used for analysis is taken from NAV-FAC Design Manual 7.2 [1982] for a continuous strip footing.

$$q_{ult} = \left(\frac{1}{2}\gamma B N_\gamma\right) + \left(\gamma D_f N_q\right)$$

Where:

| | | |
|---|---|---|
| $q_{ult}$ | = | ultimate capacity of the soil |
| B | = | footing width (Standard shoe width) |
| $\gamma$ | = | unit weight of foundation soil |
| $D_f$ | = | depth of the footing |
| $N_\gamma$, $N_q$ | = | bearing capacity factors |

The construction equipment will work on the surface of the soil. Therefore, the footing depth in the second term of the bearing capacity equation will go to zero leaving only the first term. The bearing capacity factor, Nγ, is taken from the chart in Figure 2.

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$q_{ult}$ = 0.5(110 pcf) (22 in./12 in.) (18) (1 ft$^2$ / 144 in$^2$) = 20.6 (CAT D6H LGP, Seirs II)

$q_{ult}$ = 0.5(110 pcf) (36 in./12 in.) (18) (1 ft$^2$ / 144 in$^2$) = 12.6 (CAT D6H, Seirs II)

The factor of safety for bearing capacity of the soil is calculated as the ratio of the ultimate bearing capacity, $q_{ult}$, to the applied ground pressure, $q_{eqp}$, of the construction equipment. The following table summarizes the ultimate bearing capacity of the ground and the calculated factor of safety against bearing capacity failure.

| Equipment | Standard Shoe Width, B (inches) | $n_\gamma$ (From Figure 2) | $q_{ult}$ (1) (psi) | Ground Pressure, $q_{eqp}$, (psi) | Factor of safety, ($q_{ult}/q_{eqp}$) |
|---|---|---|---|---|---|
| CAT D6H, Series II, | 22 | 18 | 12.6 | 8.56 | 1.5 |
| CAT D6H, Series II, LGP | 36 | 18 | 20.6 | 4.71 | 4.4 |

NOTES:
(1) Soil unit weight assumed to be 110 pcf..

## RESULTS

Based on the analysis presented here, the Caterpillar D6H Series II LGP and D6H Series II operating with a minimum of one foot of cover soil will not compromise the geomembrane puncture resistance or cause a bearing capacity failure of the overlying soil. Other vehicles with equal or lower ground pressures may also operate safely.

Written by: C. Pendleton Date: 03/28/03 Reviewed by: R. Espinoza Date: 03/28/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: _____

## REFERENCES

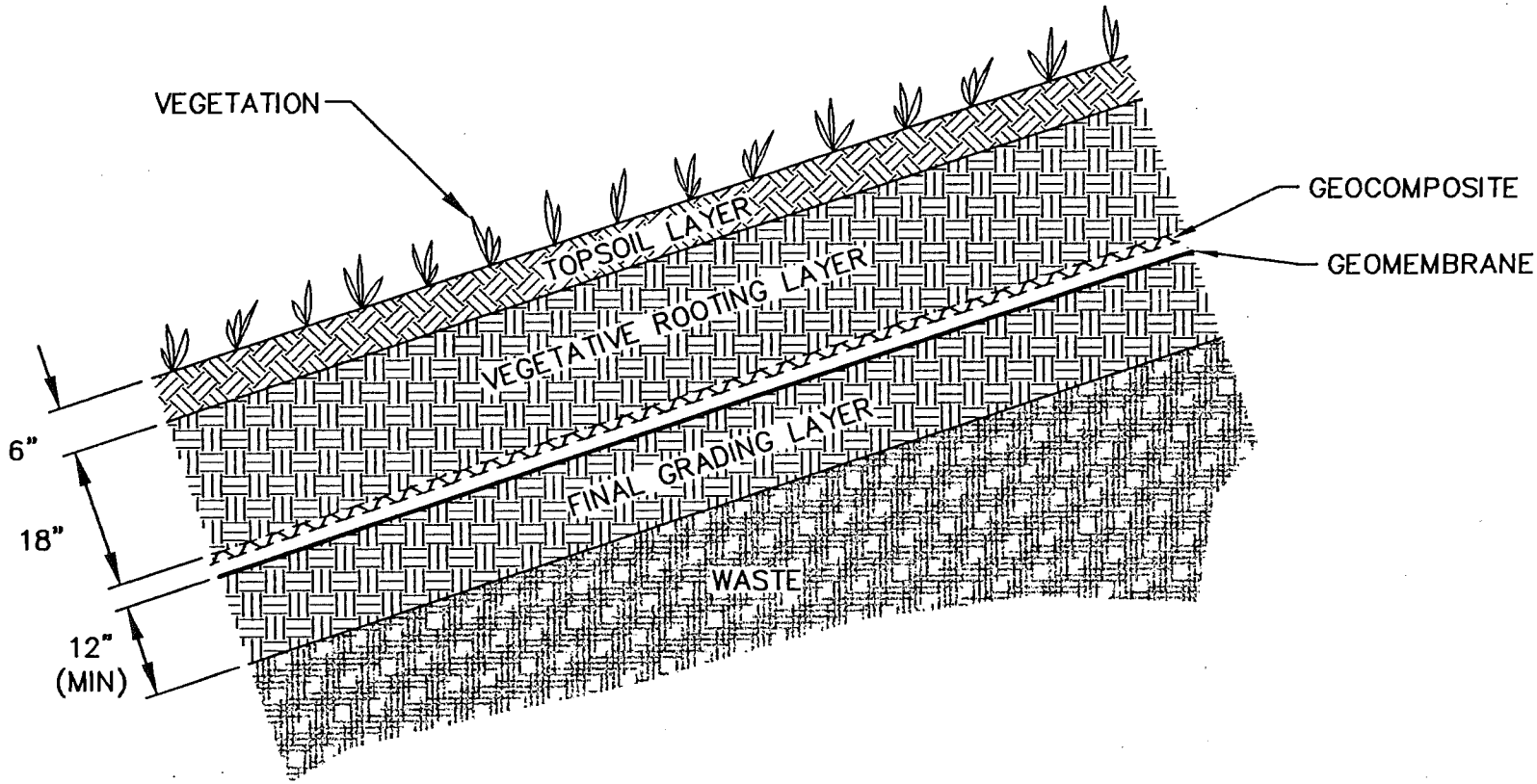
Caterpillar Performance Handbook, 23 edition, Oct. 1992.

*"Foundations and Earth Structures Design Manual 7.2"*, Department of the Navy, Naval Facilities Engineering Command, Alexandria, Virginia, May 1982.

Geosynthetics Research Institute, GM13, 1999.

Narejo, D RM. Koerner and RF Wilson-Fahmy,"Puncture Protection of Geomembranes, Part II; Experimental", Geosynthetics International, Vol 3 No. 5 1996.

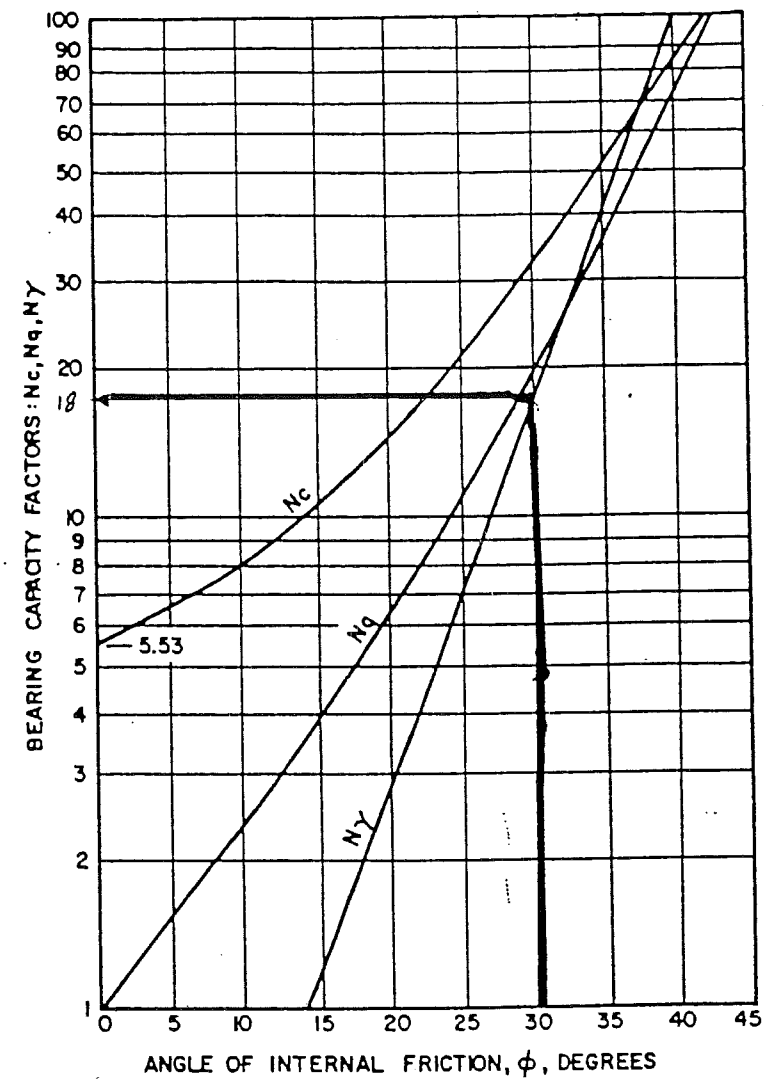
# PRESCRIPTIVE COVER DETAIL




GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

| | |
|---|---|
| FIGURE NO. | 1 |
| PROJECT NO. | ME0250 |
| DOCUMENT NO. | |
| FILE NO. | 0250F701 |

7 of 10 pts

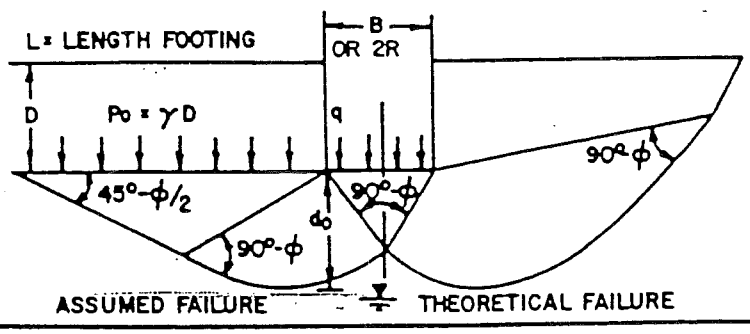



ULTIMATE BEARING CAPACITY = $q_{ult}$

FOR COHESIONLESS FOUNDATION SOILS (c = 0)

CONTINUOUS FOOTING:

$$q_{ult} = \gamma D N_q + \frac{\gamma B}{2} N_\gamma$$




ASSUMED CONDITIONS:

1. $D \leq B$
2. SOIL IS UNIFORM TO DEPTH $d_o > B$.
3. WATER LEVEL LOWER THAN $d_o$ BELOW BASE OF FOOTING.
4. VERTICAL LOAD CONCENTRIC.
5. FRACTION AND ADHESION ON VERTICAL SIDES OF FOOTING ARE NEGLECTED.
6. FOUNDATION SOIL WITH PROPERTIES $C, \phi, \gamma$

Figure 2

FIGURE 2

Ultimate Bearing Capacity of Shallow Footings With Concentric Loads



AFTER NAVFAC DM 7.2, 1982

9 of 10
DTM

Table 1 Modification factor for protrusion shape.

| Stone shape | Modification factor, $MF_S$ |
|---|---|
| Angular | 1.00 |
| Subrounded | 0.50 |
| Rounded | 0.25 |

Table 2 Modification factors for packing density.

| Protrusion arrangement | Modification factor, $MF_{PD}$ |
|---|---|
| Isolated protrusions | 1.00 |
| Packed stones | 0.50 |

Table 3 Modification factors for soil arching.

| Soil arching effect | Modification factor, $MF_A$ |
|---|---|
| None | 1.00 |
| Moderate | 0.75 |
| Maximum | 0.50 |

Table 4 Partial factors of safety for creep.

| Geotextile mass per unit area ($g/m^2$) | Partial factors of safety for creep | | | |
|---|---|---|---|---|
| | Protrusion height (mm) | | | |
| | 38 | 25 | 12 | 6 |
| No geotextile | N/R | N/R | N/R | >>1.5 |
| 270 | N/R | N/R | >1.5 | 1.5 |
| 550 | N/R | 1.5 | 1.3 | 1.2 |
| 1100 | 1.3 | 1.2 | 1.1 | 1.0 |
| >1100 | ~1.2 | ~1.1 | ~1.0 | 1.0 |

Note: N/R = not recommended.

SOURCE Narejo, et al. 1996

ENGLISH UNITS

# Table 2(a) - High Density Polyethylene (HDPE) Geomembrane - Textured

| Property | Test Method | Test Value | | | | | | | Testing Frequency (minimum) |
|---|---|---|---|---|---|---|---|---|---|
| | | 30 mils | 40 mils | 50 mils | 60 mils | 80 mils | 100 mils | 120 mils | |
| hickness (min. ave.)<br>· lowest individual for 8 out of 10 values<br>· lowest individual for any of the 10 values | D 5994 | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | per roll |
| sperity Height (min. ave.) *(1)* | GM 12 | 10 mil | 10 mil | 10 mil | 10 mil | 10 mil | 10 mil | 10 mil | every 2nd roll *(2)* |
| ensity (min. ave.) | D 1505/D792 | 0.940 g/cc | 0.940 g/cc | 0.940 g/cc | 0.940 g/cc | 0.940 g/cc | 0.940 g/cc | 0.940 g/cc | 200,000 lb |
| ensile Properties (min. ave.) *(3)*<br>· yield stress<br>· break stress<br>· yield elongation<br>· break elongation | D 638<br>Type IV | 63 lb/in.<br>45 lb/in.<br>12%<br>100% | 84 lb/in.<br>60 lb/in.<br>12%<br>100% | 105 lb/in.<br>75 lb/in.<br>12%<br>100% | 126 lb/in.<br>90 lb/in.<br>12%<br>100% | 168 lb/in.<br>120 lb/in.<br>12%<br>100% | 210 lb/in.<br>150 lb/in.<br>12%<br>100% | 252 lb/in.<br>180 lb/in.<br>12%<br>100% | 20,000 lb |
| ear Resistance (min. ave.) | D 1004 | 21 lb | 28 lb | 35 lb | 42 lb | 56 lb | 70 lb | 84 lb | 45,000 lb |
| uncture Resistance (min. ave.) | D 4833 | 45 lb | 60 lb | 75 lb | 90 lb | 120 lb | 150 lb | 180 lb | 45,000 lb |
| tress Crack Resistance *(4)* | D 5397<br>(App.) | 200 hr. | 200 hr. | 200 hr. | 200 hr. | 200 hr. | 200 hr. | 200 hr. | per GRI-GM 10 |
| arbon Black Content (range) | D 1603 *(5)* | 2.0 - 3.0% | 2.0 - 3.0% | 2.0 - 3.0% | 2.0 - 3.0% | 2.0 - 3.0% | 2.0 - 3.0% | 2.0 - 3.0% | 20,000 lb |
| arbon Black Dispersion | D 5596 | note *(6)* | note *(6)* | note *(6)* | note *(6)* | note *(6)* | note *(6)* | note *(6)* | 45,000 lb |
| xidative Induction Time (OIT) (min. ave.) *(7)*<br>a) Standard OIT<br>— or —<br>b) High Pressure OIT | D 3895<br><br>D 5885 | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 100 min.<br><br>400 min. | 200,000 lb |
| Oven Aging at 85°C *(7), (8)*<br>a) Standard OIT (min. ave.) - % retained after 90 days<br>— or —<br>b) High Pressure OIT (min. ave.) - % retained after 90 days | D 5721<br>D 3895<br><br>D 5885 | 55%<br><br>80% | 55%<br><br>80% | 55%<br><br>80% | 55%<br><br>80% | 55%<br><br>80% | 55%<br><br>80% | 55%<br><br>80% | per each formulation |
| UV Resistance *(9)*<br>a) Standard OIT<br>— or —<br>b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)* | GM11<br>D 3895<br><br>D 5885 | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | N.R. *(10)*<br><br>50% | per each formulation |

*(1)* Of 10 readings; 8 out of 10 must be ≥ 7 mil, and lowest individual reading must be ≥ 5 mil

*(2)* Alternate the measurement side for double sided textured sheet

*(3)* Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

*(4)* The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

*(5)* Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.

*(6)* Carbon black dispersion for 10 different views:
· all 10 in Categories 1 or 2

*(7)* The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

*(8)* It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

*(9)* The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

*(10)* Not recommended : since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

*(11)* UV resistance is based on percent retained value regardless of the original HP-OIT value.

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# Appendix VIb-K.2

# Geocomposite Drainage Layer Evaluation

# GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

**Client:** DSWA **Project:** Cherry Island **Project/Proposal #:** ME0250 **Task #:** ____

**TITLE OF COMPUTATIONS** GEOCOMPOSITE DRAINAGE LAYER EVALUATION

COMPUTATIONS BY:
Signature Douglas T. Mandeville — DATE 3/26/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature — DATE 3/26/03
Printed Name and Title: R. David Espinoza, Senior Engineer

COMPUTATIONS CHECKED BY:
Signature Carrie H. Pendleton — DATE 03/27/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Douglas T. Mandeville — DATE 3/28/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

APPROVED BY:
(PM or Designate)
Signature — DATE 3/30/03
Printed Name and Title: R. David Espinoza, Senior Engineer

APPROVAL NOTES: ____

REVISIONS (Number and initial all revisions)

| NO. | SHEET | DATE | BY | CHECKED BY | APPROVAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Written by: Doug Mandeville Date: 03/26/03 Reviewed by: C. Pendleton Date: 03/27/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 2.2.7

# GEOCOMPOSITE DRAINAGE LAYER EVALUATION FOR FINAL COVER SYSTEM

## PURPOSE

The purpose of this calculation package is to present and verify the adequacy of the design of the geocomposite drainage layer and geomembrane cap to be used in the final cover system for the Cherry Island Landfill (CIL) in Wilmington, Delaware. A cross section of the prescriptive final cover system required by the Delaware Regulations Governing Solid Waste (DRGSW) is shown in Figure 1; it should be noted that the cover system proposed at CIL will include a geocomposite drainage layer on top of a geomembrane cap. The geocomposite consists of two components:

- a geonet drainage layer; and
- non-woven geotextile fabric heat bonded to both sides of the geonet.

The purpose of the geotextile is to allow for free flow of percolated water from the overlying cover soil into the geonet and to prevent the migration of particles of the vegetative rooting layer into the geonet.

The purpose of the geonet is to convey the water infiltrating from the vegetative rooting layer to the cover system drainage terraces and perimeter channels to prevent seepage forces and buoyancy effects from reducing the slope stability of the cover soil. The flow capacity of the geocomposite is considered to be adequate if the hydraulic head on the geomembrane cap is less than the thickness of the geocomposite.

The purpose of the geomembrane cap is to act as an infiltration barrier for the water. A small portion of the water which flows through the cover soil and into the geocomposite will penetrate the underlying geomembrane layer. The amount of water which leaks through the geomembrane as compared to the total precipitation on the liner can be used to calculate the hydraulic efficiency of the cap system.

## GEOTEXTILE COMPONENT

Assume that a typical needlepunched non-woven geotextile will be heat-bonded to both sides of the geonet. The underlying geotextile aids in maintaining slope stability of the final cover system because of the relatively high interface friction between the textured geomembrane and the geotextile.

The overlying geotextile should be designed such that the hydraulic conductivity, apparent opening size, and mechanical properties are compatible with the vegetative rooting layer.

Based on GeoSyntec's project experience and guidelines presented by FHWA [1990], the following design criteria must be satisfied:

1. the geotextile must retain particles of the vegetative rooting layer;
2. the geotextile must be permeable enough to allow free flow of any water that infiltrates through the vegetative rooting layer;
3. the geotextile must not clog during the design life of the facility; and
4. the geotextile must have sufficient mechanical properties for survivability and durability during the post-closure period.

**Required Properties**

Retention Criterion

Based on GeoSyntec project experience, the apparent opening size of the geotextile ($O_{95}$) should meet the following design criteria:

$$O_{95}/d_{85} < 2 \qquad \text{and} \qquad O_{95}/d_{15} > 2$$

where $d_{85}$ and $d_{15}$ are the particle sizes for the vegetative subsoil for which 85 and 15 percent, respectively, of the particles are finer by weight and $O_{95}$ is the apparent opening size (AOS). According to the manufacturer's information, a typical 7 to 8 oz/yd$^2$ (240 to 270 g/m$^2$) geotextile has an apparent opening size ($O_{95}$) of 0.18 to 0.21 mm. Therefore, for this type of geotextile, the vegetative rooting layer should meet the following grain size distribution requirements:

$d_{85}$ > 0.09 to 0.105 mm (170 to 140 U.S. Std. Sieve); and

$d_{15}$ < 0.09 to 0.105 mm (170 to 140 U.S. Std. Sieve).

Hydraulic Conductivity Criterion

It is recommended that the minimum hydraulic conductivity of the geotextile be greater than or equal to ten times the maximum hydraulic conductivity for the overlying soil (i.e., vegetative rooting layer) [FHWA, 1990].

$$k_{geotextile\text{-}min} > 10\ k_{vegetative\ rooting\ layer}$$

If it is conservatively assumed that the maximum hydraulic conductivity of the vegetative rooting layer material is $1 \times 10^{-3}$ cm/s, then the minimum hydraulic conductivity of the geotextile must be greater than or equal to $1 \times 10^{-2}$ cm/s. Therefore, to have a minimum k of $1 \times 10^{-2}$ cm/s, the minimum required permittivity for a typical 8-oz/yd$^2$ (270 g/m$^2$) geotextile (typically 95-mil (2.4-mm) thick) is 0.04 sec$^{-1}$. Manufacturer's literature indicates that this permittivity can be met by most needlepunched non-woven geotextiles.

Clogging Criterion

The minimum porosity ($\eta_g$) recommended for the geotextile is $\eta_g > 30\%$. This property value can be met by most non-woven geotextiles.

Mechanical Properties

The geotextile component of the geocomposite drainage layer must satisfy the following:

| Property | Test Method | Specification |
|---|---|---|
| Grab strength | ASTM D 4632 | min. 180 lb |
| Tear strength | ASTM D 4533 | min. 75 lb |
| Puncture strength | ASTM D 4833 | min. 75 lb |

## GEONET COMPONENT

The hydraulic transmissivity of the geonet should be high enough so that the hydraulic head on the geomembrane cap (and within the geocomposite) is less than the thickness of the geocomposite. The purpose of the following calculations is to evaluate the hydraulic head on the geomembrane. Assume that the geocomposite consists of a 0.2 inch (5-mm) thick geonet. First, the transmissivity of the geocomposite will be estimated given the components of the proposed final cover system cross-section

and the final cover system geometry. Second, the average head on the geomembrane will be calculated using the USEPA Hydrologic Evaluation of Landfill Performance (HELP) model. The HELP model is capable of estimating the volume of infiltration into the final cover system as a function of precipitation and climate, landfill cover system geometry, and soil properties.

A cross-section of the final cover system is presented in Figure 1.

**Transmissivity**

The transmissivity of the geocomposite varies depending on the normal stresses applied to the geocomposite and the hydraulic gradient. The maximum normal stress for the final cover system (assuming that the unit weight of the vegetative cover soil is 125 $lb/ft^3$) is:

Normal Stress = 125 $lb/ft^3$ x 2 ft = 250 $lb/ft^2$

Based on available literature provided as Figure 2, for a 0.25 inch (6.3-mm) thick geonet surrounded by 14-$oz/yd^2$ (540 $g/m^2$) non-woven geotextile at a normal stress of 250 $lb/ft^2$ (12 kPa) with clay above the geocomposite and an HDPE membrane below, the transmissivity at a hydraulic gradient (i) equal to 0.031 is $8.3 \times 10^{-5}$ $m^2/s$.

Assume $i = 0.031$ and $\theta = 8.3 \times 10^{-5}$ $m^2/s$.

Hydraulic conductivity, $k = \theta/t = (8.3 \times 10^{-5}\ m^2/s) / 0.0063\ m = 0.0132\ m/s = 1.32\ cm/s$

**Calculate Average Head on Geomembrane**

The HELP model will be used to estimate the average head on the geomembrane cap for a 30 year simulation. The following design parameters will be used in the HELP model.

| HELP Model Input and Output | Comments |
|---|---|
| Climate | Wilmington, Delaware (precipitation, temperature, and weather) Wilmington, Delaware (evapotranspiration) |
| SCS Curve Number | Compute based on 2 percent slope with a length of 500 feet and fair ground cover |
| Vegetative Rooting Layer | 18-in. thick vertical percolation layer, Material Texture Number 23, $k_{sat} = 1.0X10^{-4}$ cm/s) |
| Geocomposite Drainage Layer | 0.2-in. thick drainage net, lateral percolation layer, $k_{sat} = 1.32$ cm/s, Slope = 5%, Length = 500 ft |
| Average Annual Head on Geomembrane (inches) | Slope length 500 ft; 1.11 in |

Although the head above the geomembrane component of the final cover system is greater than the thickness of the geocomposite, the expected height of 1.11 in. is not anticipated to interfere with the performance of the landfill cover system as a whole. The HELP output files are included as Attachment A to this calculation package.

## HYDRAULIC EFFICIENCY OF FINAL COVER SYSTEM

The efficiency of the cover geomembrane is evaluated by comparing the precipitation that falls on the landfill to the calculated infiltration through the final cover system. The following equation is used:

$$\varepsilon = \frac{P_y - I}{P_y} \times 100\%$$

where:

$\varepsilon =$ cover system efficiency (percent);

$P_y =$ average annual total precipitation (in.); and

I = average annual total infiltration (in.).

Infiltration through the geomembrane is estimated by the equation provided by Giroud et al. (1989) for the leakage rate through a composite liner:

$$Q = 0.21 \cdot a^{0.1} \cdot h^{0.9} \cdot k_s^{0.74}$$

where:

Q = leakage rate per hole ($m^3/s$)
a = area of the defect ($m^2$)
h = hydraulic head on the geomembrane (m)
$k_s$ = hydraulic conductivity of the underlying soil

The following assumptions are made in using this equation.

- The geomembrane is in good contact with the underlying soil.
- The size of the defect in the geomembrane is 2 mm in diameter, or $3 \times 10^{-6}\ m^2$ in area (Giroud and Bonaparte, 1989).
- The frequency of defects is 2 per acre.
- Hydraulic conductivity of the underlying soil is $k = 5.0 \times 10^{-3}$ cm/s or $5.0 \times 10^{-5}$ m/s, based on typical values of compacted silty sand, and the value used in HELP model analysis of the cover system.

The values of annual precipitation at CIL are taken from the HELP model calculations presented in Attachment A. Therefore, based on the HELP output, the average annual precipitation ($p_y$) is approximately 40.7 inches. The average daily head on the liner, also taken from the HELP output, is estimated to be 1.15 in.

Calculation of the leakage through the final cover system is:

Written by: Doug Mandeville Date: 03/26/03 Reviewed by: C. Pendleton Date: 03/27/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 2.2.7

$$Q = 0.21(3x10^{-6}\,m^2)^{0.1}(0.028m)^{0.9}(5x10^{-5}\,m/s)^{0.74}$$

$$Q = 1.54x10^{-6}\,m^3/s\ per\,hole$$

The amount of flow through the geomembrane, (Q) must be converted from cubic meters per hole into an infiltration rate (I) in acre-inches per year.

$$Q = 1.54x10^{-6}\frac{m^3}{s-hole}\times\frac{3600s}{hr}\times\frac{24hr}{day}\times\frac{1ft^3}{(0.3048)^3\,m^3}\times\frac{7.48gal}{ft^3}\times\frac{2holes}{acre}$$

$$Q = 70.3\,gallons/acre/day(gpad)$$

$$I = 70.3\,gpad\times\frac{ft^3}{7.48gal}\times\frac{acre}{43{,}560\,ft^2}\times\frac{365day}{year}\times\frac{12in.}{ft}$$

$$I = 0.945\,ac-in/year$$

The hydraulic efficiency of the geomembrane is:

$$\varepsilon = \frac{40.7\frac{in.}{year} - 0.945\frac{in.}{year}}{40.7\frac{in}{year}}\times 100\% = 97.68\%$$

Based on the results presented above, the hydraulic efficiency of the proposed final cover system at CIL is adequate.

Written by: Doug Mandeville Date: 03/26/03 Reviewed by: C. Pendleton Date: 03/27/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 2.2.7

## REFERENCES

FHWA (by STS Consultants, Ltd., and GeoServices, Inc.), *Geotextile Design and Construction Guidelines*, Washington, D.C., Apr 1990.

Giroud, J.P. and Bonaparte, R., "Leakage Through Liners Constructed with Geomembranes; Part I: Geomembrane Liners", Geotextiles and Geomembranes, Vol 8, No. 1, 1989, pp. 27-67.

Giroud, J.P., Khatami, A. And Badu-Tweneboan, K., "Evaluation of the Rate of Leakage Through Composite Liners", Geotextiles and Geomembranes, Vol. 8, No. 4, 1989, pp. 337-340.

Koerner, R.M., "Designing with Geosynthetics", Prentice Hall, 1998.

United States Environmental Protection Agency, "Hydrologic Evaluation of Landfill Performance", Version 3.03, Sept 1994.

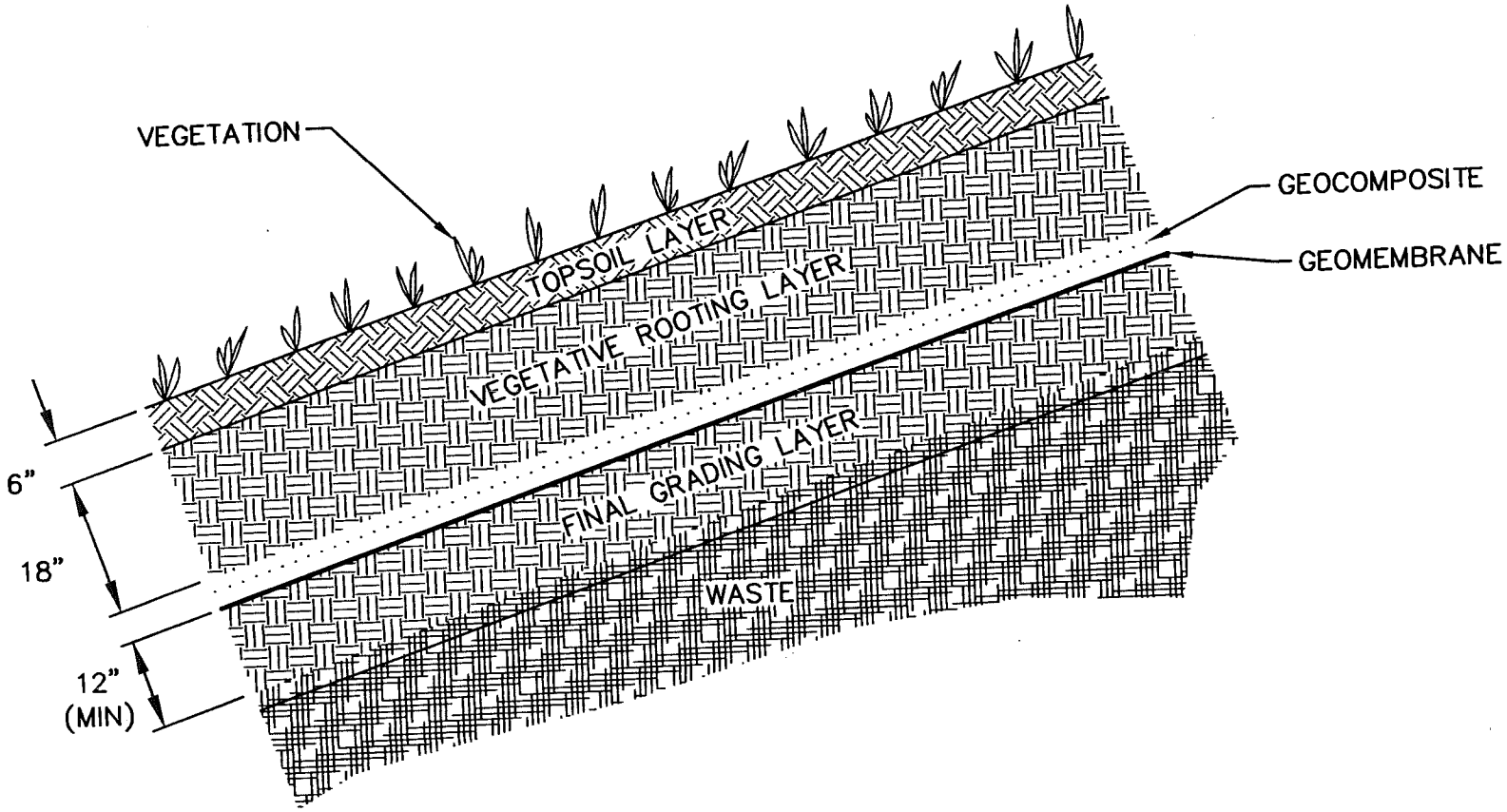


Figure 1

1B
—

DETAIL
COVER ALTERNATIVE B:
PRESCRIPTIVE DRGSW CAP
SCALE: NONE

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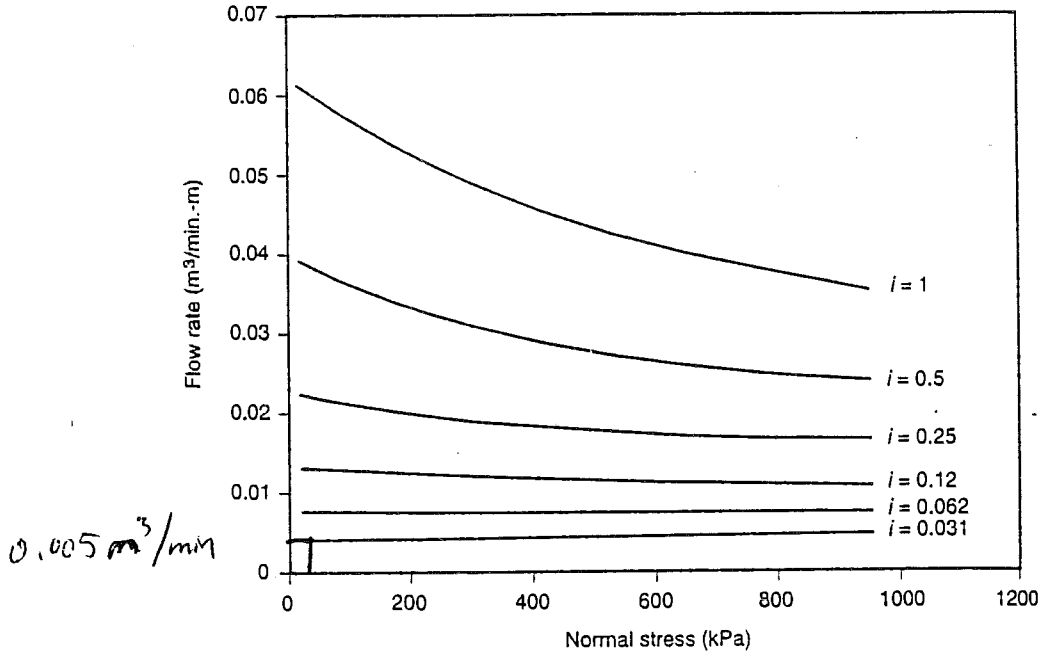
DTM
CKP

Written by: Doug Mandeville Date: 03/03/19 (YY MM DD) Reviewed by: Carrie Pendleton Date: 03/03/27 (YY MM DD)

Client: DSWA Project: Cherry Island Project/Proposal No.: ME0250 Task No.: 2.2.7




Flow-rate behavior of a 6.3 mm thick geonet sandwiched between a 540 g/m² nonwoven needle-punched geotextile with clay above and a 1.5 mm HDPE geomembrane below.

reference: Designing with Geosynthetics, Fourth Edition, Robert M. Koerner, Prentice Hall, 1998

Figure 2

Written by: Doug Mandeville Date: 03/26/03 Reviewed by: C. Pendleton Date: 03/27/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 2.2.7

# ATTACHMENT A

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      P:\PRJ1\MDENG\HELP3\ME0250\CAPPING.D4
TEMPERATURE DATA FILE:        P:\PRJ1\MDENG\HELP3\ME0250\CAPPING.D7
SOLAR RADIATION DATA FILE:    P:\PRJ1\MDENG\HELP3\ME0250\CAPPING.D13
EVAPOTRANSPIRATION DATA:      P:\PRJ1\MDENG\HELP3\ME0250\CAPPING.D11
SOIL AND DESIGN DATA FILE:    P:\PRJ1\MDENG\HELP3\ME0250\CAPDTM.D10
OUTPUT DATA FILE:             P:\PRJ1\MDENG\HELP3\ME0250\capdtm.OUT


TIME:  20:31      DATE:    3/19/2003


******************************************************************************

     TITLE:  CHERRY ISLAND LANDFILL CAPPING REPORT DRGSW PRESCRIPTIVE CAP

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   9
        THICKNESS                    =      6.00   INCHES
        POROSITY                     =      0.5010 VOL/VOL
        FIELD CAPACITY               =      0.2840 VOL/VOL
        WILTING POINT                =      0.1350 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.3453 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.190000006000E-03 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.96
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  23
        THICKNESS                    =     18.00   INCHES
        POROSITY                     =      0.4610 VOL/VOL
        FIELD CAPACITY               =      0.3600 VOL/VOL
        WILTING POINT                =      0.2030 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.4599 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.900000032000E-05 CM/SEC


                                  LAYER  3
                                  --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
                      MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =      0.20   INCHES
        POROSITY                     =      0.8500 VOL/VOL
        FIELD CAPACITY               =      0.0100 VOL/VOL
        WILTING POINT                =      0.0050 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.8500 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =   1.32000005000     CM/SEC
        SLOPE                        =      2.00   PERCENT
        DRAINAGE LENGTH              =    500.0    FEET


                                  LAYER  4
                                  --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                      MATERIAL TEXTURE NUMBER  35
        THICKNESS                    =      0.04   INCHES
        POROSITY                     =      0.0000 VOL/VOL
        FIELD CAPACITY               =      0.0000 VOL/VOL
        WILTING POINT                =      0.0000 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
        FML PINHOLE DENSITY          =     10.00   HOLES/ACRE
        FML INSTALLATION DEFECTS     =     10.00   HOLES/ACRE
        FML PLACEMENT QUALITY        =  4 - POOR


                                  LAYER  5
                                  --------
```

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Dim. CAP

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

| | | | |
|---|---|---|---|
| THICKNESS | = | 12.00 | INCHES |
| POROSITY | = | 0.4370 | VOL/VOL |
| FIELD CAPACITY | = | 0.0620 | VOL/VOL |
| WILTING POINT | = | 0.0240 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1780 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.579999993000E-02 | CM/SEC |

LAYER 6
---

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

| | | | |
|---|---|---|---|
| THICKNESS | = | 1200.00 | INCHES |
| POROSITY | = | 0.6710 | VOL/VOL |
| FIELD CAPACITY | = | 0.2920 | VOL/VOL |
| WILTING POINT | = | 0.0770 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.2925 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000005000E-02 | CM/SEC |

LAYER 7
---

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

| | | | |
|---|---|---|---|
| THICKNESS | = | 12.00 | INCHES |
| POROSITY | = | 0.3970 | VOL/VOL |
| FIELD CAPACITY | = | 0.0320 | VOL/VOL |
| WILTING POINT | = | 0.0130 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0416 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.300000012000 | CM/SEC |
| SLOPE | = | 2.00 | PERCENT |
| DRAINAGE LENGTH | = | 500.0 | FEET |

LAYER 8
---

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

| | | | |
|---|---|---|---|
| THICKNESS | = | 600.00 | INCHES |
| POROSITY | = | 0.4270 | VOL/VOL |
| FIELD CAPACITY | = | 0.4180 | VOL/VOL |
| WILTING POINT | = | 0.3670 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.4270 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000001000E-06 | CM/SEC |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA
---

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 500. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 81.10 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 21.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 8.967 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 9.921 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 3.855 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 620.387 | INCHES |
| TOTAL INITIAL WATER | = | 620.387 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

EVAPOTRANSPIRATION AND WEATHER DATA
---

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM WILMINGTON DELAWARE

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 39.80 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 4.20 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 107 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 298 | |
| EVAPORATIVE ZONE DEPTH | = | 21.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 9.20 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 67.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 67.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 72.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 71.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR WILMINGTON DELAWARE

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 3.11 | 2.99 | 3.87 | 3.39 | 3.23 | 3.51 |
| 3.90 | 4.03 | 3.59 | 2.89 | 3.33 | 3.54 |

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DTM
CHP

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR WILMINGTON DELAWARE

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 31.20 | 33.20 | 41.80 | 52.40 | 62.20 | 71.20 |
| 76.00 | 74.80 | 67.80 | 56.30 | 45.60 | 35.50 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR WILMINGTON DELAWARE
AND STATION LATITUDE = 39.80 DEGREES

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 3.22 | 2.34 | 3.98 | 3.24 | 3.36 | 3.74 |
| | 4.05 | 4.24 | 3.82 | 2.66 | 3.04 | 3.03 |
| STD. DEVIATIONS | 1.79 | 0.97 | 1.40 | 1.29 | 1.55 | 1.72 |
| | 1.83 | 2.28 | 2.24 | 1.38 | 1.45 | 1.97 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.904 | 0.968 | 0.607 | 0.021 | 0.024 | 0.035 |
| | 0.177 | 0.123 | 0.326 | 0.202 | 0.076 | 0.245 |
| STD. DEVIATIONS | 0.944 | 0.755 | 0.998 | 0.066 | 0.058 | 0.068 |
| | 0.562 | 0.266 | 0.694 | 0.471 | 0.163 | 0.701 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.743 | 0.725 | 2.261 | 3.424 | 4.323 | 4.260 |
| | 3.603 | 3.989 | 2.505 | 1.218 | 0.995 | 0.752 |
| STD. DEVIATIONS | 0.281 | 0.428 | 0.482 | 0.694 | 0.782 | 1.371 |
| | 1.283 | 1.750 | 0.923 | 0.211 | 0.210 | 0.172 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 3** | | | | | | |
| TOTALS | 0.8185 | 0.4386 | 1.1256 | 0.7506 | 0.2150 | 0.0593 |
| | 0.0028 | 0.0100 | 0.0757 | 0.3028 | 0.5266 | 0.9777 |
| STD. DEVIATIONS | 0.5959 | 0.4835 | 0.3784 | 0.5418 | 0.3438 | 0.2388 |
| | 0.0094 | 0.0477 | 0.2547 | 0.4433 | 0.5748 | 0.5620 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| TOTALS | 0.5377 | 0.2437 | 0.7976 | 0.2587 | 0.0427 | 0.0258 |
| | 0.0003 | 0.0007 | 0.0557 | 0.1839 | 0.3722 | 0.4561 |
| STD. DEVIATIONS | 0.6757 | 0.4865 | 0.6552 | 0.3245 | 0.1257 | 0.1329 |
| | 0.0009 | 0.0031 | 0.2518 | 0.4098 | 0.7185 | 0.6038 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 7** | | | | | | |
| TOTALS | 0.3789 | 0.3501 | 0.3493 | 0.5169 | 0.2348 | 0.0260 |
| | 0.0116 | 0.0010 | 0.0052 | 0.0482 | 0.1206 | 0.2367 |
| STD. DEVIATIONS | 0.4772 | 0.5638 | 0.3840 | 0.5201 | 0.3640 | 0.0901 |
| | 0.0586 | 0.0024 | 0.0247 | 0.1661 | 0.2533 | 0.3787 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 8** | | | | | | |
| TOTALS | 0.0744 | 0.0726 | 0.0810 | 0.0996 | 0.0950 | 0.0708 |
| | 0.0498 | 0.0360 | 0.0279 | 0.0287 | 0.0409 | 0.0544 |
| STD. DEVIATIONS | 0.0362 | 0.0289 | 0.0212 | 0.0080 | 0.0141 | 0.0203 |
| | 0.0149 | 0.0121 | 0.0077 | 0.0239 | 0.0350 | 0.0400 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

| | | | | | | |
|---|---|---|---|---|---|---|
| **DAILY AVERAGE HEAD ON TOP OF LAYER 4** | | | | | | |
| AVERAGES | 2.4458 | 1.1679 | 3.6109 | 1.0723 | 0.1513 | 0.1093 |
| | 0.0003 | 0.0011 | 0.2618 | 0.8334 | 1.7567 | 1.9718 |
| STD. DEVIATIONS | 3.2749 | 2.5056 | 3.2399 | 1.5064 | 0.5427 | 0.5892 |
| | 0.0010 | 0.0051 | 1.2312 | 1.9542 | 3.5941 | 2.8618 |
| **DAILY AVERAGE HEAD ON TOP OF LAYER 8** | | | | | | |
| AVERAGES | 0.1797 | 0.1818 | 0.1657 | 0.2534 | 0.1114 | 0.0127 |
| | 0.0056 | 0.0006 | 0.0027 | 0.0230 | 0.0592 | 0.1123 |
| STD. DEVIATIONS | 0.2263 | 0.2927 | 0.1821 | 0.2549 | 0.1727 | 0.0442 |
| | 0.0278 | 0.0011 | 0.0121 | 0.0788 | 0.1241 | 0.1796 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 40.71 | ( 5.898) | 147789.4 | 100.00 |
| RUNOFF | 3.708 | ( 1.8876) | 13460.47 | 9.108 |
| EVAPOTRANSPIRATION | 28.800 | ( 3.4463) | 104544.94 | 70.739 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 5.30328 | ( 1.73267) | 19250.918 | 13.02591 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 2.97528 | ( 1.65826) | 10800.267 | 7.30788 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 1.115 | ( 0.669) | | |
| LATERAL DRAINAGE COLLECTED FROM LAYER 7 | 2.27917 | ( 1.52572) | 8273.383 | 5.59809 |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.73092 | ( 0.13980) | 2653.236 | 1.79528 |
| AVERAGE HEAD ON TOP OF LAYER 8 | 0.092 | ( 0.062) | | |
| CHANGE IN WATER STORAGE | -0.108 | ( 1.7775) | -393.55 | -0.266 |

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 5.26 | 19093.801 |
| RUNOFF | 3.068 | 11137.7812 |
| DRAINAGE COLLECTED FROM LAYER 3 | 0.06107 | 221.69582 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.150700 | 547.04187 |
| AVERAGE HEAD ON TOP OF LAYER 4 | 23.792 | |
| MAXIMUM HEAD ON TOP OF LAYER 4 | 32.189 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN) | 161.6 FEET | |
| DRAINAGE COLLECTED FROM LAYER 7 | 0.09878 | 358.57047 |
| PERCOLATION/LEAKAGE THROUGH LAYER 8 | 0.003410 | 12.37741 |
| AVERAGE HEAD ON TOP OF LAYER 8 | 1.453 | |
| MAXIMUM HEAD ON TOP OF LAYER 8 | 2.707 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN) | 34.0 FEET | |
| SNOW WATER | 4.03 | 14622.6279 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4724

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1836

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.5203 | 0.2534 |
| 2 | 6.6860 | 0.3714 |
| 3 | 0.1054 | 0.5268 |
| 4 | 0.0000 | 0.0000 |
| 5 | 1.6317 | 0.1360 |
| 6 | 350.4000 | 0.2920 |
| 7 | 0.5914 | 0.0493 |
| 8 | 256.2000 | 0.4270 |
| SNOW WATER | 0.000 | |

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PTM
CMP

# Appendix VIb-K.3

# Analysis of Final Cover System Settlement

# GEOSYNTEC CONSULTANTS

## COMPUTATION COVER SHEET

**nt:** DSWA **Project:** Cherry Island Landfill **Project/Proposal #:** ME0250 **Task #:** ____

**TITLE OF COMPUTATIONS** ANALYSIS OF FINAL COVER SYSTEM SETTLEMENT

COMPUTATIONS BY:
Signature Carrie H. Pendleton — DATE 03/18/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature [signature] — DATE 3/18/03
Printed Name and Title: R. David Espinoza, Senior Engineer

COMPUTATIONS CHECKED BY:
Signature Douglas T. Mandeville — DATE 3/21/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

COMPUTATIONS BACKCHECKED BY:
ginator)
Signature Carrie H. Pendleton — DATE 03/28/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

APPROVED BY:
(PM or Designate)
Signature [signature] — DATE 3/30/03
Printed Name and Title: R. David Espinoza, Senior Engineer

APPROVAL NOTES:

The calculations presented herein are suitable for a landfill elevation of 195 ft-msl. As shown in this calculation package, the design was performed for a more conservative grading configuration than that shown in Drawing 78 entitled "Landfill Final Development and Grading Plan" (Appendix VIb-A).

REVISIONS (Number and initial all revisions) RDE 6/10/04

| NO. | SHEET | DATE | BY | CHECKED BY | APPROVAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

Written by: C. Pendleton Date: 03/18/03 Reviewed by: R. Espinoza Date: 03/18/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.:

# ANALYSIS OF FINAL COVER SYSTEM SETTLEMENT

## PURPOSE

The purpose of this calculation package is to provide the engineering calculations for settlement of the cover system at Cherry Island Landfill (CIL). The calculations provide an estimate of settlements of the cover system due to primary and secondary compression of the underlying foundation following waste placement and settlement of the waste itself. Based on the calculated settlements, an analysis is made of the maximum differential settlements and the maximum tensile strains expected in the geomembrane component of the alternative final cover system.

## PROCEDURE

The total deformation of the final cover system is a combination of the settlement of the dredge and alluvium layers under the waste and settlement of the waste itself. We can estimate the total settlement (primary and secondary) of the dredge/alluvium layer based on consolidation theory. The following equations are used in the calculation of differential settlement. Primary and secondary settlements are estimated using the following equations:

$$\delta_p = C_{c\varepsilon} H \cdot Log\left(\frac{\sigma'_{vo} + \Delta\sigma'}{\sigma'_{vo}}\right) \tag{1}$$

$$\delta_S = C_{\alpha\varepsilon} H \cdot Log\left(\frac{t_2}{t_1}\right) \tag{2}$$

where:

$C_{c\varepsilon}$ = modified coefficient of consolidation ($ft^2$/year)

$C_{\alpha\varepsilon}$ = modified secondary coefficient of consolidation ($ft^2$/year)

H = thickness of the soil layer (ft)

$\delta_p$ = primary settlement (ft)

$\sigma'_{vo}$ = initial vertical effective stress (psf)

$\Delta\sigma'$ = additional vertical effective stress (psf)

$t_2$ = time for secondary consolidation (years)

$t_1$ = time for primary consolidation (years)

Time for primary consolidation in the dredge/alluvium can be found using the following equation:

$$t = \frac{T \times H_{dr}^2}{C_v} \tag{3}$$

where:

T(U) = time factor as a function of percent consolidation
U = percentage of compression that has occurred at time t
$H_{dr}$ = height of soil layer (ft)
$C_v$ = coefficient of vertical consolidation ($ft^2$/day)
t = time to reach a given percent consolidation

The time for primary consolidation (t) can be estimated by selecting the time factor corresponding to 95 percent of consolidation ($T_{95}$). The percentage of the total settlement of the dredge/alluvium layer that will occur before the cover system is constructed can be estimated using the following set of equations (Holtz and Kovacs, 1981).

$$U(\%) = 100 \times \sqrt{\frac{4T}{\pi}} (for U < 60\%) \tag{4}$$

$$U(\%) = 100 \times \left[1 - \frac{8}{\pi^2} \exp\left(-\frac{\pi^2}{4} T\right)\right] \tag{5}$$

Equations (4) and (5) will be used to estimate the amount of settlement in the dredge/alluvium that will occur during the first 37 years. The remainder of the settlement will occur after the final cover system is constructed, and therefore only this portion of the settlement in the dredge/alluvium will affect its integrity.

The compression settlement of the waste can be calculated using expressions similar to Equations (1) and (2) (Sowers, 1973). Settlement is typically calculated as the sum of primary and secondary compression of the waste,

Total Settlement $\delta_t = \delta_p + \delta_s$

where

$\delta_p$ = primary compression settlement (surcharge dependent)
$\delta_s$ = secondary compression settlement (time dependent).

The primary compression settlement is neglected for this calculation because primary compression settlement occurs within a relatively short period of time, such that at the time of final cover system construction, settlement due to compression of the waste has already taken place, and only secondary compression settlement will take place.

The equation used for secondary compression settlement is the same as Equation (2), where $C_\alpha$ is the modified secondary compression index for waste, H is the initial layer thickness, and $t_1$ is the average age of the waste at the time of construction of the final cover system; and $t_2$ is the average time between waste placement and 100 years after construction of the final cover system

Using the total settlement calculated at each point along a cross section of the landfill, the differential settlement, grade change, and tensile strain between pairs of adjacent points along the geomembrane are calculated by the equations shown below:

*Differential Settlement, $\Delta_s$*

$$\Delta_s = \Delta h_1 - \Delta h_2$$

where $\Delta h_1$ = total settlement at Point 1
$\Delta h_2$ = total settlement at Point 2

*Grade Change:*

Grade change % = $(\Delta_s/L) \times 100$

where L = horizontal distance between points of concern

*Tensile Strain:*

$$\varepsilon = \frac{8}{3}\left[\frac{\Delta_s}{L}\right]^2 100$$ [Giroud, 1977]

## INPUT PARAMETERS

Settlement of the final cover system due to waste settlement is examined along three cross sections, shown in Figure 1. These cross sections lie along leachate collection pipes and are the same sections used in the leachate collection pipe settlement calculation. Calculation of the final cover grade change and differential settlement is performed in 100-ft increments along the cross sections.

Prior to waste placement, the site grades were approximately at elevation 40 feet (above mean sea level (msl)). The estimated maximum elevation of the waste is approximately 290 feet msl. Based on this information, the maximum thickness of waste is approximately 250 feet.

For the estimated thickness of waste at the site, the unit weight of the waste for the settlement analyses is assumed to be 85 pcf (GeoSyntec, 2003). This is a conservative value as it would result in more

The modified secondary compression index ($C_{\alpha\varepsilon}$) for waste for typical municipal landfills is estimated to be 0.01 to 0.03 (Fasset et al., 1994). An average value of 0.02 is used for this calculation.

## RESULTS

Presented in Table 1 are the calculations and results of the waste settlement calculations due to primary and secondary compression. As indicated in the table, the maximum estimated settlement of the cover system is 6.0 feet. The maximum calculated grade change in the final cover system is 0.67 percent. Finally, the maximum calculated strain is 0.012 percent. This value of tensile strain is well below the recommended maximum value of 5 percent for HDPE geomembranes [Berg and Bonaparte, 1993]. Therefore, the calculated tensile strains are not expected to damage the geomembrane.

## REFERENCES

Berg, R.R. and Bonaparte, R., "Long-Term Allowable Tensile Stresses for Polyethylene Geomembranes", *Geotextiles and Geomembranes*, Vol. 12, 1993, pp. 287-306.

Fassett, J.B., Leonards, G.A. and Repetto, P.C., "Geotechnical Properties of Municipal Solid Wastes and their Use Landfill Design", *Wastetech 94, Technical Proceeding* 1994.

GeoSyntec Consultants, "Geotechnical Characterization Report", Volume I, 2003.

Giroud, J.P., "Conception de l'etancheite des ouvrages hydrauliques par geomembranes", *Proceedings of the International R.I.L.E.M. Symposium on Plastic and Rubber Waterproofing in Civil Engineering*, Session 3, Liege, Belgium, June 1977 (French).

Holtz, R.D., and Kovacs, W.D., "An Introduction to Geotechnical Engineering", Prentice Hall, 1981.

Sowers, G.F., "Settlement of Disposal Fills", *Proceedings of the 8th International Conference on Soil Mechanics and Foundation Engineering*, Moscow, 1973, pp. 207-210.

# TABLE 1

| Pipe Segment (#) | 3 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Point No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Future Max. Waste Elevation (ft-msl) (1) | 105 | 135 | 170 | 205 | 235 | 270 | 280 | 282 | 283 |
| Bottom of Waste/Top of Liner Elevation (ft-msl) (2) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Elevation of Top of Columbia (ft-msl) (3) | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 | -29 |
| Elevation of Bottom of Columbia (ft-msl) (3) | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 |
| Elevation of Bottom of Potomac (ft-msl) (4) | -170 | -170 | -170 | -170 | -170 | -170 | -170 | -170 | -170 |
| Water Table Elevation (ft-msl) (5) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Thickness of Waste (ft) | 65 | 95 | 130 | 165 | 195 | 230 | 240 | 242 | 243 |
| Thickness of Dredge (ft) | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 |
| Time Factor at 37 years | 0.7771 | 0.7771 | 0.7771 | 0.7771 | 0.7771 | 0.7771 | 0.7771 | 0.7771 | 0.7771 |
| $U_{37}$ (%) | 88.1% | 88.1% | 88.1% | 88.1% | 88.1% | 88.1% | 88.1% | 88.1% | 88.1% |
| Time for primary, tp (dredge) (6) | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 |
| Time for primary, tp (Potomac Formation) (6) | 27.65 | 27.65 | 27.65 | 27.65 | 27.65 | 27.65 | 27.65 | 27.65 | 27.65 |
| Initial stress in dredge above GW (psf) | 3278 | 3278 | 3278 | 3278 | 3278 | 3278 | 3278 | 3278 | 3278 |
| Initial Stress in dredge below GW (psf) | 3486 | 3486 | 3486 | 3486 | 3486 | 3486 | 3486 | 3486 | 3486 |
| Initial Stress in Potomac (psf) | 8931 | 8931 | 8931 | 8931 | 8931 | 8931 | 8931 | 8931 | 8931 |
| Ds (psf) | 4875 | 7125 | 9750 | 12375 | 14625 | 17250 | 18000 | 18150 | 18225 |
| Primary Settlement (dredge) $d_P$ (ft) | 6.41 | 8.14 | 9.74 | 11.05 | 12.01 | 12.99 | 13.24 | 13.29 | 13.32 |
| Primary Settlement (Potomac Formation) $d_P$ (ft) | 0.35 | 0.47 | 0.59 | 0.69 | 0.78 | 0.86 | 0.88 | 0.89 | 0.89 |
| Secondary Settlement (dredge) $d_S$ (ft) | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 |
| Secondary Settlement (Potomac Formation) $d_S$ (ft) | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Seondary Settlement (Waste) (ft) | 0.61 | 0.89 | 1.21 | 1.54 | 1.82 | 2.14 | 2.24 | 2.25 | 2.26 |
| Total Settlement $d_T$ (ft) | 8.96 | 11.09 | 13.14 | 14.88 | 16.20 | 17.59 | 17.96 | 18.04 | 18.07 |
| Settlement after 37 years | 3.0 | 3.5 | 4.0 | 4.5 | 4.9 | 5.3 | 5.4 | 5.4 | 5.5 |
| Length of Segment (ft) | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Differential Settlement (ft) | | 0.49 | 0.52 | 0.48 | 0.39 | 0.44 | 0.12 | 0.02 | 0.01 |
| Grade Change (%) | | 0.49% | 0.52% | 0.48% | 0.39% | 0.44% | 0.12% | 0.02% | 0.01% |
| Tensile Strain | | 0.006% | 0.007% | 0.006% | 0.004% | 0.005% | 0.000% | 0.000% | 0.000% |

1) Future maximum waste elevation from Landfill Final Development and Grading Plan - Sheet 70 of 80 in Construction Drawings for Landfill Expansion.
2) Bottom of liner elevation from Figures 4-11, 4-12, 4-14, and 4-15 of "Geotechnical and Hydrogeological Report" prepared by GeoSyntec Consultants, September 2002.
3) Elevation of top and bottom of Columbia Formation from Figures 4-2 to 4-7 of "Geotechnical and Hydrogeological Report" prepared by GeoSyntec Consultants, September 2002.
4) Elevation of bottom of Potomac Formation from Figures 2-3, 2-5, and 2-6 of "Site Suitability Report, Hydrogeological and Geotechnical Evaluation of the Cherry Island Site" prepared by Terraqua Resources and Duffield Associates, 1994.
5) Water table elevation taken as the 100-year floodplain from General Site Plan - Sheet 3 of 80 in Construction Drawings for Landfill Expansion.
6) $t_p$ of the dredge and Potomac Formation assumes double drainage.

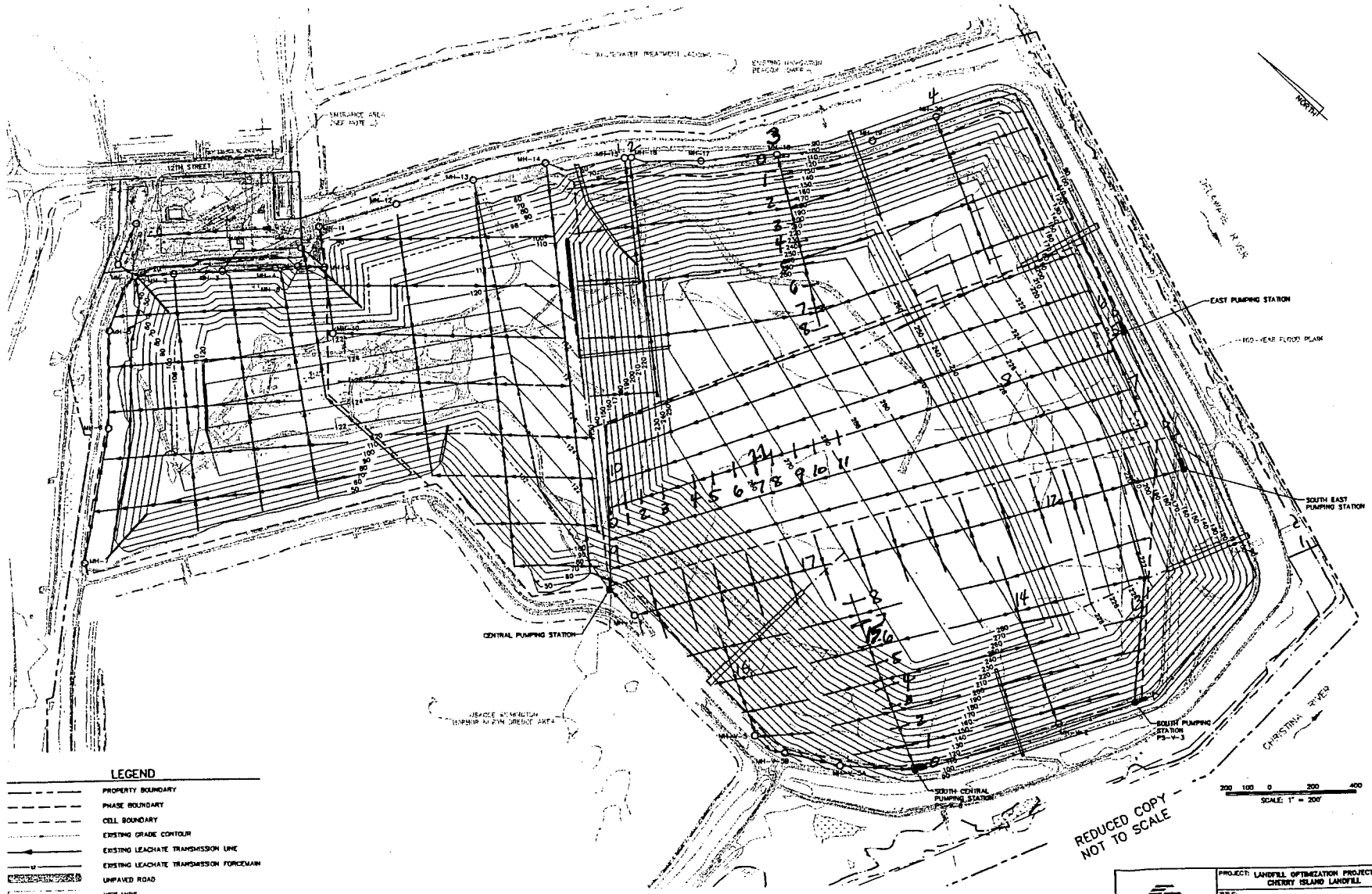
# TABLE 1

| Pipe Segment (#) | 11 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Point No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Future Max. Waste Elevation (ft-msl) (1) | 135 | 170 | 195 | 215 | 245 | 253 | 258 | 263 | 268 | 273 | 278 | 283 |
| Bottom of Waste/Top of Liner Elevation (ft-msl) (2) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Elevation of Top of Columbia (ft-msl) (3) | -22 | -22 | -22 | -22 | -22 | -22 | -22 | -22 | -22 | -22 | -22 | -22 |
| Elevation of Bottom of Columbia (ft-msl) (3) | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 |
| Elevation of Bottom of Potomac (ft-msl) (4) | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 |
| Water Table Elevation (ft-msl) (5) | 10 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Thickness of Waste (ft) | 95 | 130 | 155 | 175 | 205 | 213 | 218 | 223 | 228 | 233 | 238 | 243 |
| Thickness of Dredge (ft) | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 |
| Time Factor at 37 years | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 | 0.9625 |
| $U_{37}$ (%) | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% | 92.5% |
| Time for primary, tp (dredge) (6) | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 | 35.36 |
| Time for primary, tp (Potomac Formation) (6) | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 |
| Initial stress in dredge above GW (psf) | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 | 2945 |
| Initial Stress in dredge below GW (psf) | 3372 | 3372 | 3293 | 3214 | 3136 | 3057 | 2978 | 2899 | 2821 | 2742 | 2663 | 2585 |
| Initial Stress in Potomac (psf) | 9682 | 9682 | 9620 | 9557 | 9495 | 9432 | 9370 | 9308 | 9245 | 9183 | 9120 | 9058 |
| Ds (psf) | 7125 | 9750 | 11625 | 13125 | 15375 | 15975 | 16350 | 16725 | 17100 | 17475 | 17850 | 18225 |
| Primary Settlement (dredge) $d_P$ (ft) | 7.63 | 9.10 | 10.03 | 10.71 | 11.62 | 11.90 | 12.11 | 12.32 | 12.54 | 12.77 | 13.00 | 13.24 |
| Primary Settlement (Potomac Formation) $d_P$ (ft) | 0.52 | 0.65 | 0.74 | 0.81 | 0.90 | 0.93 | 0.95 | 0.96 | 0.98 | 1.00 | 1.02 | 1.03 |
| Secondary Settlement (dredge) $d_S$ (ft) | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 |
| Secondary Settlement (Potomac Formation) $d_S$ (ft) | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| Seondary Settlement (Waste) (ft) | 0.89 | 1.21 | 1.44 | 1.63 | 1.91 | 1.98 | 2.03 | 2.08 | 2.12 | 2.17 | 2.22 | 2.26 |
| Total Settlement $d_T$ (ft) | 10.79 | 12.72 | 13.97 | 14.91 | 16.19 | 16.57 | 16.84 | 17.12 | 17.40 | 17.69 | 17.99 | 18.30 |
| Settlement after 37 years | 3.2 | 3.7 | 4.0 | 4.2 | 4.5 | 4.6 | 4.7 | 4.8 | 4.8 | 4.9 | 5.0 | 5.0 |
| Length of Segment (ft) | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Differential Settlement (ft) | | 0.44 | 0.30 | 0.24 | 0.35 | 0.10 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Grade Change (%) | | 0.44% | 0.30% | 0.24% | 0.35% | 0.10% | 0.06% | 0.06% | 0.06% | 0.06% | 0.06% | 0.06% |
| Tensile Strain | | 0.005% | 0.002% | 0.002% | 0.003% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% |

# TABLE 1

| Pipe Segment (#) | 15 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Point No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Future Max. Waste Elevation (ft-msl) (1) | 115 | 145 | 170 | 195 | 215 | 240 | 260 | 264 | 265 |
| Bottom of Waste/Top of Liner Elevation (ft-msl) (2) | 46 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Elevation of Top of Columbia (ft-msl) (3) | -39 | -39 | -39 | -39 | -39 | -39 | -39 | -39 | -39 |
| Elevation of Bottom of Columbia (ft-msl) (3) | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 | -55 |
| Elevation of Bottom of Potomac (ft-msl) (4) | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 | -190 |
| Water Table Elevation (ft-msl) (5) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Thickness of Waste (ft) | 69 | 105 | 130 | 155 | 175 | 200 | 220 | 224 | 225 |
| Thickness of Dredge (ft) | 85 | 79 | 79 | 79 | 79 | 79 | 79 | 79 | 79 |
| Time Factor at 37 years | 0.5121 | 0.5929 | 0.5929 | 0.5929 | 0.5929 | 0.5929 | 0.5929 | 0.5929 | 0.5929 |
| $U_{37}$ (%) | 77.1% | 81.2% | 81.2% | 81.2% | 81.2% | 81.2% | 81.2% | 81.2% | 81.2% |
| Time for primary, tp (dredge) (6) | 66.47 | 57.42 | 57.42 | 57.42 | 57.42 | 57.42 | 57.42 | 57.42 | 57.42 |
| Time for primary, tp (Potomac Formation) (6) | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 | 38.11 |
| Initial stress in dredge above GW (psf) | 4038 | 3753 | 3753 | 3753 | 3753 | 3753 | 3753 | 3753 | 3753 |
| Initial Stress in dredge below GW (psf) | 4219 | 3649 | 3649 | 3649 | 3649 | 3649 | 3649 | 3649 | 3649 |
| Initial Stress in Potomac (psf) | 9827 | 9257 | 9257 | 9257 | 9257 | 9257 | 9257 | 9257 | 9257 |
| Ds (psf) | 5175 | 7875 | 9750 | 11625 | 13125 | 15000 | 16500 | 16800 | 16875 |
| Primary Settlement (dredge) $d_P$ (ft) | 7.18 | 9.41 | 10.65 | 11.72 | 12.49 | 13.36 | 14.00 | 14.12 | 14.15 |
| Primary Settlement (Potomac Formation) $d_P$ (ft) | 0.40 | 0.58 | 0.67 | 0.76 | 0.83 | 0.90 | 0.96 | 0.97 | 0.97 |
| Secondary Settlement (dredge) $d_S$ (ft) | 0.83 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 | 1.05 |
| Secondary Settlement (Potomac Formation) $d_S$ (ft) | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| Seondary Settlement (Waste) (ft) | 0.64 | 0.98 | 1.21 | 1.44 | 1.63 | 1.86 | 2.05 | 2.09 | 2.10 |
| Total Settlement $d_T$ (ft) | 9.27 | 12.23 | 13.80 | 15.19 | 16.21 | 17.39 | 18.27 | 18.44 | 18.48 |
| Settlement after 37 years | 3.3 | 4.0 | 4.5 | 4.9 | 5.2 | 5.6 | 5.9 | 6.0 | 6.0 |
| Length of Segment (ft) | | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Differential Settlement (ft) | | 0.67 | 0.47 | 0.43 | 0.33 | 0.40 | 0.31 | 0.06 | 0.01 |
| Grade Change (%) | | 0.67% | 0.47% | 0.43% | 0.33% | 0.40% | 0.31% | 0.06% | 0.01% |
| Tensile Strain | | 0.012% | 0.006% | 0.005% | 0.003% | 0.004% | 0.002% | 0.000% | 0.000% |

9 of 9
DTM




GEOSYNTEC CONSULTANTS
COLUMBIA, MARYLAND

| | |
|---|---|
| PROJECT: | LANDFILL OPTIMIZATION PROJECT CHERRY ISLAND LANDFILL |
| TITLE: | EXISTING LCS PLAN |
| SCALE: | NTS |
| PROJ. NO.: | WE0250 |
| DATE: | FEB 2003 |
| FILE NO.: | 0250F607 |
| SHEET NO: | 1 |

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# Appendix VIb-K.4

# Final Cover Veneer Stability on Side Slopes

# GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

**Client:** DSWA **Project:** Cherry Island **Project/Proposal #:** ME0250 **Task #:** 2.2

**TITLE OF COMPUTATIONS** FINAL COVER VENEER STABILITY ON SIDE SLOPES

COMPUTATIONS BY:
Signature Douglas T. Mandeville — DATE 4/3/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature — DATE 4/07/03
Printed Name and Title: R. David Espinoza, Senior Engineer

COMPUTATIONS CHECKED BY:
Signature Carrie H. Pendleton — DATE 4/07/03
Printed Name and Title: Carrie H. Pendleton, Staff Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Douglas T. Mandeville — DATE 4/3/03
Printed Name and Title: Douglas T. Mandeville, Senior Staff Engineer

APPROVED BY:
(PM or Designate)
Signature — DATE 4/07/03
Printed Name and Title: R. David Espinoza, Senior Engineer

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

| NO. | SHEET | DATE | BY | CHECKED BY | APPROVAL |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

Written by: Doug Mandeville Date: 03/26/03 Reviewed by: Carrie Pendleton Date: 03/27/03

Client: DSWA Project: Cherry Island Proj./Proposal No.: ME0250 Task No.: 2.2

# FINAL COVER VENEER STABILITY ON SIDE SLOPES

## PURPOSE:

The purpose of this engineering calculation is to evaluate the veneer slope stability factor of safety failure along the interfaces of the various components of the final cover system for the Cherry Island Landfill.

## PROCEDURE:

The veneer slope stability factor of safety of the final cover system will be evaluated based on a method presented by Giroud, et al. [1995a,b]. The method is based on a limit equilibrium analysis and takes into account soil buttressing effect, geosynthetic tensile forces, and seepage forces within the final system caused by rainfall and is based on the most critical interface that exists within the final cover system.

The veneer stability factor of safety will be calculated using the following equation from Giroud et al. [1995a,b]:

$$FS = \lambda \frac{\tan\delta}{\tan\beta} + \frac{a/\sin\beta}{\gamma_t(t-t_w)+\gamma_{sat}t_w} + \frac{\gamma_t(t-t_w^*)+\gamma_b t_w^*}{\gamma_t(t-t_w)+\gamma_{sat}t_w}\frac{t}{h}\frac{\sin\phi}{\sin 2\beta\cos(\beta+\phi)} + \frac{ct/h}{\gamma_t(t-t_w)+\gamma_{sat}t_w}\frac{\cos\phi}{\sin\beta\cos(\beta+\phi)} + \frac{T/h}{\gamma_t(t-t_w)+\gamma_{sat}t_w} \qquad \text{Eq. (1)}$$

where:

$$\lambda = \begin{cases} \dfrac{\gamma_t(t-t_w)+\gamma_b t_w}{\gamma_t(t-t_w)+\gamma_{sat}t_w} & \text{for failure surface above the geomembrane (dimensionless)} \\ 1 & \text{for failure surface below the geomembrane (dimensionless)} \end{cases}$$

$FS$ = Factor of Safety (dimensionless)
$\gamma_t$ = total unit weight of soil (pcf)
$\gamma_{sat}$ = saturated unit weight of soil (pcf)
$\gamma_b$ = buoyant unit weight of soil (pcf)
$t$ = thickness of soil layer (ft)
$t_w$ = thickness of water flow along slope (ft)
$t^*_w$ = thickness of water flow in toe of slope (ft)

$\beta$ = slope angle (degrees)
$\delta$ = interface friction angle along slip surface (degrees)
$a$ = interface adhesion (psf)
$\phi$ = internal friction angle of soil above critical surface (degrees)
$h$ = height of slope (ft)
$T$ = tension in geosynthetics (lbs/ft)
$c$ = cohesion of soil above critical surface (psf)

According to a technical manual published by the USEPA entitled "Solid Waste Disposal Facility Criteria" [USEPA, 1993], when there is no imminent danger to human life or threat of major environmental impact, the minimum recommended slope stability factor of safety is 1.25. Because a veneer stability failure of the liner system does not pose a threat to human life or the environment and a failure could be easily repaired, the stability of the final cover system will be considered acceptable if the factor of safety is greater than or equal to 1.25.

## SOIL AND GEOSYNTHETIC PROPERTIES

The maximum slope inclination for the liner system is 3H:1V and the maximum vertical slope height is approximately 40 ft. The final cover system on the side slopes consists of the following components, from top to bottom:

- a 6-in thick of top soil layer;
- a 18-in thick vegetative rooting lasyer;
- a 40-mil thick high-density polyethylene (HDPE) textured geomembrane; and
- a 12-in thick final grading layer.

| Interface/Material | Selected Properties |
|---|---|
| Final grading layer/Geomembrane | assume $\gamma_t$ = 120 pcf, and $\phi$ = 35°<br>tan $\delta$/tan $\phi$ = 0.7; $\delta$ = 26° |
| 60-mil Thick Textured HDPE Geomembrane/nonwoven geotextile | $\delta$ = 25°-35°<br>(assume 30°) |
| Vegetative Rooting Layer/Geotextile | $\phi$ = 35°<br>tan $\delta$/tan $\phi$ = 0.7; $\delta$ = 26° |

See table 1 for interface friction angles

For Case 1, the critical interface friction angle for short-term liner stability above the final grading layer. For Case 2, the critical interface friction angle for short term stability below the geomembrane liner is $\delta = 26°$.

The average depth of water within the geocomposite layer (i.e., 1.15 in.) is evaluated using the HELP model [USEPA, 1994] and it is presented in the calculation package entitled "Geocomposite Drainage Layer Evaluation for Final Cover System" (Appendix VIb-K.2). The input parameters for equation 1 are provided below. For this analysis the resisting force due to tension in geosynthetics (T) is neglected (that is, the effect of the anchor trench is conservatively neglected and the protective layer is mainly supported by frictional forces.

$FS$ = 1.25
$\gamma_t$ = 120 pcf
$\gamma_{sat}$ = 120 pcf
$\gamma_b$ = 57.6 pcf
$t_w$ = 0.1 ft (failure surface above geomembrane), 0 ft for failure surface below geomembrane.
$t^*_w$ = 0
$\beta$ = 18.4°
$a$ = 0
$\phi$ = 35°
$h$ = 32 ft (distance between terraces)
$T$ = 0 (neglect tension contribution)
$c$ = 0

*Case 1 – Failure above Geomembrane*

This case represents the condition of a failure surface above the geomembrane (i.e., $\delta = 26$), and a uniform thickness of granular protective/drainage layer (i.e., $t = 2.0$ ft). The

$$FS = \frac{120(2.0-0.1)+57.6(0.10)}{120(2.0-0.1)+120(0.1)}\frac{\tan 26}{\tan 18.4}+\frac{120(2.0-0)+57.6(0)}{120(2.0-0.1)+120(0.10)}\frac{2.0}{32}\frac{\sin 35}{\sin(2\times 18.4)\cos(35+18.4)}$$

FS = 1.53

*Case 2 – Failure below geomembrane*

This case represents the condition of a failure surface between the geomembrane and the structural fill (i.e. $\delta = 26°$).

$$FS = \frac{\tan 26}{\tan 18.4} + \frac{120(2.0-0)+57.6(0)}{120(2.0-0)+120(0)}\,\frac{2.0}{32}\,\frac{\sin 35}{\sin(2\times 18.4)\cos(35+18.4)}$$

FS = 1.57

Hence, the most critical condition is Case 1, with a FS equal to 1.53.

## RESULTS

The results indicate that for the parameters assumed, the critical interface is between the vegative soil and the geotextile component of the geocomposite drainage layer. The factor of safety is 1.53.

## REFERENCES

Giroud, J.P., Williams, N.D., Pelte, T., and Beech, J.F., "Stability of Geosynthetic - Soil Layered Systems on Slopes," Industrial Fabrics Association International, *Geosynthetics International*, Vol. 2, No. 6, St. Paul, MN, pp. 1115-1148, 1995a.

Giroud, J.P., Bachus, R.C., and Bonaparte, R., "Influence of Water Flow on the Stability of Geosynthetic - Soil Layered Systems on Slopes," Industrial Fabrics Association International, *Geosynthetics International,* Vol. 2, No. 6, St. Paul, MN, pp. 1149-1180, 1995b.

USEPA, *"Solid Waste Disposal Facility Criteria"*, Document No. EPA 530-R-93-017, United States Environmental Protection Agency, November 1993.

USEPA, "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, Vol. II, Users Guide for Version 3*", EPA/530-SW-84-010, US Environmental Protection Agency, Washington, DC, June 1994, 120p.

# APPENDIX VIb-L

# TECHNICAL SPECIFICATIONS

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Section 00330 Existing Conditions
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Section 01270 Measurement and Payment
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Section 02083 Landfill Gas Wellheads
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Section 16421 Electric Service
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Section 16970 Testing and Commissioning
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# SECTION 00310

# PRELIMINARY SCHEDULES

## PART 1 GENERAL

### 1.01 SUMMARY

A. CONTRACTOR shall perform the Work described in these Technical Specifications and shown on the Drawings in a manner that achieves OWNER's schedule milestones.

B. CONTRACTOR's schedule for completing the Work by OWNER's milestone dates shall be submitted with CONTRACTOR's bid. Assumptions to OWNER's schedule requirements, if any, shall be clearly identified and justified for the schedule to be considered responsive to the bid requirements.

C. OWNER's milestone dates are listed in Part 1.02 of this Section.

D. Prior to executing the Contract, CONTRACTOR and OWNER shall agree to a baseline schedule for the Project, which shall become an integral part of the Contract and the basis for progress payments during construction.

### 1.02 MILESTONE DATES (to be determined)

A. Notice of Award.

B. Execute Contract.

C. Mobilize to Site.

D. Establish Initial Erosion and Sediment Controls

E. Establish Temporary Construction Access, which does not interfere or delay with Landfill Operations.

F. Establish Initial Temporary Landfill Gas System.

G. Establish Initial Temporary Leachate Transmission System.

H. Complete Prefabricated Vertical Drain (PVD) Installation.

I. Complete Perimeter Berm.

J. Complete Stormwater Outfalls.

K. Establish Intermediate Landfill Gas System.

L. Complete New Leachate Collection and Transmission System.

M. Install Base Liner System on Designated Portion of the Perimeter Berm.

N. Complete Project Closeout Requirements.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 00320

# GEOTECHNICAL DATA

## PART 1 GENERAL

### 1.01 SUMMARY

A. Information on the geotechnical properties of dredge material and soil underlying the Site is provided in "*Geotechnical Characterization Report*" for the Cherry Island Landfill (Report), prepared by GeoSyntec Consultants, dated April 2003.

B. CONTRACTOR is required to review the Report and understand the subsurface site conditions. OWNER shall not be held responsible for any misinterpretation in CONTRACTOR's evaluation of the geotechnical data contained in the Report. The Report is provided as an aid for bidding purposes only and is not a warranty of subsurface conditions. OWNER and ENGINEER assume no responsibility for any variation between materials encountered during construction and those indicated in the Report or shown on the Drawings.

C. CONTRACTOR, at no cost to OWNER, may perform additional subsurface characterization to supplement and/or confirm the stratigraphic and physical properties of subsurface materials. Should CONTRACTOR choose to obtain additional data, a copy of all logs test results, laboratory reports, etc., shall be provided to OWNER at no cost.

D. Any interpretation of subsurface conditions made by CONTRACTOR based on CONTRACTOR-obtained information shall be submitted to ENGINEER for review.

### 1.02 OWNER'S RIGHT

A. OWNER reserves the right to comment on and/or dispute the findings of any additional subsurface exploration performed by CONTRACTOR.

### 1.03 VALUE ENGINEERING

A. Should the results of the additional subsurface exploration yield a reduced construction cost, then CONTRACTOR may be compensated, in whole or in part, for its exploratory and testing costs based on the overall project savings.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 SUBSURFACE EXPLORATION AND TESTING

A. All subsurface explorations shall be performed by a qualified firm(s) following applicable ASTM procedures subject to approval by OWNER.

B. All field and laboratory tests shall be performed by a qualified firm(s) following applicable ASTM procedures subject to approval by OWNER.

C. Laboratory reports shall be signed and sealed by a Professional Engineer licensed in the State of Delaware.

### 3.02 ENGINEER INTERPRETATION OF RESULTS

A. CONTRACTOR-obtained results shall be interpreted by an experienced geotechnical engineer.

B. CONTRACTOR's interpretation of the results shall be presented in a written document that includes:
   1. a narrative description of the sampling and testing;
   2. a narrative description of the results;
   3. a narrative description of the interpretation;
   4. field and laboratory test reports;
   5. appropriate plans, charts, graphs, and tables to support the above;
   6. qualifications of the geotechnical engineer responsible for the interpretation.

END OF SECTION

# SECTION 00330

# EXISTING CONDITIONS

## PART 1 GENERAL

### 1.01 SUMMARY

A. The Cherry Island Landfill (CIL) is an active solid waste management facility located at 1706 E. 12th Street, in Wilmington, Delaware.

B. CIL is owned and operated by the Delaware Solid Waste Authority.

C. The Work described in these Technical Specifications and shown on the Drawings shall not interrupt the normal business of the landfill.

### 1.02 SITE CONDITIONS

A. The Site is bounded on the north by the City of Wilmington Waste Water Treatment Plant, on the east by the Delaware River, on the south by the Christina River and a USACOE dredge material disposal site, and on the west by I-495.

B. Wetland areas have been delineated on the Site, see Drawings for locations. Delineated wetland areas shall not be disturbed. Any damage to delineated wetland areas caused by CONTRACTOR shall be restored to the satisfaction, and at no cost to, OWNER.

C. Numerous geotechnical and environmental monitoring points are located throughout the Site. These monitoring points shall not be disturbed unless otherwise directed by these Technical Specifications and Drawings. Any damage to the geotechnical and environmental monitoring points caused by CONTRACTOR shall be restored to the satisfaction, and at no cost to, OWNER.

### 1.03 SITE ACCESS

A. Entrance to the Site is provided from 12th Street.

B. All visitors to the Site must register at the landfill office.

## 1.04 HOURS OF LANDFILL OPERATION

A. Monday through Friday: 6 am through 5 pm (except on the days following New Years Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day, when landfill staff may arrive at 5:30 am).

B. Saturday: 7 am through 3 pm.

C. Sunday: Closed.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 00801

# HEALTH AND SAFETY CRITERIA

## PART 1 GENERAL

### 1.01 SUMMARY

A. Safety on the project site is of the utmost priority.

B. CONTRACTOR shall assign one person as the full-time Health and Safety Manager for the duration of the Project.

C. The Health and Safety Manager shall be responsible for: (i) maintaining health and safety records for the Project; and (ii) coordinating periodic on-site health and safety meetings.

D. All persons assigned to the Project shall be properly trained in their specific work tasks. Training records shall be submitted to OWNER immediately upon request.

### 1.02 SUBMITTALS

A. CONTRACTOR shall prepare a site-specific Health and Safety Plan (HASP) for the Project. The HASP shall be submitted to ENGINEER at least 14 days prior to the Pre-Construction Meeting. ENGINEER's review of CONTRACTOR's HASP shall be limited to verification that the various components of the Project are adequately addressed. The HASP shall conform to the requirements of 29 CPF 1910.20 and will all applicable state, federal, local, and other health and safety requirements and safe construction practices not specifically identified in these requirements.

B. CONTRACTOR shall submit to ENGINEER, HASPs for all subcontractors or submit written documentation that said subcontractors shall follow CONTRACTOR's HASP. In any case, the HASP or the written documentation shall be submitted at least 14 days prior to the subcontractor's mobilization to the site.

## PART 2 PRODUCTS

Not used.

# PART 3 EXECUTION

## 3.01 GENERAL

A. CONTRACTOR shall hold daily health and safety meetings prior to each shifts work.

B. CONTRACTOR shall provide personnel with the proper training for each work assignment.

## 3.02 DOCUMENTATION

A. CONTRACTOR shall maintain a health and safety log that shall be available and open for review to OWNER and ENGINEER.

B. CONTRACTOR shall document all reportable and non-reportable incidents to OWNER. Documentation shall include methods to prevent a reoccurrence of such an incident.

## 3.03 PREVENTION/MITIGATION

A. CONTRACTOR shall employ all means and methods necessary to ensure a safe work place for all personnel.

B. Health and safety audits by OWNER shall be performed periodically and without warning.

C. Mitigation of unsafe work conditions shall be enforced prior to continuing work.

D. OWNER reserves the right to stop work if unsafe work conditions are observed. CONTRACTOR shall not be reimbursed for costs related to work stoppage for reasons of unsafe work conditions.

END OF SECTION

# SECTION 01100

# SUMMARY OF WORK

## PART 1 GENERAL

### 1.01 SUMMARY OF WORK

A. Work that is to be performed under this Contract will include, but not be limited to:
   1. establishing and maintaining erosion and sediment control;
   2. installing site access roads;
   3. installing prefabricated vertical drains (PVDs);
   4. installing groundwater monitoring wells;
   5. establishing and maintaining temporary soil stockpiles;
   6. constructing temporary landfill gas and leachate transmission systems;
   7. constructing earth and geosynthetic components of a perimeter berm;
   8. constructing components of the stormwater management system;
   9. constructing components of a composite liner system
   10 constructing components of a leachate collection system;
   11. constructing a temporary and a permanent leachate transmission system;
   12. furnishing and installing mechanical and electrical systems; and
   13. furnishing and installing guardrail, chain-link, and litter fence.

B. CONTRACTOR shall perform Work during the construction period, and shall coordinate the construction schedule and operations with OWNER and other contractors performing Work listed under Part 1.01.A of this Section. CONTRACTOR is responsible for scheduling the activities listed below in a manner such that all activities are completed by the scheduled project completion date.
   1. Mobilize construction equipment.
   2. Implement temporary erosion and sediment control measures and maintain erosion and sediment control measures throughout the Project.
   3. Clear and grub entire construction area within limits of disturbance.
   4. Construct and maintain temporary haul roads.
   5. Install PVDs.
   6. Excavate topsoil and stockpile topsoil at designated area.
   7. Install power for the temporary leachate transmission systems.
   8. Construct temporary leachate and landfill gas transmission systems. .
   9. Supply and install approved soil for perimeter berm construction to specified grades.

10. Supply and install geogrid for perimeter berm construction.
11. Supply and install drop inlets and outfall pipes.
12. Modify existing sediment pond.
13. Construct site access roads.
14. Perform guided boring and install gravity leachate transmission piping to existing wetwells.
15. Install permanent leachate transmission system.
16. Install new leachate valve pits with associated mechanical and electrical components, as well as control and alarm systems.
17. Remove temporary leachate transmission system.
18. Prepare final subgrade surface for geosynthetics installation.
19. Install geosynthetic clay liner component of composite liner system.
20. Install geomembrane component of composite liner system.
21. Backfill anchor trenches and install leachate collection zone material.
22. Perform all other Work that is not specifically defined in this Part 1.01.B of this Section, but shown on the Drawings and described in these Technical Specifications.
23. Topsoil, seed, and mulch all disturbed areas.

## 1.02 CONTRACTOR USE OF SITE AND PREMISES

A. CONTRACTOR's access to OWNER's property is limited to the project work area as identified in the Contract Documents to include:
   1. the limits of disturbance for construction;
   2. the equipment lay down area(s);
   3. the soil stockpile area(s); and
   4. access roads.

## 1.03 OWNER OCCUPANCY

A. CONTRACTOR shall cooperate with OWNER to minimize conflict with OWNER's landfilling operations at the Site.

## 1.04 COMPLETION DATES AND SUBSTANTIAL COMPLETION

A. The completion date for all the Work items identified in Part 1.01.B of this Section shall be 24 calendar months after issuance of Notice to Proceed. The completion date is defined herein as the date when OWNER gives its approval of substantial completion of the Work, which will be given when the following conditions are met.

1. All the components necessary to operate the landfill disposal area have been completed to the satisfaction of OWNER and are operational to the satisfaction of ENGINEER. Components include, but are not limited to: PVD and geotechnical instrumentation installation, perimeter berm construction, temporary and permanent leachate and transmission systems, access roads, and composite liner construction.
2. All the components necessary to convey leachate from constructed cells to the leachate transmission system have been completed to the satisfaction of OWNER, and are operational to the satisfaction of ENGINEER. Components include, but are not limited to: leachate riser pipes, pumps, valves, controls, and alarm system.
3. All the components of the stormwater management system necessary to control stormwater and sediment have been completed to the satisfaction of OWNER, and are operational to the satisfaction of ENGINEER. Components include, but are not limited to: conveyance pipe, drop inlets, outfall pipe, and riprap placement.

B. Specific project milestone dates are provided in Technical Specification Section 00310, Part 1.02.

## 1.05 SUBMITTALS

A. No later than 14 days after notice of award, CONTRACTOR shall submit to ENGINEER a written Construction Plan specific for this project.

B. CONTRACTOR's Construction Plan shall, at a minimum, address the following.
1. CONTRACTOR's approach to executing the project scope of work.
2. Coordination with OWNER, ENGINEER, Construction Quality Assurance (CQA) Consultant, subcontractors, and others.
3. Project schedule.
4. Subcontractors, supplies, and other vendors.
5. Project staffing.
6. Equipment requirements.
7. Permitting.
8. Site access, traffic patterns, parking.
9. Temporary facilities.
10. Constructed temporary features.
11. Conflict resolution.
12. Health and Safety.
13. Erosion and sediment control.
14. Stormwater management.
15. Project management and administration.

16. Quality control.
17. Record documentation.
18. As-built documentation.
19. Project closeout.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 GENERAL

A. CONTRACTOR shall execute all Work in accordance with the requirements of the Technical Specifications, CQA Plan, and Drawings.

### 3.02 FAMILIARIZATION

A. Prior to implementing any Work described in these Technical Specifications, CONTRACTOR shall become thoroughly familiar with the site, the existing site conditions, and all portions of the Work falling within the appropriate section of the Technical Specifications.

B. Prior to implementing any Work, CONTRACTOR shall carefully inspect the previously installed Work to verify that the previous Work is complete to the point where the installation of succeeding Work may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the previously installed Work, then CONTRACTOR should immediately notify OWNER and ENGINEER verbally and in writing (within 48 hours of the site visit). Failure to notify OWNER and ENGINEER or continuance with Work will be construed as CONTRACTOR's acceptance of the previous Work.

### 3.03 PROTECTION OF WORK

A. CONTRACTOR shall use all means necessary to protect all prior Work, including all materials and completed Work of other Sections.

B. In the event of damage to Work performed by CONTRACTOR prior to OWNER's acceptance of the Work, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of ENGINEER and at no additional cost to OWNER.

END OF SECTION

# SECTION 01270

# MEASUREMENT AND PAYMENT

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This Section describes the methods for measurement and payment for the Work of this Contract.

B. As noted below, measurement and payment of Work will be made, and payment for Work will be taken to be included in, and covered by, the Contract prices and lump sum payment methods for the various bid items listed in CONTRACTOR's Bid Schedule.

C. CONTRACTOR shall take all measurements and compute the quantities. ENGINEER shall verify measurements and quantities for payment.

D. CONTRACTOR shall provide necessary equipment, workers, and survey personnel as required.

### 1.02 ENGINEER'S ESTIMATE OF QUANTITIES

A. Bid items and estimated quantities are identified in CONTRACTOR's Bid Schedule of the Contract Documents. The estimated quantities for unit price pay items are approximate only and are included solely for the purpose of comparison of Bids. OWNER does not expressly or by implication agree that the nature of the materials encountered below the surface of the ground or the actual quantities of material encountered or required will correspond with the estimated quantities.

B. If the actual Work requires a quantity different than those quantities indicated on CONTRACTOR's Bid Schedule, then CONTRACTOR shall provide the required quantities at the contract unit prices. If the actual final quantity various by more than 25 percent of the quantities indicated on CONTRACTOR's Bid Schedule, then CONTRACTOR and OWNER shall negotiate a revised unit rate to reflect either the loss or gain in price efficiency.

### 1.03 BID ITEMS

To be determined.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01310

# PROJECT MANAGEMENT AND COORDINATION

## PART 1 GENERAL

### 1.01 ORGANIZATION

A. A Project Organization Chart is presented as Figure 01310-1.

### 1.02 PRECONSTRUCTION MEETING

A. OWNER shall schedule a Preconstruction Meeting at the Site or other convenient location prior to commencement of construction activities. At the meeting, responsibilities and personnel assignments shall be reviewed.

B. OWNER, ENGINEER, Construction Quality Assurance (CQA) Consultant, and CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the meeting by persons familiar with, and authorized to, conclude matters relating to the Work.

C. OWNER shall prepare the agenda for the meeting, which shall include items of significance that could affect progress including such topics as:
   1. Health and Safety.
   2. Tentative construction schedule.
   3. Critical work sequencing.
   4. Designation of responsible personnel.
   5. Construction quality control requirements.
   6. CQA procedures and protocols.
   7. Procedures for processing field decisions and change orders.
   8. Procedures for processing applications for payment.
   9. Distribution of Contract Documents.
   10. Submittal of shop drawings, product data, and samples.
   11. Preparation of record documents.
   12. Use of the premises.
   13. Office, work, and storage areas.
   14. Equipment deliveries and priorities.
   15. Safety procedures.
   16. First aid.

17. Security.
18. Housekeeping.
19. Working days and hours.

## 1.03 PROGRESS MEETINGS

A. Progress meetings will be facilitated by OWNER or ENGINEER at the Site or other convenient location. OWNER will notify CONTRACTOR and CQA Consultant of scheduled meeting dates.

B. In addition to OWNER, ENGINEER, CQA Consultant, and CONTRACTOR, each subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination or performance of future activities shall be represented at these meetings by persons familiar with the Project and authorized to conclude matters relating to progress.

C. No later than five working days after each progress meeting date, OWNER or ENGINEER will distribute copies of the meeting minutes to each party present and to other parties who should have been present. The minutes will include a brief summary, in narrative form, of progress since the previous meeting.

## 1.04 PROBLEM OR WORK DEFICIENCY MEETING

A. A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, OWNER, ENGINEER, the CQA Consultant, and CONTRACTOR shall attend the meeting, and any affected subcontractors. The purpose of the meeting is to define and resolve the problem or work deficiency.

B. OWNER or ENGINEER shall document the meeting and shall transmit minutes to the meeting attendees and others as appropriate.

## 1.05 PROGRESS SCHEDULES

A. The progress schedule shall be furnished at least 14 days prior to the Preconstruction Meeting, and shall be updated and submitted to ENGINEER every month throughout the duration of the Contract. Throughout the Project, CONTRACTOR shall furnish in duplicate, graphic type construction progress schedules, listing trade divisions and all parts of Work, and showing the planned starting date and completion time for each part of the Work.

## 1.06 ADMINISTRATION OF CONTRACT

A. CONTRACTOR shall follow the Drawings strictly and execute all Work in accordance therewith, and with the kind and quality of materials set forth in the Technical Specifications, using the figured dimensions marked on the Drawings and not scaled measurements, unless approved by ENGINEER.

B. The Technical Specifications and Drawings shall be coordinated, so that any Work shown on the Drawings and not mentioned in the Technical Specifications, and vice-versa, shall be executed in the same manner as though mentioned in the Technical Specifications and shown on the Drawings.

C. CONTRACTOR shall furnish and install such Work and material as may be proper and suitable preparation, basis, support, or finish for the Work which is shown or specified, whether or not the same is specifically mentioned in the Technical Specifications or shown on the Drawings. CONTRACTOR shall be required to make plural and complete Work that is shown single or partially indicated to avoid needless repetition, for the sake of brevity, and for reasons of clarity. In all cases, the intent and meaning of the Drawings and Technical Specifications, as defined herein, shall be followed.

## PART 2 PRODUCTS

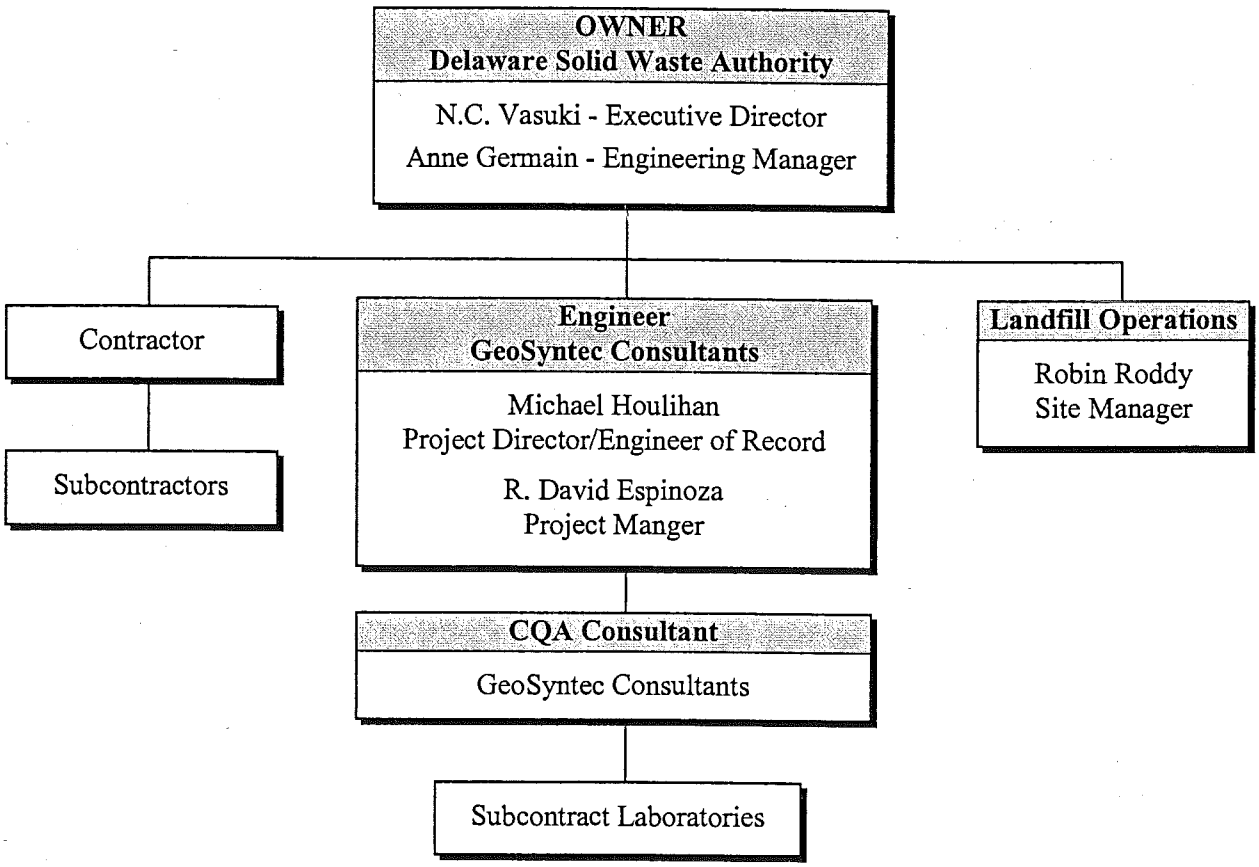
Not used.

## PART 3 EXECUTION

Not used.

# FIGURE 01310-1

## ORGANIZATION CHART




END OF SECTION

# SECTION 01320

# CONSTRUCTION PROGRESS DOCUMENTATION

## PART 1 GENERAL

### 1.01 ON-SITE RECORDS

A. CONTRACTOR shall keep one record copy of all Contract Documents (i.e., Drawings, Technical Specifications, Construction Quality Assurance (CQA) Plan, Addenda, approved Shop Drawings, change orders, field orders, other Contract modifications, product data and samples) at the Site in good order and annotated to show all changes made during manufacturing, supply, and delivery processes. Such annotations shall be kept current.

B. The Contract Documents maintained at the Site by CONTRACTOR shall be clearly marked, "Project Record Copy", be maintained in good condition, be available at all times for inspection by OWNER, ENGINEER, or CQA Consultant, and not be used for construction purposes.

C. CONTRACTOR shall keep and update redline drawings of all Work performed throughout the Project. Redline drawings shall consist of reproducible mylars of the Drawings with field changes marked in red pen.

D. CONTRACTOR shall submit to OWNER after completion of the Project the "Project Record Copy" Contract Documents and a final set of redline drawings.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01330

# SUBMITTAL PROCEDURES

## PART 1 GENERAL

### 1.01 SUMMARY

A. CONTRACTOR shall submit Shop Drawings, Working Drawings, Record Drawings, certificates of compliance, manufacturer's certifications, and manufacturer's instructions, in accordance with the requirements of the relevant Technical Specifications.

B. OWNER shall furnish to CONTRACTOR, OWNER's standard title block and border. CONTRACTOR shall be responsible for incorporating these items into the Record Drawings.

### 1.02 DEFINITIONS

A. Shop Drawings are all drawings, diagrams, illustrations, brochures, schedules, and other data prepared by CONTRACTOR, a subcontractor, manufacturer, fabricator, supplier, or distributor, that illustrates how specific portions of the Work shall be fabricated or installed.

B. Working Drawings are drawings, diagrams, or illustrations that are prepared by CONTRACTOR during construction. Working Drawings shall be used to communicate work progress or status to ENGINEER and/or OWNER.

C. Record Drawings are drawings prepared by a Professional Land Surveyor licensed in the State of Delaware. Record Drawings are used to communicate the final work product to OWNER, ENGINEER, and the CQA Consultant.

D. Certificates of compliance, manufacturer's certifications, manufacturer's instructions are information provided by the manufacturer to CONTRACTOR.

### 1.03 IDENTIFICATION

A. The Shop and Working Drawings shall have the following identification data contained thereon or permanently attached thereto: (i) Project Name; (ii) Contract Number; and (iii) description of item.

B. Shop Drawings and Working Drawings shall be reference the specific Technical Specification Section and/or Drawing sheet number. Each revised submission shall be numbered sequentially in order of original submission. Resubmittals shall include the original submittal number and shall be lettered sequentially (i.e., A, B, ...).

## 1.04 SUBMITTALS

A. At least 14 days prior to Preconstruction Meeting, CONTRACTOR shall submit to ENGINEER a list of all project submittals that will be made and the tentative dates that they will be submitted for review. ENGINEER and CONTRACTOR will use the submittal list throughout the Project to communicate submittal requirements and responsibilities.

B. CONTRACTOR shall maintain the submittal log in current and correct condition. CONTRACTOR shall provide ENGINEER with an updated submittal log with each submittal submission.

C. For required Shop Drawings, Working Drawings, certificates of compliance, manufacturer's certifications, and manufacturer's instructions, CONTRACTOR shall submit one original document and one copy to CQA Consultant for review and acceptance.

D. For required Record Drawings, CONTRACTOR shall submit six original documents and an electronic copy of the documents to ENGINEER.

## 1.05 SHOP DRAWINGS

A. Shop Drawings shall be submitted for all materials, equipment, accessories, and appurtenances as specified or shown on the Drawings prior to the fabrication, installation, or incorporation of the specified materials, equipment, accessories, and appurtenances in the Work.

B. All Shop Drawings shall be prepared to scale, shall be accurate and distinct, and shall give all dimensions required for the fabrication, installation, and incorporation of the specified items in the Work. Wherever the location of any of the materials, equipment, accessories, and appurtenances is not shown on the Drawings, CONTRACTOR shall furnish prints of Shop Drawings for the purpose of giving the exact location in plan and in elevation of the said materials, equipment, accessories, and appurtenances.

C. At the time of submission, CONTRACTOR shall call to OWNER's and ENGINEER's attention, in writing, any deviations that the Shop Drawings may have from the requirements of the Drawings and the Technical Specifications.

## 1.06 FINAL RECORD DRAWINGS

A. The Final Record Drawings shall be submitted to ENGINEER as required by the relevant Technical Specification Sections. Each individual Final Record Drawing shall be signed and sealed by a Professional Land Surveyor licensed in the State of Delaware.

B. Final Record Drawings shall conform to the standards and tolerances presented herein.

C. Final Record Drawings shall be provided in both paper and digital format. Paper copies shall be plotted on paper no larger than D-size drawing paper (i.e., 24 in. by 36 in.). The digital files shall be in AutoCAD® Release 14 format or a format fully compatible with AutoCAD® Release 14. Digital files shall be furnished on a clearly labeled compact disk.

D. Final Record Drawings shall be prepared using OWNER's title block and border.

## 1.07 SUBMITTAL REVIEW

A. After review, ENGINEER shall mark submittals as either: (i) No Exceptions Taken; (ii) Amend – Resubmit; (iii) Rejected – Resubmit; or (iv) Not Review – For Information Only.

# PART 2 PRODUCTS

Not used.

# PART 3 EXECUTION

END OF SECTION

# SECTION 01420

# REFERENCES

## PART 1 GENERAL

### 1.01 REFERENCES

A. Construction Quality Assurance (CQA) Plan.

B. Drawings.

C. Latest version available at the time of contract execution of American Society for Testing Materials (ASTM) Standards.

D. American Association of State Highway Transportation Officials (AASHTO) Standards.

E. Latest version of American Concrete Institute (ACI) standards.

F. Latest version of the Delaware Department of Transportation (DELDOT) Standard Specifications.

G. Latest version of Geosynthetic Research Institute (GRI) Test Method.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01430

# CONSTRUCTION QUALITY ASSURANCE

## PART 1 GENERAL

### 1.01 SUMMARY

A. OWNER shall retain a Construction Quality Assurance (CQA) Consultant who shall be responsible for the quality assurance testing and construction oversight for the Project. The CQA Consultant shall follow perform the quality assurance testing and construction oversight in accordance with the CQA Plan.

B. All Work shall be monitored or tested in accordance with the requirements of the CQA Plan. CONTRACTOR shall be familiar with the contents of the CQA Plan.

C. CONTRACTOR shall take the quality assurance testing frequencies and procedures into account when planning the construction schedule.

D. CQA testing procedures and frequencies for individual products, materials, and procedures are described in the CQA Plan.

### 1.02 DEFINITIONS

A. Construction Quality Assurance (CQA) is a planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

B. For this Project, CQA refers to means and actions employed by CQA Consultant and testing laboratories to assure that the components of the design are produced and installed to conform to the requirements of the Drawings and the Technical Specifications.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01450

# CONSTRUCTION QUALITY CONTROL

## PART 1 GENERAL

### 1.01 SUMMARY

A. CONTRACTOR shall assign one person as the Quality Control Manager for the Project. The Quality Control Manager shall be responsible for preparing and submitting quality control certifications and test results to the Construction Quality Assurance (CQA) Consultant, as applicable.

B. The Quality Control Manager shall maintain an appropriate frequency of contact with ENGINEER and the CQA Consultant to ensure that work quality is being maintained.

### 1.02 DEFINITIONS

A. Construction Quality Control (CQC) are those actions that provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements.

B. CQC refers to those actions taken by the manufactures, fabricators, installers, or CONTRACTOR to ensure that the materials and the workmanship meet the requirements of the Drawings and the Technical Specifications.

### 1.03 SUBMITTALS

A. CONTRACTOR shall prepare a Quality Control Plan for the Project. The Plan shall: (i) identify the Quality Control Manager; and (ii) describe the proposed means and methods for quality control to be implemented by CONTRACTOR, manufacturers, and suppliers.

1. The Quality Control Plan shall be submitted to ENGINEER 14 days prior to the Preconstruction Meeting. CONTRACTOR shall not begin work until ENGINEER provides written approval of the Quality Control Plan.

## PART 2 PRODUCTS

Not used.

# PART 3 EXECUTION

## 3.01 GENERAL

A. CONTRACTOR shall be responsible for obtaining quality control documentation, or performing quality control tests as described in the Technical Specifications.

B. Quality control testing procedures and frequencies for individual products and material are described in the Technical Specifications.

## 3.02 SAMPLING AND TESTING

A. CONTRACTOR shall perform all soils testing during construction and shall promptly provide all test results to ENGINEER and/or the CQA Consultant, as required. CONTRACTOR shall be responsible for cooperating with ENGINEER and the CQA Consultant during all testing activities and in resolving all problems identified during CQC testing. CONTRACTOR shall provide all equipment and labor for all required testing. CONTRACTOR shall repair any damage to finished Work caused by the sampling or testing activities.

B. Material sampling and testing for geosynthetics, pipe, etc., is the responsibility of CONTRACTOR and shall be performed by the appropriate manufacturer. CONTRACTOR and its subcontractor(s) shall be responsible for cooperating with the CQA Consultant during all testing activities. CONTRACTOR and its subcontractor(s) shall provide equipment and labor for all testing. CONTRACTOR and its subcontractor(s) shall repair any damage to finished Work caused by sampling or testing activities. The CQA Consultant shall monitor the testing activities.

C. CONTRACTOR shall be responsible for geometric control of the Work. Any surveying that may be performed by the CQA Surveyor does not relieve CONTRACTOR of its responsibility to layout, control, and document its Work. Any additional CQC surveying that is required, if the initial CQC survey shows that the Work has not yet been completed to the lines and grades shown on the Drawings, shall be performed at the expense of CONTRACTOR.

D. CONTRACTOR shall abide by all qualification requirements identified in these Technical Specifications (for subcontractors, supplies, manufacturers, etc.).

## 3.03 PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work, including all materials and completed Work of other Sections.

END OF SECTION

# SECTION 01510

# TEMPORARY FACILITIES AND CONTROLS

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section includes descriptions of temporary facilities and controls necessary for the Work.

B. Temporary facilities and controls addressed in this section include:
1. field office and telephone;
2. temporary water service;
3. temporary sanitary and first aid facilities;
4. temporary electric service;
5. noise control;
6. dust control;
7. fire prevention control;
8. pollution control;
9. roads and access;
10. access routes and parking areas;
11. protection of personnel, Work, and property;
12. temporary signs;
13. construction equipment;
14. protection;
15. trucking;
16. odor and fugitive emissions control;
17. utility relocation or removals;
18. security; and
19. clean-up during construction.

### 1.02 FIELD OFFICE AND TELEPHONES

A. CONTRACTOR shall provide and maintain upon the premises, where directed, proper offices for its own use and for use by ENGINEER and the CQA Consultant.

B. CONTRACTOR shall provide all offices with adequate heating, air conditioning, and electric lighting for the full duration of the Project. The offices shall have continuous

power not subject to voltage fluctuations capable of damaging electrical equipment. CONTRACTOR shall maintain the office in a clean condition.

C. CONTRACTOR shall install telephones and facsimile machines (each with long-distance service) in the offices and shall pay the cost for calls and facsimile transmissions made from the offices. Telephones and facsimile machine shall be equipped with easily audible gongs and shall be kept in operation until the construction is entirely completed. Wall-mounted pay phones are not acceptable.

D. CONTRACTOR shall provide internet access for use by the ENGINEER and the CQA Consultant.

E. The office space to be used by ENGINEER and the CQA Consultant shall be larger enough comfortably house six people with associated furniture (i.e., desks, chairs, tables).

F. CONTRACTOR shall provide a meeting place capable of comfortably seating 12 people around a common table.

## 1.03 TEMPORARY WATER SERVICE

A. CONTRACTOR shall make arrangements for supply of water to construction and portable drinking water to office areas.

B. CONTRACTOR shall provide hose extensions and trucks where required to deliver water to point of use.

## 1.04 TEMPORARY SANITARY AND FIRST AID FACILITIES

A. CONTRACTOR shall provide toilet accommodations for workers on the Project, including all workers employed by subcontractors. Toilets shall be maintained in a sanitary condition. The following conditions apply.
   1. Provide at least one unit for every 30 persons, or fraction thereof.
   2. Where water and sewer connections are not available, provide approved chemical or electric toilets.
   3. Provide first aid stations at Work areas and in the temporary field offices.
   4. Post telephone numbers of physicians, hospitals, and ambulance services by each telephone at the Site.
   5. Provide facilities and fixtures in compliance with OSHA regulations and all other applicable federal, state, and local laws and regulations.

6. Enforce proper use of sanitary facilities, including preventing the committing of nuisances in buildings on the site. Employees who violate this rule shall be discharged.
7. Dispose of all wastes in conformance with applicable regulations.

## 1.05 TEMPORARY ELECTRICAL SERVICE

A. CONTRACTOR shall provide temporary electrical service to the existing leachate transmission service. The following conditions apply.
   1. The location of temporary overhead electrical transmission lines shall be provided to ENGINEER and OWNER for approval prior to installation.
   2. If temporary electrical service does not use existing metering equipment, temporary meters shall be supplied and installed.
   3. Temporary electrical service shall be installed in a manner which minimizes the disruption to operation of the existing leachate transmission system.

## 1.06 NOISE CONTROL

A. CONTRACTOR's vehicles and equipment shall be configured in a manner that minimizes noise to the greatest degree practicable. Noise levels shall conform to the latest OSHA standards and in no case shall noise levels be permitted to interfere with the Work of OWNER or others.

## 1.07 DUST CONTROL

A. CONTRACTOR shall be responsible for controlling objectionable dust caused by operation of vehicles and equipment, by clearing or grubbing, or any other activities within the Work area. CONTRACTOR shall keep dust in the air to a minimum. CONTRACTOR shall control dust by spraying water as described in the latest version of "*Delaware Erosion and Sediment Control Handbook*".

## 1.08 FIRE PREVENTION CONTROL

A. CONTRACTOR shall take all precautions necessary to prevent fires and explosions. CONTRACTOR is hereby advised that flammable and explosive gases are naturally generated at landfills and may be present in and adjacent to the Work area.

B. Fuel for cutting and heating torches shall be contained in containers approved by the Underwriter's Laboratory.

C. CONTRACTOR shall furnish and maintain a 20-pound maximum capacity dry chemical type fire extinguisher in the immediate vicinity of the Work when welding tools or torches of any type are in use.

## 1.09 POLLUTION CONTROL

A. CONTRACTOR shall provide methods, means and facilities required to prevent contamination of soil, water, or atmosphere by discharges from construction operations.

B. CONTRACTOR's equipment used during construction shall conform to current federal, state, and local laws and regulations regarding pollution control.

## 1.10 ROADS AND ACCESS

A. Use of existing site access roads will be permitted to CONTRACTOR's personnel who lawfully frequent the Project Site.

B. Existing roads shall be kept open by CONTRACTOR for the passage of vehicular traffic and pedestrians during the construction period unless otherwise approved by OWNER.

C. CONTRACTOR shall provide signs, signals, barricades, lights, and personnel to regulate all traffic and to warn vehicles and personnel of hazards. Such Work shall conform to the requirements of authorities having jurisdiction or as required by OWNER.

D. CONTRACTOR shall construct and maintain temporary roads required for excavation operations, fill hauling operations, and disposal of excavated material.

## 1.11 ACCESS ROUTES AND PARKING AREAS

A. Routes of ingress and egress to the location of the Work shall be clearly marked by CONTRACTOR and approved by OWNER before use by CONTRACTOR.

B. CONTRACTOR shall store materials and perform the Work so that pedestrian and vehicular traffic is not impeded at access routes and parking areas.

C. CONTRACTOR shall maintain storage and Work areas free of debris and obstructions.

D. CONTRACTOR is responsible for providing security at construction entrances to the facility.

## 1.12 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

A. CONTRACTOR shall follow the requirements of its Health and Safety Plan, developed as required by Technical Specification Section 00801.

## 1.13 TEMPORARY SIGNS

A. Project Identification Sign: CONTRACTOR shall provide a project identification sign acceptable to OWNER within 10 days after Preconstruction Meeting. The sign shall be erected at a location acceptable to OWNER. Lettering on the sign shall be professionally executed, straight, uniform and evenly spaced. The sign shall be constructed of ¾-in. thick medium density overlay plywood supported on wood posts with adequate bracing to resist wind. The sign shall be painted with at least two coats of exterior paint. The paint shall be of a type formulated for use on exterior signs. The bottom of the sign shall be 4 ft. above the ground. CONTRACTOR shall maintain the sign in a first-class condition until completion of the Project.

B. No sign or advertisement, except the project identification sign, shall be displayed without OWNER's approval. Should directional signs be required, such signs shall be of size, color, and lettering that meet OWNER's and ENGINEER's approval.

## 1.14 CONSTRUCTION EQUIPMENT

A. CONTRACTOR shall provide construction equipment in good working order and properly trained operating personnel necessary to perform the Work.

B. CONTRACTOR shall provide equipment with proper guys, bracing, and other safety devices as required by local or State codes.

C. CONTRACTOR shall provide all scaffolding, staging, platforms, temporary flooring, railing, stairs, etc, as required by local and State laws and codes for the protection of workers and the public.

## 1.15 PROTECTION

A. CONTRACTOR shall take all necessary precautions to prevent any damage to the U.S. Coast Guard Navigation Beacon Tower and Bellevue Range Rear Light.

B. CONTRACTOR shall replace and put in good condition every public and private way, catch basin, pipe, tree, fence or things damaged in carrying out the Contract, unless the

same shall be permanently done away with by order of OWNER or ENGINEER as being unnecessary for the proper execution of the Contract.

C. CONTRACTOR shall take all proper precautions to protect persons from injury and unnecessary interference or inconvenience. CONTRACTOR shall leave an unobstructed way along paths and private places for pedestrians and vehicles and for access to hydrants.

D. The location of any construction fencing, and areas for on-site storage of equipment and other facilities required by CONTRACTOR shall be subject to approval by OWNER and ENGINEER.

## 1.16 TRUCKING

A. All trucks bringing to or removing earth, loose materials, or debris from the Project Site shall be loaded in a manner to prevent dropping of materials on streets.

B. CONTRACTOR shall maintain a crew at all points where trucks leave the Project Site and enter adjacent paved streets, to prevent any mud from being carried onto such adjacent paved streets.

C. Earth, loose materials, or debris deposited on the streets due to contract trucking activities shall be removed daily.

D. The beds of all trucks entering or leaving the Project Site shall be covered by a tarp.

## 1.17 ODOR AND FUGITIVE EMISSION CONTROL

A. CONTRACTOR shall control to the greatest degree practical, the emission of odors and other fugitive emissions from the Work including, but not limited to, landfill gas, dust, and blowing debris.

## 1.18 UTILITY PROTECTION RELOCATION OR REMOVALS

A. CONTRACTOR shall remove temporary facilities when they are no longer required. CONTRACTOR shall restore permanent facilities used for, or connected to, temporary facilities to their original or better condition.

B. CONTRACTOR shall protect and/or support all existing utilities that are endangered by its operations.

## 1.19 SECURITY

A. CONTRACTOR shall protect completed Work, existing premises, and OWNER's operations against theft, vandalism, and unauthorized entry.

B. CONTRACTOR shall coordinate Project Site security with OWNER's existing security system.

C. CONTRACTOR shall restrict entrance of persons and vehicles into Project Site to only those working on the Project.

D. CONTRACTOR shall allow entrance only to authorized persons with proper identification.

E. CONTRACTOR shall coordinate access of its personnel to the Site with OWNER's security forces.

## 1.20 CLEAN-UP DURING CONSTRUCTION

A. Clean-up shall be performed daily to prevent accidents to personnel, protect all Work in place, and to effect completion of the Work in an orderly manner.

B. Construction clean-up shall consist of the removal of all mud, oil, grease, sand, gravel, dirt, trash, scrap, debris, and excess materials, from any floor space, ground, or walking surface, that may cause the tripping or sliding of Workers, ladders, or equipment. Particular attention shall be given to the removal of water from areas where electrical power tools are to be used and to the prevention of stains on concrete that will be exposed in the finish Work.

C. Burning of waste material is prohibited.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01530

# TEMPORARY CONSTRUCTION

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section includes descriptions of temporary construction items necessary for the Work.

B. Temporary construction items addressed in this Section include:
   1. leachate transmission; and
   2. landfill gas management

### 1.02 SUBMITTALS

A. CONTRACTOR shall prepare a Work Plan for construction, operating, maintenance, and decommissioning the temporary leachate transmission system. This Work Plan shall be submitted to ENGINEER at least 14 days prior to the Preconstruction Meeting. ENGINEER's review of the Work Plan shall be limited to verification that the presented approach is consistent with the design intent.

B. CONTRACTOR shall prepare a Work Plan for constructing, operating, maintaining, and decommissioning the temporary landfill gas system. This Work Plan shall be submitted to ENGINEER at least 14 days prior to the Preconstruction Meeting. ENGINEER's review of the Work Plan shall be limited to verification that the presented approach is consistent with the design intent.

C. CONTRACTOR shall prepare a Work Plan for constructing, monitoring, and removing the temporary Cell 5A surcharge berm. This Work Plan shall be submitted to ENGINEER at least 14 days prior to the Preconstruction Meeting. ENGINEER's review of the Work Plan shall be limited to verification that the presented approach is consistent with the design intent.

## PART 2 PRODUCTS

Not used.

# PART 3 EXECUTION

## 3.10 LEACHATE TRANSMISSION SYSTEM

A. CONTRACTOR shall identify in the field the proposed location for the temporary leachate transmission piping. CONTRACTOR shall locate piping so as to not disturb other buried utilities or impact landfilling activities.

B. At locations where temporary leachate transmission piping crosses access roads, CONTRACTOR shall take all necessary measures to protect the transmission piping from damage due to vehicular loads.

C. Temporary leachate transmission piping shall be installed prior to decommissioning the existing leachate transmission system. Care shall be taken to minimize the shutdown period of the system. If the shutdown period for any single existing wetwell exceeds three days, then CONTRACTOR shall provide tanker trucks to remove leachate from the wetwell and discharge to other operational portions of the system.

D. CONTRACTOR shall maintain and repair cover soils over the temporary leachate transmission piping during the entire period of construction to maintain protection from frost.

## 3.02 LANDFILL GAS MANAGEMENT

A. CONTRACTOR shall identify in the field the proposed location for the temporary landfill gas management piping. CONTRACTOR shall locate piping so as to not disturb other buried utilities or impact landfilling activities.

B. At locations where temporary landfill gas management piping crosses access roads, CONTRACTOR shall take all necessary measures to protect the landfill gas piping from damage due to vehicular loads.

C. Temporary landfill gas management piping shall be installed prior to decommissioning the existing landfill gas system. Care shall be taken to minimize the shutdown period of the system. System shutdown shall occur in phases so as to avoid complete shutdown of the entire system.

D. CONTRACTOR shall close valves or otherwise isolate vacuum from landfill gas management piping prior to cutting pipes or removing wellheads. Air shall not be allowed to flow into active portions of the landfill gas management system.

END OF SECTION

# SECTION 01550

# VEHICULAR ACCESS AND PARKING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section includes descriptions for vehicular access and parking associated with the Work.

B. Vehicular access and parking items addressed in this section include:
   1. site entrance requirements;
   2. traffic patterns; and
   3. parking for construction equipment, site personnel, and visitors;

### 1.02 LOCATIONS

A. The locations for vehicular access and parking are shown on the Drawings.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 GENERAL

A. CONTRACTOR shall be aware of the normal traffic volume and traffic patterns associated with the regular business activities of the landfill and immediately surrounding properties.

B. CONTRACTOR shall not interfere with any landfill activities.

### 3.02 SITE ENTRANCE

A. CONTRACTOR shall use Site Entrance No. 1 for all vehicular ingress to the Site.

B. CONTRACTOR shall use Site Entrance No. 2 for all vehicular egress from the Site

## 3.02 TRAFFIC PATTERNS

A. CONTRACTOR shall follow the traffic patterns shown on the Drawings and shall adhere to one-way traffic flow as directed by OWNER.

B. CONTRACTOR shall upgrade and maintain the existing roadway as necessary to allow for the additional site traffic associated with this Project.

C. CONTRACTOR shall establish and maintain the access roads throughout the duration of the project.

D. CONTRACTOR shall provide amble access for construction-related equipment, materials, personnel, and visitors.

E. CONTRACTOR shall provide personnel as necessary to control traffic flow on the portion of the existing roadways that are shared with traffic associated with typical landfill activities.

F. CONTRACTOR shall provide signage and/or personnel to direct project-related vehicles (e.g., deliveries) to the appropriate location at the construction site.

## 3.03 PARKING

A. CONTRACTOR shall establish and maintain a parking area, at the location shown on the Drawing, throughout the duration of the project.

B. CONTRACTOR shall provide amble parking for construction-related personnel and site visitors.

END OF SECTION

# SECTION 01630

# PRODUCT SUBSTITUTION PROCEDURES

## PART 1 GENERAL

### 1.01 SUMMARY

A. An offer of a substitute article or material by CONTRACTOR, not specified herein, will raise the presumption that it is for the purpose of saving money. If, in such case, the article or material is accepted, then OWNER shall be given credit as follows: the difference in the net cost to CONTRACTOR of the article or material submitted and the price that it could have obtained the lowest priced article or material specified. For convenience in checking the credit, CONTRACTOR shall submit these figures with each substitute submittal, and no article or materials shall be considered without such figures.

B. If it becomes necessary, because of the inability of CONTRACTOR to obtain any items or material as specified or the equal thereof within a reasonable time frame, and could possibly cause future delays in the Project, then ENGINEER, at his discretion, may authorize use of substitute items or materials of the same, greater, or less cost than those specified.

C. In such cases as described in Paragraphs 1.01A and B above, CONTRACTOR shall submit, in writing, his request for permission to make a substitution and shall furnish full information as to costs of the item or material specified and the item or material to be substituted therefore. Such information shall be in such form and detail as to permit OWNER and/or ENGINEER to check, to its satisfaction, the costs involved and the material/item equivalency. ENGINEER's evaluation of equivalency will be based on the material/item's compliance with the design methodology. Upon acceptance of the substitution, when the cost thereof is greater or less, ENGINEER will authorize, in writing, the proper credits to be allowed OWNER, or the proper additional payments to be made to CONTRACTOR. Payment adjustments shall represent the difference between the net cost to CONTRACTOR of the accepted substituted item or material and the price at which he could have obtained the lowest priced items or material specified.

D. The decisions of ENGINEER, as to the proper credits to be allowed to OWNER, or proper payments to be made to CONTRACTOR, or substitutions to be allowed, shall be final.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01640

# OWNER-FURNISHED PRODUCTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. OWNER may furnish products for use in construction.

### 1.02 CONSTRUCTION QUALITY CONTROL

A. CQC and testing of the OWNER-furnished products shall be the responsibility of CONTRACTOR and shall be monitored by CQA Consultant.

### 1.03 DELIVERY STORAGE AND HANDLING

A. OWNER shall deliver OWNER-furnished products to the site. OWNER shall coordinate delivery and stockpile locations with CONTRACTOR.

B. CONTRACTOR shall be responsible for constructing and maintaining stockpile(s) in accordance with the Drawings and Technical Specifications.

## PART 2 PRODUCTS

### 2.01 TO BE DETERMINED

A. To be determined.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01650

# PRODUCT DELIVERY REQUIREMENTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Delivery of products whether OWNER or CONTRACTOR furnished, shall be clearly labeled for this Project.

B. Product deliveries shall be scheduled with OWNER.

C. Products shall be stored in designated areas only.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01721

# SURVEY REQUIREMENTS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall employ a licensed Surveyor to provide field survey control for CONTRACTOR's construction activities.

B. CONTRACTOR's Surveyor shall work with the Construction Quality Assurance (CQA) Surveyor to assure that the Work is completed as required on the Drawings and in these Technical Specifications.

C. CONTRACTOR shall comply with the requirements of this Section regarding field surveying.

### 1.02 QUALIFICATION OF SURVEYOR

A. CONTRACTOR's Surveyor shall be is registered in the State of Delaware and shall be acceptable to OWNER and ENGINEER.

### 1.03 SUBMITTALS

A. Prior to the start of the Work, submit to ENGINEER the name, address, and telephone number of the Surveyor.

B. Prior to the start of the Work, submit to ENGINEER the Surveyor's qualifications prior to the start of site Work.

C. Prior to the start of survey work, submit to ENGINEER the Survey Plan including project staffing, scheduling, and the type of equipment the Surveyor intends to use in the field and in the office (i.e., computer software) to complete the Project.

D. On request, submit to ENGINEER, documentation verifying accuracy of survey work.

### 1.04 PROJECT RECORD DRAWINGS

A. CONTRACTOR or CONTRACTOR's Surveyor shall maintain a complete and accurate log of control and survey work as work progresses.

B. CONTRACTOR shall keep and update redline drawings of all Work performed throughout the Project. CONTRACTOR shall allow the CQA Consultant to routinely inspect the redline drawings. At the end of the Project, CONTRACTOR shall submit a complete set of redline drawings and the surveyor's log of control and survey work to the CQA Consultant for its use in preparing the final report of construction activities.

## 1.05 EXAMINATION

A. CONTRACTOR or CONTRACTOR's Surveyor shall verify locations of survey control points prior to starting Work.

B. CONTRACTOR shall promptly notify OWNER of any discrepancies discovered.

## 1.06 SURVEY REFERENCE POINTS

A. CONTRACTOR shall protect preexisting survey control and reference points.

B. The control datum for survey is that indicated on Drawings.

C. CONTRACTOR shall protect survey control monuments during construction.

D. CONTRACTOR shall promptly report to OWNER the loss or disturbance of any monument or relocation required because of changes in grades or other reasons.

E. CONTRACTOR's Surveyor shall replace disturbed monuments based on original survey control. Changes shall not be made without prior written notice to OWNER and ENGINEER.

## 1.07 SURVEY REQUIREMENTS

A. CONTRACTOR or CONTRACTOR's Surveyor shall provide field survey services to perform CONTRACTOR's work using accepted engineering survey practices.

B. Survey equipment and services to be provided shall include, but not be limited to electronic distance measuring equipment, theodolite, transit, level, rod, tapes, and accessories.

C. CONTRACTOR shall prepare a detailed topographic survey of the Work area that indicates site conditions prior to commencing Work. The detailed topographic survey shall extend at least 100 ft. in all directions beyond the limits of grading. The survey shall have a horizontal scale of 1 in. = 50 ft. with 2-ft. contour intervals. This survey

shall be used by ENGINEER to establish the quantities for payment under the various items of Work and shall become the property of OWNER upon completion of the Work. The survey information shall be supplied in detail sufficient to substantiate applications for payment.

D. CONTRACTOR shall maintain existing survey monuments indicated on the Drawings.

E. CONTRACTOR or CONTRACTOR's Surveyor shall provide all materials required establishing and maintaining benchmarks, control points, grade stakes, and other necessary items.

F. CONTRACTOR or CONTRACTOR's Surveyor shall establish the elevations, lines and levels for the features of the construction project including, but not limited to:
   1. original ground surface elevation before construction;
   2. surface elevation after construction;
   3. surface and limits of geosynthetics including locations of key seam intersections;
   4. geosynthetic anchor trenches;
   5. location of components of the leachate transmission system;
   6. location of components of the landfill gas management system;
   7. location of the limits of prefabricated vertical drain installation areas;
   8. alignment and inverts of pipes (both inside and outside the landfill);
   9. profiles, cross sections, elevations for channels, culverts, and roads; and
   10. location of underground electric cabling.

G. Elevations, slopes, and component thicknesses may be verified by the CQA Surveyor, as described in the CQA Plan.

## 1.08 SURVEY FOR QUANTITY ESTIMATES

A. The survey of CONTRACTOR's Surveyor as confirmed by the ENGINEER shall be used to determine quantity estimates for all related bid items listed in the CONTRACTOR's Bid Schedule.

## 1.09 TOLERANCES

A. All constructed products shall meet the survey tolerances specified in the appropriate sections of these Technical Specifications.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 01775

# CLOSEOUT REQUIREMENTS, PROCEDURES, AND SUBMITTALS

## PART 1 GENERAL

### 1.01 CLOSEOUT PROCEDURES

A. CONTRACTOR shall submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete, in accordance with Contract Documents, and ready for ENGINEER's and OWNER's final inspection.

B. CONTRACTOR shall provide signed and sealed Final Record Documents, all submittals required by these Technical Specifications, and any other submittals required by governing or other authorities to ENGINEER and OWNER.

### 1.02 FINAL CLEANING

A. Upon completion of Work and prior to final inspection, CONTRACTOR shall remove all of its equipment, signs, facilities, construction materials, and trash, and shall perform any other reasonable clean-up activities requested by OWNER and ENGINEER. All disturbed areas shall be revegetated or otherwise put into a condition satisfactory to OWNER and ENGINEER. Stabilization of disturbed areas shall be carried out in accordance with the Technical Specifications.

### 1.03 COMPLETION DATES AND SUBSTANTIAL COMPLETION

A. The Work of the Project will be considered substantially completed when the following conditions are met:
   1. All the components of the Project have been completed to the satisfaction of the CQA Consultant and ENGINEER and are operational to the satisfaction of OWNER. Components include, but are not limited to, PVDs, perimeter MSE walls, geosynthetics, stormwater management features, leachate transmission and control systems, and access roads.
   2. All required Final Record Drawings for the Project has been submitted, and ENGINEER and/or the CQA Consultant has confirmed that the Final Record Drawings submitted is acceptable and complies with the Technical Specifications.
   3. All CQC and CQA testing for soils and geosynthetics required for the Project have been completed and acceptable results have been obtained.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

END OF SECTION

# SECTION 02055

# SOILS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to place and compact soil as specified in this Section, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Soil described in this Section shall be used for construction as follows.
   1. Structural fill shall be the primary soil used to construct the perimeter berm (see Section 02330).
   2. Granular fill shall be used in the lower portion of the perimeter berm (see Section 02330).
   3. Backdrain fill shall be used in the center portion of the perimeter berm (see Section 02330).
   4. Common fill shall be used for general grading purposes, unless otherwise specified.
   5. Leachate collection/protective cover layer shall be used to construct the leachate collection zone component of the liner system within Phase 5A and on the side slope of the perimeter berm.
   6. Bedding soil shall be used under culverts and pipes as shown on the Drawings.
   7. Culvert backfill shall be used to cover culverts and pipes as shown on the Drawings.
   8. Topsoil shall be used to support vegetation as shown on the Drawings.

C. CONTRACTOR shall be prepared to place and compact soil in conjunction with the construction of other components of the Work.

D. The Work of this Section shall include, but not necessarily be limited to:
   1. furnishing, placing, and compacting soil
   2. sampling and testing (laboratory and field) soil; and
   3. disposal and stockpiling of surplus soil.

E. Soil placed and compacted shall conform to the dimensions, lines, grades, and sections indicated on the Drawings.

F. CONTRACTOR shall be responsible to ensure that the soil meets the requirements of this Section. Any soil that does not conform to this Section will be rejected by ENGINEER and/or the CQA Consultant and shall be replaced by CONTRACTOR with soil that conforms to this Section at no cost to OWNER.

G. CONTRACTOR shall retain a Construction Quality Control (CQC) Consultant to perform the required field and laboratory tests described in this Section. The CQC Consultant shall be acceptable to OWNER and ENGINEER.

## 1.02 SUBMITTALS

A. At least 14 days prior to the delivery of soil to the Site, CONTRACTOR shall provide the following information to ENGINEER:
   1. the proposed material source or sources (either on-site or off-site); and
   2. laboratory test data in conformance with the requirements of Part 2.01.

B. At least 14 days prior to the delivery of soil to the Site, CONTRACTOR shall provide ENGINEER information describing the qualifications and capabilities of the CQC Consultant.

C. At least 14 days prior to starting soil placement and compaction, CONTRACTOR shall provide ENGINEER the following.
   1. A list of all earthmoving equipment to be used for the Project.
   2. The date and time that soil delivery operations will start
   3. The date and time that soil placement and compaction operations will start.
   4. The name of CONTRACTOR's representative who will be in charge of this phase of construction.

D. As soon as the information is available, CONTRACTOR shall provide ENGINEER and the CQA Consultant the results of field and laboratory tests performed on soil. Test reports of field tests are to be submitted by the following morning.

E. If Work is interrupted for reasons other than inclement weather, then CONTRACTOR shall notify ENGINEER a minimum of 24 hours prior to the resumption of Work.

## 1.03 CONSTRUCTION QUALITY ASSURANCE

A. Construction and testing of soil shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. CONTRACTOR shall employ an independent geotechnical testing laboratory acceptable to OWNER and ENGINEER to perform the following pre-qualification tests (at a frequency of 1 set of tests per source) on each soil borrow source and/or soil type that is proposed for use and shall provide the test results to ENGINEER.
   1. Particle-Size Analysis, with hydrometer - ASTM D 422.
   2. Atterberg Limits - ASTM D 4318.
   3. Standard Proctor - ASTM D 698.

B. Additional geotechnical tests on select soil materials shall be performed by CONTRACTOR's geotechnical, chemical, and/or agricultural testing laboratory as described in this Section.

C. All soil delivered to the Site shall meet the following chemical requirements.
   1. Toxicity Characteristic Leaching Procedure (TCLP) – The soil shall contain no constituents that exceed its respective regulatory level.
   2. Ignitability - The soil shall not be ignitable.
   3. Corrosivity - The soil shall not be corrosive.
   4. Reactivity - The soil shall be non-reactive.
   5. Total Petroleum Hydrocarbons (TPH) – The soil shall not have a TPH of greater than 5,000 parts per million (PPM).
   6. Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) – The soil not have a concentration greater than the following:
      a. Benzene – 0.5 ppm;
      b. Toluene – 10 ppm;
      c. Ethylbenzene – 5 ppm; and
      d. Xylene – 5 ppm.

D. The final approval of a source for the soil will be at the sole discretion of ENGINEER.

## 2.02 STRUCTURAL FILL

A. Structural fill shall consist of relatively homogeneous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Structural fill shall meet the Unified Soil Classification System (USCS) classification for GC, GM, SM, SC, SP-SM, or CL according to ASTM D 2487, and shall have a maximum PI of 15, as determined in accordance with ASTM D 4318.

C. Structural fill shall have no particles larger than 2 in. in largest dimension.

D. Structural fill shall exhibit a dry unit weight of 70 $lb/ft^3$ when compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698).

E. Structural fill shall exhibit a minimum internal angle of friction of 29 degrees when tested in accordance with ASTM D 3080. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

F. Structural fill in contact with any geosynthetic material shall exhibit a minimum interface friction angle of 25 degrees when tested in accordance with ASTM D 5321. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). The soil/geosynthetic interface shall be wetted and the test specimen shall be saturated for 24 hours prior to testing. Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

G. Structural fill shall exhibit a hydraulic conductivity of $1 \times 10^{-4}$ cm/s, when tested in accordance with ASTM D 5084. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of 6,000 $lb/ft^2$.

H. Structural fill shall no more than 10 percent organic matter when tested in accordance with ASTM D 2974, Method C.

## 2.03 GRANULAR FILL

A. Granular fill shall consist of relatively homogenous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Granular fill shall meet the USCS classification for GC, GM, SP-SM, or SM according to ASTM D 2487.

C. Granular fill shall have no particle size larger than 2 in. in largest dimension.

D. Granular fill shall exhibit a dry unit weight of 70 $lb/ft^3$ when compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698).

E. Granular fill shall exhibit a minimum internal angle of friction of 29 degrees when tested in accordance with ASTM D 3080. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

F. Granular fill in contact with any geosynthetic material shall exhibit a minimum interface friction angle of 25 degrees when tested in accordance with ASTM D 5321. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). The soil/geosynthetic interface shall be wetted and the test specimen shall be saturated for 24 hours prior to testing. Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

G. Granular fill shall exhibit a hydraulic conductivity of $1 \times 10^{-3}$ cm/s, when tested in accordance with ASTM D 5084. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of 9,000 $lb/ft^2$.

H. Granular fill shall no more than 10 percent organic matter when tested in accordance with ASTM D 2974, Method C.

## 2.04 BACKDRAIN FILL

A. Backdrain fill shall consist of relatively homogenous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Backdrain fill shall meet the USCS classification for GC, GM, SP-SM, or SM according to ASTM D 2487.

C. Backdrain fill shall have no particle size larger than 2 in. in largest dimension.

D. Backdrain fill shall exhibit a dry unit weight of 70 $lb/ft^3$ when compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698).

E. Backdrain fill shall exhibit an internal angle of friction of 29 degrees when tested in accordance with ASTM D 3080. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

F. Backdrain fill in contact with any geosynthetic material shall exhibit an interface friction angle of 25 degrees when tested in accordance with ASTM D 5321. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). The soil/geosynthetic interface shall be wetted and the test specimen shall be saturated for 24 hours prior to testing. Testing shall be performed for at normal stresses of: 2,000 $lb/ft^2$, 4,500 $lb/ft^2$, and 9,000 $lb/ft^2$.

G. Backdrain fill shall exhibit a hydraulic conductivity of $1 \times 10^{-2}$ cm/s, when tested in accordance with ASTM D 5084. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). Testing shall be performed for at normal stresses of 9,000 $lb/ft^2$.

H. Backdrain fill shall no more than 10 percent organic matter when tested in accordance with ASTM D 2974, Method C.

## 2.05 COMMON FILL

A. Common fill shall consist of relatively homogenous, natural soil that is free of debris, foreign objects, excess silt, roots, and organics.

B. Common fill shall meet the USCS classification for GC, GM, SM, SC, SP-SM, or CL according to ASTM D 2487.

C. Common fill classified as SM or SC shall have a maximum Plasticity Index (PI) of 25, as determined in accordance with ASTM D 4318.

D. Common fill shall have no particle larger than 2 in. in largest dimensions.

## 2.06 LEACHATE COLLECTION / PROTECTIVE COVER LAYER

A. Leachate collection/protective cover layer shall consist of relativity homogenous, natural soil that is free of debris, foreign objects, excess silt, roots and organics.

B. Leachate collection/protective cover layer shall meet the USCS classification of GC, GM, SM, SC, or SP-SM according to ASTM D 2487.

C. Leachate collection/protective cover layer shall have a maximum PI of 25, as determined in accordance with ASTM D 4318.

D. Leachate collection/protective cover layer shall meet the following particle size criteria:
   1. rounded or sub-rounded particles that are no larger than ¾ in. in largest dimension;
   2. 50 percent of particles less than 0.075 mm;
   3. for soils with linear coefficient of uniformity ($C'_u$) between 1 and 3, then the AOS of the geotextile (see Section 02071) shall be less than $2 \times C'_u \times d_{50}$; and
   4. for soils with linear coefficient of uniformity ($C'_u$) greater than 3, then the AOS of the geotextile (see Section 02071) shall be less than $18 \times (d_{50}/C'_u)$.

## 2.07 BEDDING SOIL

A. Bedding soil shall conform to the material requirements for Borrow Type G (Select Borrow), Grading I, as specified in Section 209.04 of the August 2001 edition of the State of Delaware Department of Transportation "*Standard Specifications for Road and Bridge Construction*" (DELDOT Standard Specifications).

## 2.08 CULVERT BACKFILL

A. Culvert backfill shall conform to the material requirements for Borrow Type C (Backfill), as specified in Sections 209.04 of the DELDOT Standard Specifications.

## 2.09 TOPSOIL

A. Topsoil fill shall conform to the material requirements specified in Section 732.02 of the DELDOT Standard Specifications, and shall not have a soluble salts concentration greater than 500 parts per million.

## 2.10 EQUIPMENT

A. CONTRACTOR shall only use equipment that has been approved by for this Work.

B. CONTRACTOR shall furnish, operate, and maintain grading equipment as is necessary to produce uniform layers, sections, and smoothness of grade for compaction and drainage.

C. CONTRACTOR shall furnish, operate and maintain compaction equipment as is necessary to produce the required in-place soil density and moisture content.

D. CONTRACTOR shall furnish, operate, and maintain tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable surface widths, if moisture conditioning of soil is required to achieve the specified in-place density and moisture content.

E. CONTRACTOR shall furnish, operate, and maintain soil spreading equipment that travels on the material being spread without traveling directly on the surface of the underlying compacted soil surface layer.

F. CONTRACTOR shall furnish, operate, and maintain miscellaneous equipment such as scarifiers, disks, spring tooth or spike tooth harrows, earth hauling equipment, and other equipment necessary for earthwork construction.

# PART 3 EXECUTION

## 3.01 GENERAL

A. Prior to placing and compacting soils, CONTRACTOR shall become thoroughly familiar with the Site, the site conditions, and all patrons of the Work falling under this Section and other relevant Sections related to specific uses of soil.

B. Prior to placing and compacting soil, CONTRACTOR shall carefully inspect the installed Work of all other sections and verify that all Work is complete to the point where Work of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed work of other sections, then CONTRACTOR shall immediately notify ENGINEER prior to the initiation of soil placement. Failure to notify ENGINEER in writing shall be construed as CONTRACTOR's acceptance of the relative Work of all other Sections.

C. Soil shall be placed and compacted to the lines and grades shown on the Drawings.

D. Soil shall be placed only on dry, unfrozen subgrade surfaces.

E. Soil shall be placed in loose lifts that result in a compacted lift thickness of 8 in. Compaction shall be performed using a static smooth-drum roller or padded-foot compactors as specified elsewhere in this Section. Hand compaction of material shall be used in locations where larger compaction is inappropriate due to limited area.

F. Unless otherwise specified, each soil lift shall be compacted to at least 95 percent of the maximum dry density and at a moisture content between -2 to +2 percent of the optimum moisture content as determined by ASTM D 698. At CONTRACTOR's request, ENGINEER may consider revising the range of acceptable moisture contents based on the field and laboratory test results submitted by CONTRACTOR.

G. CONTRACTOR shall finish each day's work with a smooth-drum roller to create a smooth surface, free from ruts or indentations, which will minimize moisture penetration. The area shall be left in a manner to promote runoff at the end of each day.

H. Prior to continuing construction from the previous day's work, CONTRACTOR shall scarify the surface to provide a bond between the layers.

## 3.02 STRUCTURAL FILL

A. Structural fill shall be placed and compacted within the perimeter berm as specified in Section 02330, and to the lines and grades shown on the Drawings.

## 3.03 GRANULAR FILL

A. Granular fill shall be placed and compacted within the perimeter berm as specified in Section 02330, and to the lines and grades shown on the Drawings.

## 3.04 BACKDRAIN FILL

A. Backdrain fill shall be placed and compacted within the perimeter berm as specified in Section 02330, and to the lines and grades shown on the Drawings.

## 3.05 COMMON FILL

A. Common fill shall be placed and compacted within trenches and in other non-specified areas in Section 02330, and to the lines and grades shown on the Drawings.

## 3.06 LEACHATE COLLECTION/PROTECTIVE COVER LAYER

A. Leachate collection/protective cover layer shall be placed over the geomembrane on the side slopes of the perimeter berm and within Phase 5A as shown on the Drawings.

B. Leachate collection/protective cover layer shall be placed as shown on the drawings using low-ground pressure equipment.

C. The 2-ft thick leachate collection/protective cover over the 2H:1V side slopes shall be placed in 20-ft length (i.e., 9 ft high) at a time, starting from the toe of the slope. Placement of longer lengths may be allowed by the Engineer after re-evaluation of the liner veneer stability using site specific protective cover/liner interface friction angle data.

## 3.07 BEDDING SOIL

A. Bedding soil shall be placed beneath and around culverts and pipes as shown on the Drawings.

## 3.08 CULVERT BACKFILL

A. Culvert backfill shall be placed above and around culverts and pipes as shown on the Drawings.

## 3.09 TOPSOIL

A. Topsoil shall be within the facing of the perimeter berm as specified in Section 02330, and to the lines and grades shown on the Drawings.

## 3.10 FIELD QUALITY CONTROL

A. CONTRACTOR shall perform field quality control testing of soil during placement and compaction, as described below.
   1. The minimum testing frequencies for material evaluation and construction quality evaluation are presented in Tables 02055-1 and 02055-2.
   2. Sampling locations will be selected by CONTRACTOR and will be reviewed when necessary by ENGINEER or the CQA Consultant.
   3. A special testing frequency by CONTRACTOR will be used at the discretion of ENGINEER or the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing will be considered when:
      a. the rollers slip during rolling operation;
      b. the lift thickness is greater than specified;
      c. the soil is at improper and/or variable moisture content;
      d. fewer than the specified number of roller passes are made;
      e. dirt-clogged rollers are used to compact the material;
      f. the rollers do not have optimum ballast; or
      g. the degree of compaction is doubtful.
   4. During construction, the frequency of testing by CONTRACTOR may also be increased by ENGINEER or the CQA Consultant in the following situations:
      a. adverse weather conditions;
      b. breakdown of equipment;
      c. at the start and finish of grading;
      d. if the material fails to meet specifications; or
      e. the work area is reduced.

B. Perforations:
   1. Perforations in the compacted soil that must be filled shall include, but not be limited to:
      a. nuclear density test probe locations;
      b. drive cylinder test locations; and
      c. sand cone test locations.

2. Perforations in the compacted soil shall be backfilled with similar soil. The soil shall be hand-tamped by CONTRACTOR to the satisfaction of the CQA Consultant.

C. Defective Areas:
1. If a defective area is discovered in the compacted soil, then the CQA Consultant will notify CONTRACTOR who shall proceed to determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, then CONTRACTOR will determine the extent of the defective area by additional tests, observations, a review of records, or other means that CONTRACTOR deems appropriate. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, then CONTRACTOR will define the limits and nature of the defect.
2. After the extent and nature of a defect has been determined, CONTRACTOR shall correct the deficiency to the satisfaction of ENGINEER and the CQA Consultant. The cost of corrective actions shall be borne by CONTRACTOR.
3. Additional testing will be performed CONTRACTOR to verify that the defect has been corrected. This additional testing will be performed before any additional work is allowed in the area of deficiency.

## 3.11 FIELD QUALITY ASSURANCE

A. The CQA Consultant will monitor the placement and compaction of soils in accordance with the CQA plan.

## 3.12 TOLERANCE

A. The soils shall be constructed to within ± 0.1 ft. of the thickness indicated on the Drawings.

# TABLE 02055-1

## MINIMUM TESTING FREQUENCIES FOR LABORATORY SOIL EVALUATION(1)

| TEST | METHOD | MINIMUM FREQUENCY OF TESTING |
|---|---|---|
| Grain Size Analysis (Sieve and Hydrometer) | ASTM D 422 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Moisture Content | ASTM D 2216 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Atterberg Limits | ASTM D 4318 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Standard Proctor | ASTM D 698 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Organic Content | ASTM D 2974 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Hydraulic Conductivity | ASTM D 2434 or D 5084 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Internal Angle of Friction | ASTM D 3080 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Interface Friction Angle | ASTM D 5321 | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Chemical Analyses | --- | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |
| Agricultural Analyses | --- | 1 per 10,000 $yd^3$ (minimum 1 test per material type and source) |

Note:

1. Tests to be performed by CONTRACTOR's CQC Consultant on samples of bulk soil samples collected from soil to be placed. These tests will be performed in addition to the pre-qualification tests to be performed by CONTRACTOR's CQC Consultant.

# TABLE 02055-2

## MINIMUM FIELD TESTING FREQUENCIES(1)

| TEST | METHOD | MINIMUM FREQUENCY OF TESTING |
|---|---|---|
| Moisture Content (Nuclear Gauge) | ASTM D 3017 | 1 per 10,000 $ft^2$ (minimum of six per lift) |
| In-Place Dry Density (Nuclear Gauge) | ASTM D 2922 | 1 per 10,000 $ft^2$ (minimum of six per lift) |
| In-Place Dry Density (Drive Cylinder Method or Sand Cone) | ASTM D 2937 D 1556 | 1 per day and 1 per material type used per day) |

Note:

1. Field tests are to be performed by the CONTRACTOR's CQC Consultant on in-place compacted material.

END OF SECTION

# SECTION 02060

# AGGREGATE

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the placement of aggregate and riprap as specified in this Section, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall be prepared to place aggregate and riprap in conjunction with other components of the Work.

C. The Work of this Section shall include procurement, testing, and placement of all aggregate and riprap.

D. Aggregate and riprap placed shall conform to the dimensions, lines, grades, and sections indicated on the Drawings.

E. CONTRACTOR shall retain a Construction Quality Control (CQC) Consultant to perform the required field and laboratory tests described in this Section. The CQC Consultant shall be acceptable to OWNER and ENGINEER.

### 1.02 SUBMITTALS

A. At least 14 days prior to the delivery of any aggregate or riprap, CONTRACTOR shall provide ENGINEER the following information.
   1. The proposed source(s) for aggregate and riprap.
   2. The results of a grain-size analysis on the proposed aggregate performed in accordance with ASTM C 136, or for riprap, certification that the material has the correct gradation.
   3. The results of tests performed in accordance with ASTM C 88 to determine the soundness of the proposed aggregate.
   4. The results of tests performed in accordance with ASTM C 535 to determine the degradation of the proposed aggregate.

B. The tests identified in Part 1.02.A shall be carried out by CONTRACTOR's CQC Consultant for each proposed material source and type of aggregate or riprap.

C. At least 14 days prior to the delivery of soil to the Site, CONTRACTOR shall provide ENGINEER information describing the qualifications and capabilities of the CQC Consultant.

D. At least 14 days prior to starting soil placement and compaction, CONTRACTOR shall provide ENGINEER the following.
   1. A list of all earthmoving equipment to be used for the Project.
   2. The date and time that aggregate and riprap delivery operations will start
   3. The date and time that aggregate and riprap placement operations will start.
   4. The name of CONTRACTOR's representative who will be in charge of the this phase of construction.

E. As soon as the information is available, CONTRACTOR shall provide ENGINEER and the CQA Consultant the results of field and laboratory tests performed on soil. Test reports of field tests are to be submitted by the following morning.

F. If Work is interrupted for reasons other than inclement weather, then CONTRACTOR shall notify ENGINEER a minimum of 24 hours prior to the resumption of Work.

## 1.03 CONSTRUCTION QUALITY ASSURANCE

A. The size and installation of the aggregate and riprap will be monitored and tested by CQA Consultant.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

# PART 2 PRODUCTS

## 2.01 AGGREGATE

A. Aggregate shall conform to the material requirements specified in Sections 804, 805, 813, and/or 821 of the August 2001 edition of the State of Delaware Department of Transportation "*Standard Specifications for Road and Bridge Construction*" (DELDOT Standard Specifications), as appropriate.

B. Aggregate supplied shall conform to the size and type shown on the Drawings.

## 2.02 RIPRAP

A. Riprap shall conform to the material requirements for stone riprap as specified in Section 712.04 of the DELDOT Standard Specifications.

B. Riprap supplied shall conform to the size and type shown on the Drawings.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to placing any aggregate or riprap, CONTRACTOR shall become thoroughly familiar with the Site, the site conditions, and all portions of the Work falling within this Section.

B. Prior to placing any aggregate or riprap, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall immediately notify ENGINEER prior to the initiation of aggregate placement. Failure to notify ENGINEER in writing shall be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 FIELD QUALITY ASSURANCE

A. CQA Consultant will visually observe the placement of aggregate and riprap.

B. CQA Consultant may perform conformance testing at its sole discretion.

## 3.03 INSTALLATION

A. Aggregate shall be placed to the lines and grades shown on the Drawings.

B. Placement of aggregate shall be performed manually or using a piece of equipment approved by ENGINEER. The maximum drop height shall be 18 in.

## 3.04 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and materials and completed Work of other Sections.

END OF SECTION

# SECTION 02071

# GEOTEXTILE

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all geotextile, labor, incidental materials, tools, supervision, transportation, and installation equipment necessary for the installation of geotextile, and as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Two types of geotextile shall be used for construction, and are described in this Section as follows.
   1. A non-woven, 10 oz/yd$^2$ woven geotextile shall be used at all locations shown on the Drawings, except for locations within the perimeter berm where a high-strength geotextile shall be used.
   2. A woven, high-strength geotextile shall be used within the perimeter berm for base reinforcement, as shown on the Drawings.

C. CONTRACTOR shall obtain all geotextile from a Geotextile Manufacturer that has the demonstrated experience with geotextile manufacturing as stated in Part 1.02 of this Section.

D. CONTRACTOR shall install all geotextile and shall be responsible for field handling, storing, deploying, seaming or connecting, temporary restraining, anchoring, and other site aspects of geotextile installation.

### 1.02 QUALIFICATIONS

A. The Geotextile Manufacturer shall have successfully manufactured a minimum of 20,000,000 ft$^2$ of the same type of geotextiles specified for this Project.

B. The Geotextile Manufacturer shall have sufficient manufacturing capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.

## 1.03 SUBMITTALS

A. At least 14 days prior to shipping any geotextile, CONTRACTOR shall provide ENGINEER with the following documentation on the proposed geotextile:
   1. manufacturer and product name;
   2. minimum property values of the proposed geotextile and corresponding test procedures;
   3. proposed geotextile delivery dates; and
   4. a statement from the Geotextile Manufacturer that the geotextiles will retain their structure during handling, placement, and long-term service; and be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration.

B. At least seven days prior to deploying the geotextile, CONTRACTOR shall provide ENGINEER the following documentation on geotextile production:
   1. a list of geotextile roll numbers delivered to the Site;
   2. lot, batch and/or roll numbers and identification; and
   3. results of quality control tests, including a description of the test methods, signed by a responsible party employed by the Geotextile Manufacturer (e.g., Production Manager).

## 1.04 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geotextile shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the construction schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the geotextile manufacturing facility during the manufacture of the high-strength geotextile in order to expedite the conformance testing and approval process.

# PART 2 PRODUCTS

## 2.01 GEOTEXTILE PROPERTIES

A. Geotextiles shall meet the properties listed in Table 02071-1.

B. The geotextiles provided shall be stock products. Products specifically manufactured to meet these Technical Specifications shall not be used unless authorized by OWNER and ENGINEER.

## 2.02 MANUFACTURING QUALITY CONTROL

A. The Geotextile Manufacturer shall sample and test the geotextile, at a minimum, once every 100,000 $ft^2$ of geotextile manufactured to demonstrate that the material conforms to all requirements listed in Table 02071-1.

B. Sampling shall, in general, be performed on sacrificial portions of the material such that repair of the material is not required.

C. Any geotextile sample that does not comply with the requirements of this Section shall result in the rejection of the roll from which the sample was obtained. The Geotextile Manufacturer shall replace any rejected roll at no cost to OWNER.

D. If a geotextile sample fails to meet the quality control requirements of this Section, then CONTRACTOR shall require that the Geotextile Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll, at no cost to OWNER. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

E. Additional sample testing may be performed at the Geotextile Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

F. The Geotextile Manufacturer shall comply with the certification and submittal requirements of this Section.

## 2.03 PACKING AND LABELING

A. Geotextile shall be supplied by the Geotextile Manufacturer in rolls wrapped in relatively waterproof and opaque protective covers.

B. Geotextile rolls shall be marked or tagged with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot number;
   4. roll number; and

5. roll dimensions.

## 2.04 TRANSPORTATION

A. Transportation of geotextile is the responsibility of the Geotextile Manufacturer. The Geotextile Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation.

B. Geotextile shall be delivered to the Site at least seven days before the scheduled date of deployment to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

## 2.05 HANDLING AND STORAGE

A. CONTRACTOR shall be responsible for handling, unloading, storage, and care of the geotextile prior to, during, and following installation. CONTRACTOR shall be liable for all damages to the geotextile incurred prior to final acceptance by OWNER and ENGINEER.

B. CONTRACTOR shall be responsible for storage of the geotextile at the Site after the material is delivered and shall protect the geotextile from moisture, long-term direct exposure to sunlight, puncture, or other damaging or deleterious conditions (e.g., mud, dirt, and dust). CONTRACTOR shall be responsible for any additional storage procedures required by the Geotextile Manufacturer.

## 2.06 CONFORMANCE TESTING

A. Samples of the high-strength geotextile will be removed by the CQA Consultant at the factory and sent to an independent geosynthetics laboratory (i.e., different than the Geomembrane Manufacturer) for testing to ensure conformance with the requirements of this Section.

B. Conformance sampling and testing will be performed in accordance with the CQA Plan.

C. Samples will be taken at a minimum frequency of one sample per 100,000 $ft^2$ with a minimum of one sample per lot. If the Geotextile Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 100,000 $ft^2$ (90,000 $ft^2$), then CONTRACTOR shall pay the cost for all.

D. The CQA Consultant may direct CONTRACTOR to increase the frequency of sampling in the event that test results do not comply with requirements of Part 2.01 of this Section until passing conformance test results are obtained for all material that is received at the Site. This additional testing shall be performed at the expense of CONTRACTOR.

E. Any high-strength geotextile roll that is not certified in accordance with Part 1.03 of this Section, or that conformance testing indicates do not comply with Part 2.01 of this Section, will be rejected by the CQA Consultant. The Geotextile Manufacturer shall replace the rejected material with new material, at no additional cost to OWNER.

## PART 3 EXECUTION

### 3.01 FAMILIARIZATION

A. Prior to implementing any Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work of this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all such Work is complete to the point where the Work of this Section may properly commence without adverse impact.

C. If CONTRACTOR has any concern regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing prior to placing any geotextile will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

### 3.02 HANDLING AND PLACEMENT

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in anyway.

B. Precautions shall be taken to prevent damage to underlying materials during placement of the geotextile.

C. After unwrapping the geotextile from its opaque cover, the geotextile shall not be left exposed for a period in excess of 30 days unless ENGINEER approves a longer exposure period. Approval may be based on a formal demonstration from the Geotextile Manufacturer that the geotextile is stabilized against ultraviolet degradation for a period in excess of 30 days.

D. If white colored geotextile is used, then precautions shall be taken against "snowblindness" of personnel.

E. CONTRACTOR shall examine the surfaces to be covered with geotextile before deployment to ensure there are no potentially harmful foreign objects. Foreign objects shall be removed prior to deploying the geotextile.

F. All geotextile shall be anchored with ballast during windy conditions. Such ballasts shall be installed during placement and shall remain until the geotextile is covered.

G. The CQA Consultant shall examine the deployed geotextile surface after installation to ensure that no potentially harmful foreign objects are present either above or below the geotextile.

H. Geotextile shall not be placed on saturated or frozen subgrade standing water.

## 3.03 SEAMS AND OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, geotextile shall be continuous down the slope; that is, no horizontal seams are allowed. Horizontal seams shall be considered as any seam having an alignment exceeding 20 degrees from being perpendicular to the slope contour lines, unless otherwise approved by ENGINEER. No horizontal seams shall be allowed within 5 ft. of the top or toe of the slopes.

B. Geotextiles shall be overlapped as indicated on the Drawings.

C. When specified on the Drawings, geotextile shall be continuously sewn (i.e., spot sewing is not allowed) using a "single prayer" seam, with the stitching a minimum of 1.5 in. from the edge of the geotextile. Stitching shall be two-thread, double-locked, 7 stitches per inch.

D. Geotextile shall be sewn with polymeric thread, having similar strength characteristics as the geotextile.

## 3.04 REPAIR

A. Any holes or tears in the geotextile shall be repaired using a patch made from the same geotextile. Geotextile patches will be sewn into place no closer than 1 in. from any panel edge. Should any tear exceed 50 percent of the width of the roll, that roll shall be removed and replaced.

B. Where geosynthetic materials underlie the geotextile being placed, care shall be taken to remove any soil or other material that may have penetrated the torn geotextile.

## 3.05 MATERIALS IN CONTACT WITH GEOTEXTILE

A. CONTRACTOR shall place all soil or aggregate on top of geotextile such that:
   1. the geotextile and underlying materials are not damaged;
   2. minimum slippage occurs between the geotextile and underlying layers; and
   3. excess stresses are not induced in the geotextile.

B. Equipment shall not be driven directly on the geotextile. Unless otherwise specified by ENGINEER, all equipment operating on earthen materials overlying the geotextile shall comply with the following.

| Allowable Equipment Ground Pressure (psi) | Thickness of Overlying Compacted Soil (ft) |
|---|---|
| <5 | 1.0 |
| <10 | 1.5 |
| <20 | 2.0 |
| >20 | 3.0 |

## 3.06 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and materials and completed Work of other Sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of ENGINEER or the CQA Consultant and at no cost to OWNER.

# TABLE 02071

## REQUIRED GEOTEXTILE PROPERTIES(1)

| PROPERTIES | QUALIFIERS | UNITS | SPECIFIED VALUES | | TEST METHOD |
|---|---|---|---|---|---|
| | | | 10 oz/yd$^2$ | High-Strength | |
| Polymer Composition (polypropylene or polyester) | minimum | percent | 95 | 95 | --- |
| Construction Type | --- | --- | needle-punched, non-woven | woven | --- |
| Mass Per Unit Area | minimum | oz/yd$^2$ | 10 | NA | ASTM D 5261 |
| Apparent Opening Size | maximum | mm | $O_{95} \leq 0.21$ | $O_{95} \leq 0.21$ | ASTM D 4751 |
| Grab Strength | minimum | lb. | 200 | NA | ASTM D 4632 |
| Tear Strength | minimum | lb. | 80 | NA | ASTM D 4533 |
| Puncture Strength | minimum | lb. | 130 | NA | ASTM D 4833 |
| Burst Strength | minimum | lb. | 450 | NA | ASTM D 3786 |
| Permittivity | minimum | sec$^{-1}$ | NA | 0.02 | ASTM D 4491 |
| Long-Term Allowable Design Strength | minimum | lb/ft | --- | 21,000 | GRI-GT7 |

Notes:

1. All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).

END OF SECTION

# SECTION 02072

# GEOSYNTHETIC CLAY LINER

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, incidental materials, tools, supervision, transportation, and installation equipment necessary for installation of geosynthetic clay liner (GCL) and a vapor barrier as specified herein, as shown on the Drawings, and in accordance with Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall obtained the specified GCL from a GCL Manufacturer that has the demonstrated experience with GCL manufacturing as stated in Part 1.02 of this Section. The vapor barrier shall be a high-density polyethylene (HDPE) geomembrane obtained from the Geomembrane Manufacturer specified in Section 02075. The GCL and vapor barrier may be two separate products or one product (i.e., bentonite adhered to the geomembrane).

C. CONTRACTOR shall retain the services of a Geosynthetics Installer to install the approved GCL and vapor barrier in conjunction with other components of the Project. The Geosynthetics Installer shall be approved by the GCL Manufacturer.

D. Installation of the GCL and vapor barrier shall be performed by the Geosynthetics Installer approved under Section 02075, and shall be responsible for field handling, storing, deploying, overlapping, temporary restraining, anchoring, maintaining the GCL in an un-hydrated state, and all other aspects of GCL installation.

E. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects.

### 1.02 QUALIFICATIONS

A. The GCL Manufacturer shall have successfully manufactured a minimum of 20,000,000 $ft^2$ of the same GCL as specified for this Project for use in at least ten landfill projects in the past five years.

B. The GCL Manufacturer shall have sufficient manufacturing capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.

## 1.03 SUBMITTALS

A. At least 14 days prior to shipping any GCL to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the GCL Manufacturer that will supply the GCL.
   1. Corporate background and information.
   2. Manufacturing capabilities, including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures; and
      d. list of material properties, including certified test results, to which are attached samples.
   3. A list of at least ten landfill projects within the last five years that the GCL Manufacturer has manufactured a minimum of 20,000,000 $ft^2$ of the same GCL as specified for this Project. The following information shall be provided for each facility:
      a. name, location, and purpose of facility, and date of installation;
      b. names of OWNER, ENGINEER, and CONTRACTOR; and
      c. surface area of GCL manufactured.
   4. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin for the vapor barrier.

B. Prior to shipping GCL rolls, CONTRACTOR shall provide ENGINEER with the following documentation on GCL roll production.
   1. Manufacturing quality control certificates for each shift's production, signed by responsible parties employed by the Manufacturer (such as the Production Manager).
   2. The quality control certificates shall include:
      a. roll numbers and identification;
      b. sampling procedures; and
      c. results of quality control tests, including description of test methods used.
   3. The GCL Manufacturer quality control tests to be performed are outlined in Part 2.02 of this Section.

## 1.04 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the GCL shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the GCL manufacturing facility in order to expedite the conformance testing and approval process.

# PART 2 PRODUCTS

## 2.01 GCL PROPERTIES

A. The GCL and vapor barrier shall meet the property values listed on Table 02072-1.

B. If the GCL consists sodium bentonite granules adhered to one side of a the vapor barrier with, then the bentonite shall be adhered to the backing material in a manner that prevents it from being dislodged when transported, handled, and installed in a manner specified by the GCL Manufacturer. The bentonite will be held in place by using adhesives. The method used to hold the bentonite in place shall not be detrimental to other components of the liner system.

C. The GCL shall have the following minimum dimensions:
   1. the minimum roll width shall be 15 ft.; and
   2. the liner length shall be long enough to conform to the requirements specified in this Section.

D. The bentonite used to fabricate the GCL shall have at least 90 percent sodium montmorillonite.
   1. The geomembrane component of the GCL shall be manufactured from new, first-quality polyethylene resin, and shall be designed and manufactured specifically for use in geomembrane.
   2. Reclaimed polymer shall not be added to the resin.
   3. However, the use of polymer recycled during the manufacturing process shall be permitted if performed with appropriate cleanliness and if the recycled polymer does not exceed 5 percent by weight of the total polymer weight.

E. The vapor barrier shall be a textured HDPE geomembrane having properties that comply with the required property values provided in Table 02072-1.

F. In addition to the HDPE geomembrane property values listed in Table 02072-1, the geomembrane shall:
   1. contain a maximum of one percent by weight of additives, fillers, or extenders (not including carbon black);
   2. not have striations, pinholes, or bubbles on the surface or in the interior;
   3. be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter; and
   4. be manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness).

## 2.02 MANUFACTURING QUALITY CONTROL

A. The GCL Manufacturer shall sample and test the GCL and vapor barrier to demonstrate that the material complies with Part 2.01 of this Section.

B. The GCL Manufacturer shall sample and test the GCL and vapor barrier for the properties listed on Table 02072-1 at a minimum frequency of once per 50,000 $ft^2$, except for hydraulic flux (ASTM D 5887), which shall be tested once per 200,000 $ft^2$.

C. Sampling shall, in general, be performed on sacrificial portions of the GCL and vapor barrier such that repair is not required.

D. Any GCL or vapor barrier sample that does not comply with the requirements of this Section shall result in the rejection of the roll from which the sample was obtained. The GCL Manufacturer shall replace any rejected rolls at no cost to OWNER.

E. If a GCL or vapor barrier sample fails to meet the quality control requirements of this Section, then CONTRACTOR shall require that the GCL Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll, at no cost to OWNER. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

F. Additional sample testing may be performed, at the GCL Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

G. The GCL Manufacturer shall comply with the certification and submittal requirements of this Section.

## 2.03 PACKING AND LABELING

A. GCL and vapor barrier shall be supplied by the GCL Manufacturer in rolls wrapped in watertight and opaque protective covers.

B. GCL and vapor barier shall be marked or tagged by the GCL Manufacturer with the following information:
   1. manufacturer's name;
   2. product identification;
   3. lot number;
   4. roll number; and
   5. roll dimensions.

## 2.04 TRANSPORTATION

A. Transportation of the GCL and vapor barrier shall be the responsibility of the GCL Manufacturer. The GCL Manufacturer shall be liable for all damage to the GCL and vapor barrier incurred prior to and during transportation, including pre-mature hydration of the GCL.

B. GCL and vapor barrier shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

## 2.05 HANDLING AND STORAGE

A. The GCL shall be stored and handled in accordance with ASTM D 5888.

B. The vapor barrier shall be stored in accordance with the requirements of Section 02075.

C. CONTRACTOR shall be responsible for handling, storage, and care of the GCL and vapor barrier prior to and following installation at the Site. CONTRACTOR shall be liable for all damages to the GCL and vapor barrier incurred prior to final acceptance by ENGINEER.

D. CONTRACTOR shall be responsible for storage of the GCL and vapor barrier at the Site after the material is delivered.

## 2.06 CONFORMANCE TESTING

A. After the GCL and vapor barrier have been received at the Site, CONTRACTOR shall assist the CQA Consultant in obtaining conformance samples.

B. GCL and vapor barrier conformance samples shall be sent to the CQA Laboratory for testing required by the CQA Plan. Passing test results are required before any GCL and vapor barrier is deployed.

C. Samples shall be taken at a minimum frequency rate of one sample per 100,000 $ft^2$, with a minimum of one sample per lot. If the GCL Manufacturer provides material that requires conformance sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 100,000 $ft^2$ (90,000 $ft^2$), then CONTRACTOR shall pay the cost for all additional testing.

D. The CQA Consultant may increase the frequency of sampling in the event that test results do not comply with the requirements of Part 2.01 of this Section until passing conformance test results are obtained for all GCL and vapor barrier that is received at the Site. This additional testing shall be performed at the expense of CONTRACTOR.

E. Any GCL or vapor barrier that is not certified by the GCL Manufacturer in accordance with Part 1.03 of this Section, or that has a hydraulic conductivity greater than that specified in Part 2.01, shall be rejected and replaced by the GCL Manufacturer, at no cost to OWNER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, the Geosynthetics Installer shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work of this Section, the Geosynthetics Installer shall carefully inspect the installed Work of all other Sections and verify that all such Work is complete to the point where the Work of this Section may properly commence without adverse impact.

C. If Geosynthetics Installer has any concern regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing or commencement of installation of the GCL and vapor barrier will be construed as Geosynthetics Installer's acceptance of the related Work of all other Sections.

## 3.02 SURFACE PREPARATION

A. The Geosynthetics Installer shall provide certification in writing that the surface on which the GCL and vapor barrier will be installed is acceptable. This certification of acceptance shall be given to the CQA Consultant prior to commencement of GCL and vapor barrier installation in the area under consideration.

B. Special care shall be taken to maintain the prepared soil surface in a smooth, dry condition.

C. No GCL or vapor barrier shall be placed onto an area which has been softened by precipitation or which has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the subgrade.

D. Any damage to the soil surface caused by installation activities shall be repaired at CONTRACTOR's expense.

## 3.03 ANCHORAGE

A. The anchor trench shall be excavated prior to GCL and vapor barrier placement to the lines, grades, and configuration shown on the Drawings and as specified in the Technical Specifications.

B. No loose soil shall be allowed in the anchor trench beneath the GCL and vapor barrier.

C. Slightly rounded corners shall be provided in the trench where the GCL and vapor barrier adjoins the trench to avoid sharp bends in the GCL and vapor barrier.

D. The anchor trench shall not be backfilled until after all geosynthetics have been installed in the trench.

## 3.04 HANDLING AND PLACEMENT

A. GCL shall be handled in such a manner as to ensure that it is not damaged or prematurely hydrated in any way.

B. GCL shall be not be allowed to hydrate greater than a moisture content of 30 percent.

C. GCL rolls that have a moisture content of greater than 30 percent shall be removed and replaced by the Geosynthetics Installer at no cost to OWNER.

D. GCL and vapor barrier shall be cut using a utility blade in a manner so as not to damage adjacent materials.

E. During placement, care shall be taken not to entrap stones, or moisture under the GCL and vapor barrier. Care shall be taken not to walk on or drag equipment across the exposed GCL.

F. Any GCL and vapor barrier damaged by stones, other foreign objects, or installation activities shall be repaired by the Geosynthetics Installer in accordance with Part 3.07 of this Section.

G. GCL and vapor barrier shall not be installed on a saturated subgrade or on standing water. The GCL shall be installed in a way that prevents hydration prior to completion of construction, including placement of overlying geosynthetics and soil/aggregate.

H. The GCL and vapor barrier shall not be installed during precipitation or other conditions that may cause hydration of the GCL.

I. The GCL and vapor barrier shall be installed such that the vapor barrier is in direct contact with the subgrade and the GCL is placed over the vapor barrier. If the bentonite is adhered to the geomembrane vapor barrier, then the bentonite component of the material shall be installed facing upwards.

## 3.05 OVERLAPS

A. On slopes steeper than 10 horizontal to 1 vertical, GCL and vapor barrier shall be continuous down the slope; that is, no horizontal seams shall be allowed on the slope.

B. GCL and vapor barrier shall be overlapped in accordance with the GCL Manufacturer's recommended procedures and as indicated on the Drawings. At a minimum, the overlaps shall be 12 in. along the length and width of the panel.

C. The overlaps shall not be nailed or stapled to the subgrade.

## 3.06 MATERIALS IN CONTACT WITH GCL

A. Geomembrane installation shall immediately follow the GCL and vapor barrier installation and shall be performed in accordance with Section 02075.

B. Geomembrane shall not be placed on GCL that is hydrated.

C. GCL that is placed during a day's work shall be covered with geomembrane before the Geosynthetics Installer leaves the site at the end of the day.

D. All geomembrane seams overlying the installed GCL shall be welded after each geomembrane panel is placed in accordance with the requirements of Section 02075. Heat sealing of the seam alone is not acceptable.

E. All defects in the geomembrane overlying the GCL and destructive sample locations shall be immediately repaired in accordance with the requirements of Section 02075.

## 3.07 REPAIR

A. Any holes or tears in the GCL shall be repaired by placing a GCL patch over the hole. The patch shall overlap the edges of the hole or tear by 2 ft. in all directions. The patch shall be secured with a water-based adhesive approved by the GCL Manufacturer.

B. Any holes or tears in the vapor barrier shall be repaired in accordance with the requirements of Section 02075.

C. Care shall be taken to remove any soil or other material that may have penetrated the torn GCL.

D. All repairs shall be made at no additional cost to OWNER.

E. The patch shall not be nailed or stapled.

## 3.08 PRODUCT PROTECTION

A. 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, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of ENGINEER and the CQA Consultant and at no cost to OWNER.

# TABLE 02072-1

## REQUIRED GCL PROPERTY VALUES[1]

| PROPERTIES | QUALIFIERS | UNITS | SPECIFIED VALUES | TEST METHOD |
|---|---|---|---|---|
| GCL Properties: | | | | |
| Bentonite Content[2] | minimum | $lb/ft^2$ | 0.75 | ASTM D 5993 |
| Hydraulic Flux[3] | minimum | $m^3/m^2$-sec | $1 \times 10^{-8}$ | ASTM D 5887 |
| Bentonite Swell Loss | minimum | mL/2g | 24 | ASTM D 5890 |
| Bentonite Fluid Loss | maximum | mL | 18 | ASTM D 5891 |
| Moisture Content (Bentonite) | maximum | percent | 30 | ASTM D 4643 |
| Geomembrane Properties: | | | | |
| Thickness | nominal | mils | 30 | ASTM D 5994 |
| | minimum average | mils | 28.5 | ASTM D 5994 |
| | lowest individual 8 out of 10 values | mils | 27 | ASTM D 5994 |
| | lowest individual for any of the 10 values | mils | 25.5 | ASTM D 5994 |
| Asperity Height | minimum | mils | 10 | GRI Test Method GM 12 |
| Tensile Properties (each direction) | | | | |
| 1. Yield Strength | minimum | lb/in. | 63 | ASTM D 638 |
| 2. Break Strength | minimum | lb/in. | 45 | ASTM D 638 |
| 3. Yield Elongation | minimum | percent | 12 | ASTM D 638 |
| 4. Break Elongation | minimum | percent | 100 | ASTM D 638 |
| Tear Resistance | minimum | lb. | 21 | ASTM D 1004 |
| Puncture Resistance | minimum | lb. | 45 | ASTM D 4833 |
| Carbon Black Content | range | % | 2.0-3.0 | ASTM D 1603 |
| Carbon Black Dispersion | N/A | none | See Note 4 | ASTM D 5596 |
| Stress Crack Resistance | minimum | hours | 400 | ASTM D 5397 |

Notes:

1. All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).
2. The sodium bentonite component shall be applied at an average concentration of 0.75 $lb/ft^2$ when measured at a water content of zero percent.
3. Hydraulic flux the GCL shall be measured under an effective confining stress of 5 $lb/in^2$.
4. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2; and
   - 1 in Category 3.

END OF SECTION

# SECTION 02075

# GEOMEMBRANE

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geomembrane as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. Either textured high-density polyethylene (HDPE) geomembrane or textured polypropylene (PP) shall be used as the geomembrane for this Project. The approved geomembrane will have properties that comply with the requirements specified in Table 02075-1.

C. CONTRACTOR shall obtain the specified geomembrane from a qualified Geomembrane Manufacturer that has the demonstrated experience with geomembrane manufacturing as stated in Part 1.02.A of this Section.

D. CONTRACTOR shall retain the services of a Geosynthetics Installer to install the approved geomembrane in conjunction with the other components of the Project. The Geosynthetics Installer shall be approved by the Geomembrane Manufacturer and have the demonstrated experience with installation of the geomembrane as stated in Part 1.02.B of this Section.

### 1.02 QUALIFICATIONS

A. Geomembrane Manufacturer:
   1. The Geomembrane Manufacturer shall be capable of manufacturing geomembrane rolls from resin and shall have sufficient production capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.
   2. The Geomembrane Manufacturer shall have successfully manufactured a minimum of 20,000,000 $ft^2$ of HDPE or PP geomembrane for use in at least ten landfill projects in the past five years.

B. Geomembrane Installer:
   1. The Geosynthetics Installer shall be responsible for field handling, storing, deploying, seaming, temporarily restraining (against wind), and other site aspects of the geomembrane and other components of the liner system, and shall provide qualified installation personnel, as outlined in this Section. The Geosynthetics Installer may also be responsible for anchoring systems.
   2. As a firm, the Geosynthetics Installer shall have successfully installed a minimum of 10,000,000 $ft^2$ of HDPE or PP geomembrane for at least ten landfill projects in the past five years.
   3. The superintendent assigned to this project shall have supervised the installation of a minimum of 2,000,000 $ft^2$ of either HDPE or PP geomembrane on at least 10 ten different landfill liner systems.
   4. All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests.
      a. At least one seamer shall have experience seaming a minimum of 1,000,000 lineal ft. of HDPE or PP geomembrane seams using the same type of seaming apparatus to be used at this Site. Seamers with such experience will be designated "master seamers" and shall provide direct supervision over less experienced seamers.
      b. Seaming personnel shall have seamed at least 100,000 lineal ft. of HDPE and PP geomembrane seams using the same type of seaming apparatus to be used at this Site.

C. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held responsible for any defects.

## 1.03 WARRANTY

A. CONTRACTOR shall provide a written warranty from the Geomembrane Manufacturer to OWNER and ENGINEER for a 20-year period against defects in material from the date the installation of the geomembrane is accepted.

B. CONTRACTOR shall provide a written warranty from the Geosynthetics Installer to OWNER and ENGINEER for a one-year period against defects in workmanship from the date the installation of the geomembrane is accepted.

C. Warranty conditions concerning limits of liability will be evaluated and must be acceptable to OWNER and ENGINEER.

## 1.04 SUBMITTALS

A. At least 14 days prior to shipping any geomembrane to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the Geomembrane Manufacturer that will supply the geomembrane.
   1. Corporate background and information.
   2. Manufacturing capabilities, including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures; and
      d. list of material properties, including certified test results, to which are attached liner samples.
   3. A list of at least ten landfill projects within the last five years that the Geomembrane Manufacturer has manufactured a minimum of 20,000,000 $ft^2$ of HDPE or PP geomembrane. The following information shall be provided for each facility:
      a. name, location, and purpose of facility, and date of installation;
      b. names of OWNER, ENGINEER, and CONTRACTOR; and
      c. thickness and surface area of geomembrane manufactured.
   4. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin.

B. At least 14 days prior to shipping any geomembrane to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the resin used to manufacture the geomembrane.
   1. Copies of quality control certificates issued by the resin supplier including the production dates, brand name, and origin of the resin used to manufacture the geomembrane for the Project.
   2. Results of tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the Project.
   3. Certification that no reclaimed or recycled polymer is added to the resin during the manufacturing of the geomembrane to be used for this Project.

C. Prior to the shipping the geomembrane rolls, CONTRACTOR shall provide ENGINEER with the following documentation on geomembrane roll production.

1. Manufacturing certificates for each shift's production of geomembrane, signed by responsible parties employed by the Geomembrane Manufacturer (such as the Production Manager).
2. The quality control certificate shall include:
   a. roll numbers and identification;
   b. sampling procedures; and
   c. results of quality control tests, including descriptions of the test methods used.
3. The Geomembrane Manufacturer quality control tests to be performed are outlined in Part 2.03 of this Section.

D. At least 14 days prior to the scheduled date of geomembrane installation, the Geosynthetics Installer shall submit to ENGINEER the following:
   1. Corporate background and information.
   2. Copy of Geomembrane Installer's letter of approval or license by the Geomembrane Manufacturer.
   3. Installation capabilities, including:
      a. information on equipment and personnel;
      b. average daily production anticipated for this Project; and
      c. quality control procedures;
   4. A list of at least ten landfill projects within the last five years that the Geomembrane Installer has installed a minimum of 10,000,000 $ft^2$ of HDPE or PP geomembrane. The following information shall be provided for each facility:
      a. the name and purpose of the facility, its location, and dates of installation;
      b. the names of OWNER, ENGINEER, and CONTRACTOR;
      c. name and qualifications of the installer's supervisor(s);
      d. thickness and surface area of installed geomembrane;
      e. type of seaming and type of seaming apparatus used; and
      f. duration of installation.
   5. Resumes of all personnel who will perform seaming operations on this Project, including dates and duration of employment.
   6. A drawing showing the installation layout identifying field seams, as well as any variance or additional details that deviate from the Drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.
   7. Installation schedule.
   8. A Certificate of Calibration less than 12 months old for the field tensiometer referenced in Parts 3.05.I and K of this Section.

E. At least 14 days prior to transporting welding rod to the Site, the Geosynthetic Installer shall submit the following documentation on welding rod to ENGINEER:

1. quality control documentation, including lot number, welding rod spool number, and results of quality control tests on the welding rod; and
2. certification that the welding rod is compatible with the geomembrane and this Section.

F. During the installation, the Geosynthetics Installer shall be responsible for the timely submission to ENGINEER the following:
   1. quality control documentation; and
   2. subgrade acceptance certificates, signed by the Geosynthetics Installer, for each area to be covered by geomembrane.

G. Upon completion of the installation, CONTRACTOR shall submit to ENGINEER the following:
   1. required warranties as specified in Part 1.03 of this Section; and
   2. record drawings of the installation as specified in Section 01721.

## 1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of geomembrane shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR and the Geosynthetics Installer shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the geomembrane manufacturing facility in order to expidite the conformance testing and approval process.

# PART 2 PRODUCTS

## 2.01 RESIN

A. The geomembrane shall be manufactured from new, first-quality resin, and shall be designed and manufactured specifically for use in geomembrane. Reclaimed or recycled polymer shall not be added to the resin.

## 2.02 GEOMEMBRANE PROPERTIES

A. The manufacturer shall furnish geomembrane having properties that comply with the required property values provided below and in Table 02075-1.

B. In addition to the property values listed in Table 02075-1, the geomembrane shall:
   1. contain a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black);
   2. not have striations, pinholes, or bubbles on the surface or in the interior;
   3. be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter; and
   4. be manufactured in a single layer (thinner layers shall not be welded together to produce the final required thickness).

## 2.03 MANUFACTURING QUALITY CONTROL

A. Rolls.
   1. The Geomembrane Manufacturer shall continuously monitor the geomembrane during the manufacturing process for inclusions, bubbles, or other defects. Geomembrane that exhibits any defects will not be accepted.
   2. The Geomembrane Manufacturer shall continuously monitor the geomembrane thickness during the manufacturing process. Geomembrane that fails to meet the specified minimum thickness will not be accepted.
   3. The Geomembrane Manufacturer shall sample and test the geomembrane in accordance with the test frequency stated in GRI Test Method GM13 for HDPE geomembrane or at a minimum of once every 50,000 $ft^2$ for PP geomembrane to demonstrate that its properties conform to the values specified in Table 02705-1.
   4. Samples of the geomembrane shall be taken across the entire width of the roll.
   5. At a minimum, the following manufacturing quality control tests shall be performed:

| Test | Procedure |
|---|---|
| Thickness | ASTM D 5994 |
| Asperity Height | GRI Test Method GM12 |
| Density | ASTM D 792 or ASTM D 1505 |
| Tensile Properties (not applicable to PP) | ASTM D 638 |
| Puncture Resistance | ASTM D 4833 |
| Carbon Black Content (not applicable to PP) | ASTM D 1603 |
| Carbon Black Dispersion (not applicable to PP) | ASTM D 5596 |

6. Any geomembrane sample that does not comply with the requirement of this Section shall result in rejection of the roll from which the sample was obtained. The Geomembrane Manufacturer shall replace any rejected rolls at no additional cost to OWNER.
7. In the case of the rejection of a roll of geomembrane, the Geomembrane Manufacturer shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
8. Additional testing may be performed at the Geomembrane Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.
9. In addition to the tests listed under Part 2.03.B.5 of this Section, CONTRACTOR and/or Geomembrane Manufacturer must provide laboratory test data that demonstrates that the geomembrane supplied meets the requirements for environmental stress crack (ASTM D 5397) and interface friction (ASTM D 5321) as listed on Table 02075-1. This testing shall be performed on geomembrane manufactured at the same time, from the same type of resin, and exhibiting the same material properties as the geomembrane to be used for this Project. The Geomembrane Manufacturer shall provide the test results as part of his quality control documentation.

C. Manufacturing Plant Visit
1. The Geomembrane Manufacturer shall allow OWNER, ENGINEER, and/or the CQA Consultant to visit the manufacturing plant for project specific visits. If possible, then the visits will be prior to or during the manufacturing of the geomembrane rolls for this Project.
2. During the visit, OWNER, ENGINEER, or CQA Consultant may:
   a. review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;

b. verify that properties guaranteed by the manufacturer comply with these Technical Specifications;
c. verify that the measurements of properties by the manufacturer are properly documented and the test methods used are acceptable;
d. check select geomembrane rolls for evidence of holes, blisters, or any sign of contamination by foreign matter;
e. review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane; and
f. verify that roll packages are labeled in compliance with Part 2.05 of this Section.

## 2.04 GEOMEMBRANE SUPPLY

A. The geomembrane shall be supplied to the Site in rolls or as factory panels. A factory panel is comprised of one or more rolls that have been seamed together in a factory.

## 2.05 LABELING

A. Geomembrane and fabricated panels shall be labeled with the following information:
1. thickness of the material;
2. length and width of the roll or factory panel;
3. names of manufacturer;
4. directions to unroll the material;
5. product identification;
6. lot number; and
7. roll or factory panel number.

## 2.06 TRANSPORTATION

A. Transportation of the geomembrane is the responsibility of the Geomembrane Manufacturer. The Geomembrane Manufacturer shall be liable for all damages to the geomembrane incurred prior to and during transportation to the Site.

B. Geomembrane shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

## 2.07 HANDLING AND STORAGE

A. CONTRACTOR shall be responsible for handling, storage, and care of the geomembrane prior to and following installation at the Site. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance by OWNER and ENGINEER.

B. CONTRACTOR shall be responsible for storage of the geomembrane at the Site. During storage, the geomembrane shall be protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall be stored in accordance with any additional requirements of the Geomembrane Manufacturer.

## 2.08 CONFORMANCE TESTING

A. Samples of the geomembrane will be removed by the CQA Consultant at the factory and sent to an independent geosynthetics laboratory (i.e., different than the Geomembrane Manufacturer) for testing to ensure conformance with the requirements of this Section.

B. Conformance sampling and testing will be performed in accordance with the CQA Plan.

C. Samples will be taken at a minimum frequency of one sample per 100,000 $ft^2$ with a minimum of one sample per lot. If the Geomembrane Manufacturer provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of 100,000 $ft^2$ (90,000 $ft^2$), then CONTRACTOR shall pay the cost for all.

D. The CQA Consultant may direct CONTRACTOR to increase the frequency of sampling in the event that test results do not comply with requirements of Part 2.02 of this Section until passing conformance test results are obtained for all material that is received at the Site. This additional testing shall be performed at the expense of CONTRACTOR.

E. Any geomembrane roll or panel that is not certified in accordance with Part 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.02 of this Section, will be rejected by the CQA Consultant. The Geomembrane Manufacturer shall replace the rejected material with new material, at no additional cost to OWNER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any Work described in this Section, the Geomembrane Installer shall become thoroughly familiar with all portions of the Work required by Section.

B. The Geosynthetic Installer shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this Section may properly commence without adverse impact to the project.

C. If the Geosynthetic Installer has any concerns regarding the installed Work of other Sections, then he should notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing or commencing geomembrane installation will be construed as the Geosynthetic Installer's acceptance of the related Work of other Sections.

## 3.02 SURFACE PREPARATION

A. The Geosynthetics Installer shall provide certification in writing that the surface on which the geomembrane will be installed is acceptable. The surface shall be free of stones, litter, organic matter, irregularities, protrusion, loose soil, and any abrupt changes in grade that could damage the geomembrane. The certification of acceptance shall be given to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration.

B. Special care shall be taken to maintain the prepared subgrade.

C. No geomembrane shall be placed onto an area which has been softened by precipitation or which has cracked due to desiccation. The soil surface shall be observed daily to evaluate the effects of desiccation cracking and/or softening on the integrity of the subgrade.

D. Any damage to the soil surface caused by installation activities shall be repaired at the CONTRACTOR's expense.

E. The CONTRACTOR or Geosynthetics Installer shall be responsible for dewatering areas that have been accepted for geomembrane deployment, including anchor trenches.

## 3.03 ANCHORAGE

A. The anchor trench shall be excavated prior to geomembrane placement to the lines, grades, and configuration shown on the Drawings and as specified in these Technical Specifications.

B. No loose soil shall be allowed in the anchor trench beneath the geomembrane.

C. The anchor trench shall be backfilled and compacted after the geomembrane has been installed in the trench. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane.

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

## 3.04 GEOMEMBRANE DEPLOYMENT

A. The Geosynthetics Installer shall prepare a geomembrane installation layout drawing(s) prior to geomembrane deployment. These drawings shall indicate the geomembrane configuration, dimensions, details, locations of seams, etc. Field seams shall be differentiated from factory seams (if any) on the drawings. Field seams shall be oriented up or down slope and not across slope. ENGINEER must approve the layout drawings prior to the installation of any geomembrane. The layout drawings, as modified and/or approved by ENGINEER, shall become part of the Contract Documents.

B. Field Panel Identification
   1. A geomembrane field panel is defined as follows:
      a. If the geomembrane is not fabricated into factory panels, then a field panel is a roll or a portion of roll cut in the field.
      b. If the geomembrane is fabricated into factory panels, then a field panel is a factory panel or a portion of factory panel cut in the field.
   2. Each field panel must be given an identification code (number or letter-number). This identification code shall be agreed upon by the CQA Consultant and Geosynthetics Installer. The field panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

C. Field Panel Placement

1. Field panels shall be installed as approved or modified at the location and positions indicated in the layout drawings.
2. 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.
3. Geomembrane may only be deployed daylight hours between one hour after sunrise and one hour before sunset.
4. Geomembrane shall not be placed when the ambient temperature is below 32°F or above 104°F, unless otherwise authorized by ENGINEER.
5. Geomembrane shall not be placed during any precipitation, in the presence of excessive moisture (e.g., frost, ice, fog, dew), in an area of ponded water, or in the presence of winds exceeding 20 miles per hour.
6. The Geosynthetics Installer shall employ placement methods consistent with the following:
   a. no vehicular traffic shall be allowed on the geomembrane.
   b. equipment used shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.
   c. personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
   d. the method used to unroll the panels shall not scratch or crimp the geomembrane and shall not damage the supporting soil.
   e. the prepared surface underlying the geomembrane shall not be allowed to deteriorate after acceptance of the surface, and shall remain acceptable up to the time of geomembrane placement.
   f. the method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).
   g. temporary loads and/or anchors (e.g., sand bags, tires), not likely to damage the geomembrane, may be placed on the geomembrane to prevent uplift by wind (in high winds, continuous loading is recommended along panel edges to minimize the risk of wind flow under the panels).
7. Any field panel or portion thereof that becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material at no cost to OWNER. Less serious damage may be repaired at the CQA Consultant's sole discretion and at no cost to OWNER. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area.
8. Placement of geomembrane shall not damage the underlying geosynthetic clay liner.

## 3.05 FIELD SEAMING

A. In general, seams shall be oriented parallel to the line of maximum slope, (i.e., oriented down, not across, the slope). In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be made within 5 ft. of any toe of the slope, except where approved by ENGINEER and/or the CQA Consultant. No seams shall be located in an area of potential stress concentration, as defined by ENGINEER.

B. All personnel performing seaming operations shall be qualified as indicated in the CQA Plan and in this Section. No seaming shall be performed unless a "master seamer" (as defined in the CQA Plan and in this Section) is present.

C. The geomembrane shall have field seams that equal or exceed the strength requirements presented in Table 02075-2.

D. Weather Conditions for Seaming

1. Seaming shall not be attempted at ambient temperatures below 32°F or above 104°F or when wind velocity exceeds 20 miles per hour. At ambient temperatures between 32°F and 50°F, seaming shall be allowed if the geomembrane is preheated either by the sun or a hot air device, and if there is no excessive cooling from wind. At ambient temperatures above 50°F, no preheating will be required. In all cases, the geomembrane shall be dry and protected from excessive wind.
2. If the Geosynthetics Installer wishes to use methods that allow seaming at ambient temperatures below 32°F or above 104°F, then he shall demonstrate that the seam so produced is equivalent to those produced under normally approved conditions, and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the Contract between OWNER and the Geosynthetics Installer shall be required that specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane.
3. To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted, and during the middle of the day if overcast conditions prevail. If the geomembrane must be seamed in the middle of a sunny day, then the Geosynthetics Installer shall ensure that the panels to be seamed are at the same temperature and that there is sufficient slack in the geomembrane to prevent the generation of excessive stresses or trampolining when the geomembrane contracts as cooler

temperatures prevail. The Geosynthetics Installer shall determine the required amount of slack and it should not be so much so as to cause significant wrinkling of the geomembrane. If trampolining of the geomembrane is observed, then the Geosynthetics Installer will be required to make repairs so that the problem is eliminated.

4. Ambient temperatures shall be measured within 6 in. above the geomembrane surface.

E. Overlapping and Temporary Bonding

1. Geomembrane panels shall be overlapped a minimum of 3 in. for extrusion welding and 5 in. for fusion welding, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
2. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of the air at the nozzle of spot welding apparatus shall be controlled such that the geomembrane is not damaged.
3. No solvent or adhesive shall be used unless OWNER has approved the product in writing. Samples of any proposed solvent or adhesive shall be submitted to CONTRACTOR for testing and evaluation at the Geosynthetics Installer's expense.

F. Seam Preparation

1. Prior to seaming, the seam area shall be cleaned and made free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, then the process shall be completed according to the Geomembrane Manufacturer's instructions within 20 minutes of the seaming operation and in a manner that does not damage the geomembrane. The grind depth shall not exceed ten percent of the geomembrane thickness. Grinding marks shall not appear beyond 0.25 in. of the extrudate after it is placed.
3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

G. General Seaming Requirements

1. Seaming shall extend to the outside edge of panels, including those panels placed in the anchor trench.
2. If required to provide a firm substrate, then a board, or similar hard surface, placed directly under the seam overlap may be used to achieve proper support.
3. Fishmouths or wrinkles at the seam overlaps shall be removed by cutting the geomembrane along the ridge of the wrinkle. At the end(s) of the cut, cut a circle in the geomembrane to achieve a flat overlap. The cut shall be seamed as described

in the Section. Any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane that extends a minimum of 6 in. beyond the cut in all directions.

H. Seaming Process

1. Approved processes for field seaming are extrusion welding and fusion welding. Seaming equipment shall be operated in a manner that does not cause damage to the geomembrane. Only apparatus that ENGINEER has specifically approved by make and model shall be used. Proposed alternate seaming processes shall be documented and submitted to ENGINEER.
2. Extrusion Equipment and Procedures:
   a. The Geosynthetics Installer shall maintain at least one spare operable extrusion seaming apparatus on site at all times.
   b. Extrusion welding apparatus shall be equipped with gauges giving the temperature in the apparatus.
   c. Prior to beginning a seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel.
   d. 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.
3. Fusion Equipment and Procedures:
   a. The Geosynthetics Installer shall maintain at least one spare operable seaming apparatus on site at all times.
   b. Fusion-welding apparatus shall be automated vehicular-mounted devices equipped with gauges giving the instantaneous temperatures and pressures of the machine.
   c. The edges of cross seams shall be abraded to a smooth incline (top and bottom) prior to welding.
   d. A movable protective layer may be used directly below each geomembrane overlap to be seamed to prevent the buildup of moisture between the sheets.
   e. 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. A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

I. Trial Seams

1. Trial seams shall be made prior to production seaming by all seamers and by all equipment to be used during production seaming. The trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual production field seams. The trial seam sample shall be at least 5-ft. long by 1-ft. wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as specified in Part 3.05.E of this Section.
2. Four adjoining specimens, each 1.0-in. wide, shall be cut from the trial seam sample by the Geosynthetics Installer. The specimens shall be tested in peel (both tracks for fusion welds) using an electronic readout field tensiometer, and the specimen shall fail by film tear bond (FTB) (i.e., failure in the parent material) rather than in the seam. The Geosynthetics Installer shall test the specimens in the presence of the CQA Consultant. Testing using the field tensiometer shall be performed in accordance with ASTM D 6392, at a strain rate of 2 in./minute. Ideally, the samples shall be conditioned at 73°F at a relative humidity of 50 percent for two hours prior to testing. If test conditions vary from this requirement, then a 1-in. wide specimen of the parent geomembrane (no weld) shall be tested in the same manner as the seam specimens to determine the break strength at this condition. At no time shall the specimens be soaked in water.
3. If a specimen fails to comply with the properties stated in Table 02075-2, then the entire operation shall be repeated. If the additional specimen fails to meet these requirements, then the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.
4. After completion of the above described tests, the remaining portion of the trial seam sample can be discarded. If a trial seam sample fails a test, then a destructive test seam sample may be taken from the seams completed by the seamer during the shift related to the considered trial seam at the discretion of ENGINEER of the CQA Consultant. These samples shall be forwarded to CQA geosynthetics laboratory and, if they fail the tests, the procedure indicated in Part 3.05.K.5 of this Section shall apply. The results of all testing shall be reported to the CQA Consultant. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam.

J. Nondestructive Seam Continuity Testing

1. The Geosynthetics Installer shall nondestructively test all field seams over their full length using a vacuum test, air pressure test (for double fusion seams only), 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 3.05.L of this Section. The following procedures shall apply to locations where seams cannot be nondestructively tested:
   a. If the seam is accessible to testing equipment prior to final installation, then the seam shall be nondestructively tested prior to final installation.
   b. If the seam cannot be tested prior to final installation, then the seaming operations must be observed in their entirety by the CQA Consultant for uniformity and completeness.
2. Vacuum testing of extrusion field seams and repairs shall be performed in accordance with ASTM D 5641.
3. Air pressure testing shall be performed on double fusion seams only, and shall be performed in accordance with ASTM D 5820 and the following:
   a. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than 5 minutes.
   b. If loss of pressure exceeds 4 psi, or if the pressure does not stabilize, then locate faulty area and repair in accordance with Part 3.05.L of this Section.
   c. Cut opposite end of air channel from pressure gauge and observe release of pressure to ensure that the entire channel is not blocked.
   d. Remove needle, or other approved pressure feed device, and seal repair in accordance with Part 3.05.L of this Section.
4. ENGINEER may allow spark testing in accordance with ASTM D 6365 if the seam cannot be tested using other nondestructive methods.

K. Destructive Testing

1. Destructive testing of field seams shall be performed on samples collected from selected locations to evaluate seam strength and integrity according to the requirements for seam strength presented in Table 02075-2. Destructive testing shall be carried out as the geomembrane installation progresses, not at the completion of all field seaming.
2. Sampling
   a. Field seam samples shall be collected for destructive testing at a minimum average frequency of one test location per 500 ft. of seam length. Test locations shall be determined during seaming, and may be prompted by

suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The CQA Consultant will be responsible for choosing the locations. The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken. ENGINEER or the CQA Consultant reserves the right to increase the sampling frequency.

b. Samples of the field seams shall be cut with rounded corners by the Geosynthetics Installer at the locations designated by the Geosynthetics CQA Consultant as the seaming progresses. Passing laboratory test results must be obtained before the field seams are covered by another material. All holes in the geomembrane resulting from the field seam sampling shall be immediately repaired in accordance with the repair procedures described in Part 3.05.L of this Section. The continuity of the new seams in the repaired areas shall be tested according to Part 3.05.J of this Section.

c. Two strips, 1-in. wide and 12-in. long with the seam centered parallel to the width, shall be taken. The strips shall be spaced a clear distance of 42-in. apart. These samples shall be tested using the field tensiometer in accordance with Part 3.05.I.2 of this Section. If these samples pass the field test, then a laboratory sample shall be taken. The laboratory sample shall be at least 1-ft. wide by 42-in. long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

   i. one 1-ft. long portion to the Geosynthetics Installer.
   ii. one 1-ft. long portion to OWNER for its archives;
   iii. one 1.5-foot long portion to the CQA Consultant laboratory testing.

3. If any field test sample fails to meet the required seam strength properties presented in Table 02075-2, then the procedures outlined in Part 3.05.K.5 of this Section shall be followed.
4. Samples shall be tested in the laboratory in accordance with the requirements of this Section and the CQA Plan.
5. Destructive Test Failure

   a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the CQA laboratory, the Geosynthetics Installer's laboratory, or by a field tensiometer. The Geosynthetics Installer shall have two options, as described in b and c below.

   b. The Geosynthetics Installer can reconstruct the seam (e.g., remove the old seam and reseam) between two passing destructive test locations. The welding path of the seaming apparatus shall be tracked (in each direction).

c. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 ft. from the location of the failed test (in each direction) and take a small sample for an additional field test at each location. If these additional samples pass the tests, then full laboratory samples shall be taken. If these laboratory samples pass the tests, then the seam shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam should be reconstructed. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken. In cases where the length of reconstructed seam exceeds 150 ft., a destructive sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the CQA Consultant may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift.

L. Defects and Repairs

1. All seams and non-seam areas of the geomembrane will be examined by the CQA Consultant and the Geosynthetic Installer for evidence of 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 examination. The geomembrane surface shall be swept or washed by the Geosynthetics Installer if surface contamination inhibits examination. The Geosynthetics Installer shall ensure that this examination of the geomembrane precedes any seaming of that section.
2. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described Part 3.05.J of this Section, as appropriate. Each location that fails nondestructive testing shall be marked by the CQA Consultant and repaired by the Geosynthetics Installer. Work shall not proceed with any materials that will cover the defective area until the suspect location is repaired and passing nondestructive test are obtained. In addition, passing destructive test results shall be achieved prior to placing any material over geomembrane.
3. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall identify excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam the wrinkle areas so identified. The seams thus produced shall be tested like any other seams.

4. Repair Procedures.
   a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Consultant and the Geosynthetics Installer. The procedures available include:
      i. patching, used to repair large holes, small tears, undispersed raw materials, and contamination by foreign matter;
      ii. abrading and reseaming, used to repair small sections of extruded seams;
      iii. spot seaming, used to repair pinholes, or other minor, localized flaws;
      iv. capping, used to repair long lengths of failed seams;
      v. removing failed seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams) and/or extrusion seams.
   b. In addition, the following shall be satisfied:
      i. surfaces of the geomembrane that are to be repaired shall be abraded no more than 20 minutes prior to the repair;
      ii. all surfaces must be clean and dry at the time of repair;
      iii. all seaming equipment used in repair procedures must be approved by ENGINEER or the CQA Consultant;
      iv. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Consultant and Geosynthetics Installer;
      v. patches or caps shall extend at least 6 in. beyond the edge of the defect, and all corners of holes and patches shall be rounded with a radius of at least 3 in.; and
      vi. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.
5. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in this Section. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the CQA Consultant, destructive testing may be required on large caps.

## 3.06 MATERIALS IN CONTACT WITH THE GEOMEMBRANE

A. The Geosynthetics Installer shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the liner system or by other construction activities. Installation on rough surfaces, such as concrete, shall be performed carefully.

B. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by ENGINEER, all equipment operating on materials overlying the geomembrane shall comply with the following:

| Allowable Equipment Ground Pressure (psi) | Thickness of Overlying Compacted Soil (ft.) |
|---|---|
| <5 | 1.0 |
| <10 | 1.5 |
| <20 | 2.0 |
| >20 | 3.0 |

C. In heavily trafficked areas such as access ramps, and in areas trafficked by rubber tire vehicles, the thickness of overlying compacted soil shall be at least 3 ft.

D. Installation of the geomembrane in sump areas, and connection of the geomembrane to appurtenances shall be made according to these Technical Specifications and as shown on the Drawings. Extreme care shall be taken while seaming around sumps and appurtenances since neither nondestructive nor destructive testing may be feasible in these areas. The Geosynthetics Installer shall ensure that the geomembrane has not been visibly damaged while making connections to sumps and appurtenances. Because of the difficulty of vacuum testing seams in the sump area, fusion seams should be made at all possible locations in the sump.

E. Placement of soils above the geomembrane will not proceed at an ambient temperature below 32°F nor above 104°F unless otherwise specified, or approved by ENGINEER.

## 3.07 GEOMEMBRANE ACCEPTANCE

A. The Geosynthetics Installer shall retain all ownership and responsibility for the geomembrane until accepted by OWNER and ENGINEER.

B. The geomembrane will not be accepted by OWNER and ENGINEER until all of the following conditions are met:
   1. the installation is finished;
   2. all documentation of installation is completed including the CQA Consultant's final report;
   3. verification of the adequacy of all field seams and repairs, including associated testing, is complete; and
   4. written certification documents, including record drawings, sealed by a professional land surveyor licensed in the State of Delaware, have been received by OWNER and ENGINEER, in accordance with section 01721.

## 3.08 PRODUCT PROTECTION

A. 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, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

# TABLE 02075-1

## REQUIRED TEXTURED GEOMEMBRANE PROPERTY VALUES[1, 8]

| PROPERTIES | QUALIFIERS | UNITS | SPECIFIED VALUES | | TEST METHOD |
|---|---|---|---|---|---|
| | | | HDPE | PP | |
| Thickness | Nominal | Mils | 60 | 45 | ASTM D 5994 |
| | minimum average | Mils | 57 | --- | ASTM D 5994 |
| | lowest individual 8 out of 10 values | Mils | 54 | --- | ASTM D 5994 |
| | lowest individual for any of the 10 values | Mils | 51 | 40 | ASTM D 5994 |
| Asperity Height | minimum average | Mils | 10 | 10 | GRI Test Method GM 12 |
| Density | Minimum | g/cc | 0.940 | | ASTM D 792 or ASTM D 1505 |
| Tensile Properties (each direction) | | | | | |
| 1. Yield Strength | Minimum | lb/in. | 126 | N/A[2] | ASTM D 638 |
| 2. Break Strength | Minimum | lb/in. | 90 | | ASTM D 638 |
| 3. Yield Elongation | Minimum | % | 12 | N/A[2] | ASTM D 638 |
| 4. Break Elongation | Minimum | % | 100 | | ASTM D 638 |
| Tear Resistance | Minimum | lb. | 42 | | ASTM D 1004 |
| Puncture Resistance | Minimum | lb. | 90 | | ASTM D 4833 |
| Interface Friction (see Note 3) | Minimum | Degrees | 25[4] | 25[4] | ASTM D 5321 |
| | Minimum | Degrees | 25[4] | 25[4] | ASTM D 5321 |
| Carbon Black Content | Range | % | 2.0-3.0 | N/A[6] | ASTM D 1603 |
| Carbon Black Dispersion | N/A | None | See Note 7 | N/A[6] | ASTM D 5596 |
| Stress Crack Resistance | Minimum | Hours | 400 | | ASTM D 5397 |

Notes:

1. All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed these values).
2. The tensile stress/strain behavior of flexible polypropylene does not exhibit a well-defined yield point. Therefore, the value for this property is not specified.
3. Interface friction testing shall be performed by CONTRACTOR on the entire liner system cross section using the proposed liner system materials (i.e., structural fill, GCL, geomembrane, geotextile, and aggregate). The testing shall be performed at the normal stresses indicated.
4. Testing shall be performed at high normal stresses of 2,000 lb/ft$^2$, 4,500 lb/ft$^2$, and 9,000 lb/ft$^2$.
5. Testing shall be performed at low normal stresses of 100 lb/ft$^2$, 200 lb/ft$^2$, and 400 lb/ft$^2$.
6. Carbon black is not used in flexible polypropylene for UV stabilization.
7. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   - 9 in Categories 1 or 2; and
   - 1 in Category 3.
8. The manufacturer shall perform EPA Test Method 9090 utilizing leachate from the Cherry Island Landfill demonstrating that the liner is chemically resistant to the waste and leachate. The results shall be provided prior to transporting any lining material to the site.

## TABLE 02075-2

## REQUIRED TEXTURED GEOMEMBRANE SEAM PROPERTIES

| PROPERTIES | QUALIFIERS | UNITS | SPECIFIED VALUES | | TEST METHOD |
|---|---|---|---|---|---|
| | | | HDPE | PP | |
| Gauge | Nominal | mils | 60 | 45 | --- |
| Shear Strength[1] at yield point | Minimum | Lb/in | 108 | | ASTM D 4437 |
| Peel Adhesion FTB[2] Fusion | Minimum | lb/in | 90 | | ASTM D 4437 |
| Extrusion | - | - | 78 | | ASTM D 4437 |

Notes:
1. Also called "Bonded Seam Strength."
2. In addition to the minimum passing values, passing seams shall exhibit film tear bond (FTB) and the seam shall not separate more that 10 percent.

END OF SECTION

# SECTION 02076

# GEOGRID

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the storage, delivery, installation, and testing of geogrid as specified here in, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall install the geogrid in conjunction with the construction of the perimeter berm.

C. Two types of geogrid shall be used for construction, and are described in this Section as follows.
   1. A structural geogrid shall be used at all locations shown on the Drawings, except for locations within the facing of the perimeter berm where a wrap geogrid shall be used.
   2. A wrap geogrid shall be used within the facing of the perimeter berm as shown on the Drawings.

D. CONTRACTOR shall obtain the specified geogrid from a qualified Geogrid Manufacturer that has demonstrated experience with geogrid manufacturing as stated in Part 1.02 of this Section

### 1.02 QUALIFICATIONS

A. The Geogrid Manufacturer shall be responsible for the production of geogrid rolls from resin and shall have sufficient production capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of the Project.

B. The Geogrid Manufacturer shall have successfully manufactured a minimum of 20,000,000 $ft^2$ of geogrid for use in at least ten similar type projects in the past five years.

## 1.03 WARRANTY

A. Upon request by ENGINEER, CONTRACTOR shall furnish to OWNER a 20-year written warranty for its Work obtained from the Geogrid Manufacturer against defects in materials and workmanship.

B. Warranty conditions concerning limits of liability will be evaluated upon receipt and must be acceptable to OWNER and ENGINEER.

## 1.04 SUBMITTALS

A. At least 14 days prior to shipping any geogrid to the Site, CONTRACTOR shall provide ENGINEER the following documentation on the Geogrid Manufacturer that will supply the geogrid.
   1. Corporate background and information.
   2. Manufacturing capabilities including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures; and
      d. list of material properties, including certified test results, to which samples are attached.
   3. A list of at least ten similar projects that the Geogrid Manufacturer has manufactured a minimum of 20,000,000 $ft^2$ of geogrid. The following information shall be provided for each facility:
      a. name, location, purpose of facility, and date of installation;
      b. names of OWNER, ENGINEER, and CONTRACTOR; and
      c. type and strength of geogrid supplied.
   4. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin.

B. Prior to shipping any geogrid to the Site, CONTRACTOR shall provide ENGINEER the following documentation on geogrid production.
   1. Manufacturing certificates for each shift's production of geogrid, signed by a responsible party employed by the Geogrid Manufacturer (such as the Production Manager).
   2. The quality control certificate shall include:
      a. roll numbers and identification;
      b. sampling procedures; and

c. results of quality control tests, including descriptions of the test methods used.

3. The Geogrid Manufacturer quality control tests to be performed are outlined in Parts 2.01 and 2.02 of this Section.

C. At least 14 days prior to the scheduled date of geogrid placement, CONTRACTOR shall provide ENGINEER samples of the proposed geogrid connections. This submission shall include details of the proposed joining method for the load-carrying direction of the geogrid.

D. Upon completion of the geogrid installation, CONTRACTOR shall provide ENGINEER the required warranty as specified in Part 1.03.

## 1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of geogrid shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities in the CQA Plan and shall account for those CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the geogrid manufacturing facility during the manufacture of the structural geogrid in order to expedite the conformance testing and approval process.

# PART 2 PRODUCTS

## 2.01 STRUCTURAL GEOGRID

A. Structural geogrid shall be stock products, rather than products specifically manufactured to satisfy this Technical Specification.

B. Structural geogrid shall consist of sheet or grid type products manufactured with polymeric materials for soil reinforcement applications.

C. Structural geogrid shall be manufactured with additives that are blended with the polymer resin in order to increase the resistance of the product to degradation from ultraviolet light.

D. Structural geogrid shall have a long-term allowable tensile strength of 5,000 lb/ft$^2$ when tested in accordance with ASTM D 6637.

E. Structural geogrid shall have an ultimate tensile strength of 12,000 lb/ft$^2$ when tested in accordance with ASTM D 6637.

F. Structural geogrid in contact with any soil shall exhibit a minimum interface friction angle of 25 degrees when tested in accordance with ASTM D 5321. Test specimens shall be compacted to 95 percent of maximum dry density and within two percent of the optimum moisture content as determined by the standard Proctor compaction test (ASTM D 698). The soil/geosynthetic interface shall be wetted and the test specimen shall be saturated for 24 hours prior to testing. Testing shall be performed for at normal stresses of: 2,000 lb/ft$^2$, 4,500 lb/ft$^2$, and 9,000 lb/ft$^2$.

## 2.02 WRAP GEOGRID

A. Wrap geogrid shall be stock products, rather than products specifically manufactured to satisfy this Technical Specification.

B. Wrap geogrid shall consist of sheet or grid type products manufactured with polymeric materials for soil reinforcement applications.

C. Wrap geogrid shall be manufactured with additives that are blended with the polymer resin in order to increase the resistance of the product to degradation from ultraviolet light.

D. Wrap geogrid shall have a tensile strength of 450 lb/ft$^2$ at two percent strain, when tested in accordance with ASTM D 6637.

E. Wrap geogrid shall have a tensile strength of 920 lb/ft$^2$ at five percent strain, when tested in accordance with ASTM D 6637.

F. Wrap geogrid shall have an ultimate tensile strength of 1,300 lb/ft$^2$ when tested in accordance with ASTM D 6637.

G. Wrap geogrid shall have an ultra violet stability of 98 percent at 500 hours, when tested in accordance with ASTM D 4355.

H. Wrap geogrid shall have a minimum polypropylene content of 97 percent when tested in accordance with ASTM D 4101.

I. Wrap geogrid shall have a minimum of two percent carbon black, when tested in accordance with ASTM D 4218.

## 2.03 LABELING

A. Geogrid rolls shall be marked or tagged with the following information:
   1. manufacturer's name;
   2. project identification;
   3. lot number;
   4. roll number; and
   5. roll dimensions.

## 2.04 TRANSPORTATION

A. Transportation of the geogrid is the responsibility of the Geogrid Manufacturer. The Geogrid Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the Site.

B. Geogrid shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining additional conformance samples, if needed.

## 2.05 HANDLING AND STORAGE

A. CONTRACTOR shall be responsible for handling, storage, and care of the geogrid prior to and following installation at the Site. CONTRACTOR shall handle, store, and care for the geogrid in accordance with the Geogrid Manufacturer's recommendations. CONTRACTOR shall be liable for all damages to the materials incurred prior to conditional acceptance by OWNER and ENGINEER.

B. OWNER shall provide adequate storage space at the Site.

## 2.06 MANUFACTURING QUALITY CONTROL

A. The Geogrid Manufacturer shall continuously monitor geogrid during the manufacturing process for inclusions, bubbles, or other defects. Geogrid that exhibits any defects will not be accepted.

B. The Geogrid Manufacturer shall sample the geogrid during manufacturing. Samples of geogrid shall be taken across the width of the roll.

C. At a minimum, the manufacturing quality control tests shall be performed every 100,000 $ft^2$, except for the following tests on the structural geogrid.

| Test | Procedure | Test Frequency |
|---|---|---|
| Tensile Strength | ASTM D 6637 | 1 per 50,000 $ft^2$ |
| Interface Friction Angle | ASTM D 5321 | 1 per 500,000 $ft^2$ |

D. Any geogrid sample that does not comply with the requirements of this Section will result in rejection of the roll from which the sample was obtained. The Geogrid Manufacturer shall replace any rejected rolls at no cost to OWNER.

E. In the case of the rejection of a geogrid roll, the Geogrid Manufacturer shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

F. Additional testing may be performed at the Geogrid Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or qualify individual rolls.

G. Manufacturing Plant Visit
   1. The Geogrid Manufacturer shall allow OWNER, ENGINEER, and/or the CQA Consultant to visit the manufacturing plant for project specific visits. If possible, then such visits will be during the manufacturing of geogrid for the Project.
   2. During the visits, OWNER, ENGINEER, or the CQA Consultants may:
      a. review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;
      b. verify that properties guaranteed by the manufacturer comply with these Technical Specifications;
      c. verify that the measurements of properties by the manufacturer are properly documented and the test methods used are acceptable;
      d. check selected geogrid rolls for evidence of holes, blisters, or any sign of contamination by foreign matter;
      e. review packaging and transportation procedures to verify that these procedures are not changing the geogrid; and
      f. verify that roll packages are labeled in compliance with Part 2.03 of this Section.

## 2.06 CONFORMANCE TESTING

A. Samples of geogrid shall be removed by the CQA Consultant at the geogrid factory and sent to an independent geosynthetic laboratory (i.e., different than the Geogrid Manufacturer) approved by ENGINEER for testing to ensure conformance with the requirements of this Section.

B. Conformance sampling and testing will be performed in accordance with the CQA Plan.

C. The CQA Consultant may direct CONTRACTOR to increase the frequency of Manufacturing Quality Control sampling and testing in the event that conformance test results do not comply with the requirement of Parts 2.01 and 2.02 of this Section until passing manufacturing quality control and conformance test results are obtained for all material received at the Site. This sampling and testing shall be performed at the expense of CONTRACTOR.

D. Any geogrid roll that is not certified in accordance with Part 1.04 of the Section or that conformance testing failure to comply with Parts 2.01 and 2.02 of this Section, will be rejected by the CQA Consultant. The Geogrid Manufacturer shall replace the rejected geogrid with new geogrid, at no cost to OWNER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work required by this Section.

B. CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the Work of this Section may properly commence without adverse impact to the Project.

C. If CONTRACTOR has any concerns regarding the installed Work of the other Sections then CONTRACTOR shall notify ENGINEER in writing prior to the start of the Work of this Section. Failure to inform ENGINEER in writing or commencing geogrid installation will be constructed as CONTRACTOR's acceptance of the related Work of other Sections.

## 3.02 GEOGRID INSTALLATION

A. Geogrid shall be placed with its roll direction perpendicular to the perimeter berm face at lengths shown on the Drawings.

B. Geogrid shall be placed side by side. Overlaps and/or connections shall be in accordance with the Geogrid Manufacturer's recommendation, as approved by ENGINEER. Overlaps and connections in the roll direction are prohibited.

C. All geogrid shall be restrained from moving out of alignment during and after placement and backfilling of the perimeter berm (Section 02330). Alignment shall be maintained by securing each geogrid roll to the ground with stakes or anchoring by hand-placing a small quantity of soil on top of the geogrid prior to placing and compacting soil.

D. When installing the geogrid, CONTRACTOR shall pull the geogrid as taut as possible in order to "prestress" the geogrid. While holding the main strip taut, stakes should be driven through the geogrid apertures, or soil should be placed on top of the geogrid, in order to hold the geogrid in place and maintain the "prestress" until the geogrid is anchored by geogrid in place.

E. CONTRACTOR shall handle all geogrid such that it is not damaged in any way. The geogrid shall be cut using a method approved by ENGINEER.

## 3.03 MATERIALS IN CONTACT WITH GEOGRID

A. Structural fill and granular fill (Section 02055) shall be placed and compacted over the structural geogrid.

B. Structural fill, granular fill, and topsoil (Section 02055) shall be placed and compacted over the wrap geogrid.

C. Soil shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in and/or movement of the geogrid. At the end of each day's work, the soil shall be worked such that positive drainage off the working platform is maintained.

D. Tracked construction equipment shall not be operated directly upon the geogrid. A minimum compacted soil thickness of 6 in. shall be maintained over the geogrid in order to operate tracked vehicles over the geogrid. Turning of tracked vehicles should

be kept to a minimum to prevent tracks from displacing the soil and damaging the geogrid.

E. Rubber-tired equipment may pass over the geogrid at speeds less than 5 miles per hour. Sudden braking and sharp turning shall be avoided.

## 3.04 GEOGRID CONNECTION TO PERIMETER BERM WALL FACING

A. The geogrid shall be connected to the wall facing in accordance with the recommendations of the Wall Facing Manufacturer.

## 3.05 GEOGRID ACCEPTANCE

A. CONTRACTOR shall retain all ownership and responsibility for the geogrid until accepted by OWNER or ENGINEER.

B. The geogrid will not be accepted by OWNER or ENGINEER until all the following conditions are met:
   1. the installation is finished; and
   2. all documentation of installation is completed including the CQA Consultant's final report.

## 3.06 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all Work and all materials and completed Work of other Sections.

B. In the event of damages, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of ENGINEER and the CQA Consultant and at no cost to OWNER.

END OF SECTION

# SECTION 02081

# LANDFILL GAS HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for installation of all high density polyethylene (HDPE) pipe, fittings and appurtenances as specified herein, as shown on the Drawings.

B. CONTRACTOR shall coordinate the installation of the HDPE pipe and fittings with other construction activities and subcontractors at the Site.

### 1.02 SUBMITTALS

A. At least 14 days prior to the start of landfill gas pipe installation, CONTRACTOR shall provide ENGINEER complete, detailed shop drawings of all HDPE pipe and fittings, a list of materials to be furnished, the names of the suppliers and the proposed dates of delivery of the materials to the Site.

B. Upon delivery of pipe materials to the Site, CONTRACTOR shall provide ENGINEER the HDPE pipe manufacturer's certification of compliance with these Technical Specifications for all materials delivered to the Site, and shall comply with the HDPE pipe manufacturer's recommendations for handling, storing, and installing HDPE pipes and fittings.

C. Prior to transporting any HDPE pipe or fittings to the Site, CONTRACTOR shall provide ENGINEER in writing the following documentation from the HDPE pipe Manufacturer on the raw materials used to manufacture the HDPE pipe and fittings:
   1. certificate stating the specific resin, its source and the information required by ASTM D 1248; and
   2. certification that no recycled compound has been added to the resin.

D. Prior to transporting any HDPE pipe or fittings to the Site, CONTRACTOR shall provide ENGINEER certification from the HDPE pipe manufacturer that stress regression testing has been performed on the specific product in accordance with ASTM D 2837.

## 1.03 WARRANTY

A. CONTRACTOR shall furnish OWNER written warranties obtained from the Manufacturer and the Installer against defects in materials and workmanship in accordance with ASTM D 3350 and ASTM F 714 and effective for a one-year period. Warranty conditions proposed by the manufacturer or installer concerning limits of liability will be evaluated and must be acceptable to OWNER.

## 1.04 RESPONSIBILITY

A. CONTRACTOR shall provide the services of a HDPE pipe and fittings manufacturer and installer. CONTRACTOR shall, however, accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed HDPE pipe and fittings.

B. The pipe manufacturer shall be responsible for the production and delivery of the HDPE pipe and fittings and shall be a well-established firm with more than two years experience in the manufacture of HDPE pipe and fittings.

C. CONTRACTOR shall be responsible for field handling, storing, installing, and other site aspects of the installation of the HDPE pipe and fittings.

## 1.05 CONSTRUCTION QUALITY ASSURANCE

A. CQA monitoring of the installation of HDPE pipe and fittings shall be conducted by OWNER.

B. CONTRACTOR shall be aware of and shall account for these CQA activities in the installation schedule.

# PART 2 PRODUCTS

## 2.01 HIGH DENSITY POLYETHYLENE COMPOUND

A. The HDPE pipe and fittings shall be manufactured from new, high performance, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P 34), ASTM D 3350 (Cell Classification PE 345434C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted.

B. The polyethylene compound shall contain a minimum of 2 percent carbon black.

C. The polyethylene compound shall have a minimum resistance of 125 hours when tested for environmental stress crack in accordance with requirements of ASTM D 1693, Procedure B.

## 2.02 HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS

A. The HDPE pipe shall have a minimum Hydrostatic Design Basis (HDB) of 1,600 psi, as determined in accordance with ASTM D 2837.

B. All HDPE pipe and fittings shall comply with the ASTM F 714.

C. All HDPE pipe shall have a Standard Dimension Ratio (SDR) of 17 unless otherwise stated on the Drawings. All HDPE fittings shall have an SDR of 11.

D. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 ft.

E. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index and other physical properties.

F. HDPE pipe shall be furnished non-perforated or perforated as shown on the Drawings. Perforations shall be drilled into the pipe after manufacture, prior to delivery to the Site. Perforations shall be in accordance with the Drawings.

## 2.03 IDENTIFICATION

A. The following shall be continuously off-set printed or indent printed on the pipe, or spaced at intervals not exceeding 5 ft.:
   1. name and/or trademark of the pipe manufacturer;
   2. nominal pipe size;
   3. standard dimension ratio (SDR);
   4. the letters PE followed by the polyethylene grade per ASTM D 1248, followed by the Hydrostatic Design Stress in psi (e.g., PE 3408);
   5. manufacturing Standard Reference (e.g., ASTM F-714-1); and
   6. a production code from which the date and place of manufacture can be determined.

## 2.04 PIPE LOCATING SYSTEM

A pipe locating system consisting of detectable marker tape and plastic coated copper wire shall be installed with all solid HDPE pipe (existing and new) to be buried. The detectable marker tape shall be placed 1 ft. below the ground surface. The copper wire shall be installed directly above the pipe, with the ends of the wires anchored and exposed.

## 2.05 PIPE BEDDING MATERIAL

A. Pipe bedding material shall conform to the requirements of structural fill as specified in Section 02055.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the site inspection. Failure to inform ENGINEER in writing or proceeding with installation of the polyethylene pipes and fittings will be construed as CONTRACTOR'S acceptance of the related work of all other Sections.

## 3.02 HANDLING AND PLACEMENT

A. CONTRACTOR shall exercise care when transporting, handling and placing HDPE pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

B. Ropes, fabric or rubber-protected slings and straps shall be used when handling HDPE pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches, or dragged over sharp and cutting objects.

D. HDPE pipe shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary, due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports. The pipes should be stored out of direct sunlight.

E. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of HDPE pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Sections of pipe with excessive cuts, gouges or scratches shall be removed and the ends of the pipe rejoined at no cost to OWNER.

F. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

## 3.03 INSTALLATION

A. General:
   1. All HDPE pipe and fittings shall be installed in accordance with the pipe manufacturer's instructions.
   2. CONTRACTOR shall carefully examine all pipe and fittings for cracks, damage or defects before installation. Defective materials shall be immediately removed from the Site and replaced at no cost to OWNER.
   3. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.
   4. Field-cutting of pipes, where required, shall be made with a machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cutter ends

shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.

5. All pipe and fittings shall be laid or placed to the lines and grades shown on the Drawings with bedding and backfill shown on the Drawings and as specified in this Section.
6. No pipe shall be laid until the CQA Consultant has approved the bedding conditions and the trench layout.
7. No pipe shall be brought into position until the preceding length has been bedded and secured in its final position.
8. Blocking under piping shall not be permitted unless specifically accepted by ENGINEER for special conditions.
9. CONTRACTOR shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

B. CONTRACTOR shall obtain custom fabricated fittings as needed. No field modification to enable use of standard, rather than custom, fittings may be made without the approval of ENGINEER.

C. CONTRACTOR shall exercise extreme care when working with piping that contained or contains landfill gas. Landfill gas pipes shall be purged with nitrogen and monitored for explosion hazard prior to any fusion being performed. In addition, CONTRACTOR shall protect against static electric discharges by placing a wet rag with a grounded wire attached over the HDPE piping.

D. Installation of 6-in. diameter gas branch lines between gas branch control valves and the gas header at Cell 3 will require uncovering 15 – 20 ft. of existing branch line, removal and storage of existing passive flares, and installing new pipe lengths to tie in to valves and headers. The passive flares shall remain in service for as long as possible and should be removed and stored by CONTRACTOR at a location selected by OWNER.

E. Installation of the gas main outside of the waste placement will require locating existing leachate and electrical lines and conduits, and moving or regrading these lines and/or adjusting the grade of the gas main to be installed, such that the slope requirements for the new gas main are not compromised.

## 3.04 JOINTS AND CONNECTIONS

A. HDPE pipe shall be joined with thermal butt-fusion joints. All joints shall be made in strict compliance with ASTM D 2657 and the pipe manufacturer's recommendations, and shall be performed by pipe manufacturer's authorized, trained fusion personnel.

B. Mechanical connections of HDPE pipe to auxiliary equipment such as valves, flow meters, pumps and tanks shall consist of the following unless otherwise specified by ENGINEER.
   1. An HDPE flange shall be butt-fused to the HDPE pipe. Outside diameter and drillings shall comply with ANSI B16.1.
   2. A 316 stainless steel back-up shall be provided if buried within limits of waste. Outside diameter and drillings shall comply with ANSI B16.5.
   3. Epoxy-coated steel back-up rings shall be used in valve boxes, manholes, and beyond the limits of waste.

C. Polyethylene stub ends and flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene. Bolts shall be drawn up evenly and in line.

## 3.05 TESTING OF HDPE PIPE AND FITTINGS

A. General:
   1. CONTRACTOR shall pressure test all solid pipe and fittings.
   2. The CQA Consultant shall be notified a minimum of 24 hours in advance of any testing.
   3. CONTRACTOR shall provide all testing apparatus, including pumps, hoses, gauges, taps, plugs, temporary connections, and fittings.
   4. All tests shall be performed in the presence of the CQA Consultant.
   5. For landfill gas system pipes, testing shall be performed in accordance with ASTM F 1417.

B. Repair:
   1. Installed pipes or pipe joints that leak, according to the test results, shall be either repaired to the satisfaction of the CQA Consutlant or replaced at no cost to OWNER.
   2. Repaired or replaced pipe shall be successfully pressure-tested prior to filling over the pipe.

## 3.06 SURVEY REQUIREMENTS

A. Prior to backfilling any pipe trench, CONTRACTOR's surveyor shall determine the location and elevation of the pipe invert at points spaced no greater than 25 ft. apart. The survey may be performed on the compacted bedding material prior to pipe placement.

## 3.07 TOLERANCES

A. The minimum slope on any installed gas main or branch line shall be 3 percent or as indicated on the Drawings.

## 3.08 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior work and materials and completed work of other Sections.

B. In the event of damage to prior work or work completed as specified in this Section, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of ENGINEER, and at no cost to OWNER.

END OF SECTION

# SECTION 02083

# LANDFILL GAS WELLHEADS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Supply all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, delivery, storage, installation, and testing of the landfill gas wellheads (wellheads), including installation as specified herein and as shown on the Drawings.

### 1.02 SUBMITTALS

A. At least 14 days prior to any wellhead installation, CONTRACTOR shall provide ENGINEER the following:
   1. wellhead manufacturer's installation instructions;
   2. wellhead manufacturer's operation and maintenance (O&M) manual (seven copies in addition to the number required for submittals);
   3. wellhead manufacturer's warranty information;
   4. Shop Drawings showing the layout and details of all features of gas management system; and
   5. a copy of the piping schematic.

### 1.03 WARRANTY

A. CONTRACTOR shall furnish OWNER with one-year written warranties obtained from the wellhead manufacturer against defects in materials and workmanship. Warranty conditions proposed by the wellhead manufacturer concerning limits of liability will be evaluated and must be acceptable to OWNER.

### 1.04 RESPONSIBILITY

A. CONTRACTOR shall provide the services of a wellhead manufacturer. CONTRACTOR shall, however, accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed wellhead.

B. Handling, storage, and care of the wellhead prior to and following installation at the Site is the responsibility of CONTRACTOR. During storage, the wellhead shall be

protected from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The wellhead shall be stored in accordance with additional requirements of the wellhead manufacturer. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance of the work by OWNER.

## PART 2 PRODUCTS

### 2.01 GAS EXTRACTION WELLHEAD

A. The wellhead shall be a nominal 2-in. size SOILTEC Model GFC 2000B wellhead with orifice plate (0 – 30 scfm) or approved equal and shall consist of well head piping, flow control gate valve, gas temperature gauge, gas sampling port with quick-connect fitting, static and impact pressure ports with quick-connect fittings, flexible connector, union disconnect, and dust cap. Wellhead piping and fittings shall be HDPE, PVC, or polypropylene.

B. The equipment shall be capable of withstanding the rigors of landfill gas recovery application including internal high vacuum, weathering, gas constituents, and ultraviolet light exposure.

C. The wellhead shall be leak free and shall be height adjustable in the field using adapter bushings.

D. The wellhead to well pipe connection shall be using procedures and materials approved by OWNER. A single 4-in. by 2-in. rubber reducing coupling is not acceptable. A two-piece rubber connection with a 4-in. straight coupling and a 4-in. by 2-in. bushing insert, or other connections recommended by the wellhead manufacturer, will be acceptable.

E. The wellhead shall be capable of being used with the LANDTEC GEM-500™ Gas Extraction Monitor (GEM-500) incorporating all GEM-500 monitoring functions.

F. It is the intent of this Technical Specification that the wellhead shall be supplied as a complete manufactured unit.

G. The gas flow rate measurement assembly shall be pre-calibrated and lab certified. The measurement assembly shall have an accuracy and repeatability of ± 5 percent through the recommended flow range when used and maintained in accordance with the wellhead manufacturer's instructions and recommendations.

H. The gas temperature gauge shall be bi-meter thermometer with minimum 2-in. dial and 0 – 200 °F operating range.

## 2.02 FLEXIBLE CONNECTOR

A. A flexible connector shall be used to connect the wellhead to the header.

B. The flexible connector shall be Kanaflex 101-PS PVC hose with Kanaflex Powerlock PS clamps or approved equal.

## 2.03 NUTS, BOLTS, AND GASKETS

A. For above ground installation, nuts and bolts shall be cadmium plated or galvanized steel.

B. For below ground installation, nuts and bolts shall be type 304 stainless steel.

C. Gasket for flange installation shall be neoprene rubber.

## 2.04 SPARE PARTS

A. CONTRACTOR shall provide five complete spare gas extraction wellheads to OWNER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all work is complete to the point where the installation of this section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the site inspection. Failure to inform ENGINEER in writing or proceeding with installation of

the wellhead will be construed as CONTRACTOR's acceptance of the related work of all other Sections.

## 3.02 LOCATION OF EXISTING HORIZONTAL GAS LINES

A. The precise location of the existing and new horizontal gas lines to which each of the wellheads will be tied-in needs to be determined. Once located, these gas lines shall be excavated as appropriate, cut to allow connection to the wellhead piping, backfilled, tested, and the finished connections and grades surveyed.

## 3.03 INSTALLATION INSTRUCTIONS

A. Work shall be performed in accordance with the wellhead manufacturer's written instructions and installation detail drawings.

## 3.04 INSTALLATION

A. The wellhead shall be lifted and handled according to written instructions supplied by the wellhead manufacturer.

B. The wellhead and 2-in. connector line shall be installed within 0.25 percent of vertical.

C. The wellhead shall be installed such that the flow measurement assembly is concentric with the well casing.

D. Where the wellhead connects directly to the header, a branch saddle shall be installed on the header in accordance with accepted methods and standards. The wellhead shall be connected to the header branch fitting in accordance with the wellhead manufacturer's written instructions. Adapters shall be used as recommended by the wellhead manufacturer.

E. The wellhead shall be installed on the well casing in accordance with the wellhead manufacturer's written instructions.

F. Install the wellhead as high as practical above the coupling to the well casing. Install the flex hose with at least 1 ft of slack to allow for landfill settlement. Wellhead valves must be at least 3 ft., but not greater than 5 ft. above ground.

## 3.05 LABELING

A. Each wellhead will be permanently labeled with the well number using an approved method.

## 3.06 TESTING

A. At the time of system start up, CONTRACTOR shall demonstrate to the satisfaction of OWNER that all wellheads are fully operational. Using the LANDTEC GEM-500 and other gas monitoring instruments as required, CONTRACTOR shall demonstrate that components and connections are leak free, the temperature gauge is accurate, the flow measurement assembly is accurate, and the control valve is fully operable.

## 3.07 ACCEPTANCE

A. CONTRACTOR shall retain responsibility for the wellhead until accepted by OWNER.

B. The wellhead shall be accepted by OWNER when:
   1. the installation is finished;
   2. verification that the wellhead has passed the tests specified in Section 3.05; and
   3. verification of the adequacy of all repairs, including associated testing, is complete.

END OF SECTION

# SECTION 02084

# LANDFILL GAS VALVES

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Supply and install gas control valves for use in LFG collection piping systems, where the maximum service temperature does not exceed 140°F, according to the Drawings.

### 1.02 SUBMITTALS

A. At least 14 days prior the start of pipe installation, CONTRACTOR shall provide ENGINEER certificates of compliance on materials furnished, and valve manufacturers' brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of valves.

B. At least 14 days prior to the start of pipe installation, CONTRACTOR shall provide ENGINEER a copy of each label and piping schematic required under Part 3.02 of this Section.

## PART 2 PRODUCTS

### 2.01 BUTTERFLY VALVES

A. Control valves shall be PVC butterfly valve ASAHI or equal, sized to match pipe diameter, as specified in the Drawings.

B. Shaft, stem, seat, bearings, handles, gear operator with hand wheel, and valve body shall be corrosion resistant. Valve assembly, components and materials shall be as specified in the Drawings.

C. The shaft shall be positively attached to the disc and be totally sealed from exposure to the process gas or environment.

D. The shaft also shall have a directional indicator on top to indicate disc position.

E. Stem extension shall be the length necessary such that the handle is between 3 ft. and 4 ft. above the final grade. All stem extensions shall consist of a two-piece stem extension ASAHI Style A or equal. Exposed portions shall be painted with two coats of orange enamel. A reinforced concrete pad shall be constructed around each stem as specified in the Drawings.

F. Valve seat material shall be Viton or Teflon.

## 2.02 SPARE PARTS

A. CONTRACTOR shall provide OWNER with the following number of spares of each size of valve used, including spacers and 6-ft. extensions:
   1. three 6-in. valves;
   2. one 8-in. valve; and
   3. one 14-in. valve.

## 2.03 QUICK-CONNECT

A. At all valve locations, a quick-connect sample tube shall be installed as indicated on the Drawings.

## 2.04 THERMOMETER

A. A vapor-filled thermometer with a 2-in. diameter dial (minimum) shall be clamped to the stem of the valve as indicated on the Drawings.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Installation shall be as specified by the valve manufacturer's printed instructions and in accordance with the Drawings and Technical Specifications.

B. For butterfly valves, CONTRACTOR shall install spacers at no additional cost if they are needed to allow full travel of the disc.

## 3.02 LABELING

A. Each valve shall be labeled with an engraved tag labeled with the pipeline type (i.e., landfill gas, compressed air, or leachate) and the valve number.

END OF SECTION

# SECTION 02085

# LANDFILL GAS CONDENSATE DRAINS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Provide all materials, equipment, and labor needed to install the landfill condensate drains in accordance with the Drawings.

### 1.02 SUBMITTALS

A. At least 14 days prior to installing the landfill condensate drains, CONTRACTOR shall provide ENGINEER manufacturer's literature and Shop Drawings with detailed parts lists.

B. At least 14 days prior to installing the landfill condensate drains, CONTRACTOR shall provide ENGINEER Shop Drawings showing the piping schematics and layout, orientation, dimensions, and details of all connections to the condensate traps.

C. CONTRACTOR shall provide ENGINEER a 1-year written warranty for all condensate traps.

## PART 2 PRODUCTS

### 2.01 CONDENSATE TRAPS

A. The condensate traps shall be fabricated according to the dimensions and material requirements identified on the Drawings.

B. The entrained condensate in the landfill gas header pipes shall be drained to the existing leachate riser pipes and shall be such that flow of gas through the traps is prevented.

C. The condensate drains will have an extended section such that it is at least 2 ft. above the final grade. The extended section shall have an access port to allow for maintenance of the condensate drains.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. CONTRACTOR shall completely install and backfill each condensate drain in one day.

B. Installation of the condensate drains shall be in accordance with the manufacturer's recommendations.

C. The condensate drains shall be tested following manufacturer's recommendations which will include manually filling the traps and drip leg with water and observing the drainage operation. The liquid must be released to the waste mass or leachate collection system.

D. An approved identification label shall be prepared and securely attached to each condensate drain cleanout at a location and in a manner approved by OWNER.

END OF SECTION

# SECTION 02230

# SITE CLEARING

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals necessary to complete the Work specified herein and shown on the Drawings. The Work shall include, but not be limited to:
   1. clearing and grubbing the work area of grass, brush, and incidental debris;
   2. stripping topsoil from work areas;
   3. transporting the topsoil to stockpiles as directed by OWNER; and
   4. stabilizing the topsoil stockpiles.

B. CONTRACTOR shall remove and dispose of all debris, vegetation, other organic and deleterious material, and other materials not suitable for soil as defined in Section 02055 that exist with the limit of disturbance.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

### 3.01 CLEARING AND GRUBBING

A. Clearing and grubbing shall only be performed in areas identified within the limits of disturbance on the Drawings and approved by OWNER and ENGINEER. Appropriate erosion and sedimentation controls shall be in place in all areas to be cleared and grubbed and in the area where the topsoil is to be stockpiled before the start of clearing, as described in Section 02370 and as shown on the Drawings.

B. If weather conditions are unsuitable for clearing and grubbing, as determined by OWNER, then CONTRACTOR shall cease operations until permission to resume operations is obtained from OWNER or ENGINEER.

C. CONTRACTOR shall clear all areas that are required for access to the Site and execution of work. CONTRACTOR shall also, to the satisfaction of OWNER, chip vegetation designated for removal, including downed timber, brush, and rubbish occurring in the area to be cleared.

D. Grubbing shall consist of the removal and disposal of stumps, roots, shrubs and debris from the work area shown on the Drawings. CONTRACTOR shall clear and grub the stockpile areas and the access roads as necessary.

E. CONTRACTOR shall clear undergrowth and deadwood without disturbing subsoil. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations shall be chipped on site and stockpiled in the designated area. Material to be chipped shall be kept as free of inorganic material as possible.

## 3.02 TOPSOIL REMOVAL

A. Topsoil shall be removed from the areas within the limits of disturbance. The depth of topsoil removal shall be confirmed by ENGINEER, as indicated by testing and evaluation of the soils encountered. Removal of excess quantities of material beneath the topsoil layer will be noted by ENGINEER. No payment will be made for excess excavation or for subsequent filling of the overexcavated portions of the work unless the soils in question are considered by OWNER to be unsuitable for use.

B. Before stripping or removing topsoil, CONTRACTOR shall mow or otherwise remove all heavy grass, weeds, or other vegetation over areas from which topsoil is to be removed.

C. Equipment and methods of operation employed shall be chosen by CONTRACTOR with the intent of avoiding overexcavation of subsoil or other unsuitable material.

D. If soil or weather conditions are unsuitable for topsoil removal, as determined by OWNER or ENGINEER, then CONTRACTOR shall cease excavation operations until permission to resume stripping and excavation operations is obtained from OWNER or ENGINEER.

E. If unsuitable soils are encountered after topsoil removal, then these soils shall be excavated and replaced with clean backfill. Unsuitable soils shall be identified by CONTRACTOR and confirmed by ENGINEER before any unsuitable soil removal work begins. Unsuitable soils may be identified when ruts or depressions occur from

the movement of construction equipment or when soil cannot be placed and compacted to the specified density.

## 3.03 TOPSOIL STOCKPILING

A. CONTRACTOR shall keep topsoil separate from other excavated materials. Topsoil shall be completely removed to the required depth from the designated area before beginning fill placement work in the area. Topsoil shall not be removed to a depth greater than directed by OWNER or ENGINEER.

B. Topsoil shall be stockpiled on well-drained land in the soil stockpile area as directed by OWNER. Topsoil shall be placed in stockpiles of neat conformations and having sideslopes no steeper than 4H:1V. The surface of each topsoil stockpile shall be shaped and tracked at the end of each working day.

C. The topsoil stockpiles shall be stabilized by temporary seeding and mulching in accordance with the requirements of Section 02370. Alternatively, the stockpiles may be stabilized by hydroseeding. The stabilization materials and methods shall be approved by OWNER or ENGINEER.

END OF SECTION

# SECTION 02240

# DEWATERING

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. CONTRACTOR shall furnish all materials, implements, machinery equipment, tools, supplies, transportation, labor and supervision required to perform and maintain all dewatering as required throughout the duration of this contract.

### 1.02 GENERAL REQUIREMENTS

A. All applicable regulations of fish and wildlife agencies and statutes relating to the prevention and abatement of water pollution shall be complied with. All permits, if required, shall be secured by the CONTRACTOR.

### 1.03 SUBMITTALS

A. CONTRACTOR must submit to the ENGINEER for approval a plan and method of dewatering including staging, locations, size and spacing, hydraulic design calculations, and proposed disposal and filtering system signed by a Delaware P.E.

### 1.04 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide and maintain at all times, before and during construction of work, ample means and devices, including all necessary equipment, power and labor to pump, bail or otherwise promptly remove and properly dispose of all water and/or leachate entering, or found in the excavations, trenches or other parts of work. Well points shall be utilized wherever necessary to maintain dry conditions throughout working areas. Excavation and structures must be kept dry until all work to be built therein is completed.

B. CONTRACTOR shall maintain throughout the duration of the contract, ample provisions to prevent flotation of structures and shall be responsible for any damage caused by water.

C. It shall be the CONTRACTOR's responsibility to assure that dewatering operations are

conducted so as not to affect adjacent structures. CONTRACTOR shall be responsible for any damage to adjacent structures.

## PART 2 PRODUCTS

(Not Used)

## PART 3 EXECUTION

### 3.01 GENERAL

A. Water from pumping must be properly filtered before discharging. Method must be approved by the ENGINEER before proceeding.

B. CONTRACTOR must provide one (1) emergency standby pump for the duration of dewatering operations.

C. All methods of executing the work shall be performed in an approved first class, safe, workmanlike manner and shall conform to the best practice of the industry.

D. CONTRACTOR shall provide continuous pumping if required and all costs shall be borne by him.

E. CONTRACTOR will not be permitted to pump water containing silt and or mud into any stream or lake.

END OF SECTION

# SECTION 02260

# EXCAVATION SUPPORT AND PROTECTION

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. This work includes but is not limited to: furnishing, installing and maintaining sheeting and shoring as required and necessary; withdrawing and removing the sheeting and shoring unless such sheeting and shoring is ordered left-in-place by the ENGINEER; cutting off of any sheeting left-in-place; driving sheeting to a sufficient depth below the bottom of the excavation and all appurtenant equipment, labor and supervision necessary to furnish, install and maintain the sheeting and shoring in a safe manner. All work must be in compliance with state and federal occupational health and safety regulations.

### 1.02 PRECAUTIONARY MEASURES

A. Trenches more than 4 feet deep shall be shored, sheeted, braced, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Trenches less than 4 feet in depth shall also be effectively protected when examination of the ground indicate hazardous ground movement may be expected.

B. If, in the opinion of the ENGINEERs, the material furnished for timbering excavations is not of proper quality, size, or improperly placed, the CONTRACTOR shall, upon notice, procure and place satisfactory timbering, or place said timbering in a satisfactory manner. Upon his failure to do so work may be ordered stopped until said notice shall have been complied with and the CONTRACTOR shall not be entitled to any claim for extra compensation, for damage, or delay.

C. Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made in locations adjacent to backfilled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, construction equipment or any other source.

D. If it is necessary to place or operate power shovels, derricks, trucks, or other heavy objects on a level above and near an excavation, the side of the excavation shall be shored, and braced as necessary to resist the extra pressure due to such superimposed loads.

E. Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

F. Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation.

G. No person shall be permitted under loads handled by power shovels, derricks, or hoists.

H. When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps, shall be provided and located so as to require no more than 25 feet of lateral travel.

I. Where employees are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided as necessary or required.

J. Climbing on or supporting construction loads from the sheeting and shoring is prohibited.

K. The trench shall be safe from exhaust gases entering from machines and equipment working nearby.

L. Excessive deflections of sheeting and shoring members will not be permitted.

M. Trenches shall be properly barricaded and protected at all times.

## 1.03 MATERIALS

A. Materials used for sheeting, bracing and shoring shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.

B. Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of a shoring system upon written permission of the ENGINEER. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection both for workers and adjacent utilities, equal to or greater than the sheeting or shoring required for the trench.

## 1.04 CONSTRUCTION METHODS

A. All sheeting and shoring shall be placed or driven by men skilled in such work and shall be arranged that it may be withdrawn as backfilling proceeds, without injury to structures built or adjacent structures or properties.

B. Bracing or shoring of trenches shall be carried along with the excavation.

C. Cross braces or trench racks shall be placed in true horizontal position, be spaced vertically, and be secured to prevent sliding, falling, or kickouts. Cross braced shall be supported against downward movement by hangers, blocks, sole plates or cleats. All wedges shall be driven tight.

D. When in quicksand or soft ground, or for protection of any structure or property, sheeting shall be driven to a depth below bottom of excavation as may be required without extra compensation.

E. The pumping arrangement shall avoid drawing materials from behind sheathing.

F. In no case shall excavated materials be stockpiled adjacent to the trench.

G. Where groundwater is present, continuous close sheeting and shoring shall be installed. Sheeting boards shall be installed with a 1/2" space between boards to allow the water to seep into the trench and relieve the hydrostatic pressure. The water shall then be pumped out as required straw or other suitable material shall be used to fill the ½" space and prevent loss of soil.

H. Timbering in excavations may be withdrawn as the backfilling is being done, except to such extent as the ENGINEERs shall order, that said timbering be left-in-place. The CONTRACTOR shall cut off any sheeting ordered by the ENGINEER left-in-place, at least twelve (12) inches below finished grade and shall remove cut-off material.

I. Backfilling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

END OF SECTION

# SECTION 02280

# ABANDONMENT OF EXISTING FACILITIES

## PART 1 GENERAL

### 1.01 GENERAL REQUIREMENTS

A. CONTRACTOR shall furnish all materials, implements, machinery, equipment, tools, supplies, transportation, labor and supervision required to abandon the existing Central, South Central, South, Southeast, and East Pumping Stations, valve pits and appurtenances. The work shall include all removals and utility relocations, disconnection of equipment, the removal of debris from the site, disconnection of utilities, filling in of wet-well valve & meter pit, and connection of new leachate collection pipe to proposed leachate wet-well manhole. Shutdown shall occur after the proposed manhole pumping station is placed in operation and all required utility re-connections are made. Guided-boring horizontal drilling techniques shall be used to connect proposed manhole pumping station to existing leachate collection pipes at existing manholes (to be abandoned) after foundation settlement is substantially completed.

B. Permits and Certificates: The CONTRACTOR shall obtain and pay for all permits and certificates required in conjunction with the work.

### 1.02 SCOPE

A. The extent of the work contained in this section generally includes the abandonment of the existing pump stations, valve pits, and meter pits.

### 1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical Demolition - Section 16060

### 1.04 LOCATION OF UTILITIES

A. The CONTRACTOR shall be responsible for locating all underground structures and utilities, such as water mains, sewers, telephone and electric conduits, etc., which may be encountered during demolition operations. Test holes shall be dug to determine the position of the underground structures and utilities, or he shall arrange with the

OWNERs of such underground structures and utilities to assign a representative to mark the locations. The CONTRACTOR shall pay the cost of digging holes and likewise he shall pay the cost of the service of the representative of the OWNERs of such utilities for locating of said utilities. The cost for determining the locations to be included in the prices bid. The locations of existing structures and utilities as shown on the plans is simply for the guidance of the CONTRACTOR and have not been field located and, since the information is as furnished by the respective utilities, or taken from non-as-built plans, the ENGINEER is not responsible for the accuracy of the plans in this respect.

## PART 2 PRODUCTS

Not used

## PART 3 EXECUTION

### 3.01 UTILITY DISCONNECTION

A. The CONTRACTOR shall arrange to have electrical service relocated and influent and effluent sewer, etc., disconnected and rerouted as required.

B. CONTRACTOR shall provide all necessary by-pass pumping, temporary electrical service and backfill, as required.

C. Influent sewer mains shall be located and redirected through proposed manholes as shown. Remainder of influent lines and all effluent sewer lines shall be severed and plugged with non-shrink grout or concrete at the shutdown sites as well as at the break-in points and discharge locations.

D. All electrical demolition and equipment salvaging shall be conducted in accordance with Section 16060.

E. All methods of disconnecting utilities shall be submitted to the OWNER for approval.

F. A demolition sequence shall be submitted to the OWNER for approval.

## 3.02 EQUIPMENT DISCONNECTION

A. The CONTRACTOR shall disconnect equipment located within the site being shut down.

## 3.03 STRUCTURE BACKFILLING

A. After all the equipment has been properly removed and all utilities have been disconnected, wetwell, valve pit & meter pits shall be backfilled as specified herein. Prior to backfilling, provide two four (4) inch holes for drainage in the bottom of structures to be abandoned.

B. Concrete lids of the structures are to be removed and demolished. Concrete structures shall be removed to 2' below surrounding ground surface and backfilled.

C. Backfill shall be compacted in accordance with Section 02221.

D. Backfill material shall be borrow Type "C" as specified in DelDOT Standard Specifications. Restoration of disturbed area shall include 6" of topsoil graded to match existing grades and seeded in accordance with specifications for final seeding.

END OF SECTION

# SECTION 02315

# UTILITY EXCAVATION, BACKFILL AND COMPACTION

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. Furnish all labor, materials and equipment to do all clearing of work areas, excavation to the depth shown and/or indicated, support of utilities, maintenance of excavation, removal of all water, backfilling, additional fill, disposal of excess fill, grading, compaction and all incidental work to complete earthwork for foundation and utility construction as shown on drawings, as specified and/or as directed by the ENGINEER.

B. All excavation shall be unclassified and shall include all materials excavated regardless of character. No specific payment will be made for excavation. The prices bid for the respective items shall include all excavation and backfill. Excavation shall be in open cut, unless written permission is given by the ENGINEER to excavate by other methods. The ENGINEER shall be empowered to require under special circumstances (such as fragile utilities nearby) that hand excavation and backfill be employed within reasonable limits and accepted construction practices, and that no extra compensation will be allowed the CONTRACTOR for the hand excavation. It shall be the responsibility of the CONTRACTOR to plan the trench work to avoid conflicts, obstructions, etc.

No additional payment will be made for rock or concrete excavation.

C. All work shall be in accordance with OSHA Safety and Health Standards (29CFR 1910), Revised July 1, 1989, or latest revision.

### 1.02 REFERENCE STANDARDS

A. Delaware Department of Transportation, Standard Specifications for Road and Bridge Construction dated July 1985.

B. American Society for Testing and Materials (ASTM)

D1556 Density of Soil in Place by the Sand Cone Method

D1557 Moisture - Density Relations of Soils and Soil Aggregate Mixtures Using 10 lb. Rammer and 18 in. Drop.

D2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods

D3017 Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods

C. OSHA Safety and Health Standards (29CFR 1910), Revised July 1, 1989.

## 1.03 QUALITY ASSURANCE

A. The services of qualified inspection and testing agencies shall be used for this work.

## 1.04 ACCOMMODATION OF TRAFFIC

A. The CONTRACTOR shall maintain access roads open for traffic with satisfactory barricades, warning signs and lights. Where permission for detouring traffic is granted, the CONTRACTOR shall post detour signs, to satisfaction of the OWNER, the CONTRACTOR shall maintain such detour routes.

B. The CONTRACTOR shall furnish, place and maintain safety fence around all excavations and other areas designated by the ENGINEER during non-work hours. Safety fencing shall be the product of Tenax Corporation, bright orange, no less than five feet in height, or approved equal.

C. All excavated material shall be stored in designated locations until it is removed from the site. Adequate protection shall be placed around excavated material to prevent erosion.

D. The CONTRACTOR shall construct and maintain, without compensation, adequate and approved bridges over excavations as may be necessary or directed by the ENGINEER for purpose of accommodating vehicles.

## 1.05 PROTECTION OF PROPERTY AND STRUCTURES

A. The CONTRACTOR shall at his own expense, sustain in their places and protect from direct or indirect injury, all pipes, conduits, poles, walls, buildings, pavement, driveways, sidewalks, fields, and other structures or property in vicinity of his work, whether above or below ground. He shall replace any pipe, if in the opinion of the ENGINEER, it is a functioning pipe. CONTRACTOR shall restore, at his own expense, any existing property damaged by construction activity. Restoration, when complete, shall render the disturbed area equal to or better than its original condition prior to construction.

B. The CONTRACTOR shall have sufficient sheeting or shoring available for

supporting his excavations and for sustaining or supporting any structures that are uncovered, undermined, endangered, threatened or weakened.

## 1.06 OBSTRUCTION SHOWN ON DRAWINGS

A. When the drawings show information in addition to structures and systems to be built, such as locations of pipes, conduits and other structures which exist along lines of work below and/or above the surface of the ground, said information is shown for the convenience of the CONTRACTOR who must verify in advance the information given to his own satisfaction.

## 1.07 REMOVAL AND STORAGE OF SURFACE MATERIALS

A. The CONTRACTOR shall grub and clear surface and remove all surface materials, of whatever nature, over line of trench and site of other structures; and he shall properly store, guard and preserve such of said materials as may be required for use in backfilling, resurfacing, repaving, or for other purposes. All concrete and paving material which may be removed, together with all materials taken from trenches, may be stored in a suitable place as shall be approved and directed. The CONTRACTOR shall be responsible for any loss of or damage to sidewalk, paving material, and grass through their careless removal or neglectful or wasteful storage, disposal or use.

## 1.08 WORK IN EXISTING ACCESS ROADWAYS & PARKING LOTS

A. The CONTRACTOR shall remove paving to the maximum allowable trench width, only, as is necessary for the excavation of the trench. In cases where paving is removed for a greater width than is necessary, or in case where the paving is removed, disturbed or damaged outside the maximum allowable trench width, the CONTRACTOR will repair or replace the paving per the Specifications and Drawings and the CONTRACTOR shall have no claim for extra compensation for this work.

B. For roadway excavation or rehabilitation, saw cutting shall be employed for removal of existing pavement to neat lines, as indicated by the Contract Documents or directed by the ENGINEER.

## 1.9 OBSTRUCTIONS AND MAINTENANCE OF SERVICES

A. The CONTRACTOR shall be required to relocate any existing utility services to any existing facility on the property in conflict with the proposed facilities and adjust any valve boxes for paving or grading and work around utility poles and underground utilities, pipes, conduits or other structures which are not in direct conflict with the work. Utility service relocations shall be performed at no additional cost to the

OWNER. The CONTRACTOR shall arrange with all utility companies for any relocation, temporary removal and restoration of their facilities when required for prosecution of work. However, the CONTRACTOR shall uncover and support said structures within the limits of his trench and shall not be entitled to any claim for damage or extra compensation because of said structure or because of any delay in removal or rearrangement of same.

B. There shall be maintained at all times a continuous flow in all existing water, force mains, sewer, conduit, electric power, and telephone lines, or any other pipes or structures encountered in prosecution of work under this project, whether above or below ground surfaces.

## PART 2 PRODUCTS

### 2.01 SOIL MATERIALS

A. Definitions:

1. Suitable soil materials are defined as those complying with unified soil classification system soil classification Groups GW, GP, GM, SW, SM and SP. Suitable soil materials shall consist of residual soils and/or decomposed rock obtained from required on site excavations. Suitable soil materials shall be free of organic matter, ice, snow, and shall not contain rock fragments greater than six (6) inches in diameter.

2. Unsatisfactory Soil Materials: Unsatisfactory soil materials are defined as those in the Unified Soil Classification System classes GC, SC, ML, CL, OL, MH, CH, OH and PT, and other highly organic soils.

B. No ashes, decomposable refuse, large stones, or other material of an unsatisfactory character shall be used in backfilling. All satisfactory excess material from trenches and other excavations in the contract shall be used and all costs for placement shall be included in the price bid.

C. In the event that additional material is needed, the CONTRACTOR shall obtain borrow material from other sources. All borrow material shall be of satisfactory quality for required purposes. In certain locations, grading and filling of adjacent ground may be required or directed by the ENGINEER. Payment for furnishing and placing borrow material shall be included in prices bid.

# PART 3 EXECUTION

## 3.01 TRENCHING

B. Trench Width and Depth:

3. Trenches shall be excavated to necessary width and depth, as specified herein or as directed. Where sheeting is used the maximum width below top of pipe shall be measured between interior faces of sheeting as driven, but in no case shall stringers or waling-strips be so placed as to interfere with proper ramming of earth under and around pipe.

4. If sheeting does not extend below a point six (6) inches above pipe as laid, the maximum width allowed shall be measured between faces of excavation below bottom of sheeting.

5. Sides of trenches shall be practically plumb and under no circumstances will they be permitted to be sloped unless approved by the ENGINEER. The maximum allowable trench width shall be two (2) feet wider than outside diameter of pipe. Where more than one pipe is placed in a trench, a maximum clear distance of 12" shall be allowed from the wall of the nearest pipe.

6. Where, in the opinion of the ENGINEER the grade is suitable for foundation of work, the bottom of the trench shall be excavated flat to receive pipe and the bottom of trench under each joint or coupling hollowed out to allow for making joints.

7. Trenches excavated below proper grade, excepting at joints, shall be filled to proper grade with satisfactory material thoroughly rammed, to insure adequate support and stability of pipe or other structures.

C. Trench Length:

1. No greater length of trench shall be left open, in advance of completed structure placed therein, than shall be authorized or directed by the ENGINEER. The ENGINEER shall be empowered at anytime to require backfilling of open trenches over completed pipe lines, if in their judgement such action is necessary. The CONTRACTOR shall have no claim for extra compensation, even though to accomplish said backfilling he may be compelled to temporarily stop excavation or other work.

2. If work is stopped on any trench, for any reason except by order of the ENGINEER, and excavation is left open for an unreasonable length of time in advance of construction, the CONTRACTOR shall, if so directed, backfill such trench at his own expense, and shall not again open said trench until he is ready to complete structure therein. If the CONTRACTOR refuses or fails to backfill such trench completely within eight (8) hours the OWNER shall authorize the work to be performed by other forces, and the OWNER shall charge expense thereof to the CONTRACTOR and retain same out of any monies due or to become due him under the contract.

3. Unless otherwise authorized, excavation of trenches may be fully completed no more than (100) feet in advance of pipe laying.

4. No trench shall be left open at the end of each work day.

D. Change of Trench Locations: Where the ENGINEER directs that the proposed location of a trench be changed, due to unforeseen conditions, the CONTRACTOR shall not be entitled to a claim of extra compensation, provided that the CONTRACTOR is notified of the change before excavation is begun. If a change, made at the direction of the ENGINEER, involves abandonment of an excavation already made, the abandoned excavation, together with necessary backfill will be classed as miscellaneous excavation and shall be paid as such.

In the event that the trench is abandoned at the CONTRACTOR's request, the abandoned excavation and backfill shall be at the CONTRACTOR's expense.

E. Preparation of Foundation: All irregularities and cavities, either in earth or rock excavation, in bottom of trenches or tunnels, shall be filled to required level with satisfactory fill material, and compacted, before pipe lines are laid therein.

F. Sheeting and Shoring:

1. The CONTRACTOR shall support sides and ends of all excavations or structures, when necessary or directed, with braces, sheeting, shores or stringers of quality and character required. All timbering or underpinning shall be placed or driven by men skilled in such work and shall be arranged so that it may be withdrawn as backfilling proceeds, without injury to structures built or adjacent structures or

properties.

2. If, in opinion of the ENGINEER, the material furnished for timbering excavation is not of proper quality or size, or is improperly placed, the CONTRACTOR shall, upon notice, procure and place satisfactory timbering, or place said timbering in a satisfactory manner. Upon his failure to do so, work may be ordered stopped until said notice shall have been complied with and the CONTRACTOR shall not be entitled to any claim for extra compensation, for damage or delay.

3. Timbering in excavations may be withdrawn as the backfilling is being done, except to such extent as the ENGINEER shall order that said timbering be left-in-place. The CONTRACTOR shall cut off any sheeting left-in-place, at least 12 inches below finished grade where ordered by the ENGINEER and shall remove cut-off material without compensation for either material removed or material cutting and removal.

G. Dewatering Excavations:

1. There shall be provided and maintained at all times during construction of work, ample means and devices, including all necessary equipment, power and labor to pump, bail or otherwise promptly remove and properly dispose of all water and/or leachate entering, or found in the excavations, trenches or other parts of work. Well points shall be utilized wherever necessary to maintain dry conditions throughout working areas.

2. All costs for dewatering shall be included in bid price.

3. Method used to accomplish dewatering must meet with the ENGINEER's approval.

4. Existing piping shall not be used for drainage of excavation or trenches.

5. When in quicksand or soft ground, or for protection of any structure or property, sheeting shall be driven to a depth below bottom of excavation as may be required without extra compensation.

6. Water from pumping must be properly filtered before discharging.

H. Responsibility for Condition of Excavation:

1. The CONTRACTOR shall be solely responsible for condition of all his excavations, and any slides or cave-ins shall be removed without extra compensation.

2. Failure or refusal of the ENGINEER to order the use of bracing or sheeting, to order better quality or larger sizes of timber; to order sheeting, bracing or shoring left-in-place; to give orders or directions on methods or placing or driving sheeting, braces or shores, shall not relieve the CONTRACTOR of any responsibility concerning the condition of excavations or his obligation under the contract.

3. Any delay, (whether caused by the CONTRACTOR or by the OWNER or their agents or employees) that requires keeping an excavation open longer than would otherwise have been necessary, shall not relieve the CONTRACTOR from his obligation to properly and adequately protect the excavation from cave-ins or slipping or any of his obligations under the contract relating to injury of persons or property. In any event it shall not entitle him to any claim for extra compensation.

I. Tunnelling:

1. Tunnelling will be allowed when permission is granted by the ENGINEER or when it is called for in the specifications or shown on the drawings.

2. Tunnels for laying pipelines shall be of sufficient size to allow joining of pipe and compacting of backfill around them. Tunnels shall be timbered where necessary, in accordance with approved methods. All methods of tunnelling used shall be subject to approval of the ENGINEER. No extra payment will be made for excavation and backfill in tunnel.

J. Miscellaneous Excavation:

1. The CONTRACTOR shall do such miscellaneous excavating work as may be necessary and directed by the ENGINEER. Such excavation shall be subject to the same conditions and requirements specified herein for trench excavation.

2. Miscellaneous excavation shall include excavation for abandoned trenches or for any special structure outside of specified trench. Widths may not be shown on the drawings or described in specifications, where such excavation is done at direction of the ENGINEER.

3. When in the opinion of the ENGINEERs an obstruction requires that the trench be excavated extra wide, such extra width shall be classified as "miscellaneous excavation" and backfill. Sloping the sides of an excavation for any reason, will not be considered as "miscellaneous excavation".

K. Test Pits: All costs for advance test pits ordered by the ENGINEER or made by the CONTRACTOR along line and site of work, to determine character of subsurface materials, or the exact location of utilities, shall be included in the CONTRACTORs price bid for the work.

## 3.02 BACKFILLING

A. The CONTRACTOR shall backfill all excavations as rapidly as practicable, following inspection and approval of work by the ENGINEER.

B. No part of a pipe line or other structure that needs to be located or measured, shall be filled over or around until required tests and measurements have been made and permission given by the ENGINEER to backfill. Any backfilling done without authorization shall be uncovered by the CONTRACTOR at his own expense.

C. The space between pipe and sides of trench shall be backfilled by hand and thoroughly tamped with a light tamper in layers not to exceed 4 inches in thickness to a depth of at least one foot above top of pipe.

D. The CONTRACTOR shall under no circumstances, bury or add to the backfill, excavated or broken-up asphalt.

E. The material for backfilling around pipes to 1 foot over top of pipe shall be Borrow Type "C" (Backfill) as specified in Section 209.03C of DelDOT Standard Specifications.

F. The material for backfilling within unpaved areas from 1 foot over top of pipe to grade shall then be suitable soils as defined in herein. The backfill material shall be evenly spread in built up layers not exceeding 8 inches for material compacted by heavy compaction equipment and 4 inches for material compacted by hand operated tampers, subject to approval of the ENGINEER. No stone will be allowed in refilling until earth or granular backfill has been placed at least 2 feet above pipe or structure as directed above. Backfill material placed above earth or granular backfill may contain some rock but in no case shall it exceed more than 20 percent by volume.

G. When the opening is across or within existing access roads or parking lot, the backfill material shall be Borrow Type "C" (Backfill). The method of backfilling above 12 inches over the top of pipe to bottom of paving section shall be backfilled as specified above except that the backfill material shall consist of Borrow Type "C" (Backfill).

H. Moisture Control

1. Where the subgrade or layer of stone material must be moisture conditioned before compaction, uniformly apply water to the layer of stone material.

2. Remove and replace, or scarify and air dry, stone materials that are to wet to permit compaction to specified density, to prevent free water appearing on the surface during or subsequent to compaction operations.

I. Dust Control

1. The CONTRACTOR shall make every effort to limit the amount of dust generated by construction activities. Appropriate methods and materials shall be employed and are subject to the approval of the ENGINEER.

## 3.03 TEMPORARY PAVING

A. The CONTRACTOR shall install temporary paving over all utility trenches in paved areas at the end of each workday. The temporary pavement shall consist of placing a 2-inch layer of cold bituminous mix in utility trenches. The CONTRACTOR shall maintain, at his expense the temporary paving. All depressions appearing in the temporary paving shall be promptly repaired by the CONTRACTOR. If the CONTRACTOR fails to make repairs within twenty-four (24) hours after receipt of written notice from the ENGINEER, the OWNER may backfill said depression and the cost deducted from any monies due the CONTRACTOR. In an emergency, the OWNER may backfill or protect any dangerous depression wherever necessary without giving any previous notice to the CONTRACTOR and deduct the cost from any monies due or to become due the CONTRACTOR.

The CONTRACTOR shall remove the temporary paving and prepare the utility trenches for permanent paving. The cost for temporary paving will be included in the base bid prices for utility excavation, backfill and compaction.

## 3.04 MAINTENANCE

A. The CONTRACTOR shall maintain, at his own expense, all backfilled excavations in proper conditions as specified. All depressions appearing in backfilled excavations shall be promptly repaired by the CONTRACTOR. If the CONTRACTOR fails to make repairs within twenty-four (24) hours after receipt of written notice from the ENGINEER, the OWNER may backfill said depression and the cost deducted from any monies due the CONTRACTOR. In an emergency, the OWNER may backfill or protect any dangerous depression wherever necessary without giving previous notice to the CONTRACTOR and deduct the cost from any monies due or to become due

the CONTRACTOR.

## 3.05 COMPACTION

A. The CONTRACTOR shall be required to compact backfill materials to the minimum compacted dry density as determined by ASTM D1557 specified in Section 208.03 of DelDOT Standard Specifications.

## 3.06 TESTING

A. Testing Laboratory

1. Tests to determine conformance with all requirements for all CONTRACTOR secured materials proposed for use shall be performed by an independent commercial laboratory retained and compensated by the CONTRACTOR and approved by the ENGINEER.

2. On-site quality control testing will be performed during construction to determine conformance with plans and specifications by an independent laboratory retained and compensated by the CONTRACTOR. Frequency of sampling and testing shall be as specified herein.

3. Testing laboratory shall furnish the CONTRACTOR, ENGINEER and OWNER with copies of all reports and certificates regarding tests and inspections of equipment, materials, and completed work.

4. Laboratory shall furnish the ENGINEER a sampling schedule to give the ENGINEER an opportunity to observe the sampling.

B. During or after the backfill operations the ENGINEER may take soils compactions tests in conformance with A.S.T.M. Standard Procedures or other available methods. If determined by the ENGINEER that any lift does not meet specified percent maximum dry density the CONTRACTOR shall be required to dig test holes, as directed by the ENGINEER at various levels, throughout the backfill, at the CONTRACTORs expense, so that additional tests may be taken. If the additional tests indicate unsatisfactory compaction the CONTRACTOR shall remove all unsatisfactory backfill and recompact same to the required standards at his expense.

C. Frequency of Testing

1. Perform at least three (3) maximum dry density tests, in accordance with ASTM D1557, on each different type of soil or material encountered in the excavation or used for backfill.

2. Perform at least one (1) in-place density test per lift per 100 feet of trench length on the backfill material. Determine in-place density in the field in accordance with ASTM D1556, or by ASTM D2922 and ASTM D3017.

3. If it is determined by the ENGINEER that any lift does not meet the specified percent dry density, the CONTRACTOR shall dig test holes, as directed by the ENGINEER at various levels, throughout the backfill, at the CONTRACTOR's expense, so that additional tests may be taken. If the additional tests indicate unsatisfactory compaction, the CONTRACTOR shall remove all unsatisfactory backfill and recompact same to the required standards at his expense.

## 3.07 DISPOSAL OF MATERIAL

A. Immediately after excavating trench, all material not required shall be removed and disposed of by the CONTRACTOR in such a manner and at such point or points he may select, subject to the approval of the ENGINEERs. All roads, or other places on line of work shall be left free, clean and in good order at the end of each work day. All removal and cleaning-up shall be done by the CONTRACTOR without extra compensation, and, if he fails to do such work within a reasonable time, after receipt of notice, the work will be performed by the OWNER, and the cost deducted out of monies due or to become due the CONTRACTOR.

B. Remove all waste and excess materials weekly, including excavated material classified as unsatisfactory soil material, trash and debris from the work area and legally dispose of it.

## 3.08 LOCATION OF EXISTING UTILITIES

A. The CONTRACTOR shall be responsible for locating all underground structures and utilities, such as water mains, sewers, telephone and electric conduits, etc., and above ground utilities, which may be encountered during construction operations. The CONTRACTOR shall contact "Miss Utility" for utility location mark-out prior to start of construction. Test holes shall be dug to determine the position of the underground structures and utilities, or the CONTRACTOR shall arrange with the OWNERs of such underground structures and utilities to assign a representative to mark the locations. The CONTRACTOR shall pay the cost of digging test holes and likewise he shall pay the cost of the service of the representatives of the OWNERs of

such utilities for locating the said utilities. And the cost of determining the locations is to be included in the prices bid. The location of existing structures and utilities as shown in the contract documents is simply for the guidance of the CONTRACTOR and have not been field located and, since the information is as furnished by the respective utilities, or taken from non-as-built plans, the ENGINEER is not responsible for the accuracy of the plans in this respect.

END OF SECTION

# SECTION 02330

# PERIMETER BERM

## PART 1 GENERAL

### 1.01 SUMMARY

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to construct the perimeter berm as specified herein and as shown on the Drawings.

B. CONTRACTOR shall construct the perimeter berm in conjunction with the construction of other components of the Work.

C. The perimeter berm shall conform to the dimensions, lines, grades, and sections indicated on the Drawings.

### 1.02 SUBMITTALS

A. CONTRACTOR shall prepare and submit for approval by OWNER and ENGINEER a Perimeter Berm Construction Plan, a minimum of 10 days prior to the Pre-Construction Meeting.

B. The Perimeter Berm Construction Plan shall describe the equipment, techniques, materials, handling, and erosion and sediment control procedures to be followed by CONTRACTOR during construction.

C. CONTRACTOR shall provide, in writing to the CQA Consultant, the CQC field test results. Test Results shall be submitted no later than two days following conclusion of the test.

### 1.03 QUALITY ASSURANCE

A. CQA Consultant will review CONTRACTOR's written CQC tests reports and observations.

B. CQA Consultant may perform duplicate tests using alternate testing methods or instruments.

# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Structural fill, granular fill, and backdrain fill shall be as specified in Section 02055.

B. High-strength geotextile shall be as specified in Section 02071.

C. Structural and wrap geogrid shall be as specified in Section 02076.

D. Litter fence shall be as described in Attachment 1 to this Section.

E. All other materials shall be as specified on the Drawings.

## 2.02 EQUIPMENT

A. Equipment shall be as approved under Section 02055, Part 2.10.

# PART 3 EXECUTION

## 3.01 PREPARATION

A. CONTRACTOR shall place new granular fill and/or grade existing granular fill within the perimeter berm construction area to establish a seven percent slope away from the existing landfill area.

B. The graded surface shall be compacted as described in Part 3.03B.

## 3.02 MATERIAL PLACEMENT AND GRADING

A. CONTRACTOR shall place soil in loose lifts of not more than 8-in. Soil shall be spread out over the underlying geosynthetics such that the entire roll is cover in a uniform lift.

B. Compaction shall be performed using approved equipment as described herein. Soil shall be compacted to a minimum of 95 percent of the maximum dry unit weight and within plus or minus two percentage points of the optimum moisture content, each as determined by the standard Proctor compaction test (ASTM D698).

B. The perimeter berm shall be constructed in successive horizontal layers.

## 3.03 RATE AND SEQUENCE OF CONSTRUCTION

A. Construction of the perimeter berm shall begin from the Phase III area and proceed toward the Phase V area.

B. Placement of soil shall be in accordance with Part 3.02 of this Section. However, the total thickness placed at any given location shall not exceed 10 ft. in a four month period. CONTRACTOR shall allow excess pore pressures to dissipate and settlement to stabilize prior to placing and compacting additional lifts.

C. CONTRACTOR shall be aware of instrumentation (e.g., settlement plates, inclinometers, and piezometers) in the work area. Instruments will be monitored in accordance with the Geotechnical Monitoring Plan. CONTRACTOR shall be aware of the Geotechnical Monitoring Plan requirements when scheduling construction activities. Instruments damaged by CONTRACTOR shall be replaced at no cost to OWNER.

D. The rate of construction described above may be increased, decrease, or halted based on the results of instrument readings.

## 3.04 FIELD QUALITY CONTROL

A. Field quality control shall conform to the requirements of Section 02055, Part 3.10.

## 3.05 FIELD QUALITY ASSURANCE

A. Field quality assurance shall conform to the requirements of Section 02055, Part 3.11.

## 3.06 TOLERANCE

A. Tolerance shall conform to the requirements of Section 02055, Part 3.12.

END OF SECTION

# ATTACHMENT 1

## TECHNICAL SPECIFICATION FOR LITTER FENCE

**Reference: Phase V Litter Fence at Northern Solid Waste Management Center-2,**
**Cherry Island Landfill**
**Contract DSWA – 436**
**November 1996**

DELAWARE SOLID WASTE AUTHORITY
PHASE V LITTER FENCE
CHERRY ISLAND LANDFILL
DSWA-436

**SECTION IV**

**TECHNICAL SPECIFICATIONS**

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| 4:03 | Technical Specifications | IV-3 |


NOT APPLICABLE

## SECTION IV

## TECHNICAL SPECIFICATIONS

4.01 Generalized Scope of Work

This project involves the installation of approximately 1875 lineal feet of litter control fencing at the Cherry Island Landfill (NSWMC-2). The project includes furnishing all materials and labor for the following items:

a. Mobilization of equipment and materials to the site. (No separate payment for this item.)
b. Layout, furnish and install the proposed poles at approximate 30-foot spacing.
c. Furnish and install panels of polypropylene netting between the poles.
d. Furnish and install 30-foot wide, double-swing chain link gates at 2 locations within the proposed fence line.
e. Demobilization (No separate payment for this item.)

4.02 Unit Price Schedule

1. Unit Price Item No. 1 – Fence Pole

   a. Description: Layout of all pole locations, furnishing and installing poles as indicated on the contract documents, as well as all hardware for netting and cable attachments to the pole. Pole locations will typically be at 30 foot spacing, however, field adjustments will be required to maintain a minimum 10-foot clearance from all existing instrumentation structures. Include installation of guy wires and anchors for end and corner poles, as indicated on the sketches included in these documents.

   b. Unit of Measurement and Payment: Each

2. Unit Price Item No. 2 – Netting Panels

   a. Description: Furnishing and installing fence netting. Include all netting, cables, helical anchors for vertical cables, and snap hook connectors. Netting shall be tied to existing and new poles as applicable.

   b. Unit of Measurement and Payment: Lineal feet of netting panel installed, rounded to the nearest 0.5 lineal foot.

~~3. Unit Price Item No. 3 – Chain Link Gate~~

~~a. Description: Furnishing and installing 10-foot high, galvanized chain link gate. Gate will be a 30' wide double swing gate. Include all poles and hardware to support gate and cables.~~

~~b. Unit of Measurement and Payment: Each.~~

4:03 Technical Specifications

1. Timber Pole

a. All fence poles shall be 60' long, Class 2 timber utility poles of Southern Yellow Pine in accordance with ANSI Standards, Section 5.1. Poles shall be treated with Chromated Copper Arsenate (CCA) in accordance with AWPA Standards.

b. Poles shall be installed at a maximum 30-foot spacing, maintaining a minimum 10-foot clearance from all existing instrumentation structures. In addition, the poles shall be a minimum of 24" O.C. away from the previously installed poles.

c. Poles shall be installed by augering a 24-inch diameter hole to a minimum depth of 20 feet. The pole should be inserted into the hole and backfilled with CR-6 stone, which shall be compacted. A minimum cover of 3 inches should be maintained on the pole. Drilling spoils will be accepted at the landfill at no charge to the Contractor.

d. Poles shall be installed with a 5 ° batter in direction of landfill.

e. Hardware for interior poles: Horizontal support cables shall be attached to the poles (on the landfill side) using a 5-3/4" long three bolt, galvanized steel cable clamp. The clamps shall have a 13/16" I.D. galvanized sheave wheel bolted to the center of the three bolt clamp to anchor the vertical support cable to the pole.

f. Hardware for end poles: Three (3), 5/8" diameter, #11 galvanized steel, threaded rods shall be drilled into the bottom, middle and top of each end pole. The horizontal cables shall be attached on the inside of each end pole to a 5/8" eye nut bolted to each 5/8" diameter, #11 threaded rod. The vertical cable shall be attached to each end pole with two (2) bolted 13/16" I.D. sheave wheels located at the bottom and top of each pole. On the outside of the end pole, an eye nut will be bolted to each of the top two (2) threaded rods. Guy lines will be attached to these two (2) eye nuts and anchored into the ground at a 45-degree angle with a helical ground anchor.

g. Corner poles shall be treated as end poles. However, the guy lines should be opposite each direction of the fencing.

2. Netting
    a. Fence netting shall consist of knitted polypropylene (or polyester) netting with a 2-inch (nominal) square mesh, as manufactured by KR Services Company (800-245-7520), or approved equivalent.
    b. The mesh should be UV stabilized with carbon black.
    c. Netting shall have a minimum tensile breaking strength of 90 lbs.
    d. Netting shall be transported, stored and installed in accordance with manufacturer's specifications.

3. Support Cables
    a. Two support cables shall run horizontally and be attached at the top and bottom of each pole. Vertical cables shall be attached to each pole and between each pole. All lines shall be 1/4", 7-strand, galvanized steel strand wire.
    b. The vertical support cable located between the poles shall be connected to top and bottom horizontal cables by looping an eye in the vertical cable around each horizontal cable. A steel thimble shall be utilized in the eye of the vertical cable. The connection shall be capable of developing the strength of the cable. The vertical support shall be anchored with a helical anchor.
    c. Cables shall be attached around each chain link gate to support the netting. The center vertical cable shall be tied to the cable running along the top of the gate instead of the helical anchor.
    d. All horizontal cables for the netting panels shall be tensioned to allow a sag of 6 inches (± 1inch) over the length of the cable.

4. Snap Hook
    a. Galvanized snap hooks shall be used to attach each netting panel to the top, bottom and vertical cables.
    b. Snap hooks shall be installed at a minimum 2-foot spacing.
    c. Snap hooks shall have a minimum working strength of 90 lbs.

5. Helical Anchors
    a. Helical anchors should be made of galvanized steel.
    b. Helical anchors should be installed by a certified specialty contractor with experience in the installation of helical anchors.
    c. Anchors should be installed to withstand a minimum ultimate pullout capacity of 10,000 lbs, as verified by installation torque. All anchors should be installed to a minimum embedment length of 10 feet. A written installation record should be maintained for each anchor installed. The record should include the following, at a minimum: location of anchor, description of the lead section and extension installed, depth of installation, torque reading for last 5 feet of installation and termination torque.

6. Chain Link Gate

a. Chain link gates shall be installed in accordance with Section 727 of DelDOT Standard Specifications.

b. Each gate shall be 30 feet wide, with an opening in the middle of the gate (i.e., a double-swing gate), and shall be 10 feet high.

c. Gate poles and fabric shall be galvanized metal.

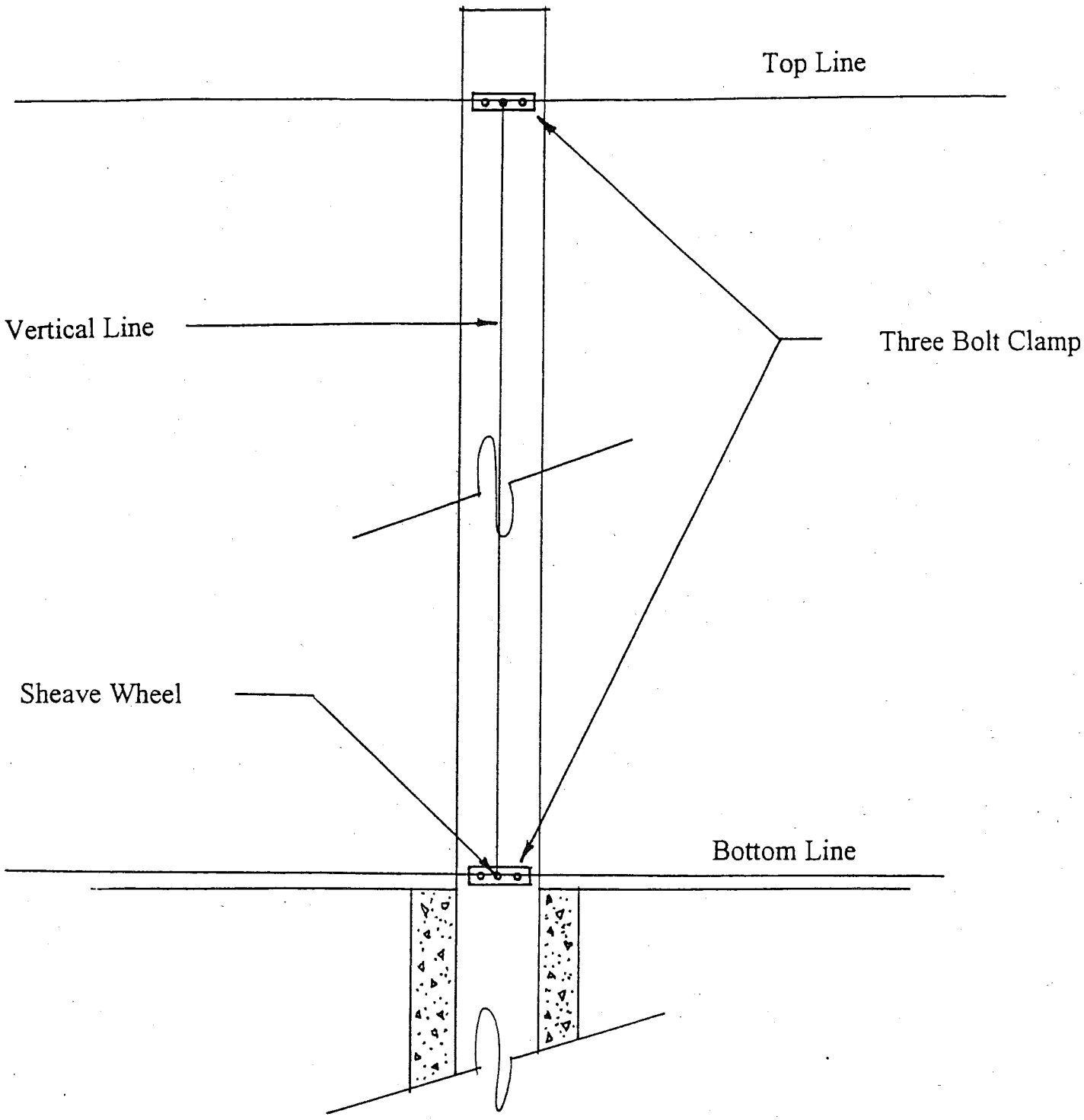



**Figure 4**

Interior Pole Detail

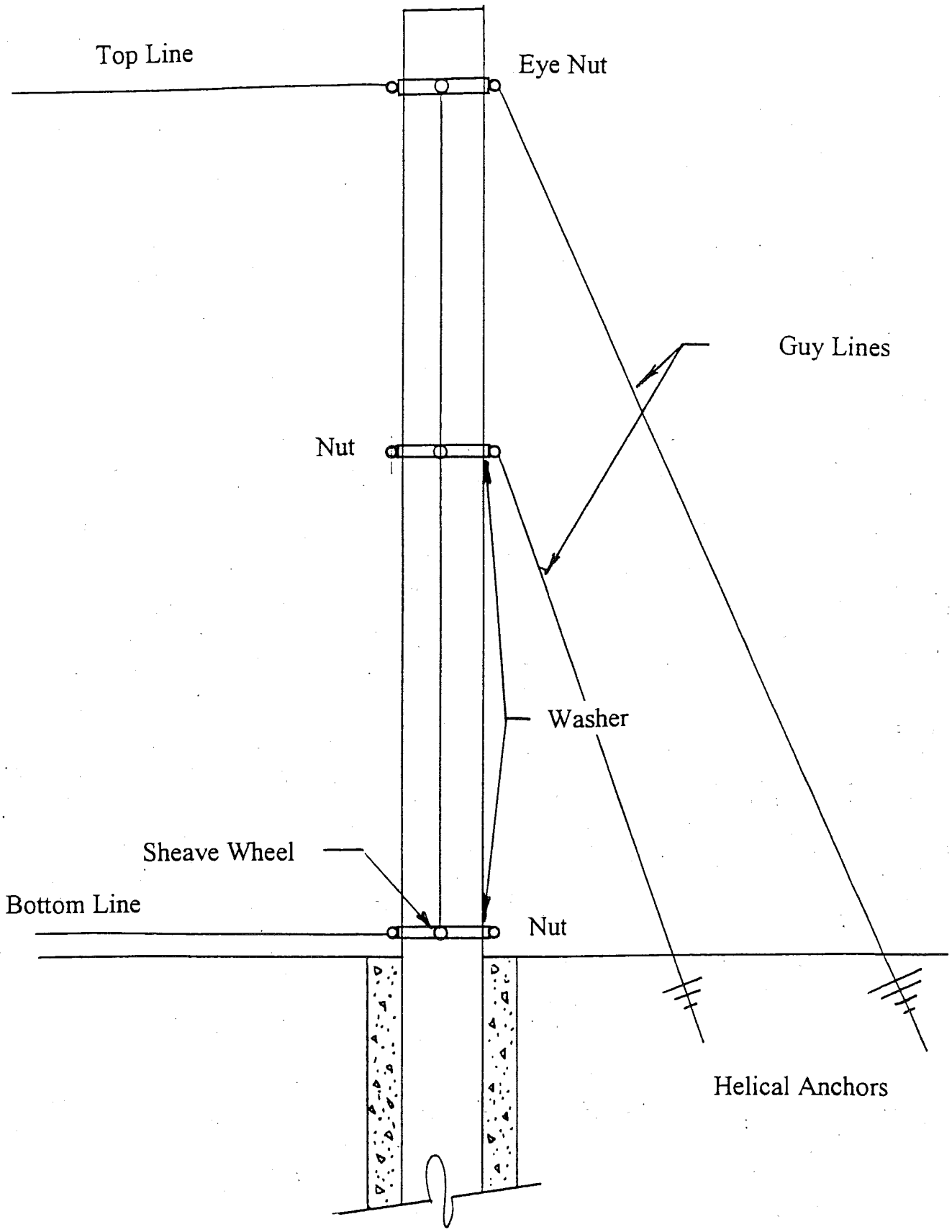



**Figure 5**

End Pole Detail

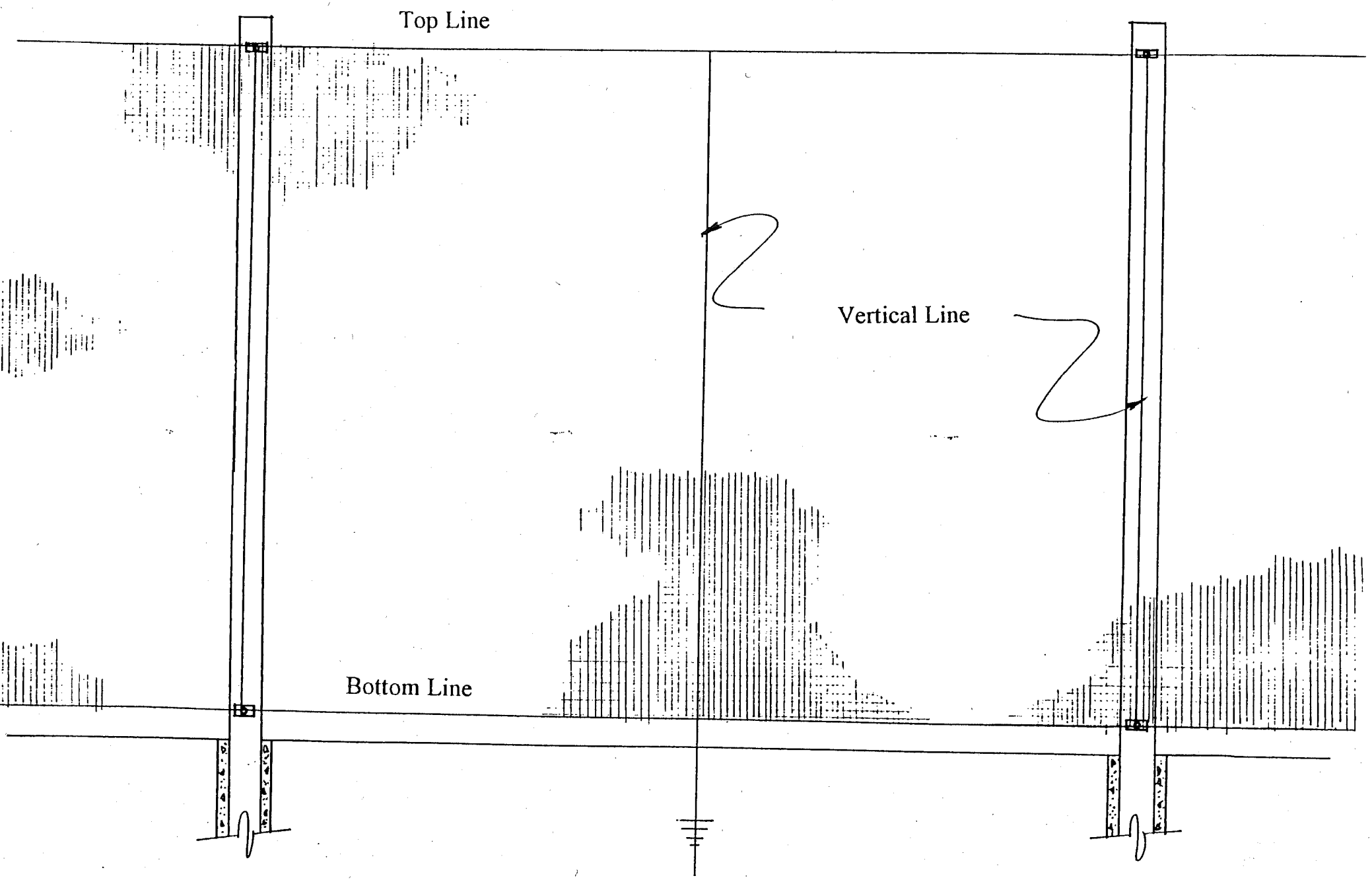



**Figure 6**

TO: ANNETTE

**CAUTION:** Working loads are tabulated for rope in good condition in non-critical applications and under normal service conditions. Working loads are not applicable where the rope is subjected to dynamic loading or other excessive use. Should the rope fail it may recoil with considerable force. Persons should be warned against standing in line with the rope.

# ROPE SPECIFICATIONS

FRANK W. WINNE — Twines & Cordage

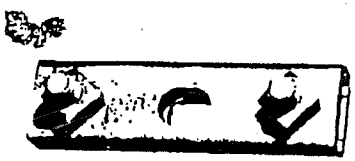
| | | POLYPROPYLENE (17%*) | | | NYLON (11%*) | | |
|---|---|---|---|---|---|---|---|
| Dia. (Nom.) | Cir. | Pounds Per 100 feet | Feet Per Pound | Tensile Strength | Pounds Per 100 feet | Feet Per Pound | Tensile Strength |
| 3/16 | 5/8 | .70 | 143.0 | 720 | 1.0 | 100.0 | 900 |
| 1/4 | 3/4 | 1.2 | 83.4 | 1,130 | 1.5 | 66.7 | 1,490 |
| 5/16 | 1 | 1.8 | 55.6 | 1,710 | 2.5 | 40.0 | 2,300 |
| 3/8 | 1-1/8 | 2.8 | 35.7 | 2,430 | 3.5 | 28.5 | 3,350 |
| 7/16 | 1-1/4 | 3.8 | 26.3 | 3,150 | 5.0 | 20.0 | 4,500 |
| 1/2 | 1-1/2 | 4.7 | 21.3 | 3,780 | 6.5 | 15.4 | 5,750 |
| 9/16 | 1-3/4 | 6.1 | 16.4 | 4,590 | 8.3 | 12.3 | 7,200 |
| 5/8 | 2 | 7.5 | 13.3 | 5,580 | 10.5 | 9.5 | 9,350 |
| 3/4 | 2-1/4 | 10.7 | 9.3 | 7,650 | 14.5 | 6.9 | 12,800 |
| 13/16 | 2-1/2 | 12.7 | 7.9 | 8,910 | 17.0 | 5.9 | 15,300 |
| 7/8 | 2-3/4 | 15.0 | 6.7 | 10,400 | 20.0 | 5.0 | 18,000 |
| 1 | 3 | 18.0 | 5.5 | 12,600 | 26.0 | 3.8 | 22,500 |
| 1-1/16 | 3-1/4 | 20.4 | 4.9 | 14,400 | 29.0 | 3.4 | 25,900 |
| 1-1/8 | 3-1/2 | 23.7 | 4.2 | 16,500 | 34.0 | 2.9 | 29,700 |
| 1-1/4 | 3-3/4 | 27.0 | 3.7 | 18,900 | 40.0 | 2.5 | 33,750 |
| 1-5/16 | 4 | 30.5 | 3.3 | 21,200 | 45.0 | 2.2 | 38,750 |
| 1-1/2 | 4-1/2 | 38.5 | 2.6 | 26,700 | 55.0 | 1.8 | 47,700 |
| 1-5/8 | 5 | 47.5 | 2.1 | 32,400 | 68.0 | 1.5 | 58,500 |
| 1-3/4 | 5-1/2 | 57.0 | 1.7 | 38,700 | 83.0 | 1.2 | 70,200 |
| 2 | 6 | 69.0 | 1.4 | 46,800 | 95.0 | 1.05 | 82,800 |
| 2-1/8 | 6-1/2 | 80.0 | 1.2 | 54,900 | 109.0 | 0.92 | 95,400 |
| 2-1/4 | 7 | 92.0 | 1.1 | 62,100 | 129.0 | 0.77 | 113,000 |
| 2-1/2 | 7-1/2 | 107.0 | 0.93 | 72,000 | 149.0 | 0.67 | 126,000 |
| 2-5/8 | 8 | 120.0 | 0.83 | 81,000 | 168.0 | 0.59 | 146,000 |
| 2-7/8 | 8-1/2 | 137.0 | 0.73 | 90,900 | 188.0 | 0.53 | 162,000 |
| 3 | 9 | 153.0 | 0.65 | 103,000 | 210.0 | 0.47 | 180,000 |
| 3-1/4 | 10 | 180.0 | 0.53 | 123,000 | 283.0 | 0.38 | 225,000 |
| 3-1/2 | 11 | 232.0 | 0.43 | 146,000 | 316.0 | 0.32 | 270,000 |
| 4 | 12 | 275.0 | 0.36 | 171,000 | 379.0 | 0.26 | 324,000 |

| | | MANILA (20%*) | | | POLYESTER (11%*) | | |
|---|---|---|---|---|---|---|---|
| Dia. (Nom.) | Cir. | Pounds Per 100 feet | Feet Per Pound | Tensile Strength | Pounds Per 100 feet | Feet Per Pound | Tensile Strength |
| 3/16 | 5/8 | 1.5 | 66.60 | 405 | 1.2 | 83.4 | 900 |
| 1/4 | 3/4 | 2.0 | 50.00 | 540 | 2.0 | 50.0 | 1,490 |
| 5/16 | 1 | 2.9 | 34.50 | 900 | 3.1 | 32.2 | 2,300 |
| 3/8 | 1-1/8 | 4.1 | 24.40 | 1,215 | 4.5 | 22.2 | 3,350 |
| 7/16 | 1-1/4 | 5.3 | 19.00 | 1,575 | 6.2 | 16.1 | 4,500 |
| 1/2 | 1-1/2 | 7.5 | 13.33 | 2,385 | 8.0 | 12.5 | 5,750 |
| 9/16 | 1-3/4 | 10.4 | 9.61 | 3,105 | 10.2 | 9.8 | 7,200 |
| 5/8 | 2 | 13.3 | 7.50 | 3,960 | 13.0 | 7.7 | 9,000 |
| 3/4 | 2-1/4 | 16.7 | 6.00 | 4,860 | 17.5 | 5.7 | 11,300 |
| 13/16 | 2-1/2 | 19.5 | 5.13 | 5,850 | 21.0 | 4.8 | 14,000 |
| 7/8 | 2-3/4 | 22.5 | 4.45 | 6,930 | 25.0 | 4.0 | 16,200 |
| 1 | 3 | 27.0 | 3.71 | 8,100 | 30.5 | 3.3 | 19,800 |
| 1-1/16 | 3-1/4 | 31.3 | 3.20 | 9,450 | 34.5 | 2.9 | 23,000 |
| 1-1/8 | 3-1/2 | 36.0 | 2.78 | 10,800 | 40.0 | 2.5 | 26,600 |
| 1-1/4 | 3-3/4 | 41.8 | 2.40 | 12,150 | 46.3 | 2.2 | 29,900 |
| 1-5/16 | 4 | 48.0 | 2.09 | 13,500 | 52.5 | 1.9 | 33,800 |
| 1-1/2 | 4-1/2 | 60.0 | 1.67 | 16,650 | 66.8 | 1.5 | 42,100 |
| 1-5/8 | 5 | 74.4 | 1.34 | 20,250 | 82.0 | 1.2 | 51,300 |
| 1-3/4 | 5-1/2 | 88.5 | 1.12 | 23,850 | 98.0 | 1.02 | 61,000 |
| 2 | 6 | 108.0 | .93 | 27,900 | 118.0 | .85 | 72,000 |
| 2-1/8 | 6-1/2 | 125.0 | .79 | 32,400 | 135.0 | .74 | 82,800 |
| 2-1/4 | 7 | 146.0 | .685 | 36,900 | 157.0 | .64 | 96,300 |
| 2-1/2 | 7-1/2 | 167.0 | .59 | 41,850 | 181.0 | .55 | 110,000 |
| 2-5/8 | 8 | 191.0 | .52 | 46,800 | 205.0 | .49 | 123,000 |
| 2-7/8 | 8-1/2 | 215.0 | .47 | 52,200 | 230.0 | .43 | 139,000 |
| 3 | 9 | 242.0 | .42 | 57,600 | 258.0 | .39 | 157,000 |
| 3-1/4 | 10 | 299.0 | .33 | 69,300 | 318.0 | .31 | 189,000 |
| 3-1/2 | 11 | 367.0 | .27 | 81,900 | 384.0 | .26 | 229,000 |
| 4 | 12 | 436.0 | .23 | 94,500 | 460.0 | .22 | 270,000 |

# Cable Suspension Clamps

Cable Suspension Clamps are available in 3-bolt type and corner type. The 3-bolt type is used generally for heavy cables and long spans. Each is furnished with two 1/2" track bolt (high carbon steel) and a center hold for mounting with a 5/8" bolt.

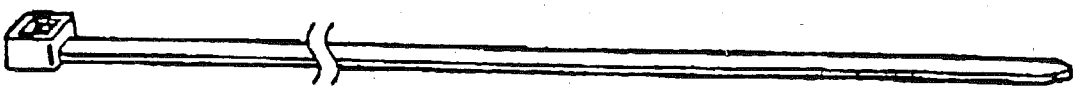
One-Bolt
Figure 1



Three-Bolt
Figure 2

Figure 3

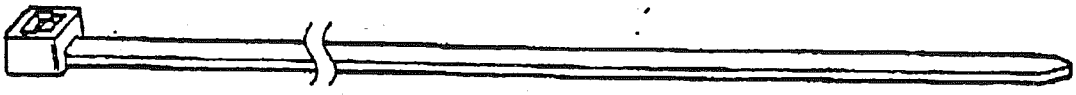
| Cat. No. | Type | Clamp Bolt Dia. | Clamp Length | Mounting Hole Dia. | Strand Dia. | Std. Pkg. Qty. | Ship Wt./100 |
|---|---|---|---|---|---|---|---|
| → | 1 bolt | — | 2-1/2" | 11/16" | 1/4"-7/16" | 25 | 67.0 |
| → | 3 bolt | 1/2" | 5-3/4" | 11/16"15/16" | 1/4"-7/16" | 25 | 196.0 |
| | angle | 1/2" | — | 13/16" | 1/4"-7/16" | 25 | 232.0 |



## HEAVY DUTY - SERIES 120

| Per Bag | Item Number | Material | Color | Bundle Diameter Inch | (mm) | Length Inch | (mm) | Width Inch | (mm) | Minimum Loop Tensile LB | (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | L-8-[illegible]HS-0-C | Heat Stabilized Nylon | Black | 3/16 - 2 | (5 - 51) | 8.0 | (202) | .300 | (8) | 100 | (54.4) |
| | L-8-[illegible]-0-C | UV Nylon | | | | | | | | | |
| | L-8-[illegible]-9-C | Nylon | Natural | | | | | | | | |
| | L-11-[illegible]-0-C | UV Nylon | Black | 5/16 - 3 | (5 - 76) | 11.1 | (282) | | | | |
| | L-11-[illegible]-9-C | Nylon | Natural | | | | | | | | |
| | L-14-[illegible]HS-0-C | Heat Stabilized Nylon | Black | 7/16 - 4 | (8 - 102) | 14.2 | (363) | | | | |
| | L-14-[illegible]-0-C | UV Nylon | | | | | | | | | |
| | L-14-[illegible]-9-C | Nylon | Natural | | | | | | | | |
| | P-14-[illegible]-2-C | Nylon Colors | Red | | | | | | | | |
| | P-14-[illegible]-5-C | | Green | | | | | | | | |
| 50 | L-18-[illegible]HS-0-L | Heat Stabilized Nylon | Black | 7/16 - 4 7/8 | (5 - 124) | 18.0 | (457) | | | | |
| | L-18-[illegible]-0-L | UV Nylon | | | | | | | | | |
| | L-18-[illegible]-9-L | Nylon | Natural | | | | | | | | |
| | L-24-[illegible]HS-0-L | Heat Stabilized Nylon | Black | 7/16 - 7 | (5 - 178) | 24.2 | (616) | | | | |
| | L-24-[illegible]-0-L | UV Nylon | | | | | | | | | |
| | L-24-[illegible]-9-L | Nylon | Natural | | | | | | | | |
| | L-28-[illegible]-0-L | UV Nylon | Black | 7/16 - 9 | (5 - 230) | 28.0 | (616) | | | | |
| | L-28-[illegible]-9-L | Nylon | Natural | | | | | | | | |

* Use L-300 or ERG-297 Installation Tool



## EXTRA HEAVY DUTY - SERIES 175

| Per Bag | Item Number | Material | Color | Bundle Diameter Inch | (mm) | Length Inch | (mm) | Width Inch | (mm) | Minimum Loop Tensile LB | (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | L-24-175-0-L | UV Nylon | Black | 3/16 - 7.2 | (5 - 184) | 24.0 | (612) | .346 | (9) | 175 | (79.3) |
| | L-24-175-9-L | Nylon | Natural | | | | | | | | |
| | L-34-175-9-L | | | 5/16 - 10 | (8 - 254) | 34.0 | (864) | | | | |
| | L-36-175-0-L | UV Nylon | Black | 2 3/4 - 10 3/4 | (70 - 273) | 36.0 | (914) | | | | |
| | L-36-175-9-L | Nylon | Natural | | | | | | | | |
| | L-41-175-0-L | UV Nylon | Black | 3/4 - 12 | (5 - 305) | 41.0 | (1032) | | | | |
| | L-41-175-8-L | Nylon | Gray | | | | | | | | |
| | L-48-175-0-L | UV Nylon | Black | 7/8 - 15 | (5 - 375) | 48.0 | (1218) | | | | |
| | L-48-175-8-L | Nylon | Gray | | | | | | | | |

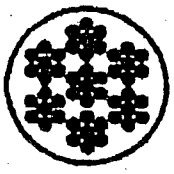
* Use L-300 or ERG-297 Installation Tool

# Vinyl Coated Cable

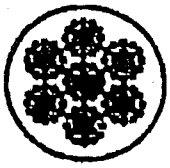
| Size Cable Dia. | Vinyl Coated Galvanized Cable | | | |
|---|---|---|---|---|
| | Coated to | Approx. Weight per 1000 Foot in Pounds | Breaking Strength in Pounds* | Construction |
| 1/16" ** | 3/32 | 9.3 | 480 | 7x7 |
| 1/16" ** | 1/8 | 11.8 | 480 | 7x7 |
| 3/32" ** | 1/8 | 18.5 | 920 | 7x7 |
| 3/32" ** | 3/16 | 25.8 | 920 | 7x7 |
| 1/8" ** | 3/16 | 35.2 | 1,700 | 7x7 |
| 3/32" ** | 1/8 | 19.9 | 1,800 | 7x19 |
| 1/8" ** | 3/16 | 36.2 | 2,000 | 7x19 |
| ~~3/16" **~~ | ~~1/4~~ | ~~77.5~~ | ~~6,000~~ 3700 | ~~7x19~~ (7x7) |
| 1/4" ** | 5/16 | 123.0 | 7,000 | 7x19 |
| 5/16" ** | 3/8 | 197.0 | 9,000 | 7x19 |
| 3/8" ** | 7/16 | 270.0 | 14,400 | 7x19 |

## Vinyl Coated Cable

Galvanized



7x7

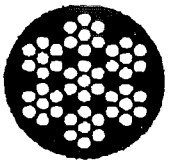


7x19

| Size Cable Dia. | 7x7 Life-line | | |
|---|---|---|---|
| | Coated to | Approx. Weight per 1000 Foot in Pounds | Breaking Strength in Pounds* |
| 1/16" | 1/8" | 1.3 | 480 |
| 3/32" | 1/8" | 2.0 | 920 |
| 1/8" | 3/16" | 3.9 | 1,700 |
| 7/32" | 7/32" | 3.9 | 1,700 |
| 1/8" | 1/4" | 5.1 | 1,700 |
| 3/16" | 1/4" | 8.0 | 3,700 |
| 3/16" | 5/16" | 8.1 | 3,700 |
| 3/16" | 3/8" | 11.2 | 3,700 |
| 1/4" | 3/8" | 14.2 | 6,100 |

## Life-line Cable/ White Jacket

Stainless Steel Type 302 and 304

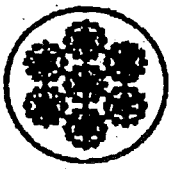


7x7

| Size Cable Dia. | Vinyl Coated Stainless Cable Type 304 | | | |
|---|---|---|---|---|
| | Coated to | Approx. Weight per 1000 Foot in Pounds | Breaking Strength in Pounds | Construction |
| 1/8" ** | 3/16 | 36.2 | 1,700 | 7x19 |
| 3/16" ** | 1/4 | 77.5 | 3,700 | 7x19 |
| 1/4" ** | 5/16 | 123.0 | 6,400 | 7x19 |
| 5/16" ** | 3/8 | 197.0 | 9,000 | 7x19 |
| 3/8" ** | 7/16 | 270.0 | 12,000 | 7x19 |

## Vinyl Coated Cable

Stainless Steel

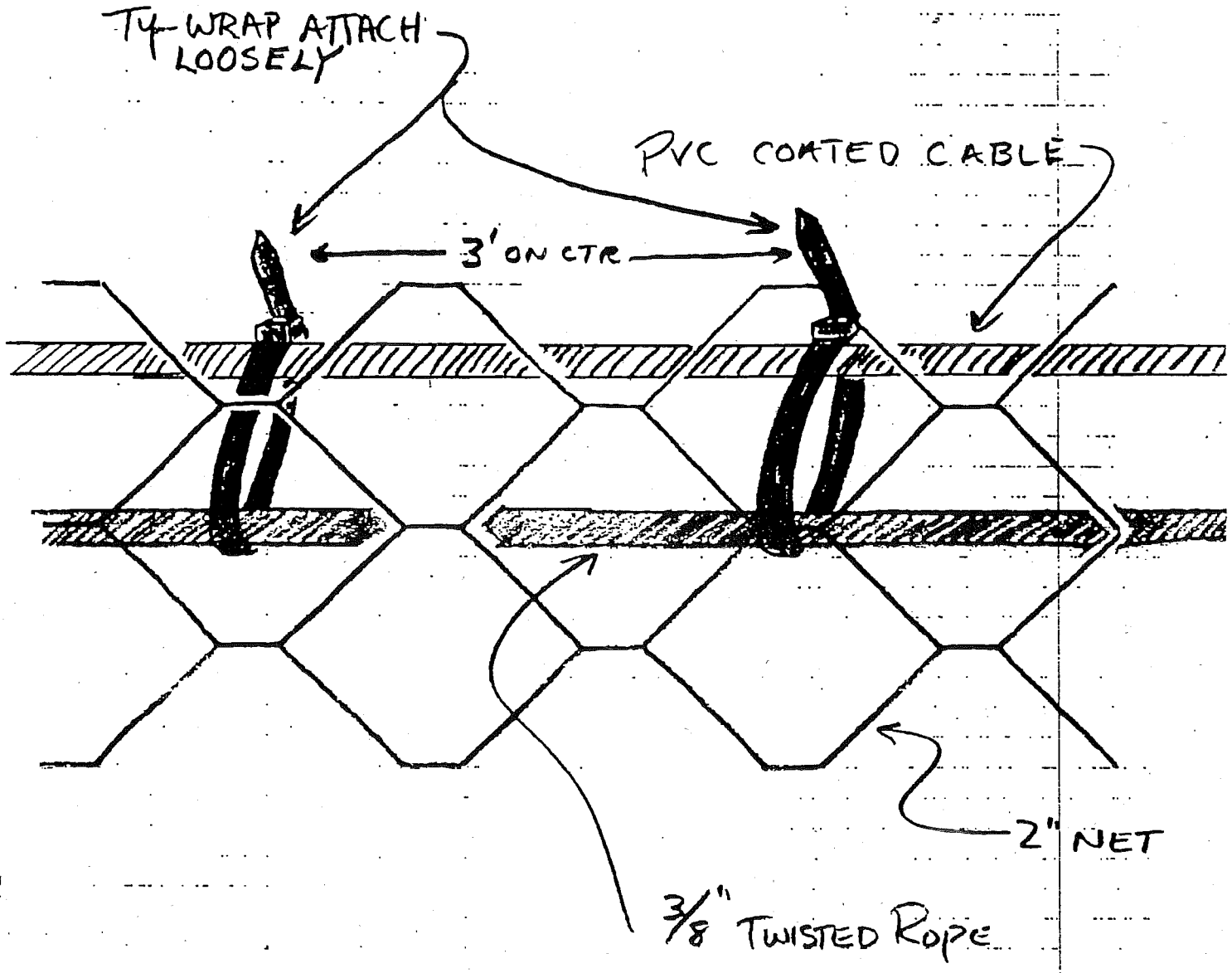


7x19

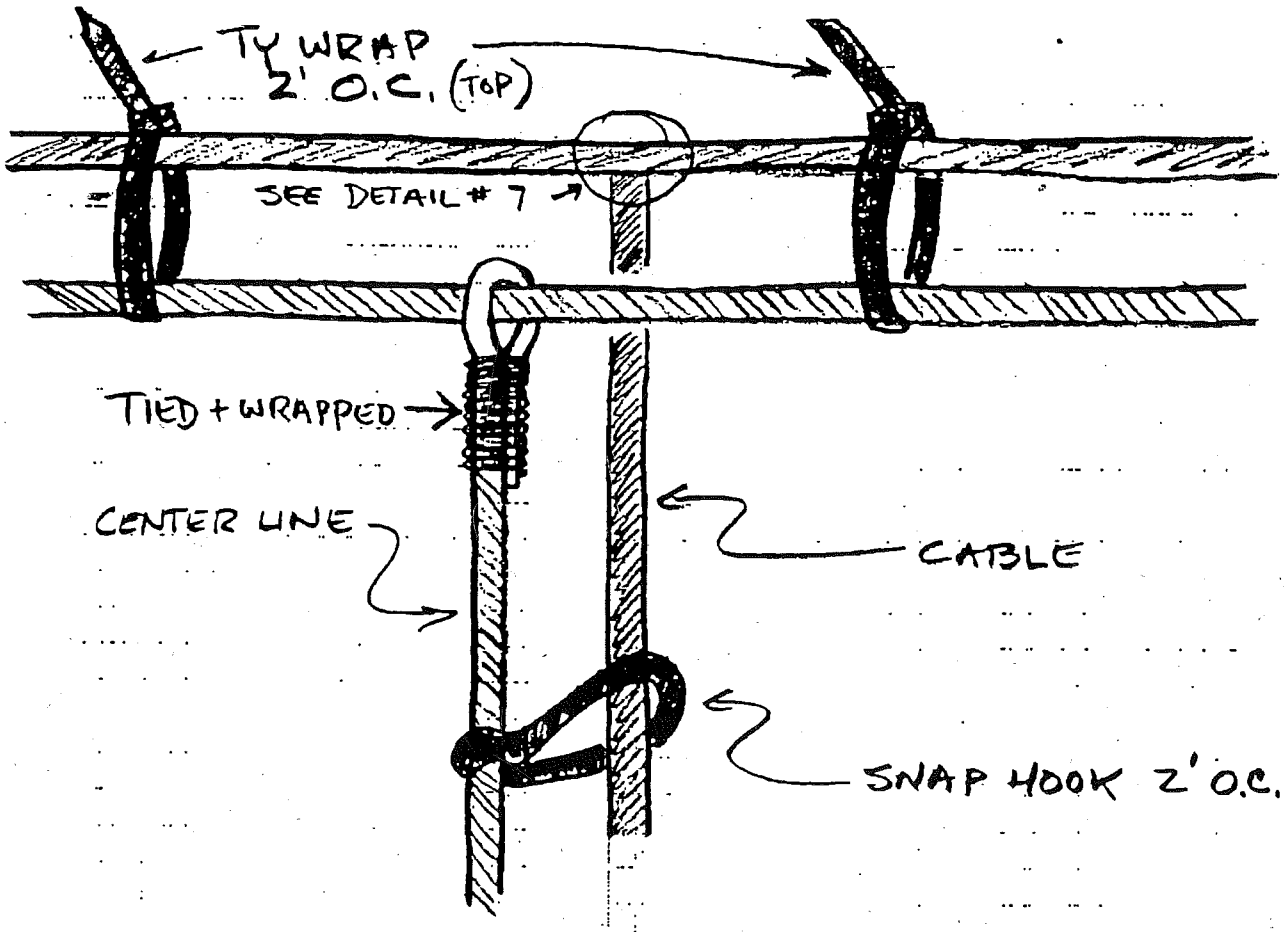
* Listed for comparison only. Actual operating loads may vary, but should never exceed recommended design factor or 1/7 of catalog breaking strength.
** Listed for comparison only. Actual factors vary between 6:1 and 3:1 depending on application.

NETTING DETAIL #4

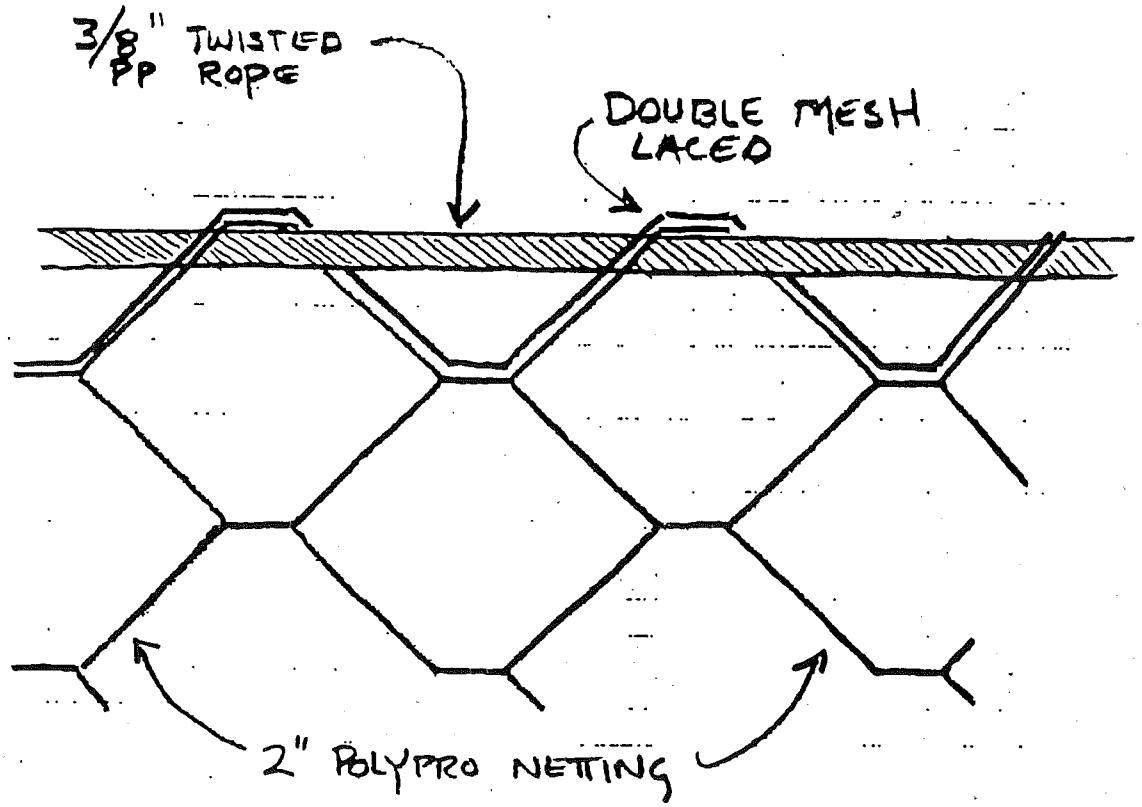
NETTING ATTACHMENT AT CENTER WIND LINE



DETAIL # 3

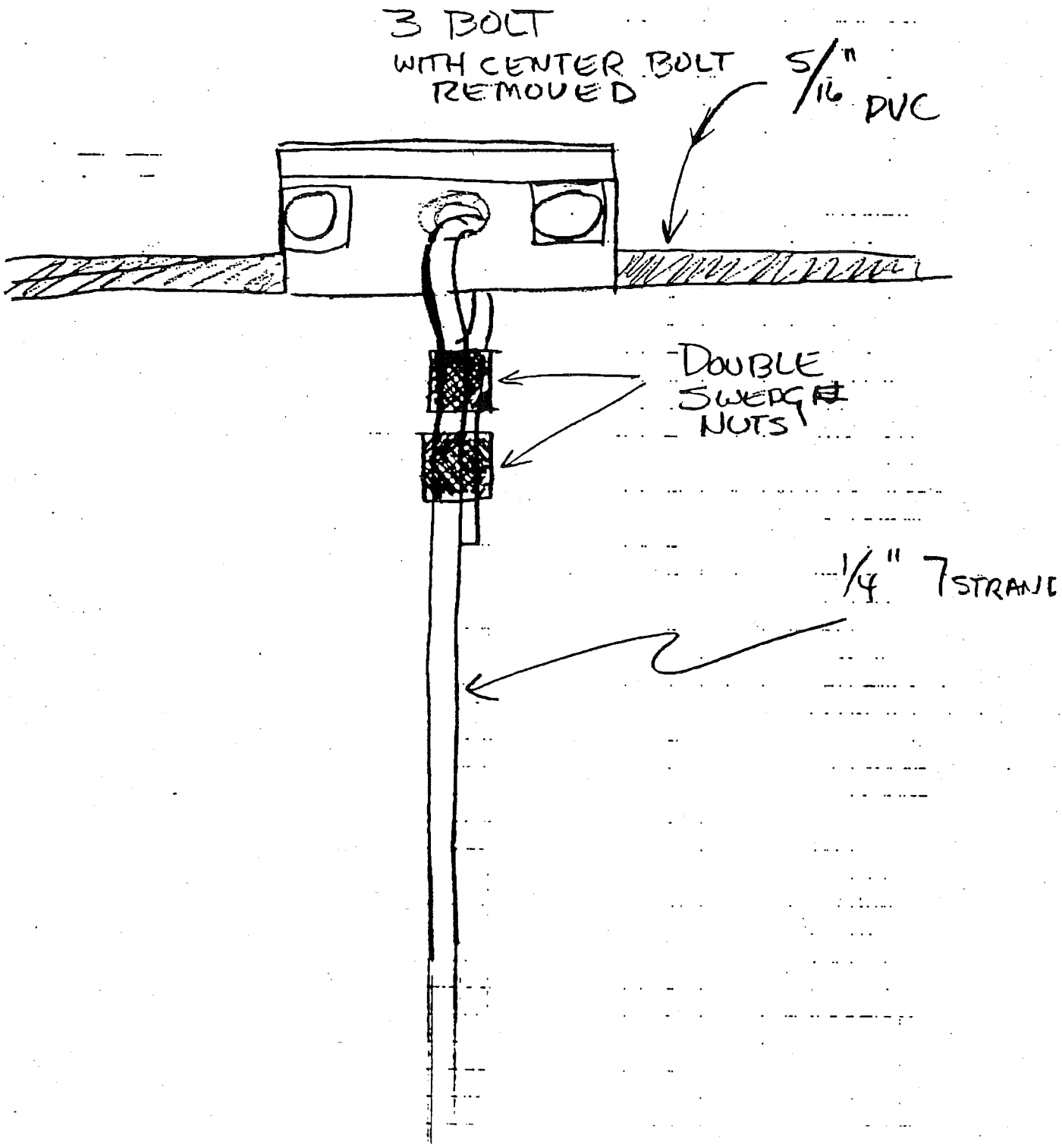

TY WRAP
2' O.C. (TOP)
SEE DETAIL # 7
TIED + WRAPPED
CENTER LINE
CABLE
SNAP HOOK 2' O.C.

NETTING DETAIL # 2



# 7

CENTER LINE
TOP DETAIL



# SECTION 02370

# EROSION AND SEDIMENT CONTROL

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to install the erosion and sediment control features show on the drawings, including: (i) erosion control mat; (ii) silt fence; and (iii) temporary stabilization, as specified herein and as shown on the Drawings.

B. CONTRACTOR shall furnish all labor, material, tools, supervision, transportation, installation equipment, and incidentals required to install erosion and sediment controls not shown on the Drawings, but required to prevent sedimentation or pollution to waters of the State or Federal waterways.

C. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to maintain all soil erosion and sediment control features and structures throughout the duration of the Project and removal of temporary measures and structures, where and when necessary, as directed by OWNER or ENGINEER.

D. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, installation equipment, and incidentals required to construct and maintain soil stockpiles on site.

E. CONTRACTOR shall not disturb wetland areas.

### 1.02 SUBMITTALS

A. At least ten days prior to the Preconstruction Meeting, CONTRACTOR shall provide ENGINEER the proposed product material data sheets, and manufacturer recommended method of installation for:
   1. erosion control mat; and
   2. silt fence; and

B. At least seven days prior to applying any temporary stabilization, CONTRACTOR shall provide ENGINEER information of:
   1. seed mixture, quantity, and application rate;

2. mulch type and application rate;
3. fertilizer type and application rate; and
4. seed bed preparation.

C. At least seven days prior to installing a sediment control feature not addressed in this Section, CONTRACTOR shall provide ENGINEER Shop Drawings and/ or product information on the proposed feature, along with calculations necessary to verify the proper functioning of the feature for the intended purpose.

## 1.03 CONSTRUCTION QUALITY ASSURANCE

A. The installation, use, and maintenance of the erosion and sediment control feature shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these when preparing the project schedule.

C. At the discretion of OWNER or ENGINEER, the Work of this Section may be subjected to CQA monitoring.

# PART 2 PRODUCTS

## 2.01 EROSION CONTROL MAT

A. Erosion control mat shall be a non-degradable turf-reinforcing mat.

B. Erosion control mat shall demonstrate acceptable performance when subjected to at least 20 hours of continuous water flow under the following conditions:
1. permissible velocity of 11 ft/sec; and
2. permissible tractive shear stress of 2 $lb/ft^2$.

## 2.02 SILT FENCE

A. Silt fence shall meet the requirements for Silt Fence as described in the "*Delaware Erosion and Sediment Control Handbook*", most recent version, and as shown on the Drawings.

## 2.03 TEMPORARY STABILIZATION

A. Temporary stabilization shall consist of placing seed, mulch, fertilizer, and/or soil amendments as needed, for the area to be stabilized.

B. Seed, fertilizer, mulch, and soil amendments shall meet the requirements for Vegetative Stabilization with Temporary Seeding as described in the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

## 2.04 PERMANENT STABILIZATION

A. Permanent stabilization shall consist of placing seed, mulch, fertilizer, and/or soil amendments as needed, for the area to be permanently stabilized.

B. Seed, fertilizer, mulch, and soil amendments shall meet the requirements for Vegetative Stabilization with Permanent Seeding as described in the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

C. Liquid mulch binders shall not be used.

D. Permanent seed mix shall conform to Seed Mix No. 4.

## 2.05 OTHER EROSION AND SEDIMENT CONTROL FEATURES

A. CONTRACTOR shall select appropriate erosion and sediment control features from Delaware Erosion and Sediment Control Handbook, most recent version, and DELDOT Division 200.

B. CONTRACTOR may use erosion and sediment control features presented in other published erosion and sediment control guidance documents or manufacturers recommendations as approved by ENGINEER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the Work of this Section will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 EROSION CONTROL MAT

A. Erosion control mat shall be installed either prior to or within 48 hours after seeding operations have been completed in the work areas.

B. The mat shall be placed on a smooth surface that is free of trash, ruts, and rocks.

C. Erosion control mat shall be placed flat and shall conform to the contours of soil surface.

D. Placement on Slopes:
   1. Anchor trenches shall be located at the crest and the toe of the terrace. Anchor trenches shall be a minimum of 6 in. deep. The anchor trench at the crest shall be located at 1 ft. from the edge of the slope. The geometry of the anchor trench, type of fastener, fastener spacing, and method of construction of the anchor trenches shall be in accordance with the manufacturer's instructions.
   2. Erosion mat shall be unrolled as directed by the manufacturer. Adjacent panels of erosion mat shall be installed with a minimum overlap of 4 in. Fastening of the erosion mat shall begin in the toe anchor trench and shall progress upslope to the crest anchor trench. Spacing of fasteners shall be in intervals of 3 to 5 ft. vertically upslope. Horizontal spacing of fasteners shall be in accordance with the manufacturer's instructions. Backfill shall be placed in anchor trenches over fasteners as construction proceeds.

## 3.03 SILT FENCE

A. CONTRACTOR shall install silt fence on a level grade downslope of all disturbed areas as shown on the Drawings. Both ends of the silt fence section must extend at least 8 ft upslope at 45 degrees to the main fence alignment.

B. Sediment accumulated against the silt fence shall be removed when it reaches one half of the above ground height of the fence.

## 3.04 TEMPORARY STABILIZATION

A. CONTRACTOR shall install temporary stabilization over disturbed areas, as needed, to minimize the potential for erosion in accordance with the requirements of Vegetative Stabilization with Temporary Seeding as described in the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

B. The selection of temporary stabilization shall be agreed to between CONTRACTOR and ENGINEER based on season, ground and weather conditions, and anticipated time area will be left undisturbed.

C. Temporary stabilization shall be applied over any disturbed are that will be left bare for more than three days.

## 3.05 PERMANENT STABILIZATION

A. CONTRACTOR shall install permanent stabilization over areas that will not be disturbed in accordance with the requirements of Vegetative Stabilization with Permanent Seeding as described in the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

## 3.06 OTHER EROSION AND SEDIMENT CONTROL FEATURES

A. CONTRACTOR shall install, operate, and maintain erosion and sediment control features in accordance with published literature and/or manufacturers recommendations throughout the duration of the Contract and direction by OWNER and ENGINEER.

## 3.07 STOCKPILING

A. Stockpiles side slopes shall be no steeper than 3H:1V (horizontal: vertical), graded to drain, sealed by tracking parallel to the slope with a dozer or other means, and dressed daily during periods when material is taken from the stockpile. CONTRACTOR shall stabilize stockpiles as described in Part 3.04 of this Section.

END OF SECTION

# SECTION 02401

# UTILITY CASINGS AND AUGER BORINGS

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. This Section includes casing pipe and casing pipe installation where indicated to install pipe without open excavation.

B. Prior to commencing construction, if required, the CONTRACTOR shall conduct subsurface investigations to determine the type and properties of the material to be excavated and construction method to be used.

C. Provide all materials, equipment and labor as required to install utility casings as indicated and as specified.

D. CONTRACTOR shall be required to implement the use of guided boring technology to accurately drill a pilot hole to the existing manhole or pump station wetwell.

E. CONTRACTOR shall install the casing pipe by using the jacking and boring method through the pilot hole.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1 - General Requirements

B. Division 2 - Sitework

### 1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

| | | |
|---|---|---|
| A 139 | - | Electric-Fusion (Arc) - Welded Steel Pipe (sizes 4 inches and over). |
| C 32 | - | Sewer and Manhole Brick (Made from Clay or Shale) |

C 270 - Mortar for Unit Masonry.

B. American Water Works Association (AWWA)

C 200 - Steel Water Pipe 6 Inches and Larger

C 206 - Field Welding of Steel Water Pipe.

C. Delaware Department of Transportation (DelDOT), " Standard Specifications", latest edition.

## 1.04 SUBMITTALS

A. Manufacturer's catalog cuts of material being supplied.

B. Copies of all subsurface investigation test results.

C. Details of construction methods to be utilized.

D. Casing pipe, end seal materials and pipe alignment guides.

E. Protective coatings and linings.

F. Certificates of Compliance with the applicable Standards.

## 1.05 DELIVERY AND HANDLING

A. Use equipment and methods adequate to maintain the quality of the pipe and coating.

B. Ship the piping to the field with a sufficient number of temporary struts to maintain a uniform cross-section along the length of the pipe and to maintain the specified internal diameter.

# PART 2 PRODUCTS

## 2.01 AUGER BORING CASING MATERIALS

A. Casing pipe shall conform to ASTM A139, Grade B steel with a minimum yield strength of 35,000 psi.

B. Casing Pipe Fabrication

1. Shall conform to AWWA C200.

2. Fabricate in a manner to keep field welds to a minimum.

C. Protective Coatings and Linings.

1. Coat exterior and line interior of all casing pipe with a prime paint equivalent to Pennsbury Coatings Corporation's 1-R-2, Bulldog Primer.

2. Hold coatings back from the end of joints to be welded at least 2 inches each side of joint.

D. Joints

1. All joints in steel pipe casings shall be field welded to conform to AWWA C206.

2. Brush clean and apply field prime paint coating to all exterior joints after field welding.

3. Brush clean and apply field prime paint field lining to all interior joints after field welding.

## 2.02 HDPE CASING MATERIALS

A. Casing material for the force main, gravity main and the pump casings shall be high density polyethylene (HDPE) pipe in accordance with section 02616.

B. Casings for the pumps shall be deburred on the inside to remove the excess material at the joints caused by fusion welding and provide an interior surface that is relatively free of bumps a ridges. The interior of the casing shall be inspected by closed circuit videotape to verify the joints have been satisfactorily deburred.

# PART 3 EXECUTION

## 3.01 AUGER BORING CASING PIPE INSTALLATION

A. All work shall, as a minimum, meet the requirements of DelDOT and any other agencies having jurisdiction and shall be subject to their inspection and approval.

B. Install casing pipe as follows:

1. By guided boring with continuous flight auger, pneumatic jacking or other acceptable method. Reinforce leading end of casing with jacking band if jacking method is used.

2. Include measures for maintaining indicated line and grade for casings within a plus or minus tolerance of 1 inch.

3. Working pits shall be of adequate size to provide safe working conditions. Install sheeting and bracing in accordance with the requirements of Section 02223.

4. Install in such a manner as not to disrupt traffic or damage the roadway grade or surface.

5. Casings rejected due to misalignment or other failures to conform to specifications shall be abandoned in place and filled with concrete grout. Casing pipe shall not be recovered for reuse, except in the case of open-cut installation.

C. All required welding shall be by experienced welders and all welds shall be of the butt type of sufficient strength to resist drilling or jacking forces exerted. Joints shall be watertight.

D. After completion of boring operation, fill voids around the exterior of the casing pipe with grout placed under pressure. Properly protect the grout for not less than three days.

## 3.02 OPEN EXCAVATION CASING PIPE INSTALLATION

A. Install HDPE casing pipe in acccordance with Section 02616.

B. Pipe joints may be made with fusion molded couplings when fusion welding of pipe ends in not practical.

## 3.03 CARRIER PIPE

A. Install in accordance with manufacturer's instructions.

B. Carrier pipe shall be installed at the indicated grade.

## 3.04 ALIGNMENT GUIDES

A. Provide pipe alignment guides for all carrier pipes to be installed in casings. Alignment guides are not required within HDPE casings installed by open excavation.

B. Alignment guides shall be fusion coated steel casing insulators with a 12-inch band width and glass reinforced runners as manufactured by Pipeline Seal and Insulators, Inc., or approved equal.

C. Shall be sized to fit the outside diameter of the carrier pipe and inside diameter of the casing pipe.

D. Spacing of the alignment guides shall be in accordance with the manufacturer's recommendations.

## 3.05 END SEALS

A. End seals will not be required. The lower end of the HDPE pipe casing in the manholes and pump station wetwells shall be capped with a fusion welded HDPE end cap.

END OF SECTION

# SECTION 02520

# GROUNDWATER MONITORING WELLS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of permanent groundwater monitoring wells as specified herein and as shown on the Drawings.

B. CONTRACTOR shall retain the services of a qualified and experience, licensed well driller to install the permanent groundwater monitoring wells.

C. The groundwater monitoring wells will provide long-term groundwater quality data related to the Site. The design and installation of groundwater monitoring wells is a costly and detailed process. Inadequate or unsuitable boring methods, and incomplete or insufficient well construction can cause the data gathered from the wells to be unsubstantiated and unusable. Similarly, a properly constructed and developed well that is not adequately secured frequently results in loss of the well or errors in data, thus making the well unusable.

### 1.02 QUALIFICATIONS

A. Installation of the groundwater monitoring wells shall be performed by person(s) holding valid license(s) in the State of Delaware. Selected drilling contractor (driller) is expected to provide proof of licensure prior to beginning work

### 1.03 SUBMITTALS

A. At least 14 days prior to installing any groundwater monitoring well, CONTRACTOR shall provide ENGINEER with the following information:
   1. qualifications of the proposed well driller; and
   2. a copy of the current valid drillers license for the State of Delaware.

B. At the completion of the well installation, CONTRACTOR shall provide ENGINEER with record drawing(s) of the groundwater monitoring wells showing:
   1. surveyed location of each groundwater monitoring well;

2. surveyed elevation of the adjacent ground surface and top of standpipe for each groundwater monitoring well;
3. log of well construction information for each groundwater monitoring well, including start and completion dates and well development informaiton; and
4. copies of the well drillers logs.

## 1.04 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the groundwater wells shall be monitored by ENGINEER.

# PART 2 PRODUCTS

Not used.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the Work of this Section will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 WELL BORING AND CONSTRUCTION

A. All drilling and construction methods shall be considered safe and lawful in the State of Delaware. If driller representative perceives specified method/material to be unsafe or unlawful, then the driller shall notify CONTRACTOR. If change to specified method or material is warranted, then ENGINEER shall provide said changes to driller in writing.

B. Borings shall be completed using the best practical methods for the soils and materials encountered. Acceptable methods include rotary drilling with water-based fluid, performed in accordance with ASTM D 5783, and/or hollow-stem auger, performed in accordance with ASTM D 5784. However other methods may be acceptable if driller can provide evidence showing benefit over these methods and DNREC approval.

C. Well construction details are shown on Design Drawings. Wells shall be constructed in general accordance with ASTM D 5092. Certain deviations from specified materials may be acceptable providing driller can offer evidence showing benefit over the specified materials. In any case, all deviations from specified materials must be approved by ENGINEER prior to use.

## 3.03 WELL DEVELOPMENT

A. Following completion of well construction, driller shall develop each well for groundwater collection. Well development shall be in accordance with ASTM D 5521 or other method similar in function and accepted DNREC.

## 3.04 WELL SECURITY

A. Driller shall provide a locking device for each well. All wells shall have keyed-alike locks. Driller will deliver all keys to ENGINEER following completion of the Work of this Section.

B. Well security components are shown in Design Drawings. Well security components shall be constructed in general accordance with ASTM D 5787.

C. Driller shall provide daily footage and material logs to ENGINEER for approval/agreement with geologist's field notebook. ENGINEER shall sign daily footage/materials logs.

D. Copies of signed daily footage and material logs should be submitted to ENGINEER.

END OF SECTION

# SECTION 02531

# PRESSURE PIPE MATERIALS, APPURTENANCES AND TESTING

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. Work included shall consist of force main piping, valves, all necessary or required fittings and appurtenances.

B. Provide all pipe, pipe fittings, pipe flanges, adaptors and connections; joint materials including gaskets, nuts, bolts and washers; pipe supports; valves, fittings, and accessories; cutting and patching; temporary piping and temporary pumping; all abandonments, removals and relocations; piping, equipment, and all other items required to perform the work and as required for a complete and operational installation as indicated on the drawings and specified herein.

### 1.02 REFERENCE STANDARDS

A. Municipal Compliance: Comply with the requirements of the City of Wilmington.

B. American Society for Testing and Materials

| | |
|---|---|
| A 126 | Gray Iron Castings for Valves, Flanges, and Pipe Fittings. |
| A 194 | Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service. |
| A 197 | Cupola Malleable Iron. |
| A 307 | Carbon Steel Externally and Internally Threaded Standard Fasteners. |
| A 506 | Steel Sheet and Strip, Alloy, Hot-Rolled and Cold-Rolled, Regular Quality. |
| A 573 | Structural Carbon Steel Plates of Improved Toughness. |
| D 429 | Tests for Rubber Property - Adhesion to Rigid Substrates. |

D 1248 Specifications for Polyethylene Plastics, Molding & Extension Materials.

C. American National Standards Institute (ANSI)

B1 - Pipe Threads.

B16 - Pipe Flanges and Flanged Fittings.

B18 - Bolts and Nuts.

D. American Water Works Association (AWWA) Compliance:

C 110 - Ductile Iron and Gray Iron Fittings, 3 in. through 48 in. for Water and Other Liquids.

C 111 - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

C 509 - Resilient-Seated Gate Valves for Water and Sewerage Systems.

E. DelDOT Standard Specifications, dated July 85.

## 1.03 SUBMITTALS

A. Submit shop drawings and product data in accordance with the provisions of these Contract Documents.

B. Before any work is started, Certificates of Conformance for all materials shall be submitted, assuring conformance with these specifications. All pipe and appurtenances specified herein shall be covered by a guarantee certificate furnished by the CONTRACTOR and signed by an officer of the respective manufacturer.

## 1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Obtain materials from firms regularly engaged in manufacture of pressure piping products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Retain a firm with at least 3 years of successful installation

experience on projects with pressure piping work similar to that required for project.

## PART 2 MATERIALS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Specifications may cite acceptable manufacturers. Alternative manufacturers meeting the performance specification may be accepted at the ENGINEER's discretion. All materials and products shall be in accordance with the AWWA sections identified herein.

### 2.02 IDENTIFICATION

A. Underground Type Plastic Line Markers: Manufacturer's standard permanent, bright colored, continuous printed plastic tape, intended for direct burial service; not less than 6" wide x 4 mils thick. Provide tape with black printing reading "CAUTION - LINE BURIED BELOW" (with appropriate utility line on tape, example water, sewer, electric, etc.). Non-ferrous metal piping shall also have a magnetic location tape placed above the pipe.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering plastic line markers which may be incorporated in the work include, but are not limited to, the following:

   a. Allen Systems, Inc.
   b. Emed Co., Inc.
   c. Seton Name Plate Corp.

### 2.03 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. Manufacturer: Pipe shall be as manufactured by Chevron; Plexco Extra High Molecular Weight High Density Polyethylene Pipe, or approved equal.

B. Application: HDPE pressure pipe and fittings shall be provided for the buried leachate force main, 3 to 6 inches in diameter and casing pipe.

C. Buried pipe shall conform to ASTM D-3035 SDR 21, HDPE material for buried pipe shall conform to ASTM D 3350-83 cell class 345434C.

D. Fittings are to be molded butt fittings manufactured to ASTM-D-3261 specifications.

E. Connections to Ductile Iron Pipe are to be made with flanged fitting inside of pre-cast concrete structure.

F. Connections to the existing force main shall be made with the appropriate fittings for the type of pipe encountered.

G. All joints between sections and joints of HDPE pipe are to be Heat Fusion Welded. Procedures for fusion welding are to be in accordance with manufacturer's procedures and recommendations.

## 2.04 DUCTILE IRON PIPE

A. Manufacturer: Pipe and fittings shall be as manufactured by American Cast Iron Pipe Co., U.S. Pipe, Griffin Pipe, Clow Corporation, or approved equal.

B. Application: Ductile iron pipe and fittings shall be used for the force main, where indicated.

C. All exposed and buried pipe and fittings within the interior and between manhole wet-well and valve chamber shall be ductile iron conforming to AWWA C151. Pipe shall be Class 52 with flanged joints conforming to AWWA C111.

D. Fittings

1. Flanged Fittings

a. Provide flanged joints for all piping within the manhole wet-well and valve chamber.

b. Flanges for pipe shall be ductile iron to conform to the applicable provisions of AWWA C110 and C115 and shall be drilled ANSI B16.1, Class 125.

c. Pipe with victaulic-style couplings may not be substituted for flanged pipe except where indicated or approved by the ENGINEER.

E. Coatings

1. All ductile iron piping and fittings shall have standard bituminous coating applied

to exterior surfaces in accordance with AWWA C203.

2. All ductile iron piping and fittings shall have a coal-tar epoxy coating applied to the interior surfaces in accordance with AWWA C210.

## 2.05 GASKETS AND BOLTING MATERIALS

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings and equipment complete and ready for service.

B. All bolting shall conform to the appropriate standards: ASTM A307 Grade B for bolts and ASTM A194 Grade 2 for nuts. All bolting shall be stainless steel.

C. Dimensions shall conform to ANSI B18.2.1 for bolts and ANSI B18.2.2 for nuts. Threading shall conform to ANSI B1.1 Class 2A fit for bolts and Class 2B fit for nuts.

D. Bolts shall extend completely through the nuts and may have reduced shanks of a diameter not less than the diameter at the root of threads.

E. Washers shall be stainless steel.

F. Gaskets shall be 1/8 inch thick cloth inserted synthetic rubber full face gaskets with holes punched for flanges conforming to AWWA C111. Gaskets for ductile iron flanged pipe and fittings 12 inch and smaller shall have "nominal" inside diameters, not the larger inside, diameters per ANSI B16.21.

G. Gaskets and bolts for other than flanged joints shall be as required for mechanical joints and/or push-on joints as applicable, in accordance with AWWA requirements.

## 2.06 RUBBER EXPANSION JOINTS

A. Manufacturer: Rubber expansion joints shall be as manufactured by General Rubber Corporation, or approved equal.

1. Model Number and Type: Shall be single open arch, butyl tube and cover, Style 1015, as manufactured by General Rubber Corp, or approved equal.

B. Working Pressure: Expansion joints shall be capable of 100 psi working pressure and 18 in. Hg vacuum.

C. Control Units: All expansion joints shall be rigidly anchored with steel rods, unless noted otherwise on plans.

D. Design:

1. Tube shall be a single piece, seamless leak proof tube made of synthetic or natural rubber designed for landfill leachate service conditions. Archway shall be filled with a soft rubber vulcanized to the carcass to provide a smooth interior.

2. Carcass shall be reinforced with high strength synthetic fabric fibers impregnated with rubber to permit flexibility. Copper coated steel wire or solid endless rings shall be imbedded in the carcass as strengthening members of the joint.

3. The exterior cover surface of the joint shall be formed from natural or synthetic rubber. A protective hypalon paint shall be applied to the cover surface.

4. The interior surface of the expansion joint shall be provided with a teflon liner to protect against severe corrosive environments expected from the leachate.

5. The integral flanges shall be construed of resilient rubber and smooth finished. The flange drilling shall be standard 125 lb. for the 6 inch diameter joints. Split steel retaining rings shall be installed on the inside of the flange and bolted through it to the metal pipe flange.

6. The control units shall be installed on all rubber expansion joints and shall consist of the following:

   a. Steel Rods: ASTM-A-307
   b. Ductile Gusset plates: ASTM-A-536.67
   c. Neoprene bushings: ASTM-D-735-SC725-BF
   d. Steel washers: ASTM-A-307
   e. Steel nuts: ASTM-A-307

   A minimum of two sets of rods shall be provided for each joint and more as needed to meet pressure rating requirements.

E. All installation procedures shall be in accordance with the manufacturer's instructions.

# PART 3 EXECUTION

## 3.01 PIPE LAYING

A. Pipe laying shall conform to AWWA C600 with excavation and backfill in accordance with Section 02221. Pipe laying shall be accomplished only in the presence of the ENGINEER, or their authorized representative. Adequate and suitable equipment and appliances for safe and convenient handling and laying of pipes shall be used.

B. Prior to being lowered into the trench, each pipe and fitting shall be carefully inspected and those not meeting specifications or are otherwise defective shall be rejected and removed from the project.

C. Pipes shall be thoroughly cleaned before they are laid and shall be kept clean until acceptance of complete work. Open ends shall be provided with a stopper carefully fitted so as to keep dirt and other substances from entering the main. Unless approved otherwise by the ENGINEER, a stopper shall be kept in the end of the line when work is not in progress.

D. Pipe shall be laid so that when completed, the interior bore will conform accurately to grades and alignment indicated by the contract documents or directed by the ENGINEER.

E. Before joints are made, each pipe shall be well bedded and no pipe shall be brought into position until the preceding length has been thoroughly secured in place. Coupling or bell holes shall be dug sufficiently large to insure the making of a proper joint. All joints shall be made in strict conformance with the manufacturer's instructions.

F. The excavation into which the pipe is being laid shall be kept free from water and no joints shall be made under water. Water shall not be allowed to rise in excavation until joint is complete. Care shall be used to secure watertightness and to prevent damage to joints during backfilling. All pipe joints shall be watertight within allowances established by these specifications.

G. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when the ENGINEER shall deem that there is a danger of formation of ice or penetration of frost at the bottom of excavation. Where the foundation is unstable or consists of rock, a stone or gravel foundation, at least six (6) inches thick, shall be

placed and tamped to form an acceptable bed for the pipe.

H. Suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Extra care shall be exercised to prevent damage to pipe lining and coating.

I. At the end of each day the end of pipe line shall be tightly closed with an expansion stopper to prevent dirt or other substances from entering the line.

J. Set, align, position and properly connect new valves and operators for proper operation and to allow maximum access for maintenance. Provide proper and adequate clearance for valve operation. When operated, valves shall operate smoothly and operators shall not bind. Valves and valve operators shall be installed in accordance with the manufacturer's instructions. Thoroughly clean and remove all shipping materials prior to setting valves. Operate all valves from fully opened to totally closed before setting. Valves shall be installed in the closed position. Provide support and anchorage as required.

K. A plastic warning tape shall be installed over all buried force main pipe. The tape shall have the warning "Caution - Sewer Line Buried Below". The tape shall be positioned above the piping at a point 24 inches below finished grade.

L. The CONTRACTOR shall be permitted a maximum of four (4) hours to make the necessary connections to the existing force main. The CONTRACTOR shall submit a detailed schedule and plan, including equipment to be used to the OWNER for approval.

## 3.02 JOINT RESTRAINT

A. Concrete Thrust Blocks: Cast-in-place concrete thrust blocks shall be placed at all points of potential thrust as required in accordance with the standards included in these specifications and drawings. Thrust blocks shall be poured against undisturbed earth and shall be of a sufficient size to resist the thrust resulting from the specified hydrostatic test pressure.

B. Restrained Joint Pipe: When thrust blocks cannot be used, restrained joints shall be placed at all points of potential thrust. The number of joints to be restrained on each side of a fitting shall be determined by the pipe manufacturer and submitted to the ENGINEER for review and approval. The length of restrained pipe shall be sufficient to resist the specified hydrostatic test pressures and shall also take into account such

factors as the burial depth, soil types and backfill material used. Restrained joint ductile iron pipe shall be of the restrained mechanical or push-on joint type. Mechanical joint retainer glands are not acceptable. Restrained joint piping shall sustain the indicated test pressures, as a minimum.

## 3.03 TESTING

A. Before being tested, mains shall be backfilled between joints to a safe level and thrust restraint suitable to withstand the hydrostatic test pressure. Pipe lines shall be thoroughly flushed to remove all foreign materials which may have entered the mains during construction.

B. Force mains shall be tested as specified in AWWA C600. Test pressures shall be as specified in the paragraphs which follow.

C. Before applying the specified test pressure, air shall be expelled completely from the pipe and valves. If permanent air vents are not located at all high points, the CONTRACTOR shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be left in place.

D. Hydrostatic Test (Perform in Accordance with AWWA C600 Requirements)

1. The trench shall be backfilled between joints before testing to prevent movement of pipe.

2. The length of force main under test shall be slowly filled with water and brought to test pressure by means of a pump connected to the pipe in a manner satisfactory to the ENGINEER, so as to obtain the specified hydrostatic test pressure at the lowest point in the section of main under test. The water, pump, pipe connection and all necessary apparatus, shall be furnished and paid for by the CONTRACTOR. If desired, the OWNER reserves the right to furnish gauges for the test, but all necessary assistance for conducting the test will be furnished and paid for by the CONTRACTOR. All air must be expelled from the pipe line prior to the test period. The test pressure shall be applied for a period of two (2) hours.

3. The specified test pressure shall be held within 5 psi for the duration of the test.

E. Leakage Test (Perform in Accordance with AWWA C600 Requirements)

1. After the hydrostatic test proves satisfactory, a leakage test shall be conducted. The pressure maintained during the leakage test shall be as specified in the following paragraphs. The test shall be conducted in the same manner as the pressure test except that suitable equipment, supplied and paid for by the CONTRACTOR, shall be provided for measuring the amount of leakage. The duration of this test shall be twenty-four (24) hours.

2. No pipe installation will be accepted if the leakage is greater than that determined by the following:

   a. The amount of leakage in piping shall be measured at the specified test pressure by pumping from a calibrated container. For new pipe, the amount of leakage at the joints shall not exceed two quarts per hour (1.89 L/h) per 100 gaskets or joints irrespective of pipe diameter.

   b. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

F. Test pressures shall be as follows:

| Hydrostatic Test Pressure (psig) | Leakage Test Pressure (psig) |
|---|---|
| 115 | 75 |

G. Should any of these tests on a section of pipe line disclose an inability to hold the stipulated test pressure or leakage in an amount greater than that permitted, the CONTRACTOR shall, at his own expense, locate and correct any defects and retest same to the satisfaction of the ENGINEER.

END OF SECTION

# SECTION 02532

# GRAVITY LEACHATE SEWER SYSTEM

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. The extent of gravity leachate sewer system work is as indicated on drawings and schedules, and by requirements of this Section.

B. Leachate sewer main shall be constructed of the materials indicated on the drawings.

C. Refer to Section 02221, "Utility Excavation, Backfill and Compaction" for excavation and backfill required for sanitary sewage system.

D. Gravity Leachate sewer system shall include but not be limited to:

1. All gravity leachate sewer systems.
2. Leachate mains.
3. Manholes.
4. Precast concrete wetwells, valve vaults and meter pits.
5. All excavating and backfill required for the gravity leachate sewer system.
6. Stakeout by CONTRACTOR from existing control points in field.

### 1.02 REFERENCE STANDARDS

A. Delaware Department of Transportation (DelDOT), Standard Specifications dated July 1985.

B. American Society for Testing and Materials (ASTM)

A 48 Gray Iron Castings.

A 126 Gray iron Castings for Valves, Flanges, and Pipe Fittings.

A 185 Welded steel Wire Fabric for Concrete Reinforcement.

| | |
|---|---|
| A 615 | Deformed and Plain Billet - Steel Bars for Concrete Reinforcement. |
| C 32 | Sewer and Manhole Brick. |
| C 478 | Precast Reinforced Concrete Manhole Sections. |
| C 923 | Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes. |
| D 429 | Tests for Rubber Property - Adhesion to Rigid Substrates. |
| D 638 | Test Method for Tensile Properties of Plastics. |
| D 790 | Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. |
| D 1239 | Test Method for Flow Rates of Thermal Plastics by Extrusion Plastometer. |
| D 1248 | Specification for Polyethylene Plastics Molding and Extrusion Materials. |
| D 1505 | Test Method for Density of Plastics by the Density Gradient Technique. |
| D 1599 | Test Method for Short Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings. |
| D 1693 | Test Method for Environmental Stress Cracking of Ethylene Plastics. |
| D 2122 | Method for Determining Dimensions of Thermal Plastic Pipe and Fittings. |
| D 2837 | Method for obtaining Hydrostatic Design Basis for Thermal Plastic Pipe Materials. |
| D 3350 | Specification for Polyethylene Plastics Pipe and Fittings Material. |
| D 4219 | Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique. |
| F 714 | Standard Specification for Polyethylene Plastic Pipe based on outside diameter. |

F 1248 Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.

## 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for sewer system materials and products. Certificates of conformance for all materials shall be submitted in accordance with Division 1, assuring conformance with these specifications. All pipe and appurtenances specified herein shall be covered by a guarantee certificate furnished by the CONTRACTOR and signed by an officer of the pipe manufacturer.

B. Shop Drawings: Submit shop drawings for leachate sewer systems, showing piping materials. Include details of underground structures, connections, manholes, covers, castings, fittings and pipe.

C. Record Drawings: At project closeout, submit record drawings of installed sewer piping and products, in accordance with specifications.

## 1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Obtain materials from firms regularly engaged in manufacture of sewer system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of sanitary sewage system materials and products. Comply with local codes and ordinances.

# PART 2 PRODUCTS

## 2.01 PIPES AND PIPE FITTINGS

A. General: Provide pipes of the following materials as indicated on the drawings and specified herein. Provide fittings and accessories of same material and weight/class as pipes, with joining method as indicated.

## 2.02 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

A. High Density Polyethylene Pipe (fusion welded) shall be the piping material used.

B. Materials used for the manufacture of polyethylene pipe and fittings shall be very high molecular weight, high density ethylene/hexene copolymer PE 3408 polyethylene resin meeting the physical property and pipe performance requirements as described in these specifications and in accordance with ASTM D-1248.

The pipe shall be extruded from pre-compounded resin. In plant blending of resin is unacceptable.

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. Said certification shall include a stress life curve per ASTM D-2837. The stress regression testing shall have been done in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDR) of 1,600 psi, as determined in accordance with ASTM D2837.

Further, the material shall be listed by PPI (the Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73°F hydrostatic design stress rating of 800 psi, and a 140°F hydrostatic design stress rating of 400 psi. The PPI Listing shall be in the name of the pipe manufacturer, and shall be based on ASTM D 2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

C. Pipe Extrusion.

The pipe shall be extruded using a melt homogenizing/plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed to minimize melt fracture of the molecular structure thus reducing the molecular weight and changing some physical properties from resin to pipe. The resin should be processed at its melt temperature of 500°F to 525°F. The die will have an internally cooled mandrel and an externally cooled bushing. This die will cool the pipe to its solidification point such that it exits to die to specification size, shape, and

wall thickness with a polished surface for smooth flow offering a Hazen Williams "C" factor of C=155.

D. HDPE Main Pipe and Fittings.

1. Leachate Pipe

Pipe supplied under this specification shall have a outside diameter as indicated on the plans. Pipe thickness shall be that of SDR 11 piping for the force main and casing and SDR 21 for the gravity piping in accordance with ASTM D-2122. Pipe shall be in accordance with ASTM C906. Typical pipe manufacturer and pipe type include Driscopipe Series 4000 by Phillips 66, or equal.

The pipe shall be produced with the nominal physical properties outlined in Section III, and to the dimensions and tolerance specified in ASTM F-714. Additionally, the pipe shall be inspected per industry accepted manufacturer standards for:

- Diameter
- Wall Thickness
- Concentricity
- Quick Burst Pressure and Ductility
- Joint Length
- Straightness
- Ovality
- Toe-in
- Overall Workmanship Inspection on ID & OD
- Print Line

The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects, and shall be identical in color, density, melt index and other physical properties throughout.

2. Design Criteria

| | |
|---|---|
| a. Working Pressure | 150 psi |
| b. Test Pressure | 200 psi |
| c. Radius of Curvature | As required for installation |
| d. Buckling Pressure | As required for dead load calculations submitted by CONTRACTOR. |

3. Pipe Performance

The pipe shall be in compliance with the physical and performance requirements of Section III of this specification. Specifically, the pipe will be extruded from resin meeting specifications of ASTM D 3350 with a cell classification of PE:355434C; and ASTM D 1248 pipe grade resin type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall exhibit the short term tensile and compressive physical properties listed in Section III. And the pipe shall provide the long term endurance characteristics recognized by: the compressed pipe ring environmental stress crack resistance greater than 5000 hrs; the slow crack growth resistance greater than 32 days; the impact strength (toughness) greater than 144 in-lb/in notch; and rotary fatigue endurance at $\pm$ 1600 psi bending stress with $F_o > 100{,}000$ cycles.

4. Fittings.

The standard HDPE fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining, or, shall be fabricated from PE pipe conforming to this specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years service at 73.4°F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade and cell classification as the pipe itself. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from crack, holes, foreign inclusions, voids, or other injurious defects. The fitting shall be as uniform as commercially practicable in color, opacity, density and other physical properties. The minimum "quick-burst" strength of the fittings shall not be less than that of the pipe with which the fitting is to be used.

## 2.03 LEACHATE SEWER MANHOLES

A. General: Provide precast reinforced concrete sanitary manholes, as indicated, and complying with ASTM C478.

B. The sections shall conform to the requirements of "Specifications for Precast Reinforced Concrete Manhole Sections" (ASTM C478), except that the joints shall be sealed with a Preformed Plastic Gasket that meets or exceeds all requirements of Fed. Spec. SS-S-00210, "Sealing Compound Preformed Plastic for Pipe Joints", Type 1, Rope Form or Rubber-O-Ring gaskets meeting the requirements of ASTM C443.

C. The Sealing Compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope-form of suitable cross-section and of such sizes as to seal the joint space when the sections are set in place. The sealing compound shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application of the sealing compound.

D. The top of base walls, the ends of reinforced concrete risers and the bottom ends of precast tops shall be so formed that when risers and tops are assembled with the base, they will make a continuous manhole. Joints shall be of such design as will permit effective joining and placement without irregularities in the interior wall surface of the manhole.

E. Manhole barrels shall consist of riser and top sections with a minimum wall thickness of 5 inches. The top section shall be an eccentric conical section with thickened upper walls with the smallest inside diameter equal 30 inches, to receive the manhole frame and cover. No more than 2 lift holes shall be cast in each barrel or top section.

F. Manhole riser and top sections shall be designed, manufactured, tested, finished and marked in accordance with this specification and ASTM C478.

G. Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated.

H. Base: Precast concrete, with base riser section and separate base slab, or base riser section with integral floor, as indicated.

I. Manholes shall have a concrete protective liner integrally anchored to concrete sections. Liner shall protect base, risers and top. See Section 02723 for liner specifications.

J. Pipe Connectors: Resilient, complying with ASTM C923.

K. Manhole Frame and Cover:

1. Manhole frames and covers shall be in accordance with the requirements of the

OWNER.

2. Manhole frames and covers shall be made of Class 30B gray iron which is tested in accordance with ASTM A48 Standard Specification for Gray Iron Castings. The name of the foundry and the heat and lot number shall be cast into the frame and into the exterior side of the cover.

3. Manholes, frames and covers shall be thoroughly cleaned. All projections and roughness shall be ground smooth. The bearing surfaces of the frame and cover shall not rock or jam.

4. Only solid watertight manhole covers are to be used.

5. All castings shall be made accurately to the pattern and to the dimensions shown on the contract drawings and shall be planned where marked or where otherwise necessary to secure perfectly flat and true surfaces. Allowances shall be made in the patterns so that the thickness shall not be reduced.

6. All castings shall be carefully coated, both inside and out, with coal-tar-pitch varnish. The varnish shall be made from a good quality of coal tar, with sufficient oil added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

7. Anchor bolts for bolting manhole frame to the precast manhole shall be 3/4" diameter galvanized all-thread cinch anchor with 5" for embedment in the manhole top and a minimum 2-inch projection through the bars of the frame.

## 2.04 CONCRETE AND REINFORCING

A. Concrete shall conform to drawings or specifications.

B. Reinforcing mesh and bars shall conform to ASTM A185 and ASTM A615, Grade 60.

## 2.05 STONE AGGREGATES

A. Crushed stone shall conform to the requirements for material requirements in accordance with DelDOT Standard Specification section 812 Portland Cement Concrete.

## 2.06 GROUT

A. Nonshrinking Grout

1. Required for patching manholes, pipes and plugging.

2. Grout shall be nonmetallic, as manufactured by one of the following:

   a. Crystex, L and M Construction Chemicals, Inc.
   b. Five Star Grout, U.S. Grout Corporation.
   c. Masterflow 713 grout, Master Builder's, Inc.
   d. Sauereisen F-100, Sauereisen Cement Company.
   e. Supreme Grout, Gifford-Hill and Company.
   f. Ferrolith C, Sonneborn-Contech.
   g. EUCO NS, Euclid Chemical.

3. Prepare and place to manufacturer's printed instructions.

# PART 3 EXECUTION

## 3.01 INSTALLATION OF PIPE AND PIPE FITTINGS

A. General:

1. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated. All excavating and backfill shall conform the specifications.

2. Inspect piping before installation to detect apparent defects. Mark defective materials with paint and promptly remove from site.

3. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

4. Shall be accomplished only in the presence of the ENGINEER, or his authorized representative. Adequate and suitable equipment and appliances for safe and convenient handling and laying of pipe shall be used.

B. HDPE Pipe: Install in accordance with manufacturer's installation

recommendations.

C. Cleaning Piping:

1. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.

2. In large, accessible piping, brushes and brooms may be used for cleaning.

3. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.

4. Flush lines between manholes if required to remove collected debris.

D. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

E. Laying Pipe:

1. Pipes shall be laid true to the lines and grades shown on the plans. The grade shown on the profile is the invert to which the work must conform. Work not conforming to the grade shall be corrected by the CONTRACTOR at his own expense. The locations of the proposed lines are shown on the plans. Approximate depths are shown on the plans.

2. For gravity pipe, the CONTRACTOR shall use a laser to control alignment and grade. The laser shall be set up and operated according to the manufacturers instructions and the CONTRACTOR shall possess all required licenses and permits for laser operation. After the trench has been brought to the proper grade as heretofore specified, the pipe and fittings shall be laid. Care shall be taken to lay the pipe to true lines and grades. Every pipe laid shall be tested as to grade and alignment. Care must be taken to fit the joints together properly so that the centers of the pipes shall be in one and the same straight line, and so as to give an opening of even thickness.

3. Carefully handle and lower pipe into the trench. Take special care in laying pipe, to ensure that each length abuts against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe line. No wedging or blocking will be permitted in laying any pipe unless by written order or permission from the ENGINEER.

4. Bed each pipe section on a solid foundation before making successive joints. Bring no pipe section into position until the preceding length has been thoroughly embedded and secured in place. Correct any defects due to settlement at CONTRACTOR's own expense. Ensure that the pipe is firmly bedded on the full length of the barrel. All pipe bedding shall be in accordance with manufacturers requirements.

5. Use proper and suitable tools and appliances for the safe and convenient handling and laying of pipes.

6. Thoroughly clean each pipe section before placement and clean until the acceptance of the completed work. Provide and install carefully fitted strong stoppers in the open ends of all pipe lines so as to keep dirt and other substances from entering. Keep stoppers in the ends of the pipe lines at all times when laying is not in actual progress.

7. Keep the excavation in which pipe is being laid free from water and make no joint under water. Do not allow water to rise in the excavation until the joint material has received its set. Use the greatest care to secure watertightness and to prevent damage to, or disturbance of the joints during the refilling process, or at any time. After pipes have been laid and the joints have been made, allow no walking on or working over them, except such as may be necessary in tamping, until there is a covering at least two feet in depth, over their top.

8. Lay no pipe upon a foundation into which frost has penetrated nor at any time when the ENGINEER shall deem that there is danger of the formation of ice or other penetration of frost at the bottom of the excavation. Work may proceed during sub-freezing conditions, at the discretion of the ENGINEER, provided that the minimum length of open trench and promptness of refilling are observed.

9. Pipe and accessories shall be handled in such a manner as to insure delivery in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating. No other pipe or material of any kind shall be placed inside of any pipe or fitting at any time after the coating has been applied.

10. The CONTRACTOR shall also take any and all measures to keep the pipe clean and free from deposits and protect the pipe from damage. If the pipe is damaged from any cause or becomes either partly or completely filled with dirt, stones, sand or other debris, the CONTRACTOR shall make all necessary repairs and remove, at his own expense, all such material. Upon refusal to do so, it will be done by the OWNER and the cost thereof shall be charged as money paid to the CONTRACTOR.

11. Before lowering and while suspended, the pipe shall be inspected for defects and cracks. Any defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, made necessary by vertical curves or horizontal curves or offsets, may be made with the pipe except that the deflection shall not exceed manufacturer's requirements. If the required alignment requires a deflection in excess of those specified, the CONTRACTOR shall either provide, at his own expense, special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within the limit set forth above.

12. When the sewers have been laid and backfilled, the ENGINEER will make an inspection. All defects found will be corrected by and at the sole expense of the CONTRACTOR.

F. Interior Inspection:

1. Inspect piping to determine whether line displacement or other damage has occurred.

2. Make inspections after lines between manholes or manhole locations, have been installed and approximately 2 feet of backfill is in place, and again at completion of project.

3. If inspection indicated poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects, and reinspect.

G. By-Pass Pumping/Fluming

1. The CONTRACTOR shall not be permitted to flume the leachate while laying new pipe, they shall by-pass pump from the manhole above the section of pipe he is working on to the pump station below.

2. The CONTRACTOR shall submit a detailed plan and schedule for bypass pumping, including equipment to be used, to the OWNER for review and approval.

H. Removal of Pipe

1. No payment shall be made for removal and disposal of existing pipe and it shall be assumed the CONTRACTOR has made provisions for same in his bid prices.

## 3.02 MANHOLES

A. General: Place precast concrete sections as indicated. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops two (2) feet above finish surface, unless otherwise indicated.

B. Install in accordance with ASTM C891.

C. Provide preformed joint sealing compound as specified on the drawings.

D. Handling:

1. All precast manhole components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the precast manhole lip.

2. All damage to precast sections shall be thoroughly repaired in the presence of the ENGINEER. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Sufficient time shall be allowed for curing before the precast sections are put together. Concrete cast-in-place bases shall be specially formed and keyed to accommodate the bottom precast section.

E. Placement:

1. Manhole bases shall rest upon a base of sound, level, Del No. 57 compacted stone.

2. Manhole sections shall not be set by wedging or placing shims to secure proper level and manholes shall not be backfilled without the permission of the ENGINEER.

F. Masonry Work: The top of all precast manholes may be brought to proper grade for receiving manhole frames by using not more than three courses of precast grade rings. All work shall be laid plumb, straight, level, square and true.

G. Flow Channels

1. The flow channels shall be monolithically constructed with the base.

2. The minimum depth of flow channel shall be equal to 3/4 the diameter of the largest sewer in the manhole to which it connects. The channel shall be graded to give a smooth, uninterrupted flow through the manhole.

3. Bench walls shall be pitched a minimum of 1 inch per foot from the inside periphery of the manhole to the edge of the flow channel.

4. Flow chanels shall be constructed with a Concrete Protective liner.

H. Bitumastic Exterior Coating:

1. Prior to delivery, the entire exterior manhole surface shall be coated with two (2) coats, producing a dry film thickness of .016 inches (16 mils) per coat of Bitumastic Super Service Black, as manufactured by Koppers Co., Inc., equivalent of Mobil Chemical Co., or equal. Prior to backfill, any damaged coating shall be repaired/reapplied to the exterior of the manhole.

I. Concrete Protective Liner:

1. Concrete protective liner is to be integrally attached to concrete of manhole. Liner joints are to be field welded to form a water and gas tight seal in accordance to the manufacturer's recommendations.

2. See Section 02723 and 02724 for concrete protective liner and base liner specifications.

## 3.03 MANHOLE FRAMES AND COVERS

A. Manhole frames and covers shall be brought to proper grade as previously noted, set in 1/4" bed of mastic, and anchored in place with the four (4) 3/4" diameter anchor bolts which shall be securely embedded in the top of the manhole. Where indicated on the plans at summit manholes, vented manhole covers shall be installed.

## 3.04 ACCEPTANCE TESTING:

A. GENERAL

1. After the gravity sewers have been laid and backfill placed to two (2) feet above the pipe, a light will be flashed between manholes, or, if the manhole has not yet been constructed, between the location of manholes, by means of a flashlight or mirrored light, to determine whether the alignment of the main is true and whether any pipe has been displaced subsequent to laying. If alignment is correct and no other defects are disclosed, backfilling may be continued. If the test shows poor alignment of the main, misplaced pipe or other defects, such defects shall be remedied by the CONTRACTOR, as required by the ENGINEER, before the work of backfilling proceeds.

2. After backfilling, the CONTRACTOR shall make tests to ascertain if joints are tight. Leaky or poor joints shall be repaired, or removed at once by the CONTRACTOR to the satisfaction of the ENGINEER.

3. No section of gravity sewer lines shall be tested for leakage before backfilling in that section has been completed. If this condition has been fulfilled, the sewer lines shall be tested for leakage between manholes as the work progresses.

4. The CONTRACTOR shall perform the tests and he shall furnish all apparatus and materials required for the tests, the cost of which shall be included in the Contract bid.

5. The tests will be witnessed by the ENGINEER.

6. The following tests shall be made:

   a. Low pressure air test
   b. X-ray inspection for HDPE pipe joints (certified sample)
   c. Manhole vacuum test
   d. Mirror test

7. Cost for testing shall be included in the CONTRACTOR's bid.

B. AIR TEST

1. The sewer mains and/or laterals shall be tested for leakage by the use of low pressure air as specified hereinafter and as approved by the ENGINEER. Each manhole run will be tested separately as the construction progresses, before trench surface restoration, and preferably with not more than four (4) manhole runs constructed ahead of testing.

2. Equipment shall be as manufactured by Cherne Industrial, Inc. of Edina, Minnesota; N.B. Products, New Britain, PA; or equal. Equipment used shall meet the following minimum requirements:

   a. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.

   b. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.

   c. All air used shall pass through a single control panel.

   d. Three individual hoses shall be used for the following connections:

      - From control panel to pneumatic plugs for inflation

      - From control panel to sealed line for introducing the low pressure air.

      - From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

3. Procedures:

   a. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs must hold against this pressure without having to be braced.

   b. After a manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig greater than the average back pressure of any groundwater than may be over the pipe (3.5 psig minimum pressure in the pipe). At least two (2) minutes shall be allowed for the air pressure to stabilize.

   c. After the stabilization period, the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "Acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe) shall not be less than 4.0 minutes.

C. X-RAY TEST

1. The manufacturer shall submit molded fitting samples from each production lot for x-ray testing.

2. Certified inspection reports shall be provided to the OWNER prior to construction.

D. MANHOLE VACUUM TEST

1. CONTRACTOR shall supply all equipment and materials to vacuum test each manhole. Equipment and material shall be approved by the ENGINEER.

2. Each Manhole shall be tested after backfilling.

3. Prior to testing all lift holes shall be plugged with an approved non-shrink grout.

4. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.

5. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendations.

6. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if time is greater than 5 minutes for 48" diameter, 6 minutes for 60", and 7 minutes for 72" diameter manholes.

7. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

## 3.05 CONCRETE CONSTRUCTION

A. All concrete construction shall be in accordance with the specifications.

END OF SECTION

# SECTION 02533

# CONCRETE PROTECTIVE LINER

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. For purposes of establishing a standard of design and quality of product, concrete protective liner shall be AGRU Sure Grip concrete protective liner as distributed by Terre Hill Concrete Products, or approved equal.

B. Furnish and install all labor, materials, equipment and incidentals required to supply and install High Density Polyethylene (HDPE) or Polypropylene Random Copolymer (PP-R) concrete protective line (CPL) in the wet well and manholes as required and as shown on the plans.

C. HDPE or PP-R concrete protective liner (CPL) shall be designed and installed to create an impermeable lining on the concrete structure's interior surface. To protect concrete surfaces from deterioration and to make the structure watertight.

## PART 2 PRODUCT

### 2.01 MATERIALS

A. Liner shall be capable of being integrally cast with the concrete manhole to develop a complete system. Products that are installed or bonded to the concrete after the manholes have been cast will not be accepted.

B. Liner shall be AGRU Sure Grip HDPE (High Density Polyethylene) or Polypropylene Random Copolymer (PP-R) with a minimum thickness of 2 mm. All HDPE liner sheets and anchors shall be extruded during a single manufacturing process. The minimum anchoring stud concentration shall be 39 studs per square foot. The anchoring studs shall not be welded or mechanically attached to the liner. The anchoring stud shall have a pull out resistance of 112.5 lbs/stud.

C. Flat liner sheet, non anchored, used for overlapping joints, shall have a minimum thickness of 3 mm. All joints shall be sealed by means of thermal welding performed

by manufacturer's certified welders.

D. The lining shall be able to span across ¼" settling cracks. This may occur in the joint after installation, without damage to the lining.

E. The lining shall be repairable at any time during the life of the structure.

F. The manufacturer's certified fabricator shall custom fit the liner to the form work in order to protect the concrete surfaces from sewer gasses. The interior surfaces to be protected shall include the walls, ceiling, pipe entries and structure chimney.

G. The liner shall have ladder rungs meeting all ASTM and OSHA requirements for manhole ladder rungs.

## 2.02 PHYSICAL PROPERTIES

A. The liner systems and welding rod shall be manufactured from the same resins and meet the following properties:

| Testing | | | | |
|---|---|---|---|---|
| Property | Method | Units | HDPE | PP-R |
| Density | ASTM D792-86 | $g/cm^3$ | 0.0945 | 1.78 |
| MF1 (Melt Flow Index) | ASTM D1238-88 | g/10min | (190/5) | (190/5) |
| Heat Reversion (Dimensional Stability) | ASTM D1638-83 | % | <2 | <2 |
| Yield Stress | ASTM D638-89 | PSI | ≥2320 | ≥2900 |
| Elongation of yield | ASTM D638-89 | % | ≥12 | ≥10 |
| Elongation | ASTM D638-89 | % | ≥200 | ≥50 |
| Fire Classification | UL-94 | | V2 | V2 |
| Maximum Working Temperature | | C°<br>F° | 60<br>140 | 90<br>194 |

B. The manufacturer shall provide written certification that the liner used meets or exceeds the requirements of this specification. The liner manufacturer shall submit certification that fabricator is qualified and trained to install their product.

C. The manufacturer shall provide chemical resistance test results for the liner. Test results shall show negligible effects on liner materials from elements similar to those that can be typically found in landfill leachate.

## PART 3 INSTALLATION

### 3.01 LINER

A. Liner is to be installed at the time of casting of the concrete sections. Joints between sections are to be field welded as per liner manufacturers recommended procedures.

### 3.02 WELDING

A. All welding shall be performed in accordance with the published directives and procedures of the manufacturer and by welders certified by the manufacturer. Completion of welding will provide a one piece monolithic concrete protective liner that will provide excellent resistance to hydrogen sulfide attack and will resist push off from the wall by external hydrostatic pressure. Infiltration and inflow shall not occur through the lined surfaces.

The following welding techniques are acceptable.

1. Extrusion welding.
2. Wedge welding.
3. Butt welding.

B. Qualified staff shall supervise and test the welded installation. The joint areas shall be cleaned and scraped with abrasive tools and the welded edges shall be beveled for maximum fusion of the extrusion weld. The area shall be dry, clean, free of oil and lubricants, free of chips and free of notches. Visual inspection shall confirm that a smooth double bead of welding seam is present. All welded joints shall be Spark Tested for leaks.

C. Pipe penetrations into the manholes or wetwell shall be welded to the liner. Connection between the pipes entering the structure and the liner shall be watertight to prevent chemical attack of concrete at the pipe penetration.

END OF SECTION

# SECTION 02532

# GRAVITY LEACHATE SEWER SYSTEM

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. The extent of gravity leachate sewer system work is as indicated on drawings and schedules, and by requirements of this Section.

B. Leachate sewer main shall be constructed of the materials indicated on the drawings.

C. Refer to Section 02221, "Utility Excavation, Backfill and Compaction" for excavation and backfill required for sanitary sewage system.

D. Gravity Leachate sewer system shall include but not be limited to:

1. All gravity leachate sewer systems.
2. Leachate mains.
3. Manholes.
4. Precast concrete wetwells, valve vaults and meter pits.
5. All excavating and backfill required for the gravity leachate sewer system.
6. Stakeout by CONTRACTOR from existing control points in field.

### 1.02 REFERENCE STANDARDS

A. Delaware Department of Transportation (DelDOT), Standard Specifications dated July 1985.

B. American Society for Testing and Materials (ASTM)

A 48 Gray Iron Castings.

A 126 Gray iron Castings for Valves, Flanges, and Pipe Fittings.

A 185 Welded steel Wire Fabric for Concrete Reinforcement.

| | |
|---|---|
| A 615 | Deformed and Plain Billet - Steel Bars for Concrete Reinforcement. |
| C 32 | Sewer and Manhole Brick. |
| C 478 | Precast Reinforced Concrete Manhole Sections. |
| C 923 | Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes. |
| D 429 | Tests for Rubber Property - Adhesion to Rigid Substrates. |
| D 638 | Test Method for Tensile Properties of Plastics. |
| D 790 | Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials. |
| D 1239 | Test Method for Flow Rates of Thermal Plastics by Extrusion Plastometer. |
| D 1248 | Specification for Polyethylene Plastics Molding and Extrusion Materials. |
| D 1505 | Test Method for Density of Plastics by the Density Gradient Technique. |
| D 1599 | Test Method for Short Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings. |
| D 1693 | Test Method for Environmental Stress Cracking of Ethylene Plastics. |
| D 2122 | Method for Determining Dimensions of Thermal Plastic Pipe and Fittings. |
| D 2837 | Method for obtaining Hydrostatic Design Basis for Thermal Plastic Pipe Materials. |
| D 3350 | Specification for Polyethylene Plastics Pipe and Fittings Material. |
| D 4219 | Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique. |
| F 714 | Standard Specification for Polyethylene Plastic Pipe based on outside diameter. |

F 1248 Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.

## 1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for sewer system materials and products. Certificates of conformance for all materials shall be submitted in accordance with Division 1, assuring conformance with these specifications. All pipe and appurtenances specified herein shall be covered by a guarantee certificate furnished by the CONTRACTOR and signed by an officer of the pipe manufacturer.

B. Shop Drawings: Submit shop drawings for leachate sewer systems, showing piping materials. Include details of underground structures, connections, manholes, covers, castings, fittings and pipe.

C. Record Drawings: At project closeout, submit record drawings of installed sewer piping and products, in accordance with specifications.

## 1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Obtain materials from firms regularly engaged in manufacture of sewer system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of sanitary sewage system materials and products. Comply with local codes and ordinances.

# PART 2 PRODUCTS

## 2.01 PIPES AND PIPE FITTINGS

A. General: Provide pipes of the following materials as indicated on the drawings and specified herein. Provide fittings and accessories of same material and weight/class as pipes, with joining method as indicated.

## 2.02 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

A. High Density Polyethylene Pipe (fusion welded) shall be the piping material used.

B. Materials used for the manufacture of polyethylene pipe and fittings shall be very high molecular weight, high density ethylene/hexene copolymer PE 3408 polyethylene resin meeting the physical property and pipe performance requirements as described in these specifications and in accordance with ASTM D-1248.

The pipe shall be extruded from pre-compounded resin. In plant blending of resin is unacceptable.

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. Said certification shall include a stress life curve per ASTM D-2837. The stress regression testing shall have been done in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDR) of 1,600 psi, as determined in accordance with ASTM D2837.

Further, the material shall be listed by PPI (the Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73°F hydrostatic design stress rating of 800 psi, and a 140°F hydrostatic design stress rating of 400 psi. The PPI Listing shall be in the name of the pipe manufacturer, and shall be based on ASTM D 2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

C. Pipe Extrusion.

The pipe shall be extruded using a melt homogenizing/plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed to minimize melt fracture of the molecular structure thus reducing the molecular weight and changing some physical properties from resin to pipe. The resin should be processed at its melt temperature of 500°F to 525°F. The die will have an internally cooled mandrel and an externally cooled bushing. This die will cool the pipe to its solidification point such that it exits to die to specification size, shape, and

wall thickness with a polished surface for smooth flow offering a Hazen Williams "C" factor of C=155.

D. HDPE Main Pipe and Fittings.

1. Leachate Pipe

Pipe supplied under this specification shall have a outside diameter as indicated on the plans. Pipe thickness shall be that of SDR 11 piping for the force main and casing and SDR 21 for the gravity piping in accordance with ASTM D-2122. Pipe shall be in accordance with ASTM C906. Typical pipe manufacturer and pipe type include Driscopipe Series 4000 by Phillips 66, or equal.

The pipe shall be produced with the nominal physical properties outlined in Section III, and to the dimensions and tolerance specified in ASTM F-714. Additionally, the pipe shall be inspected per industry accepted manufacturer standards for:

- Diameter
- Wall Thickness
- Concentricity
- Quick Burst Pressure and Ductility
- Joint Length
- Straightness
- Ovality
- Toe-in
- Overall Workmanship Inspection on ID & OD
- Print Line

The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects, and shall be identical in color, density, melt index and other physical properties throughout.

2. Design Criteria

| | |
|---|---|
| a. Working Pressure | 150 psi |
| b. Test Pressure | 200 psi |
| c. Radius of Curvature | As required for installation |
| d. Buckling Pressure | As required for dead load calculations submitted by CONTRACTOR. |

3. Pipe Performance

The pipe shall be in compliance with the physical and performance requirements of Section III of this specification. Specifically, the pipe will be extruded from resin meeting specifications of ASTM D 3350 with a cell classification of PE:355434C; and ASTM D 1248 pipe grade resin type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall exhibit the short term tensile and compressive physical properties listed in Section III. And the pipe shall provide the long term endurance characteristics recognized by: the compressed pipe ring environmental stress crack resistance greater than 5000 hrs; the slow crack growth resistance greater than 32 days; the impact strength (toughness) greater than 144 in-lb/in notch; and rotary fatigue endurance at $\pm$ 1600 psi bending stress with $F_o > 100,000$ cycles.

4. Fittings.

The standard HDPE fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining, or, shall be fabricated from PE pipe conforming to this specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years service at 73.4°F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade and cell classification as the pipe itself. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from crack, holes, foreign inclusions, voids, or other injurious defects. The fitting shall be as uniform as commercially practicable in color, opacity, density and other physical properties. The minimum "quick-burst" strength of the fittings shall not be less than that of the pipe with which the fitting is to be used.

## 2.03 LEACHATE SEWER MANHOLES

A. General: Provide precast reinforced concrete sanitary manholes, as indicated, and complying with ASTM C478.

B. The sections shall conform to the requirements of "Specifications for Precast Reinforced Concrete Manhole Sections" (ASTM C478), except that the joints shall be sealed with a Preformed Plastic Gasket that meets or exceeds all requirements of Fed. Spec. SS-S-00210, "Sealing Compound Preformed Plastic for Pipe Joints", Type 1, Rope Form or Rubber-O-Ring gaskets meeting the requirements of ASTM C443.

C. The Sealing Compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope-form of suitable cross-section and of such sizes as to seal the joint space when the sections are set in place. The sealing compound shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application of the sealing compound.

D. The top of base walls, the ends of reinforced concrete risers and the bottom ends of precast tops shall be so formed that when risers and tops are assembled with the base, they will make a continuous manhole. Joints shall be of such design as will permit effective joining and placement without irregularities in the interior wall surface of the manhole.

E. Manhole barrels shall consist of riser and top sections with a minimum wall thickness of 5 inches. The top section shall be an eccentric conical section with thickened upper walls with the smallest inside diameter equal 30 inches, to receive the manhole frame and cover. No more than 2 lift holes shall be cast in each barrel or top section.

F. Manhole riser and top sections shall be designed, manufactured, tested, finished and marked in accordance with this specification and ASTM C478.

G. Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated.

H. Base: Precast concrete, with base riser section and separate base slab, or base riser section with integral floor, as indicated.

I. Manholes shall have a concrete protective liner integrally anchored to concrete sections. Liner shall protect base, risers and top. See Section 02723 for liner specifications.

J. Pipe Connectors: Resilient, complying with ASTM C923.

K. Manhole Frame and Cover:

1. Manhole frames and covers shall be in accordance with the requirements of the

OWNER.

2. Manhole frames and covers shall be made of Class 30B gray iron which is tested in accordance with ASTM A48 Standard Specification for Gray Iron Castings. The name of the foundry and the heat and lot number shall be cast into the frame and into the exterior side of the cover.

3. Manholes, frames and covers shall be thoroughly cleaned. All projections and roughness shall be ground smooth. The bearing surfaces of the frame and cover shall not rock or jam.

4. Only solid watertight manhole covers are to be used.

5. All castings shall be made accurately to the pattern and to the dimensions shown on the contract drawings and shall be planned where marked or where otherwise necessary to secure perfectly flat and true surfaces. Allowances shall be made in the patterns so that the thickness shall not be reduced.

6. All castings shall be carefully coated, both inside and out, with coal-tar-pitch varnish. The varnish shall be made from a good quality of coal tar, with sufficient oil added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

7. Anchor bolts for bolting manhole frame to the precast manhole shall be 3/4" diameter galvanized all-thread cinch anchor with 5" for embedment in the manhole top and a minimum 2-inch projection through the bars of the frame.

## 2.04 CONCRETE AND REINFORCING

A. Concrete shall conform to drawings or specifications.

B. Reinforcing mesh and bars shall conform to ASTM A185 and ASTM A615, Grade 60.

## 2.05 STONE AGGREGATES

A. Crushed stone shall conform to the requirements for material requirements in accordance with DelDOT Standard Specification section 812 Portland Cement Concrete.

## 2.06 GROUT

A. Nonshrinking Grout

1. Required for patching manholes, pipes and plugging.

2. Grout shall be nonmetallic, as manufactured by one of the following:

   a. Crystex, L and M Construction Chemicals, Inc.
   b. Five Star Grout, U.S. Grout Corporation.
   c. Masterflow 713 grout, Master Builder's, Inc.
   d. Sauereisen F-100, Sauereisen Cement Company.
   e. Supreme Grout, Gifford-Hill and Company.
   f. Ferrolith C, Sonneborn-Contech.
   g. EUCO NS, Euclid Chemical.

3. Prepare and place to manufacturer's printed instructions.

# PART 3 EXECUTION

## 3.01 INSTALLATION OF PIPE AND PIPE FITTINGS

A. General:

1. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated. All excavating and backfill shall conform the specifications.

2. Inspect piping before installation to detect apparent defects. Mark defective materials with paint and promptly remove from site.

3. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

4. Shall be accomplished only in the presence of the ENGINEER, or his authorized representative. Adequate and suitable equipment and appliances for safe and convenient handling and laying of pipe shall be used.

B. HDPE Pipe: Install in accordance with manufacturer's installation

recommendations.

C. Cleaning Piping:

1. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.

2. In large, accessible piping, brushes and brooms may be used for cleaning.

3. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.

4. Flush lines between manholes if required to remove collected debris.

D. Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

E. Laying Pipe:

1. Pipes shall be laid true to the lines and grades shown on the plans. The grade shown on the profile is the invert to which the work must conform. Work not conforming to the grade shall be corrected by the CONTRACTOR at his own expense. The locations of the proposed lines are shown on the plans. Approximate depths are shown on the plans.

2. For gravity pipe, the CONTRACTOR shall use a laser to control alignment and grade. The laser shall be set up and operated according to the manufacturers instructions and the CONTRACTOR shall possess all required licenses and permits for laser operation. After the trench has been brought to the proper grade as heretofore specified, the pipe and fittings shall be laid. Care shall be taken to lay the pipe to true lines and grades. Every pipe laid shall be tested as to grade and alignment. Care must be taken to fit the joints together properly so that the centers of the pipes shall be in one and the same straight line, and so as to give an opening of even thickness.

3. Carefully handle and lower pipe into the trench. Take special care in laying pipe, to ensure that each length abuts against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe line. No wedging or blocking will be permitted in laying any pipe unless by written order or permission from the ENGINEER.

4. Bed each pipe section on a solid foundation before making successive joints. Bring no pipe section into position until the preceding length has been thoroughly embedded and secured in place. Correct any defects due to settlement at CONTRACTOR's own expense. Ensure that the pipe is firmly bedded on the full length of the barrel. All pipe bedding shall be in accordance with manufacturers requirements.

5. Use proper and suitable tools and appliances for the safe and convenient handling and laying of pipes.

6. Thoroughly clean each pipe section before placement and clean until the acceptance of the completed work. Provide and install carefully fitted strong stoppers in the open ends of all pipe lines so as to keep dirt and other substances from entering. Keep stoppers in the ends of the pipe lines at all times when laying is not in actual progress.

7. Keep the excavation in which pipe is being laid free from water and make no joint under water. Do not allow water to rise in the excavation until the joint material has received its set. Use the greatest care to secure watertightness and to prevent damage to, or disturbance of the joints during the refilling process, or at any time. After pipes have been laid and the joints have been made, allow no walking on or working over them, except such as may be necessary in tamping, until there is a covering at least two feet in depth, over their top.

8. Lay no pipe upon a foundation into which frost has penetrated nor at any time when the ENGINEER shall deem that there is danger of the formation of ice or other penetration of frost at the bottom of the excavation. Work may proceed during sub-freezing conditions, at the discretion of the ENGINEER, provided that the minimum length of open trench and promptness of refilling are observed.

9. Pipe and accessories shall be handled in such a manner as to insure delivery in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating. No other pipe or material of any kind shall be placed inside of any pipe or fitting at any time after the coating has been applied.

10. The CONTRACTOR shall also take any and all measures to keep the pipe clean and free from deposits and protect the pipe from damage. If the pipe is damaged from any cause or becomes either partly or completely filled with dirt, stones, sand or other debris, the CONTRACTOR shall make all necessary repairs and remove, at his own expense, all such material. Upon refusal to do so, it will be done by the OWNER and the cost thereof shall be charged as money paid to the CONTRACTOR.

11. Before lowering and while suspended, the pipe shall be inspected for defects and cracks. Any defective, damaged or unsound pipe will be rejected. Deflections from a straight line or grade, made necessary by vertical curves or horizontal curves or offsets, may be made with the pipe except that the deflection shall not exceed manufacturer's requirements. If the required alignment requires a deflection in excess of those specified, the CONTRACTOR shall either provide, at his own expense, special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within the limit set forth above.

12. When the sewers have been laid and backfilled, the ENGINEER will make an inspection. All defects found will be corrected by and at the sole expense of the CONTRACTOR.

F. Interior Inspection:

1. Inspect piping to determine whether line displacement or other damage has occurred.

2. Make inspections after lines between manholes or manhole locations, have been installed and approximately 2 feet of backfill is in place, and again at completion of project.

3. If inspection indicated poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects, and reinspect.

G. By-Pass Pumping/Fluming

1. The CONTRACTOR shall not be permitted to flume the leachate while laying new pipe, they shall by-pass pump from the manhole above the section of pipe he is working on to the pump station below.

2. The CONTRACTOR shall submit a detailed plan and schedule for bypass pumping, including equipment to be used, to the OWNER for review and approval.

H. Removal of Pipe

1. No payment shall be made for removal and disposal of existing pipe and it shall be assumed the CONTRACTOR has made provisions for same in his bid prices.

## 3.02 MANHOLES

A. General: Place precast concrete sections as indicated. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops two (2) feet above finish surface, unless otherwise indicated.

B. Install in accordance with ASTM C891.

C. Provide preformed joint sealing compound as specified on the drawings.

D. Handling:

1. All precast manhole components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the precast manhole lip.

2. All damage to precast sections shall be thoroughly repaired in the presence of the ENGINEER. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Sufficient time shall be allowed for curing before the precast sections are put together. Concrete cast-in-place bases shall be specially formed and keyed to accommodate the bottom precast section.

E. Placement:

1. Manhole bases shall rest upon a base of sound, level, Del No. 57 compacted stone.

2. Manhole sections shall not be set by wedging or placing shims to secure proper level and manholes shall not be backfilled without the permission of the ENGINEER.

F. Masonry Work: The top of all precast manholes may be brought to proper grade for receiving manhole frames by using not more than three courses of precast grade rings. All work shall be laid plumb, straight, level, square and true.

G. Flow Channels

1. The flow channels shall be monolithically constructed with the base.

2. The minimum depth of flow channel shall be equal to 3/4 the diameter of the largest sewer in the manhole to which it connects. The channel shall be graded to give a smooth, uninterrupted flow through the manhole.

3. Bench walls shall be pitched a minimum of 1 inch per foot from the inside periphery of the manhole to the edge of the flow channel.

4. Flow chanels shall be constructed with a Concrete Protective liner.

H. Bitumastic Exterior Coating:

1. Prior to delivery, the entire exterior manhole surface shall be coated with two (2) coats, producing a dry film thickness of .016 inches (16 mils) per coat of Bitumastic Super Service Black, as manufactured by Koppers Co., Inc., equivalent of Mobil Chemical Co., or equal. Prior to backfill, any damaged coating shall be repaired/reapplied to the exterior of the manhole.

I. Concrete Protective Liner:

1. Concrete protective liner is to be integrally attached to concrete of manhole. Liner joints are to be field welded to form a water and gas tight seal in accordance to the manufacturer's recommendations.

2. See Section 02723 and 02724 for concrete protective liner and base liner specifications.

## 3.03 MANHOLE FRAMES AND COVERS

A. Manhole frames and covers shall be brought to proper grade as previously noted, set in 1/4" bed of mastic, and anchored in place with the four (4) 3/4" diameter anchor bolts which shall be securely embedded in the top of the manhole. Where indicated on the plans at summit manholes, vented manhole covers shall be installed.

## 3.04 ACCEPTANCE TESTING:

A. GENERAL

1. After the gravity sewers have been laid and backfill placed to two (2) feet above the pipe, a light will be flashed between manholes, or, if the manhole has not yet been constructed, between the location of manholes, by means of a flashlight or mirrored light, to determine whether the alignment of the main is true and whether any pipe has been displaced subsequent to laying. If alignment is correct and no other defects are disclosed, backfilling may be continued. If the test shows poor alignment of the main, misplaced pipe or other defects, such defects shall be remedied by the CONTRACTOR, as required by the ENGINEER, before the work of backfilling proceeds.

2. After backfilling, the CONTRACTOR shall make tests to ascertain if joints are tight. Leaky or poor joints shall be repaired, or removed at once by the CONTRACTOR to the satisfaction of the ENGINEER.

3. No section of gravity sewer lines shall be tested for leakage before backfilling in that section has been completed. If this condition has been fulfilled, the sewer lines shall be tested for leakage between manholes as the work progresses.

4. The CONTRACTOR shall perform the tests and he shall furnish all apparatus and materials required for the tests, the cost of which shall be included in the Contract bid.

5. The tests will be witnessed by the ENGINEER.

6. The following tests shall be made:

   a. Low pressure air test
   b. X-ray inspection for HDPE pipe joints (certified sample)
   c. Manhole vacuum test
   d. Mirror test

7. Cost for testing shall be included in the CONTRACTOR's bid.

B. AIR TEST

1. The sewer mains and/or laterals shall be tested for leakage by the use of low pressure air as specified hereinafter and as approved by the ENGINEER. Each manhole run will be tested separately as the construction progresses, before trench surface restoration, and preferably with not more than four (4) manhole runs constructed ahead of testing.

2. Equipment shall be as manufactured by Cherne Industrial, Inc. of Edina, Minnesota; N.B. Products, New Britain, PA; or equal. Equipment used shall meet the following minimum requirements:

   a. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be inspected.

   b. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.

   c. All air used shall pass through a single control panel.

   d. Three individual hoses shall be used for the following connections:

      - From control panel to pneumatic plugs for inflation

      - From control panel to sealed line for introducing the low pressure air.

      - From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

3. Procedures:

   a. All pneumatic plugs shall be seal tested before being used in the actual test installation. One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs to be checked. Air shall be introduced into the plugs to 25 psig. The sealed pipe shall be pressurized to 5 psig. The plugs must hold against this pressure without having to be braced.

   b. After a manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked by the above procedure, the plugs shall be placed in the line at each manhole and inflated to 25 psig. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psig greater than the average back pressure of any groundwater than may be over the pipe (3.5 psig minimum pressure in the pipe). At least two (2) minutes shall be allowed for the air pressure to stabilize.

   c. After the stabilization period, the air hose from the control panel to the air supply shall be disconnected. The portion of line being tested shall be termed "Acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe) shall not be less than 4.0 minutes.

C. X-RAY TEST

1. The manufacturer shall submit molded fitting samples from each production lot for x-ray testing.

2. Certified inspection reports shall be provided to the OWNER prior to construction.

D. MANHOLE VACUUM TEST

1. CONTRACTOR shall supply all equipment and materials to vacuum test each manhole. Equipment and material shall be approved by the ENGINEER.

2. Each Manhole shall be tested after backfilling.

3. Prior to testing all lift holes shall be plugged with an approved non-shrink grout.

4. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.

5. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendations.

6. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if time is greater than 5 minutes for 48" diameter, 6 minutes for 60", and 7 minutes for 72" diameter manholes.

7. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

## 3.05 CONCRETE CONSTRUCTION

A. All concrete construction shall be in accordance with the specifications.

END OF SECTION

# SECTION 02534

# MANHOLE BASE LINER

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to supply manhole base liner of Fiberglass Reinforced Plastic (FRP) in the manholes as required or as shown on the plans.

B. For purposes of establishing a standard of design and quality of product, manhole base liner shall be GU Florida Inc. as distributed by Terre Hill Concrete Products or approved equal.

C. The FRP base liner shall be suited for welded connection to High Density Polyethylene (HDPE) or Polypropylene Random Copolymer (PP-R) concrete protective liner (CPL) in manholes as shown on the plans and as specified elsewhere.

D. The base liner and HDPE or PP-R concrete protective liner (CPL) shall be designed and installed to create an impermeable lining on the concrete structure's interior surface to protect the concrete surfaces from deterioration and to make the structure watertight.

E. Base liner and CPL for manholes must be compatible with each other and be capable of functioning together as a complete liner system.

## PART 2 PRODUCTS

### 2.01 GENERAL REQUIREMENTS

A. The manhole base liner shall be a rigid, mechanically bonded, non-structural sewer system fitting complying with the appropriate ASTM and CSA fitting standard for the pipes to be connected. The manufacturer shall be GU Florida Inc or approved equal.

B. The depth of the main through channel shall be equal to the diameter of the largest pipe. The depth of each lateral channel shall be equal to or greater than the diameter of the lateral pipe.

C. Unless otherwise requested by the ENGINEER, channel slopes shall be the minimum, consistent with providing for a self cleansing velocity at half bore flow conditions and exceeding the sum of hydraulic losses due to entrance, exit and friction.

D. The minimum thickness of the liner shall be 3/16 inches (5.0 mm).

E. The benching part of the base liner shall be impressed with an effective anti-skid pattern.

F. The geometry of each socket on the liner shall meet the current fitting standard for the pipe to be connected as follows:

1. For concrete pipes: ASTM C443 M
2. For PVC pipes: ASTM F789 and ASTM D3034
3. For ribbed PVC pipes: ASTM F794
4. For vitrified clay pipes: ASTM C425
5. Other pipes: When other approved pipes are to be connected to the liner, the socket geometry and gasket shall meet the requirements of the appropriate ASTM standards.

G. All pre-formed base liner units shall be proportioned for compatibility with the specified precast concrete units. The terminal edges of the liner shall extend no less than 3/4 of an inch into the base. The geometry of the liner shall comply with "STANDARD DIMENSIONS FOR GU MANHOLE LINER COMPONENTS FOR USE IN STORM AND SANITARY SEWER SYSTEMS" by GU INDUSTRIES INC.

H. A fiber backed Polyethylene welding strip shall form an integral part of the base liner edge for manholes specified to be lined with HDPE or PP-R liner.

## 2.02 MATERIAL PROPERTIES

A. The liner shall be constructed from fiberglass reinforced polyurethane meeting the following composition requirements and incorporating the manufacturer's area and point bonding system:

1. Minimum length of fibers = 0.625 inches.

2. Glass content between 12% and 15% by weight.

3. Fiberglass weight between 400 and 425 linear yards per pound.

4. Fiberglass type to be E GLASS.

B. There shall be no surface degradation of the liner when tested according to ASTM D1308 using the following reagents at 16 hour exposure.

| | |
|---|---|
| Nitric Acid | 69% |
| Hydrochloric Acid | 38% |
| Acetic Acid | 60% |
| Ammonia | 28% |
| Sodium Hydroxide | 5.25% |
| Sulfuric Acid | 50% |
| Acetone | |
| Unleaded Gasoline | |
| Turpentine | |

C. There shall be no evidence of chemical attack on the material when tested according to ASTM D2152.

D. There shall be no evidence of surface defects after testing the liner material in accordance with CSA-B45-M93 Clauses 5.2.2.1 to 5.2.2.4.

E. The channels shall have a smooth, non-porous surface with a Manning Friction Coefficient no higher than 0.009.

F. Bonding aggregate shall be pre-washed, kiln-dried, fractured 3/8 inch gravel having a well graded particle size distribution complying with the table below with the minimum size - 3/16 inch and maximum size - 3/8 inch. Rate of application is 3.5 lb/square foot. Aggregate shall be applied uniformly with sufficient exposed surface area to ensure complete and homogeneous bonding with the fiberglass reinforced polyurethane, as well as with the concrete during the precast process.

**Particle size distribution (ASTM E-11)**

| Sieve No | % Passing |
|---|---|
| 03.75 | 100 |
| 0.25 | 100 |
| 4 | 98 - 100 |

| | |
|---|---|
| 6 | 50 - 80 |
| 8 | 5 - 15 |
| 16 | 0 - 2 |

G. Bonding wire shall be grade 1006 10 gauge cold drawn wire having a tensile strength of 75,000 psi, formed into coils of 2 inch diameter. The steel shall comply with ASTM A510 and ASTM A853.

## 2.03 GASKETS

A. Gaskets for joining pipes to the manhole base liner shall be as approved by the pipe manufacturer, shall conform to the current ASTM C443 or ASTM 923 standard, and shall be installed according to the gasket manufacturers instructions.

B. Gaskets used between the precast manhole sections (base, risers, cones, and adjustment rings) shall comply with ASTM C990 or ASTM C443 and shall be installed according to the precast manufacturers instructions.

# PART 3 EXECUTION

## 3.01 GENERAL REQUIREMENTS

A. The base liner shall be installed in the precast concrete structure by a concrete fabricator qualified to install the base liner in conformance with the manufacturer's procedures and recommendations.

B. Field installation of the completed assembly shall be in strict conformance with the manufacturer's recommendations "Methods for Handling and Installation of GU Manhole Lined Concrete Structures".

C. Pipes shall be joined to the base liner in accordance with the gasket manufacturers recommendations and welded to the liner in accordance with the manufacturers recommendations.

## 3.02 PRECAST MANUFACTURING

A. The FRP base liner shall be adequately supported during placement and curing of the concrete to prevent deformation of any part of the liner.

B. When placing concrete on the FRP liner component, the concrete shall be vibrated to

ensure complete bonding with the aggregate and wire of the liner. The design of the concrete mix shall provide required strength and density. The concrete shall be free from voids, honeycombing, cracks, spalls and other material defects.

C. Precast concrete composite manhole components shall comply with ASTM C478 as modified by this specification. Where required by the ENGINEER, the outside surfaces of the precast concrete manhole shall be coated with an approved waterproofing material applied in accordance with the coating manufacturer's recommendations.

END OF SECTION

# SECTION 02620

# GEOCOMPOSITE DRAINAGE LAYER

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of the geocomposite drainage layer as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall obtain all geocomposite from a Geocomposite Manufacturer that has the demonstrated experience wit geocomposite manufacturing as stated in Part 1.02.

C. CONTRACTOR shall retain the services of a Geosynthetics Installer to install the approved geocomposite in conjunction with other components of the Project. The Geosynthetic Installer shall be approved by the Geocomposite Manufacturer.

D. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be held liable for any defects.

### 1.02 QUALIFICATIONS

A. The Geocomposite Manufacturer shall have successfully manufactured a minimum of 20,000,000 $ft^2$ of the same geocomposite as specified for this Project for use in at least ten landfill projects in the past five years.

B. The Geocomposite Manufacturer shall have sufficient manufacturing capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.

### 1.03 WARRANTY

A. The Manufacturer shall furnish OWNER and ENGINEER with a 20-year written warranty against defects in the material.

## 1.04 SUBMITTALS

A. At least 14 days prior to shipping any geocomposite to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the Geocomposite Manufacturer that will supply the geocomposite.
   1. Corporate background and information.
   2. Manufacturing capabilities, including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures; and
      d. list of material properties, including certified test results, to which are attached samples.
   3. A list of at least ten landfill projects within the last five years that the Geocomposite Manufacturer has manufactured a minimum of 20,000,000 $ft^2$ of the same geocomposite as specified for this Project. The following information shall be provided for each facility:
      a. name, location, and purpose of facility, and date of installation;
      b. names of OWNER, ENGINEER, and CONTRACTOR; and
      c. surface area of geocomposite manufactured.
   4. Origin (resin supplier's name, resin production plant) and identification (brand name, number) of the resin for the geonet component of the geocomposite.

B. Prior to shipping geocomposite rolls, CONTRACTOR shall provide ENGINEER with the following documentation on geocomposite roll production.
   1. Manufacturing quality control certificates for each shift's production, signed by responsible parties employed by the Manufacturer (such as the Production Manager).
   2. The quality control certificates shall include:
      a. roll numbers and identification;
      b. sampling procedures; and
      c. results of quality control tests, including description of test methods used.
   3. The Geocomposite Manufacturer quality control tests to be performed are outlined in Part 2.02 of this Section.

## 1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geocomposite shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain conformance samples at the Geocomposite manufacturing facility in order to expedite the conformance testing and approval process.

## PART 2 PRODUCTS

### 2.01 GEOCOMPOSITE MATERIAL

A. The geocomposite shall be composed of a high-density polyethylene drainage net with a nonwoven, needle-punched geotextile bonded to each side of the drainage net. The geotextile shall not be glued or bonded to the geonet in any manner other than heat bonding. Along edges, six inches of the geotextile shall not be heat bonded to the geonet to allow connection in the field.

### 2.02 GEOCOMPOSITE MATERIAL PROPERTIES

A. The Manufacturer shall furnish geocomposite having material properties that comply with the required property values shown in Table 02620-1. The Manufacturer shall provide test results for these procedures, as well as a certification that the materials meet or exceed the specified values.

B. In addition to the property values listed in Table 02620-1, the geocomposite shall:
   1. retain their structure during handling, placement, and long-term service;
   2. be capable of withstanding ultraviolet exposure for at least one year; and
   3. be chemically inert when immersed in a leachate representative of that from a typical landfill.

### 2.03 MANUFACTURING QUALITY CONTROL

A. The geocomposite shall be manufactured with quality control procedures that meet generally accepted industry standards.

B. The Manufacturer shall 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 Manufacturer shall replace any rejected rolls at no additional cost to OWNER.

D. If a geocomposite sample fails to meet the quality control requirements of this Section, then the Geocomposite Manufacturer shall sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.

E. Additional sample testing may be performed, at the Manufacturer's 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, at a minimum, once every 50,000 $ft^2$ to demonstrate that its properties conform to the values specified in Table 02620-1. At a minimum, the following manufacturing quality control tests shall be performed:

| Component | Test | Procedure |
|---|---|---|
| Geonet | Specific gravity | ASTM D 1505 |
| | Thickness | ASTM D 374C |
| | Carbon black | ASTM D 1603 |
| Geotextile | Mass per unit area | ASTM D 3776 |
| | Apparent opening size | ASTM D 4751 |
| | Permittivity | ASTM D 4491 |
| | Grab strength | ASTM D 4632 |
| | Tear strength | ASTM D 4533 |
| | Puncture strength | ASTM D 4833 |
| Geocomposite | Peel strength | ASTM F 904 or ASTM D 413 |

G. The hydraulic transmissivity test (ASTM D 4716) in Table 02715-1 need not be performed at a frequency of one per 50,000 $ft^2$. However, the Manufacturer shall certify that this test has been performed on a sample of geocomposite identical to the product that will be delivered to the Site. The Manufacturer shall provide test results to the CQA Consultant demonstrating that the Manufacturer performed the tests and that acceptable results were obtained.

H. The Manufacturer shall comply with the certification and submittal requirements of the CQA Plan.

## 2.04 LABELING

A. Geocomposite material shall be supplied in rolls wrapped in waterproof and opaque protective covers.

B. Geocomposite rolls shall be labeled with the following information:
   1. Manufacturer's name;
   2. product identification;
   3. lot number;
   4. roll number; and
   5. roll dimensions.

## 2.05 TRANSPORTATION

A. Transportation of the geocomposite material shall be the responsibility of the Manufacturer. The Manufacturer shall be liable for all damages to the materials incurred prior to and during transportation to the Site.

## 2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the geocomposite material prior to and following installation at the Site, is the responsibility of the Geosynthetics Installer. The Geosynthetics Installer shall be liable for all damages to the materials incurred prior to final acceptance of the lining system by the CQA Consultant.

B. The Geosynthetics Installer 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 Geosynthetics Installer's responsibility.

## 2.07 CONFORMANCE TESTING

A. Samples of the geocomposite will be removed by CONTRACTOR after the material has been received at the Site and sent to an independent geosynthetics laboratory (i.e., different that the geocomposite manufacturer) approved by ENGINEER for testing to

ensure conformance with the requirements of this Section. This testing will be carried out prior to the start of the work of this Section.

B. Samples and tests shall be selected by CONTRACTOR in accordance with this Section.

C. Samples shall be taken at a minimum frequency of one sample per 100,000 square feet with a minimum of one sample per lot. If CONTRACTOR's supplier provides material that requires sampling at a frequency (due to lot size, shipment size, etc.) resulting in one sample per less than 90 percent of this value, then CONTRACTOR shall pay the cost for all additional testing beyond one per less than 90 percent of this amount.

D. The CQA Consultant will direct CONTRACTOR to increase the frequency of sampling in the event that test results do not comply with the requirements of Part 2.02 of this Section until passing conformance test results are obtained for all material that is received at the Site. This additional testing shall be performed at the expense of the Manufacturer.

E. As a minimum, tests listed in on Table 02620-1 of this Specification shall be performed on the geocomposite.

F. Any geocomposite that are not certified in accordance with Part 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.02 of this Section, will be rejected by the CQA Consultant. The Manufacturer shall replace the rejected material with new material, at no additional cost to OWNER.

## PART 3 EXECUTION

### 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the Work

of this Section will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 HANDLING AND PLACEMENT

A. The Geosynthetic Installer shall handle all geocomposite material in such a manner as to ensure the geocomposite material is not damaged in any way.

B. The Geosynthetic Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite layers.

C. The Geosynthetic Installer shall ballast the geocomposite layers with sandbags to prevent displacement of the geocomposite by wind. Such sandbags shall be installed during placement and shall remain on the geocomposite until it is covered with soil at which time they will be removed. Care shall be exercised when handling sandbags, to prevent rupture or damage of the sandbags.

D. The geocomposite shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite in tension.

E. The geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

F. Care shall be taken during placement of geocomposite material not to trap dirt or excessive dust in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent liner. If dirt or excessive dust is entrapped in the geocomposite layer, then it should be cleaned prior to placement of the next material on top of it.

G. Geocomposite materials shall only be cut using cutting tools approved by the Manufacturer.

H. Geocomposite materials shall not be welded to liners.

I. Tools shall not be left on or in the geocomposite.

J. After unwrapping the geocomposite material from its opaque cover, the geocomposite material shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by OWNER. Such approval shall be based on a formal demonstration from the Manufacturer that the geotextile component of the

geocomposite is stabilized against ultraviolet degradation for a period in excess of 30 days.

## 3.03 SEAMS AND OVERLAPS

A. The components of the geocomposite (i.e., geotextile-geonet-geotextile) are not to be bonded together at the ends and edges of the rolls. Each component will be secured or seamed to the like component at overlaps.

B. Geonet Components
   1. The geonet components shall be overlapped by at least 4 in. These overlaps shall be secured by tying.
   2. Tying shall be achieved by plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices shall not be used.
   3. Tying shall be every 5 ft. along the slope, and every 6 in. in the anchor trench and on end-to-end seams.

C. Geotextile Components
   1. The bottom layers of geotextile shall be overlapped a minimum of 4 in. prior to seaming. The top layers of geotextiles shall be continuously sewn (i.e., spot sewing or thermal bonding is not allowed).
   2. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The seams shall be sewn using Stitch Type 401. The seam type shall be Federal Standard Type SSN-1.

## 3.04 REPAIR

A. Any holes or tears in the geocomposite material shall be repaired by placing a patch extending 1 ft. beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall be secured every 6 in. with approved tying devices. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, then the entire damaged geocomposite panel shall be removed and replaced.

## 3.05 PLACEMENT OF SOIL MATERIALS

A. CONTRACTOR shall place all soil materials over geocomposite such that:
   1. the geocomposite and underlying materials are not damaged;
   2. minimal slippage occurs between the geocomposite layer and underlying layers; and
   3. excess tensile stresses are not produced in the geocomposite.

B. Equipment shall not be driven directly on the geocomposite drainage layer. Unless otherwise specified by ENGINEER, all equipment operating on soil material overlying the geocomposite drainage layer shall comply with the following:

| Maximum Allowable Equipment Ground Pressure (psi) | Thickness of Overlying Compacted Fill (ft.) |
|---|---|
| <5 | 1.0 |
| <10 | 1.5 |
| <20 | 2.0 |
| >20 | 3.0 |

## 3.06 PRODUCT PROTECTION

A. 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, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

# TABLE 02620-1

## GEOCOMPOSITE PROPERTY VALUES[1]

| PROPERTIES | QUALIFIERS | UNITS | VALUES | METHOD |
|---|---|---|---|---|
| **Geonet Component** | | | | |
| Polyethylene Content | minimum | % | 95% by weight | --- |
| Resin Density[2] | minimum | g/cc | 0.935 | ASTM D 1505 |
| Carbon Black Content | range | % | 2.0 - 3.0 | ASTM D 1603 |
| Melt Index | maximum | g/10 min | 1.0 | ASTM D 1238 |
| Thickness | minimum | mils | 200 | ASTM D 1777 |
| Weight Per Square Foot | minimum | $lb/ft^2$ | 0.16 | ASTM D 3776 (Option C) |
| Tensile Strength | minimum | lb/in | 40 | ASTM D 1682 |
| Foaming Agents | maximum | % | 0.0 | N/A |
| **Geotextile Component** | | | | |
| Polymer Composition | minimum | % | 95 polyester or polypropylene | |
| Construction | type | --- | needle-punched | --- |
| Mass Per Unit Area | minimum | $oz/yd^2$ | 5.7 | ASTM D 3776 |
| Apparent Opening Size | maximum | mm | $O_{95} \leq 0.21$ mm | ASTM D 4751 |
| Hydraulic Conductivity | minimum | $gal/min/ft^2$ | 130 | ASTM D 4491 |
| Grab Strength | minimum | lb. | 160 | ASTM D 1682[3] |
| Tear Strength | minimum | lb. | 60 | ASTM D 1117[3] |
| Puncture Strength | minimum | lb. | 80 | ASTM D 3787 |
| Burst Strength | minimum | $lb/in^2$ | 275 | ASTM D 3786 |
| **Geocomposite** | | | | |
| Transmissivity | minimum | gal/ft/min | $1 \times 10^{-1}$ | [4] |
| Peel Strength | minimum | gm/in | 500 | ASTM F 904[2] |
| Interface Shear Strength Between Geocomposite and Textured Geomembrane | minimum | degrees | 25 | ASTM D 5321 |

Notes:

1. All values represent minimum average roll values (i.e., test results for a samples collected from any roll in a lot should meet or exceed the values in this table).
2. The density of the net resin shall not exceed that of the geomembrane.
3. Minimum of values measured in machine and cross machine directions with 1 in. clamp on Constant Rate of Extension (CRE) machine.
4. Transmissivity to be measured using water at 68°F (20°C) with gradients of 0.02 and 0.3, under a confining pressure of 15,000 lb/sf. The geocomposite shall be placed in the testing device between the protective cover soil material and the selected and approved textured 60 mil geomembrane. Measurements are taken one hour after application of confining pressure.

END OF SECTION

# SECTION 02621

# PREFABRICATED VERTICAL DRAINS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of prefabricated vertical drains (PVDs) as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance (CQA) Plan.

B. CONTRACTOR shall obtain the specified PVDs from a qualified PVD Manufacturer that has the demonstrated experience with PVD manufacturing as stated in Part 1.02.A of this Section.

C. CONTRACTOR shall retain the services of a PVD Installer to install the approved PVDs in conjunction with the other components of the Project. The PVD Installer shall be approved by the PVD Manufacturer and have the demonstrated experience in PVD installation as stated in Part 1.02.B of this Section.

### 1.02 QUALIFICATIONS

A. PVD Manufacturer:
   1. The PVD Manufacturer shall be capable of manufacturing PVDs as specified herein and shall have sufficient production capacity and qualified personnel to meet the requirements of this Section and the demands (e.g., quantity production and quality control) of this Project.
   2. The PVD Manufacturer shall have successfully produced a minimum of 5,000,000 linear ft. of PVD for use in at least ten projects in the past five years.

B. PVD Installer:
   1. The PVD Installer shall be responsible for field handling, storing, installing, and all other aspects of the PVD installation, and shall provide qualified installation personnel, as outlined in this Section.
   2. The PVD Installer shall have successfully installed a minimum of 5,000,000 linear ft. of PVD for use in at least ten projects in the last five years.

C. CONTRACTOR shall accept and retain full responsibility for all materials and installation and shall be responsible for any defects.

## 1.03 SUBMITTALS

A. At least 14 days prior to shipping any PVD to the Site, CONTRACTOR shall provide ENGINEER with the following documentation on the PVD Manufacturer:
   1. Corporate background and information.
   2. Manufacturing capabilities, including:
      a. information on plant size, equipment, personnel, number of shifts per day, and capacity per shift;
      b. daily production quantity available for this Contract;
      c. manufacturing quality control procedures, that addresses, at a minimum, delivery and handling of raw materials, production of geotextile and drainage core material, and construction of the PVD, and quality assurance/quality control of these activities;
      d. manufacturer's recommendations for installation, and PVD repair for product defect repair and construction repair/splicing procedures; and
      e. list of materials properties, including certified test results, to which are attached a PVD sample.
   3. A list of ten projects within the last five years that the PVD Installer has manufactured a minimum of 5,000,000 linear ft. of PVD. The following information shall be provided for each project:
      a. name, location, and purpose of facility, and date of installation;
      b. names of and contact information for OWNER, ENGINEER, and CONTRACTOR; and
      c. linear ft. of PVD installed.
   4. At least two samples of the proposed PVD.

B. At least 14 days prior to installing the PVDs, CONTRACTOR shall provide ENGINEER with the qualifications and experience of the PVD Installer.

C. At least 14 days prior to installing the PVDs, CONTRACTOR shall provide ENGINEER with layout plans, at an appropriate scale to allow for review. The layout plans shall show the following:
   1. the proposed PVDs lines that satisfy the spacing and depth requirements specified herein and on the Drawings;
   2. the proposed approach to creating a level work area for the PVD installation equipment.

3. the method for splicing section of PVD.

D. At least 14 days prior to installing the PVDs, CONTRACTOR shall provide ENGINEER with the PVD Installer's daily quality control (QC) log to be used during PVD installation. At a minimum, the daily QC log shall contain the number of rolls used, number of PVDs installed, and the daily and cumulative linear footage installed with their respective lot numbers.

E. Prior to shipping any PVDs to the Site, CONTRACTOR shall provide ENGINEER with certified laboratory test results for the tests required under Part 2.01 of this Section. These tests shall be performed on samples representative of PVD material to be used for this project.

F. At the completion of all PVD installation, CONTRACTOR shall prepare and provide ENGINEER, record drawings that summarize the number and termination depths of installed PVDs. The record drawings shall indicate the surveyed lines of installed PVDs and the approximate termination depth for each line of PVDs installed to a common termination depth. This summary of actual termination depths shall be presented in tabular form on the record drawings. In addition, the surveyed dimensions of the actual area of PVD installation, as well as the total number and linear ft. of installed PVDs, shall be indicated on the record drawings.

## 1.03 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the PVDs shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR and PVD Installer shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the installation schedule.

C. CONTRACTOR shall provide the CQA Consultant the opportunity to obtain samples at the PVD manufacturing.

# PART 2 PRODUCTS

## 2.01 PREFABRICATED VERTICAL DRAIN

A. The PVD shall consist of a plastic drain core wrapped in a non-woven geotextile material.

B. The geotextile and drain core materials comprising the PVD shall meet the minimum physical properties outlined in Table 02621-1. The properties shown represent the minimum values for installed materials unless otherwise indicated.

## 2.02 EQUIPMENT

A. All PVDs shall be installed with approved equipment that will cause a minimum of disturbance to the subsurface dredge/alluvium materials during the installation operations.

B. The PVDs shall be installed using a mandrel or sleeve that will be advanced through the compressible soils using static and or vibratory methods. The mandrel shall protect the PVD from tears, cuts, and abrasions during installation and shall be withdrawn after the installation of the PVD. An anchor plate of appropriate stiffness shall be attached to the end of the PVD to prevent soil or waste from entering the bottom of the mandrel during the installation and to anchor the bottom of the PVD at the required depth at the time of the removal of the mandrel. The mandrel shall have a maximum gross cross-sectional area of 10 $in^2$.

C. The installation equipment shall be carefully checked for plumbness prior to advancing each PVD, and shall not deviate more than 1 in. per ft. from the vertical.

D. The installation equipment shall be capable of driving the mandrel to a depth of 120 ft. below ground surface.

## 2.03 MANUFACTURING QUALITY CONTROL

A. The PVD Manufacturer shall test the PVD produced for this project for the properties outlined in Table 02621-1.

B. Prior to manufacturing the PVD, the geotextile and drainage core materials components of the PVDs shall be tested by their respective manufacturers, or by the manufacturer of the PVD, to ensure that the physical and mechanical properties are in accordance with Table 02621-1.

C. Test frequencies shall be in accordance with ASTM D4354, but no less than one set of tests for every 200,000 linear ft. of PVD proposed for this project. In addition, one, 12-in. long sample of PVD material installed shall be collected by CONTRACTOR and provided to ENGINEER for every 200,000 linear ft. of installed material. The date

installed, roll number and cumulative lineal footage shall be tagged on each 12-in. long sample.

## 2.04 LABELING

A. PVD rolls shall be labeled with the following information:
   1. name of manufacturer;
   2. product identification;
   3. lot number;
   4. factory number; and
   5. roll length.

## 2.05 TRANSPORTATION

A. Transportation of the PVDs to the Site is the responsibility of the PVD Manufacturer. The PVD Manufacturer shall be liable for all damages to the PVDs incurred prior to and during transportation to the Site.

B. PVD shall be delivered to the Site at least seven days before the scheduled date of installation to allow the CQA Consultant adequate time for taking inventory and obtaining samples if needed.

## 2.06 HANDLING AND STORAGE

A. CONTRACTOR shall be responsible for handling, storage, and care of the PVDs prior to and following installation at the Site. CONTRACTOR shall be liable for all damages to the materials incurred prior to final acceptance by OWNER and ENGINEER.

B. CONTRACTOR shall be responsible for storage of the PVDs at the Site. During storage, the PVDs shall be protected from excessive heat and cold, puncture, cutting, or other damaging or deleterious conditions. The PVD shall be store in accordance with the PVD Manufacturer's recommendations in an area that is reasonably level, smooth, and well-drained.

C. Individual PVD rolls shall be stored with safe walking space and clearance between them to allow full view for inspection purposes. To prevent ultraviolet degradation of the material, the protective wrapper on each PVD roll shall not be removed until the material is ready for use. Any rolls that are delivered without protective wrappers shall be rejected by ENGINEER and removed from the Site by CONTRACTOR at no cost to OWNER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of its site inspection. Failure to inform ENGINEER in writing or installation of the Work of this Section will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 SURFACE PREPARATION

A. Existing surface vegetation, if any, shall be cut to within approximately 2 to 4 in. of existing ground surface within the proposed PVD installation area. All cut vegetation and other surface debris shall be cleared from within said limits and transported and disposed at the unsuitable stockpile areas discussed in Section 02230. No grubbing or stripping of non-woody vegetation shall be performed. The intent is to provide for a relatively undisturbed ground surface for maximum support of equipment.

B. Woody vegetation (i.e., shrubs and trees) and their root masses shall be cleared and grubbed from within the limits of proposed PVD installation. All cleared and grubbed materials shall also be transported and disposed at the unsuitable material stockpile areas discussed in Section 02230.

C. As needed, CONTRACTOR shall construct a level work area for the PVD installation equipment using granular fill (Section 02055). Placement and compaction of the granular fill shall conform to the requirements provided in Section 02330 of these Technical Specifications.

## 3.03 INSTALLATION

A. PVDs shall be installed in the areas shown on the Drawings. ENGINEER may revise (i.e., increase or decrease) the PVD installation area based on field conditions.

B. Prior to PVD installation, CONTRACTOR shall stake out the proposed locations of the PVDs based on the approved layout plan. The locations of the stakes shall not vary by more than 12 in. from the locations indicated on the approved layout plan unless otherwise approved by ENGINEER. All reasonable precautions shall be taken to preserve the stakes.

C. PVDs that deviate from their approved locations by more than 12 in., and PVDs that are damaged or improperly installed, will be rejected. Rejected PVDs shall be removed or abandoned in place, at CONTRACTOR's option, at no cost to OWNER. Replacement PVDs shall be offset approximately 12 in. from the locations of rejected PVDs and within 12 in. of the approved locations. All rejected PVDs shall be replaced at no cost to OWNER.

D. PVDs shall be installed vertically to completely penetrate the dredge/alluvium deposits, and advanced at least 3 ft. into the underlying Columbia Formation (consisting of granular soil), or to refusal, whichever yields the lower PVD tip elevation, unless otherwise approved by ENGINEER.

E. The PVD installation equipment shall be carefully checked for plumbness throughout the installation process. CONTRACTOR shall provide ENGINEER with a suitable means to verify the plumbness of the mandrel and of determining the PVD tip elevation at any time.

F. The following procedure shall be adhered to should obstructions be encountered during PVD installation.
   1. CONTRACTOR shall notify ENGINEER immediately of any obstruction.
   2. If the obstruction is within 15 ft. of the ground surface, then the PVD location shall be abandoned and an attempt at installing a new PVD within a 2-ft. radius of the original location shall be made. If an obstruction is found at the new location, make one more attempt within a 2-ft. radius of the original location. If the PVD still cannot be installed after three attempts, then pre-drill the original location to a depth of about 3 ft. below the bottom of the obstruction. Install the PVD through the pre-drilled hole.
   3. If the obstruction is encountered below 15 ft. of the ground surface, then the PVD location shall be abandoned and the installation equipment shall be moved to the next PVD location.
   4. CONTRACTOR shall be paid for all obstructed PVDs at the contract unit price unless the PVD is improperly installed.

G. The PVD Installer shall be permitted to use auguring or other methods to loosen stiff or dense surficial soils, if necessary, prior to the installation of the PVD, provided that such auguring or other method does not extend more than 2 ft. into the underlying dredge deposits.

H. ENGINEER may vary the depths, spacing, or number of PVDs to be installed, and may revise the plan limits for this Work, if deemed necessary.

I. Splices or connections in the PVD materials shall be done in a workmanlike manner so as to insure the continuity of the PVD. A minimum overlap of 6 in. shall be required for each splice. ENGINEER shall approve the method of splicing.

J. After a line of PVDs has been installed, the PVD shall be tied to a strip drain.

K. CONTRACTOR shall take all precautions necessary to protect existing geotechnical and environmental instrumentation devices. No PVDs shall be installed within 4 ft. of an existing device. CONTRACTOR shall replace in kind at no cost to OWNER, device that is damaged or becomes unreliable as a result of the PVD installation.

L. Any damage to existing site features or constructed work shall be repaired/replaced at no cost to OWNER.

## 3.04 MATERIALS IN CONTACT WITH THE PVDs

A. CONTRACTOR and PVD Installer shall take all necessary precautions top ensure that the PVDs are not damaged during installation or during the construction/installation of other components of the Project.

B. Vehicular traffic over the directly over the installed PVDs and strip drains is prohibited.

## 3.05 PVD ACCEPTANCE

A. The PVD Installer shall retain all ownership and responsibility for the PVD until accepted by OWNER and ENGINEER.

B. The PVDs will not be accepted by OWNER and ENGINEER until all of the following conditions are met:
   1. the installation is finished;
   2. all documentation of installation is completed, including the CQA Consultant's final report;

3. verification that the PVDs are performing as anticipated; and
4. written certification documents, including record drawings, sealed by a professional land surveyor licensed in the State of Delaware, have been received by OWNER and ENGINEER, in accordance with Section 01721.

## 3.06 PRODUCT PROTECTION

A. 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, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

**TABLE 02621-1**

**PHYSICAL AND MECHANICAL PROPERTIES OF PVD MATERIALS(1)**

| Property | ASTM Test Method | Unit | Geotextile | Plastic Core |
|---|---|---|---|---|
| Width | --- | in. | --- | 4 |
| Thickness | --- | in. | --- | 0.125 |
| Grab Tensile Strength | D 4632 | lb. | 130 | --- |
| Trapezoidal Tear Strength | D 4533 | lb. | 60 | --- |
| Puncture Strength | D 4833 | lb. | 40 | --- |
| Mullen Burst | D 3786 | $lb/in^2$ | 140 | --- |
| Permeability | D 4491 | cm/sec | $6 \times 10^{-5}$ | --- |
| Apparent Opening Size | D 4751 | mm | < 0.01 | --- |
| Crush Strength | D 1621 | $lb/in^2$ | --- | 100 |
| Discharge Capacity(2) | D 4716 | gal/min | --- | 1.2 |

Notes:

1. All values represent minimum average roll values (i.e., test results for a samples collected from any roll in a lot should meet or exceed the values in this table).
2. Discharge capacity shall be measured for straight and crimped lengths of PVD.

END OF SECTION

# SECTION 03100

# CONCRETE FORMS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, and supervision necessary to construct the forms required for cast-in-place concrete construction as indicated on the Drawings and in this Section.

B. CONTRACTOR shall be prepared to construct the forms in conjunction with other Work at the Site.

C. CONTRACTOR shall be entirely responsible for meeting the requirements of this Section.

### 1.02 CONSTRUCTION QUALITY ASSURANCE

A. Construction of the concrete forms shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

C. CONTRACTOR shall ensure that the materials and methods used for construction of the concrete forms meet the requirements of the Drawings and Technical Specifications. Any material or method that does not conform to these documents, or to alternatives approved by ENGINEER will be rejected by the CQA Consultant and shall be repaired or replaced by CONTRACTOR at no cost to OWNER.

D. CONTRACTOR shall perform all Work in accordance with ACI 347.

# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Concrete formwork shall be designed for vertical loads and lateral pressures in accordance with the standards prescribed in ACI 347.

B. Plywood forms shall be grade marked B-B Plyform, Exterior Class 1 and 2 Medium Density Overlaid Plywood Concrete Form, B-Matte Formguard, or equal, conforming to the requirements of U.S. Product Standard PS-1, "*Construction and Industrial Plywood*".

C. Steel forms shall be a minimum 16-gauge steel, matched, tight fitting, and stiffened to support the weight of the concrete.

D. Form ties shall be factory fabricated, snap-off metal ties of adequate design to minimize form deflection and preclude concrete spalling upon removal. The ties shall be fabricated to that set back in the concrete is such that the portion of the tie remaining after snap-off and removal of the exterior portions is at least 1½ in. back from the concrete surface.

E. Bond breaker or form release agent shall be a non-staining mineral oil or similar liquid product that imparts a waterproof film to prevent adhesion of concrete and will not leave a paint impending coating on the face of the concrete or release agents which will not transfer to the concrete.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with the Site, the site conditions, and all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing prior to commencing the Work. Failure to notify ENGINEER or construction of the concrete formwork will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 CONSTRUCTION

A. CONTRACTOR shall construct and adequately brace the formwork so that the resulting concrete surfaces will conform to the dimensions specified on the Drawings and in accordance with requirements of ACI 301.

B. CONTRACTOR shall provide mortar tight forms of approved materials that conform to the required shapes, lines and dimensions, and will produce a smooth surface without fins and projections.

## 3.03 COATING

A. CONTRACTOR shall coat the forms with bond breaker prior to the placement of reinforcing steel.

B. CONTRACTOR shall allow excess coating material neither to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is to be placed.

C. CONTRACTOR shall coat bolts and rods that are to be completely removed or that are to be free to move with a bond breaker.

## 3.04 EMBEDDED ITEMS

A. CONTRACTOR shall thoroughly clean items to be embedded in concrete from oil or other foreign matter that would weaken the bond of the concrete to these items.

## 3.05 FORMWORK TOLERANCES

A. CONTRACTOR shall construct the formwork to maintain tolerances required by ACI 301.

B. CONTRACTOR shall install in the formwork requisite inserts, anchors, sleeves, and other items specified under other Sections of these Technical Specifications. Close ends of conduits, piping, and sleeves shall be embedded in concrete with caps or plugs.

C. Concrete pads, curbs, pedestals, and similar means devised by CONTRACTOR to support the forms will be subject to review by ENGINEER and the CQA Consultant.

D. Before depositing concrete, the location and support of items that are to wholly or partially embedded shall be checked by CONTRACTOR.

E. CONTRACTOR shall provide openings and recesses and place sleeves in the concrete as may be required and furnished by other Sections of these Technical Specifications.

## 3.06 REMOVAL OF FORMS

A. CONTRACTOR shall maintain forms, falsework, and centering in place until the concrete has attained the minimum percentage of specified design strength to carry their own weight and any loads to which they will be subjected without exceeding the permissible stresses and without deforming.

B. CONTRACTOR shall compute these permissible stresses on the basis of 0.6 of the compressive strength attained by the concrete at the time of removal. The concrete strength attained prior to form removal shall be determined from the results of test cylinders cured adjacent to and under the same conditions as the placed concrete. The test cylinders shall be obtained and tested in accordance with the procedures of Section 03300, Cast-in-Place Concrete.

## 3.07 PROTECTION OF WORK

A. CONTRACTOR shall use all means necessary to protect all Work of this Section and materials and completed Work of other Sections.

B. In the event of damage to this Work or other Work, CONTRACTOR shall immediately make all repairs and replacements if necessary, to the approval of ENGINEER and the CQA Consultant and at no cost to OWNER.

END OF SECTION

# SECTION 03200

# CONCRETE REINFORCEMENT

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, equipment, tools, and supervision necessary to place the concrete reinforcement to the requirements indicated on the Drawings and in this Section.

B. CONTRACTOR shall be prepared to construct the reinforcement in conjunction with other Work at the Site.

C. CONTRACTOR shall be entirely responsible for meeting the requirements of this Section.

### 1.02 SUBMITTALS

A. At least seven days prior to delivery of the concrete reinforcement, CONTRACTOR shall submit the following certificates to ENGINEER and the CQA Consultant.
   1. Certified copies of mill tests on each heat number showing chemical and physical analyses.
   2. Results of tests performed in accordance with ASTM A 615 as modified by ACI 318 building code requirements for reinforced concrete.
   3. Certificates stating that materials meet all requirements of this Section.

### 1.03 CONSTRUCTION QUALITY ASSURANCE

A. Placement of the concrete reinforcement shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

C. CONTRACTOR shall ensure that the materials and methods used for construction of the concrete reinforcement meet the requirements of the Drawings and Technical Specifications. Any material or method that does not conform to these documents, or to

alternatives approved by ENGINEER, will be rejected by the CQA Consultant and shall be repaired or replaced by CONTRACTOR at no cost to OWNER.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. CONTRACTOR shall provide concrete reinforcement that meets the requirements stated on the Drawings or specified in this Section.

B. CONTRACTOR shall supply reinforcing steel bars that meet the requirements of ASTM A 615, Grade 60, modified in accordance with ACI 318.

C. CONTRACTOR shall supply welded steel wire fabric that meets the requirements of ASTM A 185.

## PART 3 EXECUTION

### 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with the Site, the site conditions, and all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing prior to commencing the Work. Failure to notify ENGINEER or installation of the concrete reinforcement will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

### 3.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. CONTRACTOR shall be responsible for delivery, storage, and handling of the concrete reinforcement steel.

B. Reinforcement shall be shipped to the Site with bars of the same size and shape securely fastened in bundles with wired metal identification tags shall be labeled with the same designation as shown on submitted bar schedules and shop drawings.

C. All bars shall be stored off the ground and shall be protected from moisture and kept free from dirt, oil, and other foreign substances.

D. CONTRACTOR shall protect the reinforcing steel and wire fabric from damage and dirt, oil, grease, other foreign matter, and rust causing conditions.

## 3.03 CUTTING AND BENDING

A. CONTRACTOR shall perform cutting and bending in the shop. The steel shall be bent cold and in a manner that will not damage the integrity of the material.

B. CONTRACTOR shall not bend bars in the field except to correct minor errors or damage in shipment or handling, or to allow for shipment of certain bars.

C. Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness, except for bars larger than 1-in. diameter, in which case the bends shall be made around a pin of eight bar diameters. All bars shall be bent cold.

## 3.04 ALLOWABLE TOLERANCES

A. CONTRACTOR shall cut and bend reinforcing steel to conform to the dimensions shown and within the following tolerances:

Sheared length - ± 1 in.
Stirrups, ties and spirals - ± ½ in.
All other bends - ± 1 in.

B. CONTRACTOR shall place the reinforcing steel to meet the following tolerances:

Variation of protective coating 2 inch cover - ¼ in.
Variation of protective coating 3 inch cover - ½ in.
Variation from indicated spacing - 1 in.

## 3.05 BAR SUPPORTS AND SPACERS

A. CONTRACTOR shall support bars by means of bolsters or chairs with no less than the minimum required by ACI 315.

B. Reinforcing steel that is located in the bottom of slabs resting on earth may be supported by concrete, brick, mortar blocks, or reinforcing steel supports.

C. CONTRACTOR shall hold reinforcing steel in position in walls, columns, piers, and abutments by means of mortar blocks, bar supports, or spacers wired to reinforcing steel.

D. CONTRACTOR shall not use stones, clay bricks, wood blocks, or pieces of broken concrete to support reinforcing steel.

E. CONTRACTOR shall not place bars or fabricated mats on layers of fresh concrete as the work progresses.

## 3.06 PLACING AND FASTENING

A. CONTRACTOR shall arrange and place reinforcing steel as shown on the Drawings.

B. CONTRACTOR shall secure reinforcement positively against displacement during placing of concrete.

C. CONTRACTOR shall wire or clip bars together as recommended in Concrete Reinforcing Steel Institute Recommended Practice for Placing Reinforcing Bars.

D. The steel shall be free from dirt, mill and rust scale, oil, grease, and other foreign matter.

E. CONTRACTOR shall furnish reinforcing bars in full lengths as shown on the Drawings and Shop Drawings.

F. CONTRACTOR shall not splice bars unless approved by ENGINEER in writing.

G. CONTRACTOR shall place reinforcement so that there will be a clear distance of at least 2 in. between the reinforcement and any anchor bolts or other embedded metal work.

H. Unless otherwise shown on the Drawings, splices in reinforcement bars shall be lapped not less than 24 diameters. All bar splices shall be staggered wherever possible. When splicing bars of different diameters, the length of lap is based on the larger bar.

I. Before placing in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings that may reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be reinspected and cleaned when necessary.

## 3.07 INSPECTION

A. CONTRACTOR shall deposit concrete only when the placement of the reinforcement has been checked and approved by ENGINEER or the CQA Consultant.

## 3.08 PROTECTION OF WORK

A. CONTRACTOR shall use all means necessary to protect all Work of this Section and materials and completed Work of other Sections.

B. In the event of damage to this Work or other Work, CONTRACTOR shall immediately make all repairs and replacements if necessary, to the approval of ENGINEER or the CQA Consultant and at no cost to OWNER.

END OF SECTION

# SECTION 03300

# CAST-IN-PLACE CONCRETE

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the manufacture, storage, delivery, and installation of cast-in-place concrete, as specified herein, and as shown on the Drawings.

B. CONTRACTOR shall coordinate the installation of the cast-in-place concrete with other construction activities and subcontractors at the Site.

C. All Work shall be performed in accordance with ACI 318 and ACI 301.

D. CONTRACTOR shall retain a Construction Quality Control (CQC) Consultant to perform the field and laboratory testing of cast-in-place concrete. The CQC Consultant must be acceptable to OWNER.

### 1.02 SUBMITTALS

A. At least 14 days prior to starting the Work of this Section, CONTRACTOR shall submit to ENGINEER Shop Drawings for all cast-in-place concrete. These Shop Drawings shall provide details for formwork and reinforcing steel.

B. At least 14 days prior to staring the Work of this Section, CONTRACTOR shall submit to ENGINEER the proposed concrete design mixes. The design mixes shall present the composition of the concrete mix including all materials, admixtures, ratios, compressive strength, slump, and air entrainment in accordance with ACI 318.

C. At least 14 days prior to starting the Work of this Section, CONTRACTOR shall submit to ENGINEER the methods proposed for use against low and high temperatures for protection of the concrete.

D. At least 14 days prior to starting the Work of this Section, CONTRACTOR shall submit to ENGINEER information describing the qualifications and capabilities of the CQC Consultant.

E. For each truck load of concrete delivered to the Site, CONTRACTOR shall submit a delivery ticket to the CQA Consultant. The certificate or delivery ticket shall set forth the following information:
   1. name of supplier;
   2. name of batching plant and location;
   3. date;
   4. truck number;
   5. specific job designation (contract number and location);
   6. the volume of concrete (cubic yards);
   7. specific Class and Type of concrete (in conformance with the Technical Specifications);
   8. time loaded;
   9. type and brand of cement;
   10. weight of cement;
   11. maximum size of aggregates;
   12. weights of coarse and fine aggregates, respectively;
   13. amount of water added at the plant and maximum amount of water to be added at the site, if any; and
   14. kind and amount of admixtures.

F. As soon as the data is available, CONTRACTOR shall submit to ENGINEER compression test data from compression test cylinders. Testing of compression test cylinders shall be performed by CONTRACTOR's Construction Quality Control (CQC) Consultant in accordance with the ACI Code and ASTM C 39. Cast-in-place concrete that does not meet these Technical Specifications shall be removed and replaced at CONTRACTOR's expense or may be subjected to a load test, also at CONTRACTOR's expense.

G. Following installation, CONTRACTOR shall submit a placement log to the CQA Consultant for all cast-in-place concrete items including the following information:
   1. date of placement;
   2. location and extent of placement;
   3. quantity of concrete;
   4. air temperature; and
   5. tests and samples taken.

## 1.03 CONSTRUCTION QUALITY ASSURANCE

A. Placement of cast-in-place concrete shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

C. The Ready Mixed Concrete Plant selected by CONTRACTOR for this Project shall be currently certified to comply with approval requirements of one or more of the following:
   1. Concrete Materials Engineering Council;
   2. National Ready Mixed Concrete Association; and
   3. Prestressed Concrete Institute.

D. CONTRACTOR's CQC Consultant shall be currently accredited by one or more of the following:
   1. Concrete Materials Engineering Council; and
   2. Other accreditation authority of equivalent standing to the above, on the basis if its compliance with the requirements of ASTM C 1077.

# PART 2 PRODUCTS

## 2.01 CONCRETE MATERIALS

A. Concrete mix shall conform with ASTM C 94, and shall be ready-mixed, normal weight, air entrained, with a minimum compressive strength 4,000 psi at 28 days. Slump and air entrainment shall be in accordance with ACI 318.

B. Cement shall conform to ASTM C 150, Type I.

C. Aggregate shall conform with ASTM C 33. Maximum size of coarse aggregate shall be the smallest of 1½ in., ¾ of the minimum clear spacing between reinforcing bars, or one half the thickness of slab.

D. Water shall be potable.

E. All deformed billet steel shall conform to ASTM A 615, Grade 60. All wire fabric shall be welded steel in conformance with ASTM A 185.

F. Anchor bolts shall be hot-dipped galvanized carbon steel conforming to ASTM A 307.

## 2.02 ADMIXTURES

A. Admixtures shall be free of all chlorides.

B. Water-reducing admixtures shall conform to ASTM C 494, Type A and shall be used in accordance with manufacturer's recommendations. Technical assistance from the manufacturer's representative shall be provided upon request.

C. Air-entraining admixtures shall conform to ASTM C 260 and shall be used in accordance with manufacturer's recommendations. Testing of air-entraining admixtures shall be performed in accordance with ASTM C 233. Technical assistance from the manufacturer's representative shall be provided upon request.

D. Other admixtures shall not be used without written acceptance by ENGINEER.

## 2.03 CONCRETE MIXING

A. Concrete mixing shall conform to ACI 211.1 and ACI 304R-85.

B. Mix proportions for all concrete, unless otherwise specified, shall be selected preferably on the basis of field experience. In the case where sufficient or suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design.

C. The concrete shall have adequate workability and proper consistency to allow it to be readily worked into the forms and around reinforcement without excessive segregation or bleeding.

D. Ready Mix Concrete shall comply with requirements of ASTM C 94 for mixing time and water addition. Total mixing time for concrete shall be determined in accordance with ASTM C 94 for type of mixing equipment used.

E. Concrete that has been in a truck for more than 1½ hours after addition of water, or had more than 300 revolutions, or concrete which has become hard or non-plastic, shall not be used and shall be rejected by ENGINEER or the CQA Consultant.

F. Concrete that has been in a truck for more than 1½ hours from batch plant to placement shall not be used and shall be rejected by ENGINEER or the CQA Consultant.

F. When concrete arrives at the Site with a slump below that specified herein, water may be added only if neither the maximum specified water/cement ratio nor the maximum specified slump is exceeded. At no time shall more than 10 gallons of water be added to any one truck load. The additional water should be incorporated into the mix by increasing the mixing time at least 1½ times the total mixing time required by ASTM C 94. However, CONTRACTOR shall bear total responsibility for the effects of adding water on the quality and strength of the concrete.

G. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

## PART 3 EXECUTION

### 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work in this Section, CONTRACTOR shall carefully inspect the installed Work for all other Sections and verify that all Work is complete to the point where the installation of this Section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed Work of other sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the Site inspection. Failure to inform ENGINEER in writing or installation of cast-in-place concrete shall be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

### 3.02 EXAMINATION AND PREPARATION

A. The CQA Consultant shall examine formwork, reinforcing steel, enbed inserts, sleeves, and joint materials prior to placement of concrete. Defective material shall be removed and replaced with new material at no cost to OWNER.

B. CONTRACTOR shall clean all formwork and structural excavations of foreign matter, debris, loose material, and water.

C. ENGINEER and the CQA Consultant shall be notified at least two working days in advance of a scheduled delivery to allow time for adequate observation of the Site.

## 3.03 PLACING CONCRETE

A. Concrete shall not be placed until the forms, reinforcement and other conditions are approved by ENGINEER or the CQA Consultant.

B. Water shall be removed from the space to be occupied by concrete, and any continuous flows of water shall be diverted to a sump or removed by pumping.

C. Concrete placement practices shall comply with ACI 304.
   1. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent segregation or loss of materials.
   2. Aluminum conveying equipment shall not be used.
   3. Conveying equipment shall be capable of providing a supply of concrete at the placement site without interruptions sufficient to permit loss of plasticity between successive increments.
   4. Concrete shall be place as nearly as practicable to its final position to avoid segregation due to re-handling or flowing.
   5. Concrete placement shall be performed at such a rate that the concrete is plastic at all times and readily flows into the spaces between the reinforcement.
   6. Concrete placement shall be performed at such a rate to assure that lifts below have not taken initial set before fresh concrete is placed.
   7. Concrete that has partially set shall not be re-tempered; it shall be discarded.
   8. No concrete that has hardened or has been contaminated by foreign materials shall be placed, nor shall re-tempered concrete or concrete that has been re-mixed after initial set be used, unless approved by ENGINEER.

D. Concrete shall be consolidated by internal mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping in accordance with ACI 309 during and immediately after placing.

E. Reinforcing shall be maintained in proper position during concrete placement.

F. In the event of rain during concrete placement, the placement shall be terminated as soon as practicable at a point approved by the CQA Consultant and freshly placed concrete shall be protected with a waterproof covering that shall prevent marring or damage of surfaces.

G. Concrete shall not be placed without consent of ENGINEER or the CQA Consultant when the temperature is 50°F or less, or when there is reason to expect a drop in temperature to below 50°F within 12 hours of the conclusion of the pour. Concrete placed at air temperature below 40°F shall have a minimum temperature of 60°F. When the air temperature is below 40°F or near 40°F and falling, the water and aggregates shall be heated before mixing. Accelerating chemicals shall not be used to prevent freezing.

H. Hot weather placement of concrete shall comply with ACI 305R.

I. Cold weather placement of concrete shall comply with ACI 306R.

## 3.04 CONCRETE CURING

A. Freshly placed concrete shall be protected from premature drying and excessive cold or hot temperatures.

B. Curing procedures shall begin immediately after placement in accordance with ACI 308 procedures to provide continuous moist curing above 50°F for at least seven days.

C. Curing of concrete shall be performed by moist curing and by moisture retaining cover curing, as herein specified. Moisture curing shall be provided by one of the following methods: covering with water, sprinkled with water, continuous water fog spray, and covering concrete surface with specified absorptive cover, thoroughly saturating cover with water, and keeping continuously wet. No salt, manure, or other chemicals shall be used for protection.

## 3.05 FINISHES

A. Concrete finishes shall be as specified and defined in ACI 301.

## 3.06 PROTECTION OF COMPLETED WORK

A. Concrete shall be protected from damaging mechanical disturbances, water flow, loading, shock, and vibration during the entire curing period.

B. Concrete surfaces shall be kept free from all foot and vehicular traffic and all other sources of abrasion for not less than 72 hours after finishing.

C. Any protective coverings shall be maintained continuously during entire curing period, and damage to coverings shall be repaired immediately at no additional expense to OWNER.

D. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

## 3.07 REPAIRS

A. Repair of rock pockets, honeycombs, and sand streaks shall be done by:
   1. cutting and removing concrete to at least 1-in. deep with sides perpendicular to surface;
   2. flushing with clean water;
   3. coating with neat cement paste;
   4. filling with cement drypack mix;
   5. curing as specified for concrete; and
   6. grinding smooth and flush with adjacent surfaces.

## 3.08 FIELD QUALITY CONTROL

A. CONTRACTOR's CQC Consultant shall perform tests and submit test reports as defined in this Section.

B. Sampling fresh concrete shall be performed in accordance to ASTM C 172, except modified for slump to comply with ASTM C 94:
   1. Slump test according to ASTM C 143 and air content test according to ASTM C 231 shall be measured as follows:
      a. one test at point of discharge for each set of compression cylinders taken;
      b. additional tests when concrete consistency appears to have changed; and
      c. one test on each truck load of concrete delivered to the site.
   2. Molded concrete compression cylinders shall be sampled in accordance with ASTM C 172, processed and cured in accordance with ASTM C 31, and prepared and tested in accordance with ASTM C 39:
      a. One set of six cylinders shall be obtained for each 50 cubic yards, or fraction thereof, for each day's placement of each mix design.
      b. Two cylinders shall be tested at seven days and two cylinders for one valid strength test at 28 days.
      c. The last two cylinders shall be cured and held for testing at 42 days if 28-day test indicated deficient results, or as a spare in case of cylinder damage.

C. Written reports, signed and sealed by a Profession Engineer licensed in the State of Delaware, shall be promptly submitted with the following additional data:
   1. time concrete batched and time sampled;
   2. water added at Site;
   3. strength class;
   4. delivery ticket number;
   5. concrete suppliers mix designation;
   6. location of concrete in the Work;
   7. results of slump and air content testing; and
   8. results of laboratory compressive strength testing.

## 3.09 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work, including all materials and completed Work of other Sections.

B. In the event of damage to prior Work or Work specified in this Section, CONTRACTOR shall immediately make all repairs and replacements necessary to the approval of OWNER or ENGINEER and at no cost to OWNER.

END OF SECTION

# SECTION 03400

# PRECAST CONCRETE STRUCTURES

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. CONTRACTOR shall furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to install precast concrete structures, frames, covers, manhole rungs, appurtenances, and related Work, as specified herein and as shown on the Drawings.

B. CONTRACTOR shall coordinate the installation of the precast concrete structures with other construction activities and subcontractors at the Site.

### 1.02 SUBMITTALS

A. At least 10 days prior to starting the Work of this Section, CONTRACTOR shall submit to ENGINEER the following:
   1. Shop Drawings showing, as a minimum, the layout and details of all precast concrete structures, including reinforcing, joints, joint fillers and gaskets, pipe connections, rungs, frames, and covers;
   2. Shop Drawings shall have seal of Professional Engineer licensed in the State of Delaware;
   3. design calculations bearing the seal of a Professional Engineer licensed in the State of Delaware;
   4. materials list; and
   5. manufacturer's product data and recommended methods of installation.

### 1.03 CONSTRUCTION QUALITY ASSURANCE

A. The installation of precast concrete structures shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the construction schedule.

C. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by OWNER or ENGINEER. Such inspections may be made at the place of manufacture, or at the Site after delivery, or at both locations. The materials shall be subject to rejection for failure to meet any of the requirements of these Technical Specifications even though samples may have been accepted as satisfactory at the place of manufacture. Material rejected after delivery to the Site shall be marked by CONTRACTOR for identification. CONTRACTOR shall immediately remove the rejected materials from the Site and shall replace them with new materials at no cost to OWNER. All materials damaged after delivery to the Site will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced with new materials, entirely at CONTRACTOR's expense.

D. The materials will be examined for compliance with ASTM standards, these Technical Specifications, and the approved manufacturer's Shop Drawings. Precast concrete sections shall be inspected for general appearance, dimensions, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

E. Imperfections in precast concrete sections may be repaired, subject to the approval of OWNER or ENGINEER, after demonstration by the Manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the production of similar items and with a history of successful production acceptable to ENGINEER.

B. Precast concrete culvert sections shall conform to AASHTO M 170, as indicated on the Drawings.

C. Precast concrete riser and base sections shall conform to AASHTO M 199, as indicated on the Drawings.

D. All other precast concrete features shall be designed for a minimum of H-20 loading plus the weight of the soil above, and shall conform to the material requirements of this Section.

E. The date of manufacture and the name and trademark of the manufacturer shall be clearly marked on the inside of each precast section.

## 2.02 MATERIALS

A. Cement shall conform to ASTM C 150, Type II. The same brand, type, and source of supply shall be used throughout.

B. The air-entraining agent shall conform with ASTM C 260.

C. Aggregates shall conform with ASTM C 33.

D. Potable water or water which is free from foreign materials in amounts harmful to the concrete shall be used.

E. All deformed billet steel shall conform to ASTM A 615, Grade 60. All wire fabric shall be welded steel in accordance with ASTM A 185.

F. Grouts used for repairs shall be mixed at a rate of one part Portland cement to two parts sand (by volume). The amount of water shall be kept to a minimum, yet the sand and cement shall be as specified for use in concrete.

G. All bonding agents shall be moisture insensitive, epoxy-resin bonding agent as manufactured by one of the following, or an equal:
   1. Epoxtite (W.R. Grace);
   2. Euco Epoxy (Euclid Chemical Company); or
   3. Sikastix 370 (Sika Chemical Company). The bonding agent shall be used as specified for repair of units and in conformance with Manufacturer's printed instructions.

H. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi after seven days and 5,000 psi after 28 days, when tested in 3-in. by 6-in. cylinders stored in the standard manner.

I. Epoxy mortar may be used, subject to the approval of ENGINEER.

## 2.03 MIXES

A. The concrete mix shall achieve a minimum 4,000 psi compressive strength at 28 days.

## 2.04 FABRICATION

A. Formwork shall be designed and constructed so as to maintain precast concrete units within their specified tolerances. Anchorage devices shall be securely attached to formwork in locations not affecting position of main reinforcement or placing of concrete.

B. Concrete shall be placed in a continuous operation to prevent formation of seams.

C. Placed concrete shall be consolidated by vibration without dislocation or damage to reinforcement and built-in items.

D. Permanent marking shall be provided in precast unit to identify pick-up points and location in structure.

E. Precast units shall be cured until 70 percent of the minimum 28 day compressive strength has developed before removing the units from the forms.

## 2.05 OTHER MATERIALS

A. All materials, not specifically described, but required for a complete and proper installation of precast concrete sections, shall be selected by CONTRACTOR subject to the approval of ENGINEER.

# PART 3 EXECUTION

## 3.01 FAMILIARIZATION

A. Prior to implementing any of the Work described in this Section, CONTRACTOR shall become thoroughly familiar with all portions of the Work falling within this Section.

B. Prior to implementing any of the Work specified in this Section, CONTRACTOR shall carefully inspect the installed Work of all other Sections and verify that all Work is complete to the point where the installation of the Work specified in this Section may properly commence without adverse impact.

C. If CONTRACTOR has any concerns regarding the installed Work of other Sections, then CONTRACTOR shall notify ENGINEER in writing within 48 hours of the inspection. Failure to inform ENGINEER in writing or installation of precast concrete structures will be construed as CONTRACTOR's acceptance of the related Work of all other Sections.

## 3.02 INSTALLATION

A. Care shall be taken in loading, transporting, and unloading to prevent damage to precast structures and components. CONTRACTOR shall examine all materials before installation. CONTRACTOR shall not install any material that is defective. ENGINEER and/or the CQA Consultant may reject defective materials. Defective materials shall be removed and replaced with new materials by CONTRACTOR at no cost to OWNER.

B. Precast concrete structures shall be constructed to the dimensions shown on the Drawings and as specified in these Technical Specifications.

C. All work shall be protected against flooding and flotation.

## 3.03 PRODUCT PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior Work and materials and completed Work of other Sections.

B. In the event of damage to prior Work or Work specified in this Section, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of ENGINEER and CQA Consultant and at no cost to OWNER.

END OF SECTION

# SECTION 03480

# PRECAST CONCRETE SPECIALTIES

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. Furnish all plant, labor, supervision, materials and equipment to furnish and install the concrete valve vaults with stairs, vent piping, wall and slab penetrations and protective bollards as shown on the drawings or herein specified. All work shall be done in accordance with ACI 318 "Building Code Requirements for Reinforced Concrete" and ACI 301, "Specification for Structural Concrete for Buildings". Unless otherwise specified, all references to standards and codes shall be the latest revision to date.

### 1.02 SUBMITTALS

A. Submit valve vault layout plan, concrete mixture design, reinforcement design and wall/slab thickness design for each precast concrete valve vault.

B. Submit shop drawings cuts for stairs, vent piping, doors, hatches, coatings, fasteners and penetrations.

## PART 2 PRODUCTS

### 2.01 PRECAST CONCRETE VALVE VAULT AND APPURTENANCES

A. Provide precast concrete valve vaults to be installed as shown on the plans. Valve vault shall contain two (2) coats of bitumastic coating on the exterior. All penetrations shall be designed to be water tight. Valve vault, and valve vault doors shall be designed to safely support the standard 300 pound loading.

B. Provide two (2) valve vault hatch doors for each vault at the locations and dimensions shown on the plans, and in accordance with the following requirements:

1. The frames and lids shall be flush with the valve vault roof slab and shall also have recessed flush hinges and retractable-to-flush hand holds for opening. Hatches shall also have safety mechanisms to prevent accidental hatch closings.

2. Hatches shall be aluminum and shall be designed to withstand 300 pound loading with the required design safety margins.

3. All aluminum in contact with concrete shall be prime painted with 1.6 mils dry film thickness of zinc chromate primer and when cured shall receive one coat of heavy bodied coal tar epoxy prior to installation.

4. Acceptable manufacturers are Bilco, or approved equal.

5. Manufacturer's shop drawings shall be submitted as required for approval prior to manufacture or shipping of products to job site. The OWNER shall retain the right to reject products not conforming to this specification and/ or approved submittal drawings.

C. Provide and install a PVC vent in each pit. PVC vent shall be install inside a cast-in pipe wall sleeve designed to provide a watertight seal between the sleeve and the PVC vent pipe. Sleeve may contain A-lok gasket or approved equal. PVC vent shall be schedule 80, installed as shown on drawings.

D. Provide and install fiberglass vault stairs as indicated on the drawing. Stairs shall be sized as required to provide level steps from top of vault to the vault bottom slab. Stairs shall be standard 7-inch risers with attached fiberglass handrail. Stairs shall be fastened to the vault in accordance with the manufacturer's requirements.

## PART 3 EXECUTION

### 3.01 VALVE VAULT INSTALLATION

A. Handle and install valve vault in accordance with manufacturer's requirements.

B. Valve vault shall be installed level on a minimum 12-inch AASHTO No. 57 stone bedding.

C. CONTRACTOR shall provide all concrete pipe supports, fasteners, seals, gaskets, miscellaneous concrete and miscellaneous appurtenances for a complete installation as shown on the drawings.

END OF SECTION

# SECTION 09900

# PAINTING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Surface preparation and field application of paints and coatings.

### 1.02 REFERENCES

A. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.

B. ASTM D2016 - Test Method for Moisture Content of Wood.

C. NACE (National Association of Corrosion ENGINEERs) - Industrial Maintenance Painting.

D. NPCA (National Paint and Coatings Association) - Guide to U.S. Government Paint Specifications.

E. PDCA (Painting and Decorating CONTRACTORs of America) - Painting - Architectural Specifications Manual.

F. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

### 1.03 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this Section.

### 1.04 SUBMITTALS

A. Product Data: Provide data on all finishing products.

B. Samples: Submit two samples, 12 x 12 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.

C. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.

## 1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing the work of this section with minimum three years experience.

## 1.06 REGULATORY REQUIREMENTS

A. Conform to 1990 B.O.C.A. code for flame and smoke rating requirements for finishes.

B. Conform to applicable State and Federal VOC and VOS regulations.

## 1.07 FIELD SAMPLES

A. Provide field sample panel, four feet long by four feet wide, illustrating special coating color, texture, and finish.

B. Locate where directed.

C. Accepted sample may remain as part of the Work.

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

## 1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

C. Minimum Application Temperatures for Latex Paints: 45 degrees F (7 degrees C) for interiors; 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperature for Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

## 1.10 EXTRA MATERIALS

A. Furnish under provisions of Division 1.

B. Provide two (2) gallons of each color, type, and surface texture to OWNER.

C. Label each container with color, type, texture, room locations, in addition to the manufacturer's label.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Manufacturers

1. MAB Paints and Coatings.
2. Finnaren & Haley.
3. Dupont.

B. Substitutions: Under provisions of Division 1.

## 2.02 MATERIALS

A. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

C. Patching Materials: Latex filler.

D. Fastener Head Cover Materials: Latex filler.

## 2.03 FINISHES

A. Refer to schedule at end of section for surface finish schedule.

B. Colors shall be as selected by the OWNER.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify site conditions.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. Test shop applied primer for compatibility with subsequent cover materials.

E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:

1. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
2. Concrete Floors: 8 percent.

3.02 PREPARATION

A. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

B. Correct defects and clean surfaces which affect work of this section.

C. Seal with shellac and seal marks which may bleed through surface finishes.

D. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

E. Concrete Floors: Remove contamination, acid etch, and shot blast floors. Verify required acid-alkali balance is achieved.

F. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

G. Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

H. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

I. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime metal items including shop primed items.

J. Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

K. All metals for immersion service must be sand blasted to SSPC 10 – white metal.

## 3.03 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry.

C. Apply each coat to uniform finish.

D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

E. Sand wood and metal lightly between coats to achieve required finish.

F. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

G. Allow applied coat to dry before next coat is applied.

## 3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to 3.6 and 3.7 for schedule of exterior and interior surfaces to be painted.

B. Paint shop primed equipment. Touch-up shop painted equipment whose finishes are damaged during shipment or installation.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports except where items are prefinished.

E. Paint exposed conduit and electrical equipment occurring in finished areas.

F. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

G. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated.

H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

## 3.05 CLEANING

A. Clean work under provisions of Division 1.

B. Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.

## 3.06 SCHEDULE - EXTERIOR SURFACES

A. Steel - Shop primed:

1. MAB:

   a. Spot prime bare metal areas with one coat Rust-O-Lastic Anti-Corrosive Primer.
   b. Two coats Rust-O-Lastic Finish.

2. Finnaren & Haley:

   a. Spot prime bare metal areas with one coat No. 878 Corrosion Fighter Primer.

   b. Two coats Machine & Deck Enamel.

B. Steel - Galvanized:

1. MAB:

a. One coat Rust-O-Lastic Hydro Prime II.
b. Two coats Rust-O-Lastic Finish.

2. Finnaren & Haley:

a. One coat Acrylic Polyurethane Primer.
b. Two coats Machine & Deck Enamel.

C. Concrete Masonry Units:

1. Finnaren & Haley:

a. One coat R.M. Block Filler.
b. Two coats Weather Barrier #2010 Elastomeric.

## 3.07 SCHEDULE - INTERIOR SURFACES

A. Concrete Masonry Units & Concrete Planks:

1. MAB:

a. One coat Block Kote 2000, Block Filler.
b. Two coats Ply-Tile 530, Semi-Gloss Water Reducible Epoxy.

2. Dupont:

a. One coat R.M. Block Filler.
b. Two coats, #191 Water-base Epoxy.

B. Steel - Shop primed:

1. MAB:

a. Spot prime bare metal areas with one coat Rust-O-Lastic Anti-Corrosive Primer.
b. Two coats Rust-O-Lastic Finish.

2. Finnaren & Haley:

   a. Spot prime bare metal areas with one coat No. 878 Corrosion Fighter Primer.

   b. Two coats. Machine & Deck Enamel.

C. Steel - Galvanized:

1. MAB:

   a. One coat Rust-O-Lastic Hydro Prime.
   b. Two coats Rust-O-Lastic Finish.

2. Finnaren & Haley:

   a. One coat Acrylic Polyurethane Primer.
   b. Two coats Machine & Deck Enamel.

## 3.08 SCHEDULE - PIPING

A. Non-Immersed Piping - Indoors

1. Prime Coat: MAB, Ply-Mastic Epoxy Coating compatible with finished coats.
2. Two Finish Coats: MAB, Ply-Thane 890 HS Coating.

B. Non-Immersed Piping - Outdoors

1. Prime Coat: Dupont, 25P Epoxy Mastic at 1.5 - 2.0 mils D.F.T.
2. Intermediate Coat: Dupont, 25P Epoxy Mastic at 2.0 - 2.5 mils D.F.T. Color shall be compatible with finish coat color selection.
3. Finish Coat: Dupont, Imron #333 Polyurethane at 1.5 - 2.0 mils D.F.T.

C. Immersed Piping - Indoors

1. Prime Coat: Dupont, 25P High Solids Epoxy Mastic at 6.0 mils D.F.T.
2. First and Second Coats: Dupont, 25P Epoxy Mastic at 8.0 mils D.F.T. per coat.

D. Stainless Steel, PVC, HDPE, Polyethylene piping and copper tubing shall not be painted.

E. Paint colors shall be selected by the OWNER.

## 3.09 INSPECTION

A. All cleaning and painting shall be subject to inspection by a representative of the OWNER and the paint manufacturer.

B. The OWNER reserves the right to inspect all cleaned surfaces prior to primer application and also each coat of paint prior to subsequent paint applications. It is understood that such inspection will be made available by the OWNER within one (1) hour after proper notification by the CONTRACTOR.

C. The dry film thickness (D.F.T.) and uniformity of the paint coatings shall be measured using an Elcometer or Mikrotest gauge which shall be supplied by the CONTRACTOR and available for use at the site. The OWNER reserves the right to use a low voltage holiday detector to check the finished paint film integrity.

D. The CONTRACTOR shall correct such work as is found defective under the specifications and supply such materials and equipment required to make the repairs at his own expense.

E. The CONTRACTOR shall provide the services of the paint manufacturer's inspector to instruct the CONTRACTOR on paint application in the field before any work is started. This inspector shall make routine visits to the job site and shall be available upon request by the OWNER for consultation.

## 3.10 TESTING

A. At no cost to the OWNER, a trained representative of the paint manufacturer shall inspect the completed project to verify that the film thickness requirements of the specification have been met. It shall be the responsibility of the CONTRACTOR to arrange for the inspection and to provide all equipment.

B. When the project is complete, the Contracting Officer will select random sample test locations. The CONTRACTOR shall have the paint manufacturer test each location for porosity and film thickness. The finish coating on all surfaces shall be completely without porosity when tested according to the low-voltage, wet-sponge method. All porosity and mil thickness tests shall be reported to the Contracting Officer in writing. Deficiencies in the coating shall be corrected by applying additional finish coats, at

the expense of the CONTRACTOR. Upon completion of the inspection, the manufacturer shall provide a letter of certification to the Contracting Officer that the coating systems comply with the thickness requirements of the specifications.

## 3.11 GENERAL PAINT SCHEDULE

A. Factory-Painted Equipment: Except as otherwise noted in the Painting Schedule or specified, the following items of equipment shall receive final finish coats at the factory and shall be protected against damage during transit, storage, and erection. Damaged areas must be refinished as the original. Factory-painted items shall be of a color specified, selected, or accepted by the ENGINEER.

- Valves.
- Electric distribution panels.
- Gauges and meters.
- Instrument and control panels.
- Instruments.
- Pump Equipment.
- Flow Meters.
- Transmitters.

All other factory-finished equipment shall be field painted as specified hereinafter and as shown in the Painting Schedule.

B. Field-Painted Equipment: The following items shall be painted, unless specifically noted otherwise in Plans and Specifications.

- Existing and new pump equipment .
- All new piping (except for surfaces indicated in paragraph 3.8 D.)
- New Supports and hangers.

C. Items Not Painted: The following items shall not be painted, unless specifically called for:

- Aluminum grating.
- Aluminum, brass, bronze, copper, plastic, rubber, PVC, stainless steel, chrome, everdur, or lead surfaces and/or tubing.
- Buried or encased piping or conduit.
- Concrete floors and slabs.
- Grease fittings.

- Nameplates.
- Plastic or fiberglass piping.
- Warning or operating instruction labels.

END OF SECTION

# SECTION 11300

# PRECAST CONCRETE PUMPING STATION STRUCTURES

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. CONTRACTOR shall furnish all materials, implements, machinery, equipment, tools, supplies, transportation, labor and supervision required to construct the facility as shown on the contract drawings and specified herein. It shall be the responsibility of the CONTRACTOR to proceed with the work in the manner and within such limitations as may be prescribed by the ENGINEER.

B. Furnish, deliver, install, and place into successful operation one each precast concrete pumping station wetwell structure and one each precast concrete valve chamber, and one each precast concrete meter pit for six (6) new Cherry Island Leachate Pumping Stations, and all appurtenances required for a complete and operational installation in accordance with the drawings and specifications.

### 1.02 GENERAL REQUIREMENTS

A. All manufacturers shall have at least ten (10) years experience in the manufacture of precast concrete pumping stations and shall have at least ten (10) in successful operation for at least five (5) years.

### 1.03 SUBMITTALS

A. Submittals shall include:

1. Complete dimension drawings of the factory assembled pumping station including location of inlet, outlet, electrical, and other connections.
2. Manufacturers literature and technical data for all appurtenant equipment.
3. Detailed installation instructions for hoisting, setting in place, making connections, making field joints, etc.
4. Operation and maintenance instructions for the pumping station equipment and appurtenances.

5. Detailed calculations as prepared by a registered professional ENGINEER verifying that the unit proposed has been designed to prevent flotation and to withstand the burial depth indicated.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

A. The drawings and specifications are based on a pumping station as fabricated by ROTONDO/CARLGEN. Consideration shall be given to alternate suppliers who meet the specified requirements of these specifications on an "or equal" basis determined solely by the ENGINEER.

B. Any costs, including ENGINEERing costs, resulting from changes to the structure, piping, electrical works, etc, arising from the use of alternate equipment shall be borne by the CONTRACTOR.

C. The equipment and material is specified by trade name and/or name of one or more manufacturers. These items are so specified for reasons of operation and maintenance and for reasons of obtaining desirable features necessary for optimum performance of this equipment.

D. Equipment which is a "standard product" with the manufacturer shall be modified, redesigned from the standard mode, if necessary, or shall be furnished with special features or accessories or of special materials or with special finishes as may be necessary to conform to the requirements of the specification and contract drawings.

### 2.02 PRECAST CONCRETE STRUCTURES

A. General:

1. Provide precast concrete wetwell, valve chamber, and meter pit as shown on the drawings, as specified herein, and complying with ASTM C478 and DelDOT Standard Specifications.

2. Waterproofing

a. Apply coal tar epoxy to exterior walls.

b. Wetwell, valve chamber, and meter pit shall have a concrete protective

liner integrally anchored to concrete sections. Liner shall protect base, risers and top. See Section 02723 for liner specifications.

B. The Pump Station wetwell, valve chamber, and meter pit shall be of inside dimensions and elevations as shown on the Plans, and of modular construction.

C. The modules shall have a maximum shipping weight limit of twenty (20) tons including any installed equipment or pumps.

D. The exterior wall shall be designed for a full exterior hydrostatic load.

E. Top slab shall be designed for H-20 loading plus impact and shall have a broom finish.

F. Cutouts shall be made or wall sleeves cast in the proper locations for all pipe and conduit penetrations, and openings for hatches.

G. The modules shall be reinforced concrete with a minimum 28-day compressive strength of 5,000 psi. Reinforcing steel shall meet the requirements of ASTM designation A-615 and shall be certified Grade 60. To insure proper quality, the modules shall be poured and vibrated using steel forms. The manufacturer shall have the necessary equipment to perform compressive strength tests of concrete cylinders as required by the ENGINEER. The modules shall have monolithically poured walls and floor and shall be the same size and general configuration as shown in the plans.

H. If more than one module is furnished, they shall be marked for proper alignment in the field prior to shipment. The joints between the modules shall be sealed for maximum water-tightness with a field formed hydro-ester system as hereinafter specified.

I. All joints shall be sealed in the field with a vulcanized butyl rubber compound sealant conforming to AASHTO M-198 (latest revision).

J. The below grade exterior of all precast concrete modules shall be coated with an epoxy Hydro-Ester coating which is 100% moisture insensitive, containing no solvents.

| | |
|---|---|
| Viscosity | 1800 $\pm$ 700 |
| Compressive Strength | 4000 psi (2 days) |

| | |
|---|---|
| (ASTM C-109 Modified) | 5000 psi (7 days) |
| Tensile Strength | 2000 psi (2 days) |
| (ASTM D-695) | 4500 psi (28 days) |
| Elongation | 5% - 15% (2 days) |

This material shall be applied to the outside of the ejector system in two coats, each not less than 10 mils. thick.

K. Wall Penetrations

1. All wall and top slab penetrations for pipes and conduits shall be sealed watertight with wall penetration seals as manufactured by "Link-Seal", or approved equal.

2. Sealant shall be of a type to ensure connections are air and water tight. Pipes passing through these sleeves shall be sealed with expandable, modular, mechanical interlocking, synthetic rubber segments with pressure plates shaped to continuously fill the annular space between the pipe and sleeve. Grouting will not be considered an equivalent or approved method. All wall sleeves shall be integrally cast in the concrete modules as required and as shown on the plans.

L. Structure Access Doors

1. Access door for wet well, valve chamber, and meter pit shall be as described below:

   a. Access door and frame shall be aluminum with mill finish rated for H-20 live loading. Cover shall be of diamond plate design and hardware shall be stainless steel. Portions of door to be in contact with concrete shall be bituminous coated.

   b. Access door shall have recessed - flush hinges and a flush slam lock mechanism.

   c. Access door shall be equipped with a lifting handle located in the corner of the door, an automatic hold open arm with a red colored release handle, and compression spring operators for ease of operation and a check in retarding downward motion.

2. Access door shall be neoprene gasketed, waterproof and gas tight.

3. Access door for wet well shall be equipped with a safety net.

4. Access door shall be cast into the precast top slabs in the shop before delivery to site.

M. Valve Chamber and Meter Pit Ladder with Safety Extension

1. The ladders, manufactured by Halliday Products Inc. of Orlando, Florida, shall be constructed entirely of aluminum. The rails shall be ½-inch x 2¾-inch aluminum extrusion and shall be spaced 16 inches apart. The wall mounted standoffs shall be 3/8-inch x 2½-inch flat bar and welded to the rails at a maximum of 60 inches on center. The standoffs shall be a minimum of 7 inches and manufactured to fit flush with the wall. Slip resistant 1 3/8-inch diameter ribbed rungs shall be spaced at 12 inches on center and welded to the outside of each rail.

2. The safety extension, manufactured by Halliday Products, Inc. of Orlando, Florida, shall be constructed entirely of aluminum and stainless steel. The aluminum housing shall mount to the ladder by means of stainless steel channel clamps secured to the ladder rungs with stainless steel "U" bolts. The aluminum telescoping post shall extend 37 inches above the top of the housing and lock into position with a stainless steel pin.

N. Exterior Wet Well Vent

1. One steel exterior vent shall be provided for intake and exhaust. This vent shall be constructed as shown on the drawings.

O. Portable Hoist

1. The CONTRACTOR shall furnish six (6) portable hoists for common use at the Pump Stations. All hoists shall be manufactured by Halliday Products, Inc., capable of lifting a maximum load of 1000 pounds. Anchor sockets shall be generally as located on the drawings with detailed location and installation instructions provided by the pump supplier.

2. All hoists shall feature a Dutton-Lainson Co. marine grade zinc plated gear/brake winch, with minimum 40 feet of ¼-inch stainless steel cable and safety hook.

3. Hoists shall have an adjustable reach of 24 to 36 inches. Embedded type stainless steel sockets shall be provided with a safe load capacity of 1,000 pounds. Sockets shall be cast into the concrete slab. Caps shall be provided to keep the sockets debris free.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Installation of the access covers and portable hoist sockets shall be in accordance with the pump manufacturer's written instructions. Frame shall be securely placed, mounted above the pumps. Verify the required masonry openings and mounting requirements before pouring the roof slab.

B. Handling:

1. All precast components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the precast sections or liner.

2. All damage to precast sections shall be thoroughly repaired in the presence of the ENGINEER. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Sufficient time shall be allowed for curing before the precast sections are put together.

### 3.02 ELECTRICAL

A. The CONTRACTOR shall provide all electrical conduit, control wiring and power supply wiring required for a complete and operable pumping system.

B. All conduits exiting the wet well, valve chamber, and meter pit shall be installed with conduit seals.

C. All electrical work shall be in accordance with the requirements of Division 16.

### 3.03 FIELD TESTS

A. The station shall be completely assembled which shall be flooded with water and the station subjected to a complete operational performance test. The ENGINEER and/or the Representative of the OWNER shall witness the performance test and inspect the

station at the manufacturer's facilities. The manufacturer shall designate the date for the test. If the ENGINEER and/or the Representative of the OWNER cannot be present, the manufacturer shall perform the test and inspection and submit the test/inspection results.

B. Field Installation - The manufacturer shall have a factory representative present during field installation. The CONTRACTOR shall obtain the recommended installation procedures from the manufacturer and shall comply with same, it shall be the CONTRACTOR's responsibility to provide temporary power. The CONTRACTOR shall exercise care so that debris or water shall not be allowed to enter the station.

## 3.04 WARRANTY

A. The station manufacturer, through the CONTRACTOR, shall warrant the concrete modules for a period of 25 years from date of shipment, and warrant all other equipment for one year from date of station start-up. The station manufacturer shall furnish replacement parts for parts proved defective during the warranty period.

Manufacturer - It is the intent of these specifications to obtain a factory-built station as manufactured by Rotondo/Carlgen, ENGINEERed Process Systems Inc. of Avon Connecticut or its approved equal.

B. Warranties shall not begin until acceptance of the equipment by the Contracting Officer.

END OF SECTION

# SECTION 11610

# SUBMERSIBLE PUMPS, MOTORS, AND ACCESSORIES

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. These specifications and accompanying drawings are intended to cover the furnishing of all supervision, labor, material, tools, and equipment necessary or required for the complete installation of two (2) new submersible nonclog leachate pumping units at the existing North Central Pump Station to replace the existing pumps. CONTRACTOR shall provide a first class complete and operable installation.

B. The CONTRACTOR shall be responsible for checking field dimensions, and shall inspect the existing field conditions especially as they relate to the installation of the new pumps, motors, and piping connections to the existing suction and discharge piping.

C. Pumps and pump associated equipment shall be furnished as part of a complete package including pumps, base plates and fittings, rails, sealing flanges, lifting cables, control panel, alarms, pump cable, connections, hardware and all items incidental thereto.

### 1.02 CODES AND STANDARDS

A. Pumps shall be designed, fabricated, and tested to the standards of the Hydraulic Institute.

B. All electric motors shall meet or exceed the latest design, construction and performance standards of the ANSI, NEMA and IEEE.

### 1.03 APPLICATION OF EQUIPMENT

A. Pumping units shall be a standard, current, production model of the manufacturer as published in their most recent catalog. Each model of equipment shall have been in general production for at least five (5) years prior to the date of bid opening.

B. The CONTRACTOR shall satisfy the OWNER that the equipment he proposes to furnish will:

1. Meet or exceed the Specifications.
2. Fit in the installations without modification to the equipment and with the use of standard fittings.
3. Retain the basic design layout of the pumping station, so that equipment will be readily accessible and serviceable.

C. The drawings and specifications for the pumps utilized refer to the products of Flygt Pumps.

D. The CONTRACTOR shall be responsible for all ENGINEERing required when equipment other than that shown on the Contract Drawings is supplied, and results in changes in dimensions or configuration. Said equipment, layout and/or configuration shall be approved by the ENGINEER.

## 1.04 SUBMITTALS

A. Submit the following for each pump model/type:

1. Certified pump characteristic curve with design points indicated.
2. Certified outline dimension drawings for complete pumping unit, accessories and pump control panel.
3. Pump control panel data and wiring diagram.
4. Manufacturer's literature and technical manuals for pumping units and motors.
5. Installation instructions and guide.
6. Operation and maintenance manual.
7. Parts list for pumping units and motors.
8. Motor test data as indicated in Section 2.04.
9. Warranty.
10. Pump Supplier's written certification

B. Submit certification that each pump has been dynamically balanced.

C. Submit detailed installation drawings showing location of pumps, pump mounting and foundation details, piping layout with dimensions, valves, and connections to discharge piping.

D. Shop drawings for pumping units will not be approved until dimension drawings have been approved.

## 1.05 CERTIFIED PUMP TESTS

A. Certified pump tests shall be conducted by the pump manufacturer at the factory for the pump assembly. Test curves shall be submitted to the ENGINEER for approval prior to shipment of pumps.

B. Pump shall meet or exceed the specified performance standards.

C. Tests shall consist of checking the pump assemblies at the specified speed, head condition, and capacity for vibration, efficiency, and horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Pump tests shall be a minimum of two (2) hours duration (continuous) with suction levels and discharge heads identical to actual field conditions. Performance data shall be determined at the end of the test. The Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

D. Should the pump assembly fail to meet the performance requirements, either at the factory or in the field, or not perform as certified, the ENGINEER may require the replacement of the pump assembly or the substitution of another pump model or manufacturer.

# PART 2 PRODUCTS

## 2.01 LEACHATE PUMPS

A. General

1. The CONTRACTOR shall remove the two (2) existing submersible pumps with motors, and associated equipment, and install two (2) new submersible pumps.

B. Pump Type

1. New leachate pumps shall be vertically mounted centrifugal, single-suction, non-clog, explosion-proof, submersible pumps with close-coupled submersible electric motors.
2. Pumps shall be specifically designed to operate in a completely and/or partially submerged condition for continuous operation and shall be provided with the appropriate water jacketed motor accordingly.
3. Pumps shall be as manufactured by Flygt or approved equal.

C. Pump Characteristics

1. The new pumps shall conform to the capacities, pumping heads, minimum heads, minimum efficiencies as stated below.
2. The pumps shall be designed to handle landfill leachate. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump(s) shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. There shall be no need for personnel to enter the wet well to remove or reinstall the pumps.

   Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. Sliding guide brackets shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by two (2) guide bars and shall press tightly against the discharge connection elbow. Sealing of the discharge interface will be accomplished by hydraulic sealing. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of waterweight integrity to a depth of 65 ft.

3. Pump shall have characteristics as indicated below:

   a. Capacity: 555 gpm.
   b. Total Dynamic Head: 37-ft.
   c. Shut-off Head at Max. Speed: 57-ft.
   d. Suction Size: 4-inch
   e. Discharge Size: 4-inch
   f. Motor Nameplate Horsepower: 11 hp (maximum)
   g. Maximum Speed: 1710 (nominal)
   h. Electrical Characteristics of Motors:

      (1) Voltage 200 (volts ac)
      (2) Phase: 3
      (3) Hertz: 60
      (4) NEC Locked – Rotor Code Letter F (max)
      (5) Service Factor 1.15 (minimum)

D. Pump Construction

1. Major pump components shall be of AISI Type 329 stainless steel construction, with smooth surfaces devoid of blow holes or other irregularities. Materials used in the construction of the pump are summarized as follows:

| | |
|---|---|
| Volute | AISI Type 329 S.S. |
| Impeller | AISI Type 329 S.S. |
| Shaft | AISI Type 329 S.S. |
| Gaskets | Viton Rubber O-Rings |

2. All exposed nuts and bolts shall be of AISI Type 316 stainless steel.
3. All mating surfaces where watertight sealing is required shall be machined and fitted with Viton rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of Viton-rubber O-rings without the requirement of a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be utilized.

E. Pump Casing

1. Casing: Casing shall be stainless steel, Type 329, in accordance with AISI of sufficient strength, weight and metal thickness to ensure long life, accurate alignment, and reliable operation. The pump volute shall be single-piece AISI 329 stainless steel non-concentric design with smooth passages large enough to pass any solids that may enter the impeller.
2. Casing Connection: Discharge connection shall be 125 pound standard in accordance with ANSI B16.1. All flange bolt holes shall be slotted for ease of assembly and disassembly.
3. Discharge Connection: Pump discharge connection elbow shall be stainless steel designed for permanent mounting to the wetwell floor, to support the total weight of the pumping unit, and to permit automatic connection of the pump to the discharge elbow when the pump is lowered into place.

F. Impeller

1. The impeller(s) shall be of AISI Type 329 stainless steel, dynamically balanced, double shrouded non-clog design having a long throughlet without acute turns. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in landfill leachate. Mass moment of inertia calculations

shall be provided by the pump manufacturer. Impeller shall be retained with an Allen head bolt and shall be capable of passing a minimum two (2) in. (minimum) diameter solid.

G. Mechanical Seals

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, silicon-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system.
2. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft.
3. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.
4. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.
5. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
6. Seal lubricant shall be FDA Approved, nontoxic.

H. Pump Shaft

1. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be AISI Type 329 Stainless Steel (S.S.) and shall be completely isolated from the pumped liquid.

I. Bearings

1. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

J. Wear Rings

1. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. The wear ring shall be stationary and made of Type 316 stainless steel, which is drive fitted to the volute inlet.

K. Cooling System

1. Each unit shall be provided with an adequately designed cooling system. The water jacket shall encircle the stator housing; thus, providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling and seal flushing shall also be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 104 degrees F. Restrictions below this temperature are not acceptable.

L. Explosion-Proof Design

1. The pump system including the pump, motor and power cable shall be approved for use in areas classified as hazardous locations in accordance with the NEC Class I, Div. 1, Group C and D service as determined and approved by a U.S. nationally recognized testing agency (U.L., FM) at the time of the bidding of the project. As required by Factory Mutual (FM) the motor shall be capable of operating in pumped media up to 104 degrees F. The motor thermal switch shall allow safe motor operation up to 260°F (125°C). Service of explosion-proof submersible units shall be performed by qualified FM experienced personnel.

M. Miscellaneous

1. Data Plates: All data plates shall be of stainless steel or brass, suitably attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating and other pertinent data. A special data plate shall be attached to the pump frame which shall contain identification of frame and bearing numbers.
2. Hardware: All machine bolts, nuts and capscrews shall be stainless steel and of the hex head type. Hardware or parts requiring special tools or wrenches shall not be used.
3. Lifting Cable: Provide approximately 40 feet of stainless steel lifting cable for each pumping unit. The lifting cable, ring and their connections must be of sufficient strength to permit raising and lowering the pump with a 1.5 safety factor.

## 2.02 SUBMERSIBLE ELECTRIC MOTORS FOR LEACHATE PUMPS

A. Motor Type: Motors shall be of the submersible, squirrel cage, induction, shell type design housed in an air-filled, watertight chamber, NEMA B type. Motor shall be of explosion-proof design, in accordance with Paragraph 2.01 (L.1) of this Section. Motors shall be sufficiently cooled by the surrounding environment or pumped media, whether in a submerged condition or operating on a continuous non-submerged basis.

B. Pump Motor:

1. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.
2. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.
3. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour.
4. The rotor bars and short circuit rings shall be made of cast aluminum.
5. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

6. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer compression seal.
7. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board.
8. The motor and the pump shall be produced by the same manufacturer.
9. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
10. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.
11. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

C. Cable Entry Seal

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.
2. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
3. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

D. Protection

1. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125°C (260°F), stop the motor and activate an alarm.

2. A leakage sensor shall be available to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.
3. The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS shall be designed to be mounted in the control panel.

E. Balance and Vibrations: Balance and vibration shall meet NEMA Standards MG1-12.05 and MG1-12.06.

F. Nameplate Data:

1. Nameplate data shall be provided on stainless steel nameplates, permanently attached to the motor frame by means of stainless steel pins.
2. Nameplates shall provide all information as required by the IEC. In addition, the nameplates shall provide the bearing numbers for both bearings.

G. Tests:

1. IEEE Test Procedure No. 117 (or successor), with data from at least three temperature tests, extrapolated linearly to indicate not less than 10,000 hours at rated hot spot insulation temperature. Test shall be run on a similarly rated motor.
2. Insulating varnish shall have a heat aging of not less than 10,000 hours of maximum rate operating temperature, using test methods applicable to the particular insulation class.

## 2.03 ELECTRICAL CONTROLS AND CONTROL PANELS

A. General Requirements - Duplex Control Panel.

1. Provide one (1) Duplex control panel for the pumps for the pump station.
2. The control panel shall contain the features described in the Detailed Requirements as well as those described in the General Requirements.
3. Each control panel shall include system short circuit, motor overload, motor over-temperature protection, and motor liquid leakage protection.
4. Control features shall be intrinsically safe with intrinsically safe relays and intrinsically safe barriers as required in the pump control panel/enclosure.

5. Control panel enclosures shall be gasketed, weatherproof, dust-tight, and corrosion resistant. Enclosures shall be NEMA Type 4X, stainless steel. Enclosures shall be of door-in-door dead front construction with all controls and indicators mounted in the inner door. Enclosures shall be lockable.
6. Pumps shall have level controls as described in Detailed Requirements.
7. Control panel shall be furnished by the same manufacturer as the pumps.

B. Detailed Requirements - Duplex Control Panel.

1. Provide automatic alternating pump controller programmed by five (5) liquid level sensors (float switches).
2. The liquid level sensors (float switches) shall perform the functions indicated on the drawings or as directed in the field. The "normal" operation lead-lag modes shall automatically switch to the next sequence each time a pump cycle is completed. The positions of the liquid level sensors (float switches) shall initially be set at the elevations as shown on the drawings.
3. "Normal" Level Control and Alarm Operation: The system shall provide all proper level controls and equipment and shall have wiring connections to the level control equipment for the pumping station so that it operates in the following manner.

    a. When the water level rises to the first "Pump On" level, the lead pump will start.
    b. When the water level is lowered to the "Pump Off" level, the lead pump will stop.
    c. The alternator will then make the above pump the lag pump and the "lag" pump will then become the "lead" pump.
    d. When the water level again rises to the first "Pump On" level, the lead pump will start.
    e. The lead pump will then run until the water level is lowered to the "Pump Off" level.
    f. If the water level continues to rise and reaches the "Lag Pump On" level, the lag pump will start.
    g. Both pumps will continue running until the water level is lowered to the "Pump Off" level.
    h. If the water level rises to the "High Water Alarm" level, an alarm will be activated. This alarm shall also send a signal to the automatic telephone dialer unit.

i. If the water level is lowered to the "Low Level Alarm" level, an alarm will be activated. This sensor (float) shall also serve as a redundant "Pump Off" safety feature.

4. The following functional features shall be provided for each pump/motor.

   a. A combination circuit breaker/overload unit providing overload protection, short-circuit protection, reset, and disconnect. The circuit breaker/disconnect shall be furnished with provisions for locking in the off position.
   b. Across-the-line NEMA rated magnetic starters suitable for fifteen (15) motor starts per hour.
   c. Overload device to be precalibrated to match motor characteristics and factory sealed.
   d. Hand-Off-Automatic pump operation selector switch.
   e. 120 volt control panel pilot circuitry.
   f. Control circuit with disconnect circuit breaker and overload protection. Connections for external pilot circuitry shall be included along with an automatic electric alternator. Alternator shall provide alternating operation of pumps under normal conditions and operation of lead and lag pump as is applicable in the event of high water level conditions. Provide adjustable starting time-delay circuitry (0-120 seconds, minimum).
   g. Ammeter.
   h. Elapsed time meter.
   i. Circuitry for high water level alarm, low water level alarm, motor over-temperature alarm and pump shutdown, and motor liquid leakage alarm and pump shutdown.

      (1) A front of panel mounted pilot light shall be activated upon obtaining a high water level condition in the wet well. In the absence of an alarm the light shall glow half bright. In the presence of an alarm, the lights shall glow full bright and flash rapidly. When the condition is cleared, the system shall go back to the absence of an alarm mode.
      (2) A front of panel mounted pilot light indication of the motor over-temperature alarm.
      (3) A front of panel mounted pilot light indication of liquid leakage alarm.
      (4) A front of panel mounted pilot light indication of a low water level condition.
      (5) A front of panel mounted pilot light indication of pump interlock inhibit alarm.

(6) Provide contacts so that activation of any of the above alarm conditions can transmit a signal to a remote alarm device.
(7) Provide a red flashing alarm light mounted on the top exterior of the control panel/enclosure. This light shall be activated in response to any of the above alarm conditions. The alarm light shall be Edwards (General Signal) Catalog No. 52R-N5 or an acceptable equivalent.

j. Provide for each pump a "Reverse Rotation Protection Relay" in the control panel that will detect voltage induced in the stator windings due to the rotation of the rotor. The relay will not allow the pump to restart until the induced voltage drops below a preset level which corresponds to the rotor being a rest.
k. Terminal boards for power supply, pumps, and level sensors.
l. Pump running lights.
m. Condensation Heater: A properly sized heater shall be supplied in the panel. The heater shall consist of a thermostat, resistance type heating grid and fan to circulate air through the enclosure. The entire unit shall be enclosed with all heater components within the enclosure.
n. Lightning Arrestor: A lightning arrestor shall be installed in the panel and connected to each line of the incoming side of the power input terminals. The arrestor shall protect the motors and controls against damage due to lightning strikes on the incoming power line.

5. Provide control circuitry with connections for external wiring interlock(s) which shall allow operation of the pumps under normal conditions in the downstream pumping station(s) and inhibit operation of the pumps in the event of high water level conditions in the downstream pumping station(s). This interlock circuitry shall be furnished with a panel mounted pilot light indicating when the pumps are inhibited and a manual over-ride switch.

6. Panel Description.

a. The control panel shall be a NEMA Type 4X, stainless steel (14 gauge minimum) enclosure with assembly for security locking. The enclosure shall be hinged and front opening of the door-in-door style. The operating controls, indicator lights, indicating meters, etc. shall be mounted on the hinged inner door of the enclosure.
b. All major components and sub-assemblies shall be identified as to function with laminated, engraved, bakelite nameplates.
c. Control panel/enclosure shall be suitable for surface (wall) mounting.

7. Liquid Level Sensors (Float Switches).

   a. Liquid level floats shall have mechanical switching and shall be of the non-floating displacement type as manufactured by Flygt Model No. ENM-10, or shall be of the weighted type as manufactured by Hydromatic Model No. 3900, or an acceptable equivalent.
   b. Provide a sufficient length of cable, cable hanger, etc. for the float switches.
   c. Float switches shall be rated for intrinsically safe operation.

## 2.04 FACTORY TESTS

A. Prior to shipment from the manufacturer, the manufacturer shall provide the following tests in addition to certified pump tests.

   1. Impeller, motor rating and electrical connections shall first be checked for conformance to specifications.
   2. A motor and cable insulation test for moisture content or insulation defects.
   3. Run pump dry to establish correct rotation and mechanical integrity.
   4. The pump shall be run for two (2) hours submerged, a minimum of six (6) ft. underwater.
   5. After operational test specified in Paragraph 4, the insulation test in Paragraph 2 shall be repeated.

B. Provide written report stating the foregoing steps have been completed for each pump at the time of shipment.

## 2.05 FINISH

A. Pumps, motors, and all appurtenances shall receive both prime and finish coats of epoxy paint at the factory.

## 2.06 PUMP WARRANTY

A. The Pump Supplier shall warrant for a minimum of two (2) years from the date of acceptance by the OWNER, that the equipment will be free from defects in design, material and workmanship.

B. Warranties and guarantees by the suppliers of various components in lieu of a single source responsibility by the Pump Supplier shall not be accepted. The Pump Supplier

shall be solely responsible for the warranty of the equipment and all related components.

C. In the event a component fails to perform as specified or is proven defective in service during the warranty period, excluding items of supply normally expended during operation, the Pump Supplier shall provide a replacement part without cost to the OWNER.

D. Warranties shall not begin until acceptance of the equipment by OWNER.

## 2.07 MANUFACTURER'S WRITTEN CERTIFICATION

A. The manufacturer will submit four (4) copies of written certification verifying that each complete pumping system (pumping units, bases, sealing flanges, lifting cables, rails, level controls, alarms, floats, pump controls, pump cables and appurtenant parts) provided for this contract has been successfully factory tested to full design load capacity, has been installed and is operating in accordance with these contract documents and the manufacturer's specifications, and has been successfully field tested by the manufacturer or his appointed representative.

# PART 3 EXECUTION

## 3.01 GENERAL

A. Installation and start-up of the new pumping units and associated equipment shall be in accordance with the pump manufacturer's printed instructions.

## 3.02 SUBMERSIBLE LEACHATE PUMPS

A. Pump Mounting: Pump guides and discharge elbow shall be properly aligned, plumb and level. Mounting plates shall be pressure grouted with a non-shrink grout. Pumping units shall be leveled, set and aligned according to the pump manufacturer's instructions prior to grouting.

## 3.03 START UP

A. Provide the pump manufacturer's competent and experienced ENGINEER to supervise the initial operation, final adjustments and testing of the new pumping units.

B. Field Testing: Testing of new pumping units shall be under full load conditions.

END OF SECTION

# SECTION 11620

# INCLINED SUBMERSIBLE PUMPS, MOTORS, AND ACCESSORIES

## PART 1 GENERAL

### 1.01 DESCRIPTION OF WORK

A. These specifications and accompanying drawings are intended to cover the furnishing of all supervision, labor, material, tools, and equipment necessary or required for the complete installation of a total of twelve (12) new submersible leachate pumping units (two pumping units at six (6) different locations) for installation in an inclined position on landfill side slopes, including fittings, disconnects, lifting cables, alarms, pump control panel, pump cable, connections, and all hardware to furnish a complete mechanical installation. CONTRACTOR shall provide a first class completely operable installation.

B. Pumps and pump associated equipment shall be furnished as part of a complete package including pumps, rails, disconnects, lifting cables, control panels (duplex), pump cable and all items incidental thereto.

### 1.02 CODES AND STANDARDS

A. Pumps shall be designed, fabricated, and tested to the standards of the Hydraulic Institute.

B. All electric motors shall meet or exceed the latest design, construction and performance standards of the ANSI, NEMA and IEEE.

### 1.03 APPLICATION OF EQUIPMENT

A. Pumping units shall be a standard production model of the manufacturer as published in their most recent catalog. Each model of equipment shall have been in general production for at least five (5) years prior to the date of bid opening.

B. The CONTRACTOR shall satisfy himself and the OWNER that the equipment he proposes to furnish will:

1. Meet or exceed the Specifications.
2. Fit in the installations without modification to the equipment and with the use of standard fittings.

3. Retain the basic design layout of the pumping station, so that equipment will be readily accessible and serviceable.

C. The plans and specifications for the pumps utilized refer to the products of EPG SurePump ™ Wheeled Sump Drainer for Side Slope Riser installations.

D. The CONTRACTOR shall be responsible for all ENGINEERing required when equipment other than that shown on the Contract Drawings is supplied, and results in changes in dimensions or configuration. Said equipment, layout and/or configuration shall be approved by the ENGINEER.

## 1.04 SUBMITTALS

A. Submit the following for each pump:

1. Certified pump characteristic curve with design points indicated.
2. Certified outline dimension drawings for complete pumping unit, accessories and pump control panel.
3. Pump control panel data and wiring diagram.
4. Manufacturer's literature and technical manuals for pumping units and motors.
5. Installation instructions and guide.
6. Operation and maintenance manual.
7. Parts list for pumping units and motors.
8. Warranty.
9. Pump Supplier's written certification

B. Submit detailed installation drawings showing location of pumps, pump mounting and foundation details, piping layout with dimensions, valves, and connections to discharge piping.

C. Shop drawings for pumping units will not be approved until dimension drawings have been approved.

## 1.05 CERTIFIED PUMP TESTS

A. Certified pump tests for each pump size/model shall be conducted by the pump manufacturer at the factory for the pump assembly. Test curves shall be submitted to the ENGINEER for approval prior to shipment of pumps.

B. Pump shall meet or exceed the specified performance standards.

C. Tests shall consist of checking the pump assemblies at the specified speed, head condition, and capacity for vibration, efficiency, and horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Pump Tests shall be a minimum of eight (8) hours duration (continuous) with suction levels and discharge heads identical to actual field conditions. Performance data shall be determined at the end of the eight hour test. The Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

D. Submit certification that each pump has been dynamically balanced.

E. Should the pump assembly fail to meet the performance requirements, either at the factory or in the field, or not perform as certified, the ENGINEER may require the replacement of the pump assembly or the substitution of another pump model or manufacturer.

## PART 2 PRODUCTS

### 2.01 PUMPS

A. Pump Type

1. Each pump shall be a SurePump ™ Wheeled Sump Drainers capable of pumping landfill leachate and/or contaminated groundwater.
2. New leachate pumps shall be inclined mounted centrifugal, single-suction, submersible pumps with close-coupled submersible (Class I, Division 2 rated) electric motors and suitable for side slope riser installation as shown on the plans.
3. Pumps shall be specifically designed to operate in a completely submerged condition for continuous operation and shall be provided with the appropriate motor accordingly.
4. Pumps shall be as manufactured by EPG or approved equal.

B. Pump Characteristics

1. The new pumps shall conform to the capacities, pumping heads, minimum heads, minimum efficiencies as indicated on the plans.
2. A transmitter with mount shall be welded at the center bottom of each Sump Drainer for liquid level control. The Sump Drainer shall permit the unit to "pump down" to within 6 inches of the sump bottom without any loss of performance or damage to the pump. The Sump Drainer shall be

equipped with a vent valve to assist with the evacuation of air from the Sump Drainer.

3. The pump design shall have at least four (4) wheels in contact with riser pipe surface at all times.
4. Each pumping unit shall be equipped with a built-in check valve. Check valve housing and disc shall be 304 stainless steel with seat of E-Glide™.
5. The pump(s) shall have a quick disconnect to a threaded discharge nozzle which shall provide detachment of pump for inspection or service.
6. The entire weight of the pump unit shall be supported by stainless steel lifting cables of sufficient strength to permit removal of the unit. Sealing of the discharge interface will be accomplished by hydraulic sealing. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of waterweight integrity to a depth of 65 ft.
7. Pump shall have the following operating characteristics:

| | *No. 1 Central P.S. (Relocated)* | *No. 2 South Central P.S.* | *No. 3 South P.S.* | *No. 4 South East P.S.* | *No. 5 East P.S.* | *No. 6 North P.S. (New)* |
|---|---|---|---|---|---|---|
| (1) Number of Pumps | 2 | 2 | 2 | 2 | 2 | 2 |
| (2) Capacity (gpm) | 75 | 50 | 50 | 50 | 55 | 90 |
| (3) Total Dynamic Head (ft) | 80 | 77 | 62 | 72 | 69 | 33 |
| (4) Discharge Size | 3 | 2 | 2 | 2 | 2 | 3 |
| (5) Motor Horse-power (Nominal) | 3 | 2 | 2 | 2 | 2 | 2 |
| (6) Electrical Characteristics | | | | | | |

a. Voltage (Volts AC) 460V
b. Phase 3
c. Hertz 60

C. Pump Construction

1. Major pump components shall be of AISI Type 304 stainless steel construction, with smooth surfaces devoid of blow holes or other irregularities. Materials used in the construction of the pump are summarized as follows:

| | |
|---|---|
| Casing | AISI Type 304 S.S. |
| Impeller | AISI Type 304 S.S. |

| | |
|---|---|
| Shaft | AISI Type 304 S.S. |
| Diffuser Chamber | AISI Type 304 S.S. |
| Bearings (fluid lubricated) | E-Glide™ |
| Built-In Check Valve w/Seat | AISI Type 304 S.S. E-Glide™ |

2. All nuts and bolts and other fasteners shall be of Type 316 stainless steel.

D. Pump Casing

1. Casing: Casing shall be stainless steel, AISI Type 304, in accordance with AISI of sufficient strength, weight and metal thickness to ensure long life, accurate alignment, and reliable operation. The pump volute shall be single-piece AISI 304 stainless steel design with smooth passages large enough to pass any solids that may enter the impeller.
2. An inlet screen with a mesh size of 1/8-inch shall be provided on each pump and shall be of Type 304 S.S. construction.
3. Discharge Connection: Discharge connection shall be threaded. A quick disconnect shall be attached for ease of assembly and disassembly.

E. Impeller

1. The impeller(s) shall be of AISI Type 304 stainless steel, dynamically balanced. The pump shall be capable of handling all screened matter found in landfill leachate. The pump manufacturer shall provide Mass moment of inertia calculations.

F. Diffuser Chamber

1. The diffuser chamber for each impeller shall be Type 304 S.S. and fitted with E-Glide™ impeller seal rings.

G. Pump Shaft

1. The shaft shall be AISI Type 304 Stainless Steel (S.S.) and shall be completely isolated from the pumped liquid. The pump shaft shall rotate on E-Glide™ bearings which are fluid lubricated.

H. Bearings and Seal Rings

1. The pump bearing and seal rings shall be made of E-Glide ™ and shall be bonded to stainless steel rather than press fit.

I. Classified Area

1. The pump system including the pump, motor and power cable shall be approved for use in areas classified as hazardous locations in accordance with the NEC Class I, Div. 2, Group C and D service as determined and approved by a U.S. nationally recognized testing agency (U.L., FM) at the time of the bidding of the project. As required by Factory Mutual (FM) the motor shall be capable of operating in pumped media up to 104 degrees F.

J. Miscellaneous

1. Data Plates: All data plates shall be of stainless steel, suitably attached to the pump. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, number of impeller stages, capacity and head rating and other pertinent data.
2. Hardware: All machine bolts, nuts and capscrews shall be Type 316 stainless steel and of the hex head type. Hardware or parts requiring special tools or wrenches shall not be used.
3. Lifting Cable: Provide sufficient length of stainless steel lifting cable for each pumping unit as indicated on plans. The lifting cable, ring and their connections must be of sufficient strength to permit raising and lowering the pump with a 1.5 safety factor.

## 2.02 SUBMERSIBLE ELECTRIC MOTORS FOR PUMPS

A. Motor Type: The motor shall be a submersible, hermetically sealed Franklin Motor of 304 and 316 stainless steel construction. The motor shall be designed for continuous duty, capable of sustaining up to 6 (minimum) starts per hour. The motor shall be connected to the pump via a motor adaptor and coupling in 304 stainless steel. Three phase motors shall have thermal protection located in the control panel which is to be manually reset.

B. Motor Lead Wire: The lead wire shall be no-splice with EPG's "CP" water proof and chemically resistant insulation and be of the length as indicated on Plans.

## 2.03 ELECTRICAL CONTROLS AND CONTROL PANELS

A. General Requirements - Duplex Control Panel.

1. Provide total of six (6) Duplex U.L. listed, L950PT control panels for the pumps at six (6) new inclined-submersible pump station (valve vault) locations.
2. The control panel shall contain the features described in the Detailed Requirements as well as those described in the General Requirements.
3. Each control panel shall include system short circuit and motor overload protection.
4. Control features shall be intrinsically safe with intrinsically safe relays and intrinsically safe barriers as required in the pump control panel/enclosure.
5. Control panel enclosures shall be gasketed, weatherproof, dust-tight, and corrosion resistant. Enclosures shall be NEMA Type 4X, stainless steel. Enclosures shall come equipped with an inner door, stainless steel drip shield and tamper resistant latch with all controls and indicators mounted in the inner door. Enclosures shall be lockable.
6. Pumps shall have level controls as described in Detailed Requirements.
7. Control panel shall be furnished by the same manufacturer as the pumps.
8. The control system will operate from a 480 volt, 60 hertz, 3 phase power supply.

B. Detailed Requirements - Duplex Control Panel.

1. Provide automatic alternating pump controller programmed using submersible pressure transmitter level sensors.
2. The pressure transmitter level sensor shall perform the functions indicated on the drawings or as directed in the field. The "normal" operation lead-lag modes shall automatically switch to the next sequence each time a pump cycle is completed. The settings of the pressure transmitter level sensor shall initially be set at the elevations as shown on the drawings.
3. "Normal" Level Control and Alarm Operation: The system shall provide all proper level controls and equipment and shall have wiring connections to the level control equipment for the pumping station so that it operates in the following manner.

    a. When the water level rises to the first "Pump On" level, the lead pump will start.

b. When the water level is lowered to the "Pump Off" level, the lead pump will stop.
c. The alternator will then make the above pump the "lag-lag" pump and the "lag" pump will then become the "lead" pump.
d. When the water level again rises to the first "Pump On" level, the lead pump will start.
e. The lead pump will then run until the water level is lowered to the "Pump Off" level.
f. If the water level continues to rise and reaches the "Lag Pump On" level, the lag pump will start.
g. Both pumps will continue running until the water level is lowered to the "Pump Off" level.
h. If the water level rises to the "High Water Alarm" level, an alarm will be activated. This alarm shall also send a signal to the Automatic Telephone Dialer Unit.
i. If the water level is lowered to the "Low Level Alarm" level, an alarm will be activated.

4. The following functional features shall be provided for the control panel.

a. Main Circuit Breaker Disconnect Switch with Door Interlock: Prevents opening of panel while power is on.
b. Control Transformer: Transformer with fused primary to isolate control circuit from power circuit and for easier and safer field wiring of accessories. It shall lower incoming voltage to 120 volts.
c. Heater with Adjustable Thermostat: To provide even distribution of heat and elimination of hot spots and condensation. Heater element shall be mounted in space between the sub-panel and the back of the enclosure and provide a minimum of 100 watts of heating area.
d. Level Master™ Level Control: The Level Master shall be mounted on the inner door. Meter shall provide digital display and have the capability to monitor and maintain pumping operations as well as one other level signal. Level control shall be accurate to within 0.1 inch.
e. Electronic Alternator: To equalize wear on pump motors. Alternator shall include lead, lag pump operation.
f. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter that shall protect internal components of control panel from corrosion for up to one year.
g. Lightning Arrestor: Shall be grounded, metal to metal, to water strata.

h. Each circuit breaker/disconnect shall be furnished with provisions for locking in the OFF position.

i. Provide control circuitry with connections for external wiring interlock(s) which shall allow operation of the pumps under normal conditions in the downstream pumping station(s) and inhibit operation of the pumps in the event of high water level conditions in the downstream pumping station(s). This interlock circuitry shall be furnished with a panel mounted pilot light indicating when the pumps are inhibited and a manual over-ride switch.

j. Provide adjustable starting time-delay circuitry (0-120 seconds, minimum).

k. Provide a running time meter for each pump.

l. Provide circuitry for high water level alarm, low water level alarm, and motor overload alarm.

(1) A front of panel mounted pilot light shall be activated upon obtaining a high water level condition in the wet well. When the condition is cleared, the system shall go back to the absence of an alarm mode.

(2) A front of panel mounted pilot light indication of the motor overload alarm.

(3) A front of panel mounted pilot light indication of pump interlock inhibit alarm.

(4) A front of panel mounted pilot light indication of a low water level condition.

(5) Provide contacts so that activation of any of the above alarm conditions can transmit a signal to a remote alarm device.

(6) Provide a red flashing alarm light mounted on the top exterior of the control panel/enclosure. This light shall be activated in response to any of the above alarm conditions. The alarm light shall be Edwards (General Signal) Catalog No. 52R-N5 or an acceptable equivalent.

m. Provide a front of panel mounted selector switch for input of either pump mounted submersible pressure transmitter level sensor signal into the controller.

5. The following functional features shall be provided for each pump/motor.

   a. Motor Protection: To be provided by 480 volt, MCP Type CB and motor starter with ambient compensated quick trip thermal overloads.
   b. Motor Starter: The motor starter will be sized to the pump motor horsepower, and shall be NEMA rated and equipped with built in single phasing protection, and ambient compensated adjustable quick trip thermal overloads.
   c. "Hand-Off-Auto" Selector Switch: Allows manual or automatic operation. The selector switch shall be a heavy duty, oil tight, NEMA 4 rated switch mounted on the inner door.
   d. Running Light: Indicates energization of motor circuit. It shall be heavy duty, oil tight, NEMA 4 rated with a voltage surge suppressor built in to prolong lamp life.
   e. Motor Overload Light: Indicates motor not running due to overload condition. Light shall be heavy duty, oil tight, NEMA 4 rated with a voltage surge suppressor built in to prolong lamp life.
   f. Terminal Strip: Provides easy connection of external components.

6. Panel Description.

   a. The control panel shall be a NEMA Type 4X, stainless steel (14 gauge minimum) enclosure with assembly for security locking. The enclosure shall be hinged and front opening of the door-in-door style. The operating controls, indicator lights, indicating meters, etc. shall be mounted on the hinged inner door of the enclosure.
   b. All major components and sub-assemblies shall be identified as to function with laminated, engraved, bakelite nameplates.
   c. Control panel/enclosure shall be suitable for surface (wall) mounting.

7. Submersible Pressure Transmitter Level Sensor.

   a. Pressure transmitter level sensor shall have a range of 0 to 10 ft with a 4 to 20mA output signal.
   b. Transmitter construction shall be stainless steel body, stainless steel diaphragm and Viton seals with chemical resistant signal cable.
   c. Transmitter circuit shall be rated for intrinsically safe barriers.

## 2.04 PUMP WARRANTY

A. The Pump Supplier shall warrant for a minimum of two (2) years from the date of acceptance by the OWNER, that the equipment will be free from defects in design, material and workmanship.

B. Warranties and guarantees by the suppliers of various components in lieu of a single source responsibility by the Pump Supplier shall not be accepted. The Pump Supplier shall be solely responsible for the warranty of the equipment and all related components.

C. In the event a component fails to perform as specified or is proven defective in service during the warranty period, excluding items of supply normally expended during operation, the Pump Supplier shall provide a replacement part without cost to the OWNER.

D. Warranties shall not begin until acceptance of the equipment by OWNER.

## 2.05 MANUFACTURER'S WRITTEN CERTIFICATION

A. The manufacturer will submit four (4) copies of written certification verifying that each complete pumping system (pumping units, bases, disconnects, lifting cables, level controls, alarms, floats, pump controls, pump cables and appurtenant parts) provided for this contract has been successfully factory tested to full design load capacity, has been installed and is operating in accordance with these contract documents and the manufacturer's specifications, and has been successfully field tested by the manufacturer or his appointed representative.

# PART 3 EXECUTION

## 3.01 GENERAL

A. Installation and start-up of the new pumping units and associated equipment shall be in accordance with the pump manufacturer's printed instructions.

## 3.02 START UP

A. Provide the pump manufacturer's competent and experienced ENGINEER to supervise the initial operation, final adjustments and testing of the new pumping units.

B. Factory Tests: Prior to shipment from the manufacturer, the manufacturer shall provide the following tests in addition to certified, witnessed pump tests:

1. Impeller, motor rating and electrical connections shall first be checked for conformance to specifications.
2. A motor and cable insulation test for moisture content or insulation defects.
3. "Bump" pump to establish correct rotation and mechanical integrity.
4. The pump shall be run for 30 minutes submerged, a minimum of five (5) ft. underwater.
5. After operational test the insulation test specified herein shall be repeated.
6. Provide written report stating the foregoing steps have been done for each pump at the time of shipment.

C. Field Testing: Testing of new pumping units shall be under full load conditions.

END OF SECTION

# SECTION 15011

# MECHANICAL - GENERAL REQUIREMENTS

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. The work covered by this Section of the specifications shall include the furnishing, installation and complete erection of the mechanical equipment specified herein. Included is all supervision, labor, materials, tools, equipment, and services required for installation, test operation and start-up of the equipment.

B. Installation shall include placing, shimming, anchoring, grouting, cleaning, lubricating, assembling and adjusting of all mechanical equipment. Installation shall also include providing all miscellaneous parts.

C. The CONTRACTOR shall coordinate his work to provide a complete and workable installation. All items of mechanical equipment included in these specifications shall be furnished and installed by the CONTRACTOR. It is the intention that these specifications shall provide a complete properly operating installation. All construction and equipment necessary for the completion of the work shall be included, and the omission of specific reference to any part of the work necessary for such completion shall not be interpreted as relieving the CONTRACTOR from furnishing or constructing such parts.

D. The material and mechanical equipment to be furnished and installed shall be based on the specified type and make. The award of the contract shall be made on this basis. Material of foreign manufacture shall not be used and will not be accepted for this project.

### 1.02 CODES, STANDARDS, PERMITS AND INSPECTIONS

A. The CONTRACTOR shall obtain all licenses and permits for CONTRACTOR installed equipment. Installation of equipment shall comply with all applicable federal, state and local laws. Where required, the CONTRACTOR shall submit a certificate of approval from the final inspecting authority for the equipment provided.

B. Manufacturer's published data is made a part of these specifications.

## 1.03 TOOLS AND ACCESSORIES

A. The CONTRACTOR shall furnish, with each type, make, or size of equipment, any special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment. Such tools and appliances shall be high-grade, properly labelled, and delivered to the OWNER prior to initial operation of the equipment.

## 1.04 IDENTIFICATION NAMEPLATES

A. Each piece of equipment shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the equipment manufacturer's names year of manufacture, serial number, and principal rating data. These nameplates shall not be painted.

## 1.04 WORKMANSHIP

A. All work and methods of executing same under these Specifications shall be completed in an approved first class workmanlike manner and shall conform to the best mechanical practice.

## 1.05 QUALITY OF EQUIPMENT

A. Equipment and appurtenances shall be designed in conformity with ANSI (formerly ASA), ASME, AWWA, IEEE, NEMA, UL, GNA, and other generally accepted applicable standards. They shall be of rugged construction and of sufficient strength to withstand all stresses, which may occur during fabrication, testing, transportation$ installation, and all conditions of operations. All bearings and moving parts shall be adequately protected against wear by bushings or other approved means. Provisions shall be made for adequate lubrication with readily accessible devices.

B. Machinery parts shall conform to the dimensions shown on the working drawings within allowable tolerances. The corresponding parts of identical machines shall be made interchangeable. Ample clearance shall be provided for repairs, inspection and adjustment. Protruding members such as joints, corners and gear covers shall be finished in appearance. All exposed welds shall be ground smooth and the corners of structural shapes shall be rounded.

## 1.06 RESPONSIBILITY FOR EQUIPMENT

A. The CONTRACTOR shall be liable for all damage to the equipment which is to be installed under this contract, as well as for any damage to the building structures or other property, real or personal, resulting from the movement of equipment or installation work. This liability shall continue until the work is accepted by the OWNER.

B. It will be the CONTRACTOR's responsibility to determine weights of equipment to be handled, and to provide adequate handling equipment and experienced riggers.

## 1.07 SAFETY REQUIREMENTS

A. All machinery and equipment shall be safeguarded in accordance with the safety codes of the ANSI, OSHA and local industrial codes.

B. All mechanical equipment shall be provided with a local pushbutton station locking emergency stop or disconnect switch.

C. All gears, couplings, projecting set screws, and similar rotating or reciprocating parts shall be protected in accordance with the latest revision of ANSI B15.1.

## 1.08 PROTECTIVE COATINGS

A. All machined surfaces and shafting shall be cleaned and protected from corrosion by the proper type and amount of coating necessary to assure protection during shipment and prior to installation.

B. Oil lubricated gearing, bearings, etc., are to be shipped with an oil soluble protective coating as recommended by the equipment manufacturer.

C. All ferrous metal materials and accessories not to receive finish coats at the factory shall receive a protective shop prime finish compatible with the appropriate final coatings as specified in Section 09900, "Painting"," prior to shipment.

D. All equipment including pumps, pump accessories, motors, reducers and electric controls shall have the specified factory finish prior to delivery.

## 1.9 VERIFICATION OF THE FIELD CONDITIONS

A. Before ordering any material or doing any work, verify all measurements and be responsible for the correctness of same. No extra compensation will be allowed on

account of differences between actual dimensions and those measurements indicated on the drawings. Any difference which may be found shall be submitted to the ENGINEER for consideration before proceeding any further with the work.

B. Before ordering any equipment or material, the CONTRACTOR shall submit complete dimension drawings showing that the equipment and/or material which he proposes to install will be workable and feasible. Complete manufacturer's information on the proposed equipment shall accompany the drawing. CONTRACTOR shall not order material or equipment until dimension drawings, shop drawings and equipment information have been approved by the ENGINEER.

## 1.10 SHOP DRAWINGS AND SUBMITTALS

A. Before proceeding with the work, submit to the ENGINEER four (4) copies of shop drawings for the complete job. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval of Shop drawings by the ENGINEER will not relieve trade from responsibility for errors or omissions therein. All such errors or omissions must be made good by the trade irrespective of any approval by the ENGINEER.

Shop Drawings shall include:

1. Manufacturer's literature, catalog cuts of all equipment details for all equipment.
2. Certified outline dimension drawings.
3. Bill of materials.
4. Parts lists.
5. Electrical wiring and control diagrams..
6. Piping and/or ductwork.
7. Performance data
8. Location of equipment
9. Sleeves and chases.
10. Installation instructions.
11. Operating and maintenance instructions.

B. All shop drawings will be assumed to bear only minor field changes. CONTRACTOR is required to point out major changes and explain why they are requested. Failure to comply herewith negates the approval of shop drawings for such change.

C. Should CONTRACTOR do any work before he has approved copies of shop drawings, he may be required to remove, change, modify and/or replace such work to meet plans and/or specifications without additional compensation.

## 1.11 INSTALLATION OF EQUIPMENT

A. The CONTRACTOR shall have on site sufficient proper construction equipment and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory assembled when practical.

B. Equipment shall be erected in a neat and workmanlike manner on the foundations and supports at the locations and elevations shown on the Contract Drawings.

C. All equipment shall be installed in such a manner as to provide access for routine maintenance including lubrication.

D. For various types of equipment such as pumping units, which require field alignment and connections, the CONTRACTOR shall provide the services of the equipment manufacturer's qualified mechanic, millwright, machinist, ENGINEER or authorized representative, to align or adjust the equipment prior to making piping connections or anchoring the equipment base.

E. Provide temporary pumping if necessary for proper completion of the work.

## 1.12 EQUIPMENT MANUFACTURER'S INSTALLATION INSTRUCTIONS

A. The CONTRACTOR's work procedure shall conform to the Equipment Manufacturer's installation instructions unless expressly directed in writing otherwise by the OWNER.

B. Any conflict between the Equipment Manufacturer's drawings and the Contract Drawings shall be brought to the OWNER's immediate attention in writing, for resolution prior to proceeding with actual equipment installation.

## 1.13 EQUIPMENT MANUFACTURER'S SERVICE REPRESENTATIVE

A. The CONTRACTOR shall have the manufacturer furnish the services of a competent and experienced ENGINEER to supervise the start-up and initial operation, and to provide proper instructions to the OWNER's personnel in the operation and care of all mechanical equipment.

## 1.14 SIMILAR INSTALLATIONS

A. The CONTRACTOR shall provide written evidence of at least ten (10) installations where the same type of equipment without major changes therein, has been satisfactorily in operation for at least five (5) years prior to the date of the Advertisement for Bids for this project, if so requested by the ENGINEER.

## 1.15 SERVICING AND MAINTENANCE

A. Evidence shall be furnished that there is an efficient and reliable service organization within 150 miles of the installation which regularly carries a stock of repair parts for all proposed equipment.

## 1.16 CONCRETE

A. All concrete work related to and including equipment foundations and supports shall be performed by the CONTRACTOR. Concrete work shall be in accordance with the specifications of Section 03300, "Concrete".

B. All concrete for equipment foundations, curbing, etc. shall have a minimum 28 day compressive strength of 3500 psi, or greater if indicated, or required to be in accordance with equipment manufacturer's installation instructions. All work shall be in accordance with ACI standards.

C. Metal reinforcement shall conform to ASTM-A615. Welded wire fabric shall conform to ASTM-A185.

## 1.17 EQUIPMENT FOUNDATIONS, ANCHORS AND SUPPORTS

A. CONTRACTOR shall provide concrete work and supports required for equipment furnished under this Section. Pads and supports detailed on the drawings are for bidding purposes. CONTRACTOR shall submit shop drawings for approval showing pads and supports for actual respective equipment to be provided for this project.

B. The CONTRACTOR shall furnish, install, and protect all necessary guide, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installations. These shall be of ample size and strength for the purpose intended and shall be approved by the ENGINEER.

C. Anchor bolts where required shall be furnished and installed by the CONTRACTOR unless otherwise specified. Suitable templates shall be used by the CONTRACTOR when necessary.

## 1.18 CUTTING AND PATCHING

A. All cutting and patching of every nature required in connection with these specifications shall be done by mechanics experienced in their respective lines of work. Cutting shall be done with great care so as not to cause unnecessary damage or leave unsightly surfaces which say not be concealed by plates, escutcheons, or other normal concealing construction. All patching must meet the approval of the ENGINEER.

## 1.19 REMOVAL OF RUBBISH

A. During the course of construction, periodically remove from the premises all rubbish resulting from the work so as to prevent its accumulation. At the completion of the work contemplated under these specifications, remove from the work area and site all rubbish and accumulated materials of whatever nature and leave the work, and equipment free of all foreign matter and in a clean, orderly, acceptable and usable condition.

## 1.20 LUBRICATION

A. The CONTRACTOR shall thoroughly lubricate all equipment in accordance with the Equipment Manufacturer's instructions. Lubricating oils and greases shall be of type and viscosity as recommended by the Equipment Manufacturer.

B. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be of the "Alesite" button head type, Zurn or approved equal, unless otherwise stated in the detailed equipment specifications.

C. All lubricants shall be provided by the CONTRACTOR.

D. All systems requiring oil lubrication for gearing, bearings, etc. are to be flushed with flushing oils as recommended by the Equipment Manufacturer. This includes all gearings, bearings, etc., regardless of whether they have been shipped with or without oil soluble protective coatings.

E. Following flushing, oil lubricated systems shall be filled with "run-in" oil as recommended by the Equipment Manufacturer. The equipment will be "run-in" at the no-load condition for a minimum period of 2 hours. Following "run-in" and inspection, the equipment is to be drained and flushed again with flushing oil as recommended by the Equipment Manufacturer.

F. The schedule for the above procedures is to be submitted for review by the ENGINEER at least two (2) weeks prior to the selected procedure starting date. At this time, inspection details will be worked out.

## 1.21 TEST OPERATION

A. All mechanical equipment shall be tested to the satisfaction of the ENGINEER. When an item of equipment, including controls and instrumentation, has been completely erected, the CONTRACTOR shall notify the ENGINEER, who will designate a time to make such tests as required, and operate the item to the satisfaction of the ENGINEER. "Completely Erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, required lubricants and hydraulic fluid have been added and the unit has been cleaned up.

B. CONTRACTOR shall furnish labor, lubricants, and all other materials, equipment and instruments necessary for all acceptance tests.

## 1.22 FAILURE OF TESTS

A. Any defects in the equipment, or deviations from the guarantees or requirements of the specifications, shall be promptly corrected by the CONTRACTOR by replacements or otherwise. The decision of the ENGINEER as to whether or not the CONTRACTOR has fulfilled his obligations under the Contract shall be final and conclusive. If the CONTRACTOR fails to correct any defects or deviations, or if the replaced equipment when tested shall fail again to meet the guarantees or specified requirements, the OWNER, notwithstanding his having made partial payment for work and materials which have entered into the manufacture for such equipment, may reject that equipment and order the CONTRACTOR to remove it from the premises at the CONTRACTOR's expense.

## 1.23 RESPONSIBILITY DURING TESTS

A. The CONTRACTOR shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for

damage which may occur to equipment prior to the time when the OWNER formally takes over the operation thereof.

## 1.24 ACCEPTANCE OF EQUIPMENT BY THE OWNER

A. After an item of equipment has satisfied all of the specified conditions, the CONTRACTOR shall notify the ENGINEER and shall, at such time as directed, demonstrate to the ENGINEER's satisfaction that the equipment is ready for operation. The equipment shall then be designated as "accepted" and the OWNER will be responsible for all further maintenance and operation of same except that which is covered by guarantees or warranties or provisions of the Maintenance Bond.

## 1.25 MANUFACTURERS' OPERATING AND MAINTENANCE INSTRUCTIONS

A. The CONTRACTOR shall initially submit one copy of the manufacturer's operating and maintenance instructions for all equipment for the ENGINEER's approval. Information shall include description of equipment, operating instructions, troubleshooting techniques, schematic wiring diagrams, maintenance instructions, etc. Operating and maintenance instructions shall be sufficiently detailed as to be self-instructive.

B. Upon the ENGINEER's approval, four (4) sets of the approved Operating and Maintenance Instructions, Technical Bulletins, Diagrams, and other printed materials shall be furnished and delivered bound to the ENGINEER, prior to initial operations. Photo-copied literature will not be acceptable.

## 1.26 WARRANTY

A. All equipment furnished shall be guaranteed for a period of two years unless otherwise stipulated from the date of project final acceptance thereof against defective materials, design, workmanship or performance. Upon receipt of notice from the OWNER of failure of any part of the equipment during the warranty period, the affected part or parts shall be replaced promptly by and at the expense of the CONTRACTOR. Warranties shall not begin until acceptance of equipment by the ENGINEER.

END OF SECTION

# SECTION 15060

# PIPE, PIPE FITTINGS, AND ACCESSORIES

## PART 1 GENERAL

### 1.1 SCOPE

A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, supervision, tools, equipment, materials, services, and related items necessary to complete all mechanical piping work. The work includes, but is not limited to:

B. Remove and dispose of all existing suction and discharge piping, valves, and accessories, as shown on the Contract Drawings.

C. Provide and install all suction and discharge piping, valves, and accessories required to provide a complete and operational installation as shown on the contract drawings.

D. Provide all pipe, pipe fittings, pipe flanges and connections; joint materials including gaskets, nuts, bolts and washers; pipe hangers and supports; miscellaneous small diameter piping, valves, fittings, and accessories; cutting and patching; temporary piping and temporary pumping; all abandonment, removals and relocations; piping equipment, and all other items required to perform the work and as required for a complete and operational installation.

### 1.02 GENERAL REQUIREMENTS

A. Before work is started, Certificates of Conformance for all materials shall be submitted to the ENGINEER, proving conformance with specifications. All pipe shall be covered by a guarantee certificate furnished by the CONTRACTOR and signed by an officer of the pipe manufacturer.

B. Piping relocations, abandonments and replacements shall be performed in such a manner as to minimize disruption to the operation of existing facilities.

C. Handle piping in a manner to ensure installation in a sound and undamaged condition. Do not drop or bump.

D. Use slings, lifting lugs, hooks or other devices designed to protect pipe, joint elements, coatings and linings.

E. Provide covers suitable for the protection of pipe ends and flanges.

F. Prevent contact with adjacent units during shipping, moving and storage.

G. Pipe damaged during transportation or handling which, in the opinion of the ENGINEER, cannot be satisfactorily repaired will be rejected and shall be removed from the jobsite.

H. Pipe not in conformance with the applicable physical dimension and tolerance specifications will be rejected and shall be removed from the jobsite.

I. Pipe which, in the opinion of the ENGINEER, has not been satisfactorily repaired will be rejected and shall be removed from the jobsite.

## 1.03 SUBMITTALS

A. Submit the following for acceptance prior to fabrication:

1. Pipe and joint details.
2. Fitting and coupling details.
3. Laying and installation schedule.

B. Certificates of Compliance: Furnish the following prior to shipment.

1. Certificate of Compliance with applicable standards.
2. Test Certificates.

# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Ductile Iron: Provide pipe material as indicated or specified.

B. High Density Polyethylene (HDPE): Provide pipe material as indicated or specified.

## 2.02 DUCTILE IRON PIPE

A. Manufacturer: Pipe shall be as manufactured by U.S. Pipe & Foundry Co., Griffin Pipe, American Cast Iron Pipe Company or Clow Corporation.

B. Design:

1. Ductile-iron pipe shall conform to AWWA C115, C150, and C151 except as otherwise specified.

2. Ductile iron pipe shall be Class 52, bituminous coated interior, epoxy coated exterior.

3. All piping shall be supplied with flange joints unless specifically noted otherwise.

C. Joints:

1. Flanged:

a. Provide flanged joints for all interior, exposed exterior and submerged pipe except where otherwise specified or indicated.

b. Flanges for pipe shall be ductile iron and conform to the applicable provisions of AWWA C110 and C115 and shall be drilled ANSI B16.1, Class 125, or as noted on plans.

c. Pipe with victaulic-style couplings may not be substituted for flanged pipe except where indicated or approved by the ENGINEER.

1. Sleeved or Coupled:

a. Sleeves or couplings shall be kept to a minimum.

b. Provide sleeves or couplings where indicated or approved by the ENGINEER for field closures necessitated by pipe laying sequence.

b. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.

c. Provide anchored couplings where restraint is required to withstand hydrostatic test pressure and where indicated.

D. Fittings:

1. Fittings shall conform to AWWA C110 and shall have a pressure rating of 250 psig.

2. Fittings shall be ductile iron with flanges joints.

3. Include all taps, plugs, flanges and wall fittings as required.

4. Provide openings for drains, sensing, testing, etc., connections with threaded bosses or flange outlets.

E. Lining and coating:

1. Ductile iron pipe and fittings shall be coated inside with a bituminous coating at least 1 mil. thick which conforms to the requirements for seal coat in accordance with ANSI A21.4 latest revision. Exterior coating shall be epoxy enamel in accordance with Section 09900. Pipe with cement lining shall not be provided.

2. Flange faces shall be coated in accordance with ANWA C115.

## 2.03 HIGH DENSITY POLYETHYLENE PIPE

A. All high density polyethylene pipe and fittings shall be provided in accordance with Section 02722 of these specifications.

B. All connections to piping of differing materials shall be made with flanged joint connections specifically designed for adapting between differing pipe materials.

## 2.04 SLEEVES AND COUPLINGS

A. Sleeves:

1. Sleeves shall not be permitted on ductile iron pipe.

2. Sleeves shall be installed as required for installation of HDPE piping.

B. Couplings:

1. Couplings for ductile iron pipe shall be installed where identified on the Contract Drawings or as approved by the ENGINEER

2. Couplings shall be middle ring and compression gland type without pipe stop.

3. Standard middle ring length shall be provided for pipe end space of 1-inch or less. Long middle ring length shall be provided when pipe end space exceeds 1-inch. Include spacer ring to reduce end space to not more than ¼-inch.

4. Steel or iron couplings shall be as manufactured by:

   a. Smith-Blair, Rockwell International Corporation.
   b. Dresser Industries, Inc.
   c. Ford Meter Box Company, Inc.
   d. Approved equal.

5. Bolts, nuts washers and other accessories shall be stainless steel.

6. Middle Rings and Followers shall be:

   a. Ductile or cast iron for iron couplings.
   b. Steel for steel couplings.

7. Lining and Exterior Coating:

   a. Completely coat middle ring and end follower glands.
   b. Two-part epoxy or nylon fuse-coated to a minimum 10 mils thickness.
   c. Line interior of all steel couplings intended for exposed-interior installations. Coat exterior with normal shop coating.

C. Anchored Couplings

1. Furnish where joint restraint is required to offset internal pipeline forces, and hydrostatic test pressure.

2. Harnesses shall consist of lugs or clamps securely fastened to opposite joint elements with tie bolts between opposing lugs.

3. Mechanical joint retainer glands shall not be used where joint restraint is required.

## 2.05 WALL PIPES AND SLEEVES

A. Wall pipes and wall sleeves shall be ductile iron, flange joint or plain end type as indicated. Link Seal or approved equal shall be installed for all pipe and floor penetrations.

## 2.06 PIPE HANGERS AND SUPPORTS

A. CONTRACTOR shall design, furnish and install pipe hangers for all overhead piping unless otherwise indicated.

B. Pipe hangers, brackets, clamps, concrete inserts, rods and bolts shall be of a design sufficient to support the imposed loads. Support spacing shall not exceed the spacing recommended by the pipe manufacturer for the pipe size and material used.

C. CONTRACTOR shall furnish shop drawings indicating the proposed support locations and type of support to be used, prior to fabrication.

D. The approximate location of pipe supports for pipe and base fittings are indicated on the Drawings. CONTRACTOR shall coordinate support locations with approved pipe laying schedule and drawings.

E. Pipe supports shall conform to the requirements of NSS-SP58 and NSS-SP69.

F. Pipe supports shall be as manufactured by Grinnell or approved equal.

# PART 3 EXECUTION

## 3.01 GENERAL

A. All installation shall be performed in a neat and workmanlike manner.

B. All installation procedures shall be in accordance with the manufacturer's instructions and with AWWA C600.

C. Suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Extra care shall be exercised to prevent damage to pipe lining and coating.

D. Prior to installation, each pipe and fitting shall be carefully inspected and those not meeting specifications or are otherwise defective shall be rejected and removed from the project.

## 3.02 PIPE INSTALLATION

A. The drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions and coordination between trades without additional cost.

B. CONTRACTOR shall determine length of spool pieces required to suit field conditions.

C. Piping shall be laid out using standard fittings.

D. Anchor hangers and pipe securely and as indicated.

E. Concrete supports shall be installed where indicated on Drawings or required in approved pipe layout schedule.

F. Plug existing and new piping as required during installation.

## 3.03 TESTING

A. General:

1. At the completion of all piping work, the piping shall be tested for leakage. Test all joints for leaks. Repair all leaks and retest until system proves free of all leaks under full load.

2. All tests shall be run in the presence of the ENGINEER.

3. Provide all test equipment, labor and fittings to complete all tests.

B. Pressure Piping:

1. Test separately in sections between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs.

2. CONTRACTOR shall furnish and install test plugs. CONTRACTOR shall provide all anchors, braces, and other devices to withstand hydrostatic pressure on the plugs.

3. The length of piping under test shall be slowly filled with water and brought to test pressure by means of a pump connected to the pipe in a manner satisfactory to the ENGINEERs, so as to obtain the specified hydrostatic test pressure at the highest point in the section of piping under test.

4. The pump, pipe connection and all necessary apparatus, shall be furnished and paid for by the CONTRACTOR. If desired, the OWNER reserves the right to furnish gauges for the test, but all necessary assistance for conducting the test shall be furnished and paid for by the CONTRACTOR. All air must be expelled from the pipe line prior to the test period. The test pressure shall be maintained for a period of two (2) hours.

5. Should any of these tests on a section of pipeline disclose an inability to hold the stipulated test pressure or leakage in an amount greater than that permitted, the CONTRACTOR shall, at his own expense, locate and correct any defects and retest same to the satisfaction of the ENGINEERs.

6. Pressure and leakage tests shall conform to AWWA C600.

END OF SECTION

# SECTION 15100

# VALVES

## PART 1 GENERAL

### 1.01 SCOPE

A. Provide new valves as indicated including installation, valve operators, joint materials, temporary pumping, equipment and all items required to perform the work and as required for a complete and operational installation.

B. The work includes, but not limited to, providing and installing valves where shown on the Contract Drawings.

C. This Section includes specifications for all valves required for piping system.

### 1.02 SUBMITTALS:

A. Submit shop drawings and manufacturer's literature for the valves and accessories as required. Submittals shall include, but not be limited to, the following:

1. Catalog data and detailed drawings showing principal parts, dimensions, and materials.
2. Manufacturer's instructions for installation, adjustment and maintenance.

B. Certificate of Conformance with specifications.

## PART 2 PRODUCTS

### 2.01 GATE VALVES 3 INCHES TO 12 INCHES

A. Valves shall conform to AWWA C509. Valves shall be rated for 250 psi working pressure, resilient seated type, bonded encapsulated wedge, high strength cast iron body, double "O" ring at stem with reinforced flanged, corrosion resistant threaded bronze stem with bronze or plated steel stem nut. Valves shall be manufactured by A.P. Smith, American Darling or M&H Valve Company.

B. Encapsulated wedge and valve sealing shall be bubble tight in both directions with zero leakage. Gate shall be made with low friction, non-abrasive thermoplastic inserts in order to minimize wear on the internal coating of the valve body.

C. Wedge travel shall be smooth up and down and shall not abrade the protective coating.

D. Valve body and bonnet shall be fusion bonded epoxy, coated inside and outside to a minimum thickness of 8 mils. All other ferrous metal surfaces shall be provided with a permanent fusion bonded epoxy coating and no exceptions to this shall be permitted. All protective coatings shall conform to AWWA C550 latest revision.

E. Waterway area shall be unobstructed and valves shall be capable of passing a full size shell cutter. Valve interior shall be of very smooth contours, free of ledges, pockets or other areas which can collect debris or sediment.

F. Stem seal design shall allow replacement of "O" ring seals while valve is in any position of service. Stem shall also include thrust washers.

G. Valves shall be factory tested. Valves shall be certified to pass a 500 cycle test at 200 psi unbalanced pressure without wearing away the coating to bare metal. Valves shall also seal after cycle test without leakage at the gate or "O" ring stem seals. Valves shall be tested in the "Disc Up" position at 400 psi, and there shall be no leakage at joints or connections.

H. All valves shall be flanged and open counter clockwise. Valves within the wetwell shall be of the non-rising stem type (NRS) with a 2-inch square operating nut. Non-buried valves shall be the rising stem type and furnished with handwheels.

I. Valves shall have flanged ends as required or indicated. Flanged end connections shall have a drilling pattern conforming to ANSI B16.1, Class 125.

## 2.02 CHECK VALVES 3 INCHES AND LARGER

A. Manufacturer: Valves shall be counter-weighted, cushioned swing check valve conforming to AWWA C508 as manufactured by APCO Valve and Primer Corporation, G.A. Industries or approved equal. For purposes of establishing a standard of design, valve shall be Fig. 250-D as manufactured by G.A. Industries, or approved equal.

B. Each check valve shall consist essentially of a body flow control device and a removable bolted cover. The valve shall permit flow in one direction only and shall close automatically when flow is reversed.

C. The manufacturer shall certify that the check valves will be suitable for the service and velocities to which they will be applied. Valves shall also be certified for silent operation at operating conditions.

D. The closure assembly of swing check valves shall consist of a strap or hanger; hinge pins; disk bolt and nut; metallic disc with a stainless steel disc seat. The fluid flow shall swing the closure assembly away from the seat. The seating mechanism of the valve shall be such that the disc assembly will close by the force of gravity when the valve is installed in a horizontal line. The valve shall be equipped with stops on the body, cover, or hanger strap to prevent disc from sticking or wedging in the wide open position. Swing check valves shall be suitable for installation in a horizontal or vertical run of piping.

E. Renewable Parts: The term "renewable" as applied herein to discs and seat rings shall mean that the part is affixed or contained by a threaded element and can be readily removed for replacement. Seat rings requiring the use of special seat ring wrenches for removal shall be considered renewable.

F. Body: Body for cast-iron valve shall be unidirectional flow valve having a single disc and a set which provide a controlled closing rate, proportional to the flow. The flanges shall be cast integrally with the body.

1. Material: Cast iron conforming to the requirements of ASTM A126, Class B, or ASTM A278, Class 40.

2. Cover Plates: The check valve shall be equipped with a readily removable and replaceable bolted cover plate located on the top of the valve, designed to permit access to and removal of replaceable working parts from the valve without removal of the valve from the line. Cover plates shall be fabricated of the same material or better, as approved by the ENGINEER, than that specified herein for the body.

3. Seats: Seats shall be renewable. Body seat and disc seat material shall be stainless steel. Renewable seat rings shall be locked; in place with stainless steel lock screws and shall prevent leakage between the seat ring and body under the applicable service conditions.

4. Flow Control Devices: The flow control device shall be a swing disc suspended from the shaft. Material for the disc shall be cast iron. All flow control devices shall be renewable. Disc hangers and disc holders on cast iron body valves shall be fabricated of cast iron, malleable iron, ductile iron or steel.

5. Pivot Shaft: A one piece stainless steel shaft shall support the swing disc and shall extend from the valve body with enough clearance for the unobstructed operation of a weight-loaded operating level.

6. End Connections: End connections for valves shall be flat faced flanges conforming to ANSI B16.1, Class 125.

7. Operating Lever: A counter weighted operating lever shall be keyed to the pivot shaft. The torque on the operating lever shall be controlled by manual movement of the weight. The lever and weight assembly shall be designed to be repositioned so as to provide a force balancing the disk thereby minimizing the pressure at which the disc will open.

G. Finish

1. Interior ferrous metal surfaces of the valve shall be provided with a permanent fusion bonded epoxy coating. Coating shall conform to the requirements of AWWA C550.

2. Exterior ferrous metal surfaces of the valve shall be coated with manufacturer's standard bituminous coating.

H. Seat Wrenches: Valves with a renewable seat shall be provided with seat ring wrenches.

## 2.03 COMBINATION AIR/VACUUM VALVE

A. Manufacturer: Combination air/vacuum valve shall be Model No. 445 (Series 440 S.C.A.V.) with 2-inch inlet/outlet as manufactured by APCO Valve and Primer Corp., or approved equal.

B. Operation: Combination Air Valve (single body, double orifice) shall be designed to allow large volumes of air to escape or enter through the larger diameter air and vacuum orifice when filling or draining a pipeline.

When the pipeline is filled and pressurized the large air and vacuum orifice shall stay closed, but the smaller diameter air release orifice shall remain operative and open to allow small pockets of air accumulation, to escape automatically and independently of the large orifice.

The large air and vacuum orifice shall shut-off when the free floating-center guided plug is raised into the orifice by the lifting force of the concave - bottom float. The large orifice shut-off shall be "without spilling".

C. Material: The Buna-N seal must be fastened to the valve cover, without distortion, for drop tight shut-off. The overall height shall not exceed 27-inches and overall diameter shall not exceed 9½-inches. Materials of construction shall be as follows:

| | | |
|---|---|---|
| 1. Body and cover | Cast Iron | ASTM A126 GR.B |
| 2. Float-Concave | Stainless Steel | ASTM A240 |
| 3. Stem | Stainless Steel | ASTM A240 |
| 4. Needle and Seat | Buna-N | Nitrile Rubber |
| 5. Plug | Bronze | ASTM B124 |
| 6. Leverage Frame | Delrin or Cast Iron | ASTM D1233 |
| 7. Exterior Paint | Phenolic Primer | FDA Approved Red Oxide for Potable water |

## 2.04 PLUG VALVE

A. Manufacturer: Valves shall be the Keystone Ballcentric plug valve, DeZurik Series 100 eccentric plug valve or approved equal.

B. Design

1. Valves shall be of the non-lubricated eccentric type with resilient faced plug and shall be furnished with flanged connections as shown on the drawings. Flanged valves shall have flanges in full compliance to ANSI B16.1 Class 125 Standards, including facing and drilling. Face to face dimensions of flanged valves size shall be that of standard gate valves.

2. Port areas for all valves shall be at least 80% of full pipe area.

3. Valve bodies shall be of ASTM A126 Class B, cast iron. All exposed nuts, bolts,

springs, washers, etc., shall be stainless steel or zinc plated. Resilient faced plugs shall be of Buna-N or Neoprene. All valves to be of the bolted bonnet design and must be repacked under line pressure.

4. Valve bodies shall be furnished with a welded-in nickel seat across full profile of surface in contact with plug.

5. Valves shall be furnished with either permanent or replaceable stainless-steel bearing surfaces in the upper and lower journals designed to withstand full rated bearing loads and provide long life.

6. Valve shaft seals shall be externally adjustable with packing gland and shall be of either V packing or "O" ring type. If "O" ring type is used, the seal(s) shall be contained in a removable corrosion resistant cartridge or recess.

7. Nominal valve pressure ratings, body flanges and wall thicknesses shall be in full conformance to ANSI B16.1. Valves shall seal leak-tight against full rated pressure in both directions. Valve seats shall be tested and provide leak-tight shut-off to 175 psi with pressure in each direction. A hydrostatic shall test at twice rating shall be performed with plug open to demonstrate overall pressure envelope integrity.

C. Actuators

1. Plug valves shall have lever actuator unless otherwise indicated or specified.

## PART 3 EXECUTION

### 3.01 VALVE INSTALLATION

A. Set, align, position and properly connect new valves and operators for proper operation and to allow maximum access for maintenance. Provide proper and adequate clearance for valve operation. When operated, valves shall operate smoothly and operators shall not bind. Valves and valve operators shall be installed in accordance with the manufacturer's instructions.

B. Steady bearings for extended operators shall be set true with shaft and securely fastened to wall or structural steel.

END OF SECTION

# SECTION 15140

# SUPPORTS AND ANCHORS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Pipe and equipment hangers and supports for piping and ducts.

B. Equipment bases and supports.

C. Sleeves and seals.

D. Flashing and sealing equipment and pipe stacks.

### 1.02 REFERENCES

A. ASME B31.9 - Building Services Piping

B. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

### 1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate system layout with location and detail of hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of piping.

# PART 2 PRODUCTS

## 2.01 PIPE HANGERS AND SUPPORTS

A. Piping: All piping including PVC.

1. Conform to ASME B31.9, ASTM F708.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 Inches and Over: stainless steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Stainless Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
6. Wall Support for Pipe Sizes 4 Inches and Over: Type 304 stainless steel bracket and wrought steel clamp.
7. Vertical Support: Stainless Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or stainless steel support.

## 2.02 ACCESSORIES

A. Hanger Rods: Stainless steel threaded both ends, threaded one end, or continuous threaded.

## 2.03 INSERTS

A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## 2.04 FLASHING

A. Metal Flashing: 26 gage galvanized steel.

B. Metal Counterflashing: 22 gage galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb/sq ft sheet lead.
2. Soundproofing: 1 lb/sq ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

## 2.05 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Sleeves for Round Ductwork: Galvanized steel.

E. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

F. Stuffing or Firestopping Insulation: Glass fiber type, non-combustible.

G. Sealant: Acrylic.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

## 3.02 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

## 3.03 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal pipe adjacent to each joint, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide sheet lead packing between hanger or support and piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. All steel hangers and supports shall be stainless steel.

## 3.04 EQUIPMENT BASES AND SUPPORTS

A. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct supports of steel members. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors for pipes after vibration isolation components are installed.

## 3.05 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and calk, metal counterflash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower and mop sink drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

## 3.06 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

C. Extend sleeves through floors one inch above finished floor level. Calk sleeves.

D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and calk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

E. Install stainless steel escutcheons at finished surfaces.

## 3.07 SCHEDULES

HANGER ROD

| PIPE SIZE (Inches) | MAX. HANGER SPACING (Feet) | DIAMETER (Inches) |
|---|---|---|
| 1/2 to 1-1/4 | 6.5 | 3/8 |
| 1-1/2 to 2 | 10 | 3/8 |
| 2-1/2 to 3 | 10 | 1/2 |
| 4 to 6 | 10 | 5/8 |
| PVC (All Sizes) | 6 | 3/8 |

END OF SECTION

# SECTION 15160

# PRE-ENGINEERED SELF-PRIMING PUMP STATION

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. Work under this section includes, but is not limited to, furnishing and installing two (2) factory built duplex pump station with stainless steel pumps as indicated on the project drawings, herein specified, as necessary for proper and complete performance. Each pump station shall be built and rated for explosion-proof service.

### 1.01 REFERENCES

A. Publications listed below form part of this specification to extent referenced in the text by basic designation only. Consult latest edition of publication unless otherwise noted.

1. American National Std. Institute (ANSI) / American Water Works Assoc. (AWWA)

| | | |
|---|---|---|
| a. | ANSI B16.1 | Cast iron pipe flanges and flanged fittings. |
| b. | ANSI/AWWA C115/A21.15 | Cast/ductile iron pipe with threaded flanges. |
| c. | ANSI Z253.1 | Safety Color Code for Marking Physical Hazards. |
| d. | ANSI B40.1 | Gages, Pressure and Vacuum. |
| e. | AWWA C508 | Single Swing Check Valves. |

2. American Society for Testing and Materials (ASTM)

| | | |
|---|---|---|
| a. | ASTM A48 | Gray Iron Castings. |
| b. | ASTM A126 | Valves, Flanges, and Pipe Fittings. |
| c. | ASTM A307 | Carbon Steel Bolts and Studs. |
| d. | ASTM A36 | Structural Steel. |

3. Institute of Electrical and Electronics ENGINEERs (IEEE)

| | | |
|---|---|---|
| a. | ANSI/IEEE Std 100 | Standard Dictionary of Electrical Terms. |
| b. | ANSI/IEEE Std 112 | Test Procedure for Polyphase Induction Motors. |

| | | |
|---|---|---|
| c. | IEEE Std 242 | Protection of Industrial and Control Power Systems. |

4. National Electrical Code (NEC) / National Electrical Manufacturers Assoc. (NEMA)

| | | |
|---|---|---|
| a. | NEC | National Electrical Code. |
| b. | NEC 701 | National Electrical Code Article 701 |
| c. | NEMA MG1 | Motors and Generators. |

5. Miscellaneous References

| | | |
|---|---|---|
| a. | Ten-State Standards | Recommended Standards for Sewage Works. |
| b. | Hydraulic Institute | Std for Centrifugal, Rotary and Reciprocating Pumps. |
| c. | NMTBA and JIC Std | National Machine Tool Builders Association and Joint Industrial Council Standards |
| d. | ISO 9001 | International Organization for Standardization |

## 1.02 SYSTEM DESCRIPTION

A. CONTRACTOR shall furnish and install two (2) factory built above ground, automatic pump stations. Each pump station shall be located at the Cherry Island Landfill as indicated on the plans. The stations shall be complete with all equipment specified herein, factory assembled on a common steel base installed within a fiberglass reinforced polyester resin enclosure. The pump stations shall be rated for explosion-proof environment.

B. Principal items of equipment at each self-priming pump station location shall include the following:

1. Two self priming, horizontal, centrifugal pumps, V-belt drives, explosionproof motors, piping, and valves.

2. A pump control panel with thermal-magnetic circuit breakers, magnetic motor starters, automatic liquid level control system and internal wiring suitable for remote (surface/wall) mounting on an electrical equipment rack.

## 1.04 PERFORMANCE CRITERIA

A. Pumps must be designed to handle landfill leachate and/or contaminated groundwater and pumps shall have 4 inch suction connection, and 4 inch discharge connection. Each pump shall be selected to perform under following operating conditions:

| | | Self-Priming P.S. No. 3 | Self-Priming P.S. No. 5 |
|---|---|---|---|
| 1. | Number of Pumps | 2 | 2 |
| 2. | Capacity (GPM) | 175 | 280 |
| 3. | Total Dynamic Head (FT) | 73 | 62 |
| 4. | Total Dynamic Suction Lift (FT) | 12 | |
| 5. | Maximum Repriming Lift (FT) | 25 | |
| 6. | Total Discharge Static Head (FT) | 0 | |
| 7. | Minimum Submergence Depth (FT) | 2 | |

B. Site power furnished to each pump station shall be 3 phase, 60 hertz, 480 volts, 4 wire, maintained within industry standards. Voltage tolerance shall be plus or minus 10 percent.

## 1.05 SUBMITTALS

A. Product Data

1. Prior to fabrication, pump station manufacturer shall submit 4 copies of submittal data for review and approval.

2. Submittal shall include shop drawings, and support data as follows: Catalog cuts sheets reflecting characteristics for major items of equipment, materials of construction, major dimensions, motor and v-belt drive data, pump characteristic curves showing the design duty point capacity (GPM), head (FT), net positive suction head required (NPSHr), and hydraulic brake horsepower (BHP). Electrical components used in the motor branch and liquid level control shall be fully described. Include comprehensive/complete wiring diagrams for all equipment and controls.

3. Pump Manufacturer shall certify that the pump is suitable for this installation as currently designed.

4. Shop drawings shall provide layout of mechanical equipment and anchor bolt locations for station. CONTRACTOR piping connections and station access clearances shall be dimensioned relative to the station centerline.

B. Operations Maintenance Manuals

1. Installation shall be in accordance with written instructions provided by the Pump Manufacturer. Comprehensive instructions supplied at time of shipment shall enable personnel to properly operate and maintain all equipment supplied. Content and instructions shall assume operating personnel are familiar with pumps, motors, piping and valves, but lack experience on exact equipment supplied.

2. Documentation shall be specific to the pump station supplied and collated in functional sections. Each section shall combine to form a complete system manual covering all aspects of equipment supplied by the station manufacturer. Support data for any equipment supplied by others, even if mounted or included in overall station design shall be provided by those supplying the equipment. Instructions shall include the following as a minimum:

   a. Functional description of each major component, complete with operating instructions.
   b. Instructions for operating pumps and pump controls in all modes of operation.
   c. Calibration and adjustment of equipment for initial start-up, replacement of level control components, or as required for routine maintenance.
   d. Support data for commercially available components not produced by the pump manufacturer, but supplied in accordance with the specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices.
   e. Electrical schematic diagram of the pump station circuits shall be in accordance with NMTBA and JIC standards. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.
   f. Mechanical layout drawing of the pump station and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping.

3. Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

## 1.06 QUALITY ASSURANCE

A. The manufacturer of the pump station shall have a quality management system in place and shall be ISO 9001 certified.

B. Upon request from the ENGINEER, the Pump Manufacturer shall prove financial stability and ability to produce the station within the specified delivery schedules. Evidence of facilities, equipment and expertise shall demonstrate the manufacturer's commitment to long term customer service and product support.

C. Pump Performance Certifications. All internal passages, impeller vanes, and recirculation ports shall pass a 2½ inch spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

D. Reprime Performance

1. Consideration shall be given to the landfill leachate sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

2. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

3. Pump must be designed to reprime 15 vertical ft. at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:

a. A check valve to be installed down stream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.
b. A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
c. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 4.5 feet minimum horizontal run, a 90° elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
d. Impeller clearances shall be set as recommended in the pump service manual.
e. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
f. Liquid to be used for reprime test shall be water.

4. Certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional ENGINEER, shall be submitted for approval prior to shipment.

E. Factory System Test

1. All components including the pumps, motors, valves, and piping will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational test shall duplicate actual performance anticipated for the complete station.

2. Upon request from the ENGINEER, the operational test may be witnessed by the ENGINEER, and/or Representatives of his choice, at the manufacturer's facility.

3. Manufacturer shall submit copies of pump test results indicating a minimum of 4 test points for performance and 2 test points for NPSHR plotted on published pump curves for model number, impeller size and speed of pump being supplied. These test results are to be signed and sealed by a Professional ENGINEER.

F. The manufacturers technical representative shall inspect the completed installation, correct or supervise the correction of any defect or malfunction, and instruct

operating personnel in the proper operation and maintenance of the equipment as described in Part 3 of this section.

G. Mass Elastic Systems and Critical Speeds:

1. Each complete system, including pump, motor, and all appurtenances, shall have no dangerous critical or resonance frequencies or multiples of resonance frequencies within 20 percent above and 35 percent below the speed range required by the pump to meet the specified operating conditions.

2. For the purposes of design, a dangerous vibratory critical speed shall be defined as one which produces a torsional stress exceeding 3,500 psi. The CONTRACTOR shall be responsible for the analysis of critical speeds and the complete mass elastic system, which shall be analyzed and certified by a registered professional ENGINEER regularly engaged in this type of work. Nothing in this provision shall be construed as relieving the CONTRACTOR of his responsibility for this portion of the work.

## 1.07 MANUFACTURER'S WARRANTY

A. The Pump Manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

1. The pump station enclosure shall be warranted for a period of 10 years to be completely resistant to rust, corrosion from moisture, corrosive soils, or physical failures occurring in normal service, without protective coating, when installation is made according to the manufacturer's recommendations.

2. All equipment, apparatus, and parts furnished shall be warranted for five (5) year after start-up, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump and all components.

B. Components failing to perform as specified by the ENGINEER, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the OWNER.

# PART 2 PRODUCTS

## 2.01 UNITARY RESPONSIBILITY

A. In order to unify responsibility for proper operation of the complete pumping station, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source). The pumping station must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted.

## 2.02 MANUFACTURER

A. The pump station system integrator shall have a quality management system in place and shall be ISO 9001 certified.

B. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company which are deemed suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The CONTRACTOR shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

C. After execution of the Contract Documents, the CONTRACTOR may offer substitutions to the specified equipment for consideration. The equipment proposed for substitution must be superior in construction and performance to that specified in the contract, and the higher quality must be demonstrated by a list of current users of the proposed equipment in similar installations.

D. In event the CONTRACTOR obtains ENGINEER's approval for equipment substitution, the CONTRACTOR shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the ENGINEER prior to acceptance.

E. It will be assumed that if the cost to the CONTRACTOR is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

## 2.03 PUMP STATION ENCLOSURE

A. Enclosure Construction and Design:

1. Each station enclosure shall provide sufficient inside area for maintenance personnel to perform normal operation and maintenance inside, sheltered, and free from foul weather. The enclosure shall consist of a base to support the pumps and a cover that can be moved without lifting. Minimum dimensions of the enclosure shall be seven feet by ten feet and six feet in height.

2. Each station enclosure shall be manufactured of molded fiberglass reinforced orthophthalic polyester resins with a minimum of 30% fiberglass, and a maximum of 70% resin. Glass fibers shall have a minimum average length of 1¼ inches. Resin fillers or extenders shall not be used. Major design considerations shall be given to structural stability, corrosion resistance, and water-tight properties. The polyester laminates shall provide a balance of mechanical, chemical, and electrical properties to insure long maintenance free life. They must be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases which can reasonably be expected to be present in the environment surrounding the wet well. Wood core type enclosures shall not be considered acceptable and shall be basis for equipment rejection. See manufacturer's requirements for enclosure warranty in these specifications.

3. All interior surfaces of the housing shall be gel coated with a polyester resin. It shall be of suitable thickness and formulated to provide:

   a. Maintenance-free service
   b. Abrasion resistance
   c. Protection from sewage, greases, oils, gasoline, and other common chemicals
   d. Color fastness
   e. Gloss retention

4. Interior surfaces of the enclosure cover and end panels shall be white for maximum light reflectivity. The base shall be of a darker color to de-emphasize the presence of dirt, grease, etc. Colors used for both portions shall result in a pleasing looking structure.

5. The outside of the enclosure shall be coated with a suitable UV resistant, pigmented resin compound to insure long, maintenance-free life. The fiberglass enclosure shall be a regular product of the pump station manufacturer.

6. Station base shall be constructed with a completely encapsulated structural steel frame for corrosion protection. Frame shall provide adequate structural support for pumps, motors, and piping. The encapsulated frame shall extend to lift points provided and assure adequate strength to resist deformation of structure during

shipping, lifting, or handling. The structural steel base shall be completely encapsulated within a molded fiberglass reinforced polyester base shell. Wall thickness shall be a minimum of 3/16 inch and base height a minimum of 5 inches to provide natural drainage of pump station floor to concrete pad. Interior of base shall be filled with a foamed in place rigid polyurethane structural foam. Foam shall be of closed cell type with a minimum density of 2.5 Pounds/cubic feet to give adequate floor support for maintenance personnel and for handling of equipment.

7. Holes through the base shall be provided for suction and discharge lines, air release lines, and level control line. Holes for the suction and discharge lines shall be provided with a grout dam incorporated in a grout retention cavity which the CONTRACTOR shall fill at installation with suitable grout to seal each pipe-to-base joint against the entrance of hazardous gases from the wet well.

8. Station base shall incorporate a suitable flange designed for securing the pump station to the concrete pad in accordance with the station plans.

9. The enclosure cover shall be movable without lifting to permit overhead access to either half of the station interior and shall be completely removable. A hasp and staple locking device shall be completely removable. A hasp and staple locking device shall be provided to secure the enclosure over the station base. Suitable gasketing shall be provided between the enclosure cover and end panels and base for protection from the elements.

10. The enclosure cover shall be provided with a hinged fiberglass reinforced access door. Minimum dimensions of the door shall be 27 inches wide by 56 inches high for access by maintenance personnel to station interior. Door shall be a minimum 5/8 inch thick and shall be hinged with a full-length stainless steel piano hinge to a full perimeter aluminum door casing secured to the enclosure cover. Such door casing shall incorporate a suitable drip shield over the opening. Door shall be furnished with a locking handle connected to a three-point latching mechanism. Latch shall engage door casing at top, side and bottom for maximum security against vandalism. All mounting hardware for door casing and door must be concealed or of such type as to prevent vandalism with ordinary tools.

B. Enclosure Functional Equipment:

1. All equipment, devices, conduits, fittings, wiring, and appurtenances shall be rated for use in a Class I, Division 1, Groups C and D hazardous location.

2. A shuttered exhaust fan with a minimum capacity of 500 CFM to change the air in the enclosure once every minute, shall be mounted in one end wall. In the wall approximately opposite to this end panel shall be mounted an air intake. Both intake and exhaust opening prevent the entrance of rain, snow, rocks, and other foreign material. Fan circuit shall be protected by a remotely mounted normal duty circuit breaker and shall be provided with a disconnect switch. Fan shall be explosion-proof.

3. An enclosed and gasketed 300-watt explosion-proof light fixture shall be provided. The fixture shall be vapor-tight, universal type. The fixture shall be furnished with a metallic guard and centrally located to provide adequate light to all parts of the station and shall not constitute a physical hazard to inspection of service personnel. Light circuit shall be protected by a remotely mounted normal duty circuit breaker and shall be provided with a disconnect switch.

4. An explosion-proof 3 kW, 480 volt, 3-phase forced air heater with thermostat shall be provided for protection of equipment to –30 deg. F. Heater circuit shall be protected by a remotely mounted normal duty circuit breaker and shall be provided with a disconnect switch.

## 2.04 UNIT BASE

A. The unit base shall be comprised of structural steel with a perimeter flange and reinforcements. Perimeter flange and reinforcements shall be designed to prevent flexing or warping under operating conditions. Perimeter flange shall be drilled for hardware used to secure unit base to concrete pad as shown on the contract drawings. Unit base shall contain provisions for lifting the complete pump unit during shipping and installation.

## 2.05 PUMP DESIGN

A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling landfill leachate and/or contaminated wastewater. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this section. The pumps shall be constructed of complete stainless steel material including all hardware and accessories in contact with the pumped fluid.

B. The manufacturer of the pumps shall have a quality management system in place and shall be ISO 9001 certified.

C. Materials and Construction Features

1. Pump casing: Casing shall be CD4MCU alloy stainless steel with integral volute scroll. Casing shall incorporate following features:

   a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.
   b. Fill port cover plate, 3 ½ inch diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.
   c. Casing drain plug shall be at least 1 ¼ inch NPT to insure complete and rapid draining.
   d. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this section.

2. Cover plate: Cover plate shall be CD4MCU alloy stainless steel. Design must incorporate following maintenance features:

   a. Retained by hand nuts for complete access to pump interior. Cover plate removal must provide ample clearance for removal of stoppages, and allow service the impeller, seal, wear plate or check valve without removing suction or discharge piping.
   b. A replaceable wear plate secured to the cover plate by weld studs and nuts shall be CD4MCU alloy stainless steel.
   c. In consideration for safety, a pressure relief valve shall be supplied in the cover plate. Relief valve shall open at 75-200 PSI.
   d. O-ring of Viton material shall seal cover plate to pump casing.

3. Rotating Assembly: A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

   a. Seal plate and bearing housing shall be CD4MCU alloy stainless steel. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped and lip seals will prevent leakage of oil. The bearing cavity to have an oil level sight gauge and fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

b. Impeller shall be CD4MCU alloy stainless steel, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.
c. Shaft shall be 17-4 PH stainless steel.
d. Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.
e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy. Each mating surface shall be lapped to within three light band flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the seal plate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be AISI 316 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.
f. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means. Stainless steel adjusting shims shall be used to move the entire rotating assembly as a unit when adjusting the working clearances. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.
g. Suction check valve shall be molded Viton with integral steel and nylon reinforcement. A blowout center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the cover plate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.
h. Spool flanges shall be one-piece CD4MCU alloy stainless steel, fitted to suction and/or discharge ports. Each spool shall have one 1-1/4 inch NPT and one ¼ inch NPT tapped hole with pipe plugs for mounting gauges or other equipment.

D. Serviceability

1. The Pump Manufacturer shall demonstrate to the ENGINEER's satisfaction that consideration has been given to reducing maintenance costs by incorporating the following features.
2. No special tools shall be required for replacement of any components within the pump.

E. Drain Kit:

1. Pumps to be supplied with a drain kit for ease of maintenance. The kit to contain 10' length of reinforced plastic hose with a female quick connect fitting at one end, and factory installed drain fittings in each pump. Fittings include a pipe nipple, bushing, bronze gate valve and male quick connect fitting. All fittings shall be stainless steel.

F. Spare Parts Kit:

1. The following minimum spare parts shall be furnished with each pump station:

   a. One spare pump mechanical seal (complete with shaft sleeve).
   b. One cover plate O-Ring.
   c. One rotating assembly O-Ring.
   d. One set of impeller clearance adjustment shims.
   e. One wear plate.
   f. One impeller.

## 2.06 VALVES AND PIPING

A. Each pump shall be equipped with a full flow type check valve, capable of passing a 3 inch spherical solid, with flanged ends and be fitted with an external lever and spring. The valve seat shall be constructed of stainless steel and shall be replaceable. The valve body shall be cast iron and incorporate a 3 inch cleanout port. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings, sealing bushing shall have double o-rings. O-rings shall be easily replaceable without requiring access to interior of valve body. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3 inch spherical solid shall not be acceptable. All internal hardware shall be 316SS.

B. A 3-way plug valve must allow either or both pumps to be isolated from the force main. Valve shall pass 3 inch spherical solids. The plug valve shall be non-lubricated,

tapered type. Valve body shall be semi-steel with flanged end connections drilled to 125 pound standard. The drip-tight shutoff plug shall be mounted in stainless steel bearings, and shall have a resilient facing bonded to the sealing surface. Valve shall be operated with a single lever actuator providing lift, turn, and reseat action. The lever shall have a locking device to hold the plug in the desired position.

C. Automatic Air Release Valves:

1. An automatic air release valve shall be furnished for each pump designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming cycle or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visual indication of valve closure, and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.

2. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms, if used, shall be of fabric-reinforced neoprene or similar inert material.

3. A cleanout port, three inches in diameter, shall be provided for ease of inspection, cleanout, and service.

4. Valves shall be field adjustable for varying discharge heads.

D. Gauge Kit

1. A gauge kit shall be supplied for each pump. Suction pressure must be monitored by a glycerin-filled compound gauge, and discharge pressure by a glycerin-filled pressure gauge. Gauges to be at least 4 inches in diameter, graduated in feet water column. Rated accuracy shall be 1% of full scale reading. Compound gauge shall be graduated -30 to +30 feet water column minimum. Pressure gauge to be graduated 0 to 70 feet water column minimum.

2. Gauges to be factory mounted on a resilient panel with frame assembly secured to pumps or piping. Gauge installations shall be complete with all hoses and fittings, including a shutoff valve for each gauge line at the point of connection to suction and discharge pipes. All fittings and valves shall be stainless steel.

E. Piping

1. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.

2. Flanges shall be cast iron class 125 and Comply with ANSI B16.1.

3. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.

4. Bolt holes shall be in angular alignment within 1/2 degrees between flanges. Flanges shall be faced with a gasket finish having concentric grooves a minimum of 0.01 inch deep by approximately 0.03 inch wide, with a minimum of three grooves on any given surface spaced a maximum of 1/4 inch apart.

F. Supports and Thrust Blocks

1. CONTRACTOR must insure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping. Pump station discharge force main piping shall be anchored with thrust blocks.

## 2.07 DRIVE UNIT

A. Motors:

1. Each motor shall be 10 hp 480 volt, 3 phase, 60 hertz, horizontal, explosion-proof, 1800 RPM, NEMA design B with cast iron frame with copper windings, induction type, with Class F insulation and 1.15 SF for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.

2. Motor shall be tested in accordance with provisions of ANSI/IEEE Std. 112.

B. Drive Transmission

1. Power to the pumps shall be transmitted by V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.

2. Each drive assembly shall utilize at least two V-belts providing minimum a combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5 are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer.

3. The Pump Manufacturer shall submit power transmission calculations which document the following:

   a. Ratio of pump/motor speed.
   b. Pitch diameter of driver and driven sheaves.
   c. Number of belts required per drive.
   d. Theoretical horsepower transmitted per belt, based on vendor's data.
   e. Center distance between pump and motor shafts.
   f. Arc-length correction factor applied to theoretical horsepower transmitted.
   g. Service factor applied to established design horsepower.
   h. Safety factor ratio of power transmitted/brake horsepower required.

4. Belt guards

   a. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed ½ inch.
   b. Guards must be completely removed without interference from any unit component, and shall be securely fastened and braced to the unit base.
   c. Metal to be free from burrs and sharp edges. Structural joints shall be continuously welded. Rivet spacing on panels shall not exceed five inches. Tack welds shall not exceed four inch spacing.
   d. The guard shall be finished with one coat of gray W.R. non-lift primer and one coat of orange acrylic alkyd W.R. enamel in accordance with section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

## 2.08 FINISH:

A. Pumps, piping, and exposed steel framework shall be cleaned prior to painting. Exposed surfaces to be coated with one coat gray W.R. non-lift primer and one coat white acrylic alkyd W.R. enamel. Paint shall be low VOC, alkyd based, high solids, semi-gloss white enamel for optimum illumination enhancement, incorporating rust inhibitive additives. The finish coat shall be 1.0 to 1.5 MIL dry film thickness (minimum), resistant to oil mist exposure, solvent contact, and salt spray. The factory finish shall allow for over-coating and touch up after final installation.

## 2.09 ELECTRICAL CONTROL COMPONENTS

A. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.

B. The electrical control components shall be provided by the pump station supplier and shall be provided with the following features. Control panel shall be shipped loose for mounting outside enclosure.

C. Pump Control Panel Enclosure.

1. Enclosure shall be constructed in conformance with National Electrical Manufacturer's Association (NEMA) standards for Type 4X electrical enclosures. Enclosure shall be fabricated of stainless steel (14 gauge) minimum. All seams shall be continuously welded and shall be free of burrs and voids. Interior and exterior surfaces shall be white enamel. There shall be no holes through the external walls of the enclosure for mounting the enclosure or any components contained within the enclosure. Panel enclosure shall be mounted on floor stands.

2. Enclosure shall be equipped with a door mounted on a continuous stainless steel hinge, and sealed around its perimeter. Door shall be held closed with clamps that are quick and easy to operate. The door shall accommodate the mounting of switches and indicators.

3. Enclosure shall be furnished with a removable back panel, fabricated of steel (12 gauge) minimum, which shall be secured to the enclosure with collar studs. Panel shall be of adequate size to accommodate all basic components.

4. All control components shall be securely fastened to a removable back panel with screws and lock washers. Switches, indicators and instruments shall be mounted through the control panel door. Self-tapping screws shall not be used to mount any components. All connections from the back panel to door mounted or remote devices shall be made through terminal blocks.

D. UL Label Requirement: Pump station controls shall conform to third party safety certification. The panel shall bear a serialized U.L. label listed for "Enclosed Industrial Control Panels". The enclosure and all components mounted on the subpanel or control cover shall conform to U.L. descriptions and procedures.

E. Auxiliary Power Transformer: The Pump Control Panel shall be equipped with a 3 KVA stepdown transformer to supply 120 volt, AC, single phase electric power for the control and auxiliary equipment. The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door with a padlockable operator handle secured on the exterior surface.

Interlocks shall prevent opening of the door until circuit breakers are in the "OFF" position.

F. Motor Control Components:

1. A main terminal block and ground lug shall be furnished for field connection of the electrical supply. The connections shall be deigned to accept copper conductors of sufficient size to serve the pump station loads. The main terminal block shall be mounted to allow incoming wire bending space in accordance with Article 373 of the National Electrical Code (NEC). A separate terminal strip shall be provided for 120 volt, single-phase control power and shall be segregated from the main terminal block. Ten percent of the control terminals shall be furnished as spares.

2. All motor control components shall be of the highest industrial quality. Operating coils of all AC control devices shall be rated for 120 volts, 60 hertz.

3. A properly sized heavy duty circuit breaker shall be furnished for each pump motor, and shall have a symmetrical RMS interrupting rating of 14,000 amperes at 480-volts, minimum. A padlockable operating mechanism shall be installed on each motor circuit breaker. Operator handles for the mechanisms shall be located on the exterior of the control panel door with interlocks to prevent opening of the door until circuit breakers are in the "OFF" position.

4. A full voltage non-reversing, NEMA rated magnetic motor starter shall be furnished for each pump motor. Starters shall be NEMA Size 1 or larger and shall have at least two auxiliary contacts. Power contacts shall be double-break and made of cadmium oxide silver. All motor starters shall be equipped to provide undervoltage release and overload protection on all three phases. Motor starter contacts shall be easily replaceable without removing the motor starter from its mounted position.

5. Overload relays shall be block-type, utilizing melting alloy type spindles, and shall have visual trip indication with trip-free operation. Pressing of the overload reset lever shall not actuate the control contact until such time as the overload spindle has reset. Resetting of the overload reset lever will cause a snap-action control contact to reset, thus re-establishing a control circuit. Overload relays shall be manual reset only and not convertible to automatic reset. Trip setting shall be determined by heater element only and not by adjustable settings.

6. Overload reset pushbuttons shall be mounted through the door of the control panel in such a manner as to permit resetting the overload relays without opening the control panel door.

7. The control panel shall be equipped with a surge arrester to minimize damage to the pump motors and control from transient voltage surges. The arrester shall utilize metal-oxide varistors encapsulated in a non-conductive housing.

8. The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, and low voltage. A time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart when power conditions return to normal.

9. The control panel shall be supplied with a properly sized condensation heater. The heater shall consist of a thermostat, resistance type heating grid and fan to circulate air through the enclosure. The entire unit shall be enclosed with all heater components within the enclosure.

G. Miscellaneous Control Components:

1. The control circuit shall be fused and shall be provided with a disconnect switch connected in such a manner as to allow control power to be disconnected from all control circuits.

2. Pump mode selector switches shall be connected to permit manual start and manual stop of each pump motor individually. Manual operation shall override shutdown systems supplied with the level control system except motor overload.

3. Pump sequence selector switch shall permit selection of automatic pump alternation or selection of either pump to run as lead pump for each cycle.

4. A pushbutton switch shall be provided to silence alarm circuits while corrective actions are underway. Depressing the alarm silence pushbutton shall also cause the high water alarm circuit to reset when the liquid level has been lowered.

5. The control panel shall be equipped with circuitry to override the level control system and shut down the pump motor(s) when required to protect the pump from damage caused by excessive temperature.

6. An explosionproof or intrinsically safe thermostat shall be mounted on each pump to detect its temperature. If the pump temperature should rise to a level which

could cause pump damage, the thermostat shall cause the shutdown circuit to drop out the motor starter. An indicator, visible on the front of the control panel, shall indicate that the pump motor has been stopped because of a high temperature condition. The pump shall remain locked out until the pump has cooled and the circuit has been manually reset. Automatic reset of such a circuit shall not be acceptable.

7. Six-digit elapsed time meters (non-reset type) shall be connected to each pump motor starter to indicate the total running time of each pump in "hours" and "tenths of hours".

8. A duplex ground fault indicating utility receptacle providing 120 VAC, 60 hertz, single-phase current shall be mounted on the side of the control enclosure. Receptacle circuit shall be protected by a 15-ampere thermal-magnetic circuit breaker installed in the pump control panel.

9. Provide control circuitry with connections for external wiring interlock(s) which shall allow operation of the pumps under normal conditions in the downstream pumping station(s) and inhibit operation of the pumps in the event of high water level conditions in the downstream pumping station(s). This interlock circuitry shall be furnished with a panel mounted pilot light indicating when the pumps are inhibited and a manual over-ride switch.

10. Indicating lights shall be oil tight type and equipped with integral step-down transformers for long lamp life. Lamps shall be incandescent type rated 14 volts or less. Lamps shall be replaceable from the front without opening the control panel door and without the use of tools. Indicating lights will be provided for the following functions:

    a. Pump #1 high pump temperature shutdown.
    b. Pump #2 high pump temperature shutdown.
    c. High wet well level.
    d. Low wet well level.
    e. Alarm silenced.
    f. Pump #1 run.
    g. Pump #2 run.
    h. Pump interlock inhibit.
    i. Back-up system engaged.

11. The control panel shall be equipped with a redundant "high water level alarm" float switch including intrinsically safe circuitry suitable for landfill leachate wet well use. The float switch shall be installed in the wet well and the redundant

circuitry shall be connected (in parallel) to the high water level alarm channel of a remotely mounted automatic telephone dialer.

12. Provide circuitry for high water level alarm, low water level alarm, and pump excessive temperature alarm.

    a. A front of panel mounted pilot light shall be activated upon obtaining a high water level condition in the wet well.
    b. A front of panel mounted pilot light indication of pump excessive temperature alarm.
    c. A front of panel mounted pilot light indication of pump interlock inhibit alarm.
    d. A front of panel mounted pilot light indication of a low water level condition.
    e. Provide contacts so that activation of any of the above alarm conditions can transmit a signal to a remote alarm device.
    f. Provide a red flashing alarm light mounted on the top exterior of the control panel/enclosure. This light shall be activated in response to any of the above alarm conditions. The alarm light shall be Edwards (General Signal) Catalog No. 52R-N5 or an acceptable equivalent.

H. Wiring.

1. Each pump station as furnished by the manufacturer shall be completely wired except for the power feeder lines and final connections to pump motors, auxiliary equipment, and remote alarm devices. All interconnecting wire, conduit, and other materials required shall be furnished and installed by the CONTRACTOR.

2. All wiring, workmanship, and schematic wiring diagrams shall be in compliance with applicable standards and specifications for industrial controls set forth by the Joint Industrial Council (JIC), National Machine Tool Builders Association (NMTBA), and the National Electrical Code (NEC).

3. All user serviceable wiring shall be type MTW or THW, 600 volts and shall be color coded as follows:

| | | |
|---|---|---|
| a. | Line and load circuits, AC or DC power: | black. |
| b. | AC control circuit less than line voltage: | red. |
| c. | DC control circuit: | blue. |
| d. | Interlock control circuit, from external source: | yellow. |
| e. | Equipment grounding conductor: | green. |
| f. | Neutral: | white. |

g. Hot with circuit breaker open: orange.

4. Control circuit wiring inside the panel, with the exception of internal wiring of individual components, shall be 16-gauge minimum, type MTW or THW, 600 volts. Wiring in conduit shall be 14-gauge minimum. Motor branch wiring shall be 10-gauge minimum.

5. Motor branch conductors and other power conductors shall not be loaded above 60-degree C temperature rating, on circuits of 100 amperes or less, nor above 75-degree C on circuits over 100 amperes. Wires shall be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall be of the ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied. All wires extending from components mounted on door shall be terminated on a terminal block mounted on the back panel. All wiring outside the panel shall bee installed in conduit.

6. Control conductors connecting components mounted on the enclosure door shall be bundled and tied in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall be allowed so that the door can swing to its full open position without undue mechanical stress or abrasion on the conductors or insulation. Bundles shall be clamped and held in place with mechanical fastening devices on each side of the hinge.

I. Conduit.

1. All conduit and fittings shall be UL listed.

2. Liquid tight flexible metal conduit shall be constructed of a smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight, polyvinyl chloride cover.

3. Conduit shall be supported in accordance with Articles 346, 347, 350, and 351A of the National Electrical Code.

4. Conduit shall be sized according to the National Electrical Code.

J. Grounding.

1. The pump station manufacturer shall ground all electrical equipment to the enclosure back panel. The mounting surface of all ground connections shall have any paint removed before making final connections.

2. The CONTRACTOR shall provide an earth driven ground connection to the control panel at the main ground lug in accordance with the National Electrical Code (NEC).

K. Spare Parts: The following spare parts shall be furnished with the Pump Control Panel.

1. Three (3) of each size and type of indicator lamps used in the panel.

2. Two (2) of each size and type of fuse used in the panel.

## 2.10 LIQUID LEVEL CONTROL SYSTEM (EPS WITH SUBMERSIBLE TRANSDUCER)

A. The level control system shall be provided with an electronic pressure switch (EPS) to start and stop the pump motors in response to changes in the wet well level.

B. The level control system shall utilize a submersible transducer which shall extend into the wet well. The transducer shall provide wet well level signals for the level control system.

C. The level control system shall be designed to accomplish the following tasks:

1. Continuously monitor the level of liquid in the wet well.

2. Start and stop pumps as required by the level of liquid in the wet well.

3. Select the operation of one pump or both pumps.

4. Select the sequence of pump operation upon operator command for automatic alternation.

5. Provide alarm indications upon occurrence of predetermined malfunctions.

6. Upon restoration of power after a power outage, the system shall delay the start of the pumps by a length of time that has been preselected by the operator.

7. Shut down a pump motor when the temperature of that pump reaches a level which could cause pump damage.

D. The level control system shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the electronic pressure switch shall start the second pump when the liquid reaches the "lag pump start level", so that both pumps are operating to pump down the well. Pumps shall stop at their respective "stop" levels. These levels shall be adjustable.

E. The level control system shall utilize an alternator relay to select first one pump, then the second pump, to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle.

F. Electronic Pressure Switch.

1. The electronic pressure switch shall include integral components to perform all pressure sensing signal conditioning, EMI and RFI suppression, DC power supply and 120 volt outputs. Comparators shall be solid state and shall be integrated with the other components of the system.

2. The electronic pressure switch shall be capable of operating on a power supply 120 volts AC, 60 hertz, in an ambient temperature range of 14 degrees F through 131 degrees F. Control range shall be 0 to 12.0 feet of water with an overall repeat accuracy of plus or minus 0.1 feet of water.

3. The electronic pressure switch shall consist of the following integral components: submersible type pressure sensor, display, electronic comparators, and output relays.

   a. Submersible Type Pressure Sensor: The (level) pressure sensor shall be a diffused silicon piezoresistive semi-conductor submersible sensor which shall be designed to install into the wet well. The sensor shall convert the wet well level to a proportional electrical signal for distribution to the display and electronic comparators. The sensor output shall be filtered to prevent control response to level pulsations or surges. The sensor range shall be 0 to 5 psi, temperature compensated from 32 degrees F through +122 degrees F, with a total accuracy of plus or minus 0.50% full scale about a fixed temperature. Sensor overpressure rating shall be 3 times full scale. Sensor housing and diaphragm shall be stainless steel of non-clogging design with silicone oil fill fluid. A laser trimmed hybrid circuit shall be used to standardize output and

null offset and to provide precise temperature compensation. The pressure sensor shall be a strain gauge transducer type. The sensor shall be provided with intrinsically safe circuitry suitable for landfill leachate wet well use.

b. Display: The electronic pressure switch shall incorporate a digital panel meter which, upon operator selection, shall display liquid level in the wet well, and the preset start and stop levels for both the lead and lag pumps. The meter shall be a 3½ inch digit display calibrated to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full scale indication of not less than 10 feet.

c. Electronic Comparators: Level adjustments shall be electronic comparator setpoints to control the levels at which the lead and lag pumps start and stop and at which the high and low water level alarms activate. Each of the level settings shall be adjustable, and accessible to the operator without opening the control panel or any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.

d. Output Relays: Each output relay in the electronic pressure switch shall be solid state. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. The "ON" state of each relay shall be indicated by illumination of a light emitting diode. The output of each relay shall be individually fused providing fused overload and short circuit protection. Each output relay shall have an inductive load rating of 10A, 240 VAC.

4. The electronic pressure switch shall be equipped with replaceable plug-in integrated circuits and output fuses. The main circuit board assembly shall be provided with keyed plug-in connections to "off board" components permitting main board removal without de-soldering All printed circuits shall have a conformal coating applied to both sides to protect against moisture or fungus.

5. Circuit design in which the application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.

## 2.11 BACK-UP LEVEL CONTROL SYSTEM

A. The Pump Control Panel (PCP) shall be provided with a float back-up system in the event that the Level Transmitter (LT) fails or is disabled. The float back-up system shall be comprised of two (2) float switches which shall be used to operate one (1) of the pumps. The upper float shall have a dual function – Back-up High Water Level Alarm & Pump Start and the lower float shall act as the Pump Stop. A Back-up Pump

Selector Switch shall allow operator(s) to choose which of the pumps to place on the back-up system (Pump No. 1 or Pump No. 2). The back-up system shall over-ride the electronic controller if the upper float initiates the back-up system.

B. Liquid Level Sensors (Float Switches).

1. Liquid level floats shall have mechanical switching and shall be of the non-floating displacement type or the weighted type or an acceptable equivalent.

2. Provide a sufficient length of cable, cable hanger, etc. for the float switches.

3. Float switches shall be rated for intrinsically safe operation.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. CONTRACTOR shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Pump Manufacturer shall provide written instruction for proper handling. Immediately after off-loading, CONTRACTOR shall inspect pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturers representative of any unacceptable conditions noted with shipper.

### 3.02 INSTALLATION

A. Install, level, align, and lubricate pump as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Suction pipe connections are vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.

C. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.

D. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

E. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump base with non-shrink grout.

## 3.03 FIELD QUALITY CONTROL

A. Operational Test

1. Prior to acceptance by OWNER, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

2. After construction debris and foreign material has been removed from the wet well, CONTRACTOR shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

B. Manufacturers Start-up Services

1. Coordinate station start-up with manufacturer's technical representative. The representative or factory service technician will inspect the completed installation. He will calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions.

2. Training. A factory service technician shall provide training to OWNER's designated personnel on maintenance and service of pumps, motors, and drives. A minimum of 8 hours of training shall be provided or as required so as to cover disassembly of pump to clean clogs, replace rotating assembly, replacement of bearings, seals, oil, drive belt and any other normal maintenance item.

## 3.04 CLEANING

A. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Remove from the job site all tools, surplus materials, scrap and debris.

## 3.05 PROTECTION

A. Each pump station should be placed into service immediately. If operation is delayed, drain water from pumps and piping. Open motor circuit breakers and protect station controls and interior equipment from cold and moisture.

END OF SECTION

# SECTION 16010

# BASIC ELECTRICAL REQUIREMENTS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Basic electrical requirements applicable to all electrical work involved with the project.

B. General description of electrical work.

### 1.02 DESCRIPTION OF WORK

A. The work covered by the Contract Documents is at existing and new facilities. The work required for electrical systems shall consist of furnishing all labor, materials, tools, equipment, services, and related items necessary to accomplish the installation and proper operation of the work as indicated and described in the Contract Documents. The complete installation as a whole, and in every part, shall be left ready for satisfactory operation.

B. Equipment or materials and labor obviously a part of the work and necessary for installation and proper operation of same, although not specifically shown on the drawings or specified, shall be provided as if called for in detail at no additional cost to the OWNER.

C. Without intending to limit or restrict the amount of work involved and solely for the convenience of the CONTRACTOR, the work in general shall comprise the following:

1. Temporary electric services, distribution systems, and lighting systems for CONTRACTOR's use during construction, including all work and costs for same.

2. All coordination activities with Conectiv Power Delivery (CPD) involving temporary electric services, including all work and costs for same.

3. All coordination activities with other CONTRACTORs involved with the project, the United States Coast Guard (USCG), and the OWNER.

4. Permanent electric services to the facilities, including all work and costs for same.

5. All coordination activities with CPD involving permanent electric services, including all work and costs for same.

6. Permanent telephone services to the facilities, including all work and costs for same.

7. All coordination activities with Verizon involving permanent telephone services, including all work and costs for same.

8. Maintenance of electric services, distribution systems, and lighting systems at the existing facilities at all times throughout the course of the project, including any temporary electric services, distribution systems, or lighting systems required to accomplish same.

9. Demolition and removal of existing electrical equipment, devices, and items as indicated and/or as specified or as necessary to accomplish proper completion of the work.

10. Maintenance of existing electrical equipment, devices, items, wiring, etc., at the project location not specifically involved in the project, but which are impacted by the work during the course of the project.

11. Relocation of existing equipment, wiring, and appurtenances as required to meet actual field construction conditions.

12. Installation of complete power distribution, lighting, and control systems including all equipment, devices, items, conduit, fittings, wiring, and all associated appurtenances as indicated and/or specified and/or required.

13. All wiring and connections for existing equipment/items which remain or are reused in the work.

14. All wiring and connections for equipment/items furnished by the OWNER for use in the work.

15. All wiring and connections for equipment furnished under other division/sections of the specifications.

16. Automatic telephone dialers.

17. Instrumentation.

18. Control and alarm devices.

19. Pump Control Systems/SCADA.

20. Transient voltage surge suppression systems.

21. All equipment foundations, dowels, supports, anchors, bolts, etc. required for the complete installation of all equipment furnished under this division and for all equipment/devices required to be installed by the electrical CONTRACTOR under other divisions/ sections of the Contract Documents.

22. All cutting, coring, and patching required for the complete installation of all equipment furnished under this division and for all equipment/devices required to be installed by the electrical CONTRACTOR under other divisions/sections of the Contract Documents.

23. All trenching, excavation, backfilling, shoring, and care for all groundwater required for the complete installation of all equipment furnished under this division and for all equipment/devices required to be installed by the electrical CONTRACTOR under other divisions/sections of the Contract Documents.

24. Repair or replacement of damage caused by construction.

25. Cleaning, painting, legends, and labelling.

26. Testing, adjusting, and instructions.

27. Shop drawing and product data submittals.

28. Installation instructions and operation and maintenance documents submittals.

29. Record shop drawing submittals.

30. Installation instructions and operation and maintenance information manuals.

31. Record drawings and documents.

## 1.03 REFERENCES

A. ANSI/NFPA 70: National Electrical Code.

B. NECA: Standard of Installation.

C. UL: Electrical Construction Materials Directory.

## 1.04 SUBMITTALS

A. Submit as required.

B. Proposed Products List: Submit products specified in the individual sections.

1. Within 15 days after date of Notice to Proceed, submit a complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

2. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

3. The Proposed Products List and individual items therein will be used for verification/reference during submittal reviews and will not be reviewed for acceptance.

C. Equipment/Product Submittals: Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in single submittals.

1. A minimum of five (5) copies of each shop drawing/product data submittal shall be submitted and acceptance obtained before shipment and/or installation of material. Acceptance is given only to indicate general compliance with contract requirements and does not relieve the CONTRACTOR from any obligation undertaken under the contract. All acceptances are subject to reversal if field inspection reveals unfavorable conditions not previously disclosed.

2. Submittals shall be checked and corrected before submission. All deviations from contract requirements shall be noted. If more than one item appears on a submission and the proposed item is not marked, acceptance will be based upon the item that meets specifications.

3. Mark shop drawings and product data with the appropriate specifications section, drawing and/or detail reference number(s).

4. Mark dimensions, ratings, and values in units to match those specified.

5. Without intending to limit or restrict the types or quantity of shop drawing/product data submittals, and solely for the convenience of the CONTRACTOR, these submittals shall include, but not be limited to, the following:

   a. Hand holes.

   b. Wiring devices.

   c. Cabinets and enclosures.

   d. All identification markings.

   e. Enclosed switches.

   f. Panelboards.

   g. Circuit breakers.

   h. Motor controls.

   i. Lighting fixtures.

   j. Lamps.

   k. Poles.

   l. Lightning protection system.

   m. Instrumentation equipment.

   n. Control alarm devices.

   o. Pump control equipment.

   p. Transient voltage surge suppression equipment.

6. All equipment/product submittals shall be transmitted for review simultaneously (as a group).

7. In general, where a manufacturer's name and/or style number is mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that it is for the purpose of setting a standard. Material and/or equipment of other makes may be supplied, providing it is of similar design and equivalent in construction, performance, workmanship, and finish to that mentioned.

    a. Where three manufacturers are named, the material or equipment shall be from one of those named.

    b. When a proprietary product is specified, the material or equipment shall be that specified.

8. If any substitute items are to be submitted and there is any question of quality of such items, the CONTRACTOR may be required, at his own expense, to submit samples of both the item specified and that to be substituted, or furnish further proof of equivalence to the entire satisfaction of the OWNER. In no case shall he be allowed additional remuneration if he must supply any items as specified because of the rejection of a substitute.

D. Record Equipment/Product Submittals: Submit record shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in single submittals.

1. A minimum of four (4) copies of each record shop drawing/product data submittal shall be provided.

2. Submittals shall be prepared by the original equipment manufacturer (OEM) and shall be certified by the OEM.

3. Submittals shall indicate the as-built conditions, arrangements, ratings, sizes, etc. for the equipment/products and shall include, address, or incorporate all review comments, notations, or corrections contained in the equipment/product submittals.

4. These submittals will be used for record purposes only and will not be reviewed for acceptance. However, if inaccuracies or omissions are discovered they shall

be corrected by the CONTRACTOR/OEM at no additional cost to the OWNER.

5. Without intending to limit or restrict the types or quantity of record shop drawing/product submittals, and solely for the convenience of the CONTRACTOR, these submittals shall include, but not be limited to, the following:

   a. Panelboards.

   b. Motor controls.

   c. Instrumentation equipment.

   d. Pump control equipment.

E. Submit installation instructions and operation and maintenance (O&M) information grouped into a complete/combined and bound manual formatted by specification section with index, for the entire project.

   1. Installation instructions and O&M information shall consist of, but shall not be limited to, the following:

      a. Description of equipment/system.

      b. Installation instructions.

      c. Start-up instructions.

      d. Operating instructions.

      e. Maintenance instructions.

      f. Recommended maintenance schedule.

      g. Troubleshooting information techniques.

      h. Spare parts list.

      i. Schematic diagrams.

      j. Wiring diagrams.

k. Safety/precautionary instructions.

l. Factory warranties/guarantees.

m. List of manufacturers' local representatives or service agents.

2. One (1) copy of the Manual shall be submitted for review and comment. Comments shall be included/addressed/incorporated in the final O&M Manuals for the project.

3. Installation instructions and operation and maintenance information shall be submitted not more than 45 days after acceptance of equipment/product submittals.

4. Without intending to limit or restrict the types or quantity of installation instructions and operation and maintenance information, and solely for the convenience of the CONTRACTOR, this information shall be provided for, but not limited to, the following:

   a. Panelboards.

   b. Motor controls.

   c. Lighting equipment.

   d. Instrumentation equipment.

   e. Control and alarm devices.

   f. Pump control equipment.

   g. Transient voltage surge suppression equipment.

F. Specific submittals and other submittals (not listed in this section) are required by the Contract Documents and/or are listed in the specifications. The CONTRACTOR shall be responsible for all submittals.

G. Prior to submission, the CONTRACTOR shall mark all submittals with an appropriate submittal number (e.g. 1, 2, 3, etc. in sequence) and with the CONTRACTOR's review stamp indicating that the CONTRACTOR has reviewed the

submittal for compliance with the Contract Documents and found it acceptable.

H. Review of submissions, in whole or in part, shall not constitute acceptance of any errors, omissions, changes, or other deviations from the Contract Documents. Checking is only for conformance with the design concept of the project and compliance with the information given in the Contract Documents. CONTRACTOR is responsible for dimensions to be confirmed and correlated at the job site; for information that pertains solely to the fabrication, shipping, handling, storage, assembly, installation or to techniques of construction; for coordination of the work of all trades, and for all safety aspects of the work.

## 1.05 DEFINITIONS

A. Wherever the word "Provide" appears in the Contract Documents, it shall mean furnish and install with all required associated work, wiring, raceways, and appurtenances, make all final connections and leave in a satisfactory operating condition.

B. Wherever the word "Equipment" appears in the Contract Documents, it shall mean all wiring, apparatus, raceways, fixtures, panels, boxes, switches, appurtenances, devices, and similar items as required.

C. Wherever the word "Work" appears in the Contract Documents, it shall mean all required equipment and all materials, supervision, transportation, adjustments, labor, rigging, scaffolding, and tools of an auxiliary nature required to install the equipment for a complete approved installation.

D. Wherever the word "Wiring" appears in the Contract Documents, it shall mean all cables and conductors, insulated and uninsulated, grounded and ungrounded, and their enclosed raceways, including all associated fastenings, supports, boxes, bushings, devices, appurtenances, fixtures, and equipment as required.

E. Wherever the word "Conduit" appears in the Contract Documents, it shall refer to rigid metal conduit, PVC externally-coated rigid metal conduit, rigid nonmetallic conduit (Schedule 40 PVC), or liquidtight flexible metal conduit.

F. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete the entire installation.

## 1.06 REGULATORY REQUIREMENTS

A. Rules and Regulations: All work shall be done in strict compliance with the requirements of the National Electrical Code; all local, state, and federal safety requirements; all local, state, and federal environmental requirements; and all other public authorities having jurisdiction. These rules and regulations shall be considered as forming a part of the Contract Documents.

B. Fees and Certificates: Obtain and pay for all permits and certificates required in conjunction with the work. Furnish a copy of all permits and certificates to the OWNER.

C. CONTRACTOR's License: All electrical work shall be done by a fully qualified and duly licensed electrical CONTRACTOR. The electrical CONTRACTOR shall maintain his license in effect throughout the course of the work.

D. Underwriter's Label: All material for which label service is available shall bear the label of the Underwriters Laboratories, Inc.

E. Underwriter's Inspection: During the course of the work at periodic intervals, the CONTRACTOR shall, at his expense, have an inspection of the work made by a representative of an independent inspection agency. Corrections to the work required by said inspections shall be accomplished immediately at no additional cost to the OWNER.

1. Prior to commencing work, submit to the OWNER evidence that inspection services of an independent inspection agency has been obtained.

2. Prior to the installation of finish materials, and while all concealed work is accessible, obtain a certificate/letter from the independent inspection agency indicating approval of the rough wiring. This certificate/letter shall be forwarded to the OWNER.

3. Upon completion of the work, an approved Certificate of Electrical Inspection for the entire project shall be delivered to the OWNER.

## 1.07 PROJECT/SITE CONDITIONS

A. Install work as indicated in the Contract Documents, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections/divisions. Obtain permission of the OWNER before proceeding.

C. Commencement of construction shall mean that the CONTRACTOR accepts project/site conditions.

## 1.08 COORDINATION

A. Electrical work shall be coordinated with other trades/utilities involved in the project. All work shall be carefully laid out in advance coordinating electrical features with architectural, structural, and mechanical features of construction before the work is installed. Prior to roughing-in, the CONTRACTOR shall review approved shop drawings of the other trades involved in the project.

## 1.09 COOPERATION

A. Cooperate fully with other trades/utilities employed on the project and the OWNER, as is necessary to accomplish intelligent and proper execution of work.

## 1.10 SEQUENCING AND SCHEDULING

A. Existing electrical equipment shall be maintained in operation until the new facilities are complete and ready for start-up.

B. All change-overs from existing facilities to new facilities shall be coordinated by the CONTRACTOR with the OWNER and the other trades/utilities involved in this project and shall be accepted by the OWNER prior to commencement of the change-over.

C. All change-overs shall be conducted in a continuous and expedient manner (i.e from commencement to completion without a stoppage in the change-over work).

## 1.11 SUPERINTENDENCE

A. The CONTRACTOR shall give his personal superintendence to the work or have a competent superintendent satisfactory to the OWNER present at all times during construction with full authority to act for him in matters relating to the work. The CONTRACTOR shall provide an adequate organization for the proper coordinating and expediting of the work. The CONTRACTOR shall lay out his own work and shall be held fully responsible for all measurements executed by him under the

contract. He shall verify all information shown in the Contract Documents and shall be held fully responsible for all errors resulting from failure to exercise these precautions.

## 1.12 DRAWINGS

A. The Contract Drawings have been made to scale with the best knowledge of conditions, dimensions, and space requirements available at the time of drafting. Report errors or discrepancies to the OWNER immediately upon discovery for instructions as to further procedure. The wiring/conduit layout shown on the drawings shall not be considered as absolute, but shall be subject to such revisions as may be necessary to overcome field obstructions. No changes shall be made in the location or placement of apparatus without approval of the OWNER. The drawings may not indicate all of the existing equipment, devices, wiring, structures, piping, etc., either exposed or concealed. Prior to commencing construction, the CONTRACTOR shall obtain or verify the exact location of all the existing items that affect the work.

## 1.13 DISCREPANCIES

A. In the event of discrepancy, immediately notify the OWNER. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

## 1.14 PROTECTION

A. Effectively protect all parts of the installation, materials stored on site, and materials installed against theft and vandalism. All materials and equipment removed or damaged through theft or vandalism shall be replaced by the CONTRACTOR at no additional cost to the OWNER. The CONTRACTOR shall also effectively protect all portions of the work, materials, and equipment that are liable to injury during the period of construction. Conduit and openings into same, wiring, and all materials and equipment under the contract before and after being set in place, shall be adequately covered and protected to prevent damage or entrance of foreign matter detrimental to the operation of the equipment. The CONTRACTOR shall be held responsible for all damage done to his work until such is finally and fully accepted by the OWNER.

## 1.15 EXAMINATION OF THE WORK

A. Furnish all labor, material, equipment, and instruments as may be required by the OWNER, in making examination of the work.

## 1.16 RECORD DRAWINGS AND DOCUMENTS

A. It shall be the CONTRACTOR's responsibility to annotate the record drawings and documents to show "As-Built" conditions as the construction proceeds.

B. Upon completion of the work, the CONTRACTOR shall furnish two (2) set of record drawings and documents to the OWNER.

C. Record drawings and documents shall consist of annotated Contract Drawings, Specifications, Addendums, Change Orders, shop drawings, and field directives.

D. These drawings and documents shall indicate as a minimum, equipment locations, conduit layout, wiring diagrams, and related details. They shall show wire and conduit sizes and equipment capacities, all important dimensions, and necessary information for operation and maintenance of equipment.

## 1.17 INSTRUCTIONS

A. Upon completion of the work and prior to acceptance, the CONTRACTOR shall instruct designated employees of the OWNER in the operation of the various items of equipment and in the operation of each of the systems as a whole.

## 1.18 SPECIAL REQUIREMENTS

A. The CONTRACTOR shall be responsible to insure "on the job" safety for his employees. In addition, he shall be responsible to insure that his work shall be performed in a manner that will provide safe conditions for other persons employed on the project, employees of the OWNER, all other persons having authorized or unauthorized access to the work, and the public.

B. It shall be the responsibility of the CONTRACTOR to conduct his work in such a manner as to minimize the interference and/or interruption of the normal activities at the project site.

C. The CONTRACTOR shall notify the OWNER not less than three (3) working days prior to commencing any electrical work that may interfere and/or interrupt the normal activities at the project site.

D. The CONTRACTOR shall assure, and take all necessary actions to assure, that the existing facilities are kept operational. If it becomes necessary to interrupt electric service to any part of the facilities, schedule activities to be performed at times

agreeable to the OWNER. The work shall be conducted in such a manner that electric service will never be completely interrupted. CONTRACTOR shall include, in his bid, all premium pay that may be required in connection with these requirements.

E. It shall be the responsibility of the CONTRACTOR to verify the actual electrical requirements of all equipment involved in the work and to size all wire, all conduit, all circuit protection, etc. in accordance with the National Electrical Code, and the published requirements/recommendations of the equipment manufacturer. However, sizes and ratings shall not be less than those indicated on the drawings or specified, unless approved by the OWNER.

F. It shall be the responsibility of the CONTRACTOR to obtain accurate dimensional data of the equipment and to determine that such equipment will fit the space allocated with adequate clearance for installation, operation, and maintenance.

G. The CONTRACTOR shall be responsible for the replacement and/or repair of all damage caused by his work. Replacement and/or repair work shall conform to the existing conditions.

H. Each and every bidder is hereby instructed that prior to submitting a proposal, he shall visit the site and carefully examine the existing conditions affecting the work and verify those items that impact the project. Additional labor, materials, and equipment required through failure to follow these instructions shall be provided by the CONTRACTOR at no additional cost to the OWNER.

## 1.19 OPERATION AND MAINTENANCE MANUALS

A. Provide three (3) complete, bound and indexed copies of final O&M Manuals for the project.

B. Final O&M Manuals shall be submitted not less than 30 days before start-up and/or Substantial Completion of the work and shall consist of the following:

1. All items as outlined in Section 16010 - 1.4E corrected/modified in accordance with the review comments.

2. One copy each of all Record Equipment/Product Submittals as outlined in Section 16010 - 1.4D.

C. O&M information for each item shall be prepared by the original equipment manufacturer (OEM) and certified by the OEM. The CONTRACTOR shall

coordinate, collate, index, and bind all items into final O&M Manuals.

D. These manuals will be used for O&M purposes only and will not be reviewed for acceptance. However, if inaccuracies or omissions are discovered, they shall be corrected by the CONTRACTOR/OEM at no additional cost to the OWNER.

## 1.20 GUARANTEE

A. All new materials or equipment and all workmanship shall be fully guaranteed in writing for a period of one (1) years from the date of acceptance by the OWNER. This guarantee shall include an agreement to repair or replace all material or work which is discovered to be defective during said period.

## 1.21 EXISTING EQUIPMENT

A. The landfill facilities contain existing equipment which shall be retained and reused in the new work. The CONTRACTOR shall be responsible to coordinate/verify the specific selection of retained equipment with the OWNER, prior to reuse.

B. The CONTRACTOR shall be responsible to thoroughly familiarize himself with all aspects of the existing equipment in order to properly use same.

# PART 2 PRODUCTS

## 2.01 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be new and free of defects. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production of such materials. Equipment shall be manufacturer's latest standard design that complies with the specification requirements. When two or more units of the same type, class, and sizes of equipment are required, these units shall be products of a single manufacturer. However, the component parts of a system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer's name, address, and the model and serial number on a nameplate securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

B. Items not specified but necessary for the proper installation of the electrical work and operation of the system shall be furnished in a grade and quality meeting normal trade standards. Materials shall be compatible with the materials of the system in which

they are to be installed.

C. All material and equipment shall be acceptable to the authority having jurisdiction or shall be replaced with acceptable items at no additional cost to the OWNER.

## PART 3 EXECUTION

### 3.01 WORKMANSHIP

A. Install all work using the procedures as defined in the NECA Standard of Installation.

B. All equipment shall be installed and wired in strict compliance with the requirements and recommendations of the equipment manufacturer.

C. All work shall be installed in a first class manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct and all work shall comply with the requirements of the National Electrical Code and all local codes having jurisdiction.

D. Installation, wiring, and connections of equipment furnished under other divisions/sections of the Contract Documents shall be accomplished using the requirements and recommendations of the equipment manufacturer.

### 3.02 CLEANING

A. During the course of construction, the CONTRACTOR shall maintain all areas in which he is working or using for storage and access free from rubbish and debris at all times.

B. Upon completion of the work, the CONTRACTOR shall thoroughly clean all parts of the installation to the satisfaction of the OWNER. The hand holes, receptacles, light switches, cabinets, enclosures, disconnect switches, panelboards, motor controls, lighting fixtures, poles, instrumentation equipment, pump control equipment, transient voltage surge suppression equipment, and similar items shall be thoroughly cleaned prior to final acceptance.

### 3.03 PAINTING

A. Paint all damaged factory finished surfaces. Use paint and method of application as recommended by the equipment manufacturer.

## 3.04 LEGENDS

A. Provide for each, equipment cabinet, enclosure, disconnect switch, panelboard, motor control unit, instrument device, and similar items of equipment, a laminated plastic nameplate of molded phenolic compound to indicate the device and equipment served. Characters shall be white, not less than one-eighth inch (1/8") high.

B. Provide tags for all feeders, at both ends and at intermediate junction and pull boxes, indicating feeder designation or equipment served.

## 3.05 TESTING

A. Upon completion of the work and prior to acceptance, the CONTRACTOR shall test all conductors to insure freedom from unwanted grounds, continuity, proper splicing, and insulation values in accordance with National Electrical Code requirements. In addition, the CONTRACTOR shall check all conduits for continuity. Preliminary testing with a magneto or ohmmeter shall be permitted, but final results shall be obtained with a "Megger" of suitable voltage output. The CONTRACTOR shall furnish all required instruments, labor, material, and other equipment necessary for testing.

## 3.06 ADJUSTMENTS

A. Upon completion of the work, all component parts, individually and as a whole, shall be adjusted and left in a satisfactory operational condition.

B. All overload devices shall be set and adjusted to load conditions.

C. Motor rotation shall be checked and corrected, if necessary.

## 3.07 REPAIRS OR REPLACEMENT

A. The CONTRACTOR shall be responsible to repair and/or replace all damage caused by his work.

B. All repair and/or replacement work shall be performed in a neat and workmanlike manner by craftsmen skilled in the trades involved and shall be accomplished in accordance with the best practice of the trade.

C. All damaged and inoperative plates, glassware, lamps, and equipment shall be replaced before acceptance of the work, regardless of who caused the damage. In areas where electrical construction has been performed over finished surfaces, all marred surfaces shall be touched-up as directed by the OWNER. All burned-out lamps shall be replaced at the completion of the project.

END OF SECTION

# SECTION 16060

# ELECTRICAL DEMOLITION

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Electrical demolition.

B. Salvaged equipment.

### 1.02 SECTION INCLUDES

A. Safely disconnect from service, demolish, remove, and dispose of, the existing equipment/devices/materials and similar items as indicated in the Contract Documents and/or as may be necessary for the proper completion of the work.

B. Repair or replace all damage caused by the demolition work.

C. Prior to the commencement of demolition and removal work, the CONTRACTOR shall compile a list of equipment and material he is to remove and shall deliver this list to the OWNER for evaluation. The OWNER will review the list and inform the CONTRACTOR, in writing, of any equipment or material to be salvaged. All salvaged equipment or material shall be removed and then delivered by the CONTRACTOR to the OWNER. Items shall be delivered in the same condition as when removed and shall be unloaded and placed as directed by the OWNER. The CONTRACTOR shall prepare a receipt and obtain the OWNER's signature on same for all salvaged equipment or material.

### 1.03 REFERENCES

A. All demolition work shall be done in strict compliance with the requirements of the National Electrical Code.

B. The CONTRACTOR may refer to existing drawings for general information only. The information on these drawings shall not relieve the CONTRACTOR of any responsibilities under the contract, or the obligation to visit the site and ascertain the existing conditions affecting the work during the bidding process.

# PART 2 PRODUCTS

## 2.01 MATERIALS AND EQUIPMENT

A. In general, all demolished equipment/devices/materials shall become the property of the CONTRACTOR and shall be removed from the site.

B. All materials and equipment for repairs, patching, or replacement, shall be new and free of defects.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify field conditions and circuiting arrangements are as shown on drawings.

B. Verify that wiring and equipment indicated for demolition serve only facilities to be demolished.

C. Demolition work shown on drawings is based on casual field observations and existing documents. Report discrepancies to the OWNER before disturbing existing installations.

D. It shall be the responsibility of the CONTRACTOR to obtain or verify the existing circuit numbers/circuiting for all of the existing equipment/devices that shall be demolished prior to commencing work on these items and to safely remove from service all existing equipment/devices/materials and similar items indicated on the drawings and/or as may be necessary for the proper completion of the work.

E. Commencement of demolition work shall mean that the CONTRACTOR accepts the existing conditions.

## 3.02 PREPARATION

A. Safely disconnect electrical systems in areas of demolition work.

B. Coordinate electrical system outages with the OWNER.

C. Coordinate instrumentation system outages with the OWNER.

D. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

E. Existing Electrical Systems: Maintain existing systems in service until new systems are complete and ready for service. Disable systems only to make switchovers and connections. Obtain permission from the OWNER and all other concerned parties at least three (3) working days before partially or completely disabling systems. Minimize outage durations. Make temporary connections to maintain service in areas adjacent to work area.

F. Existing Instrumentation Systems: Maintain existing systems in service until new systems are complete and ready for service. Disable systems only to make switchovers and connections. Obtain permission from the OWNER and notify all other concerned parties at least three (3) working days before partially or completely disabling systems.

G. Existing Pumping Systems: Maintain existing systems in service until temporary provisions or new systems are complete and ready for service. Disable systems only after temporary provisions have been accepted by the OWNER or to make switchovers and connections. Obtain permission from the OWNER and notify all other concerned parties at least three (3) working days before partially or completely disabling systems. Make temporary connections to maintain service in areas adjacent to work area.

## 3.03 DEMOLITION OF EXISTING ELECTRICAL WORK

A. Remove and/or relocate existing installations to accommodate new construction.

B. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

C. Repair adjacent construction and finishes damaged during demolition work.

D. Maintain access to existing electrical installations which remain active.

E. Remove wiring to source of supply.

F. Remove all exposed conduit. Cut embedded conduit flush with walls and floors and patch surfaces.

G. Cut-off underground/buried wiring to a depth of twelve inches (12") below grade and abandon-in-place.

H. Disconnect outlets and remove devices. Remove outlets and the conduit servicing them. Provide blank cover for outlets which are not removed.

I. Disconnect, remove, and salvage selected equipment and devices at the abandoned Pump Stations.

J. Disconnect, remove, and salvage selected equipment and devices at the abandoned Pump Station Flow Metering Vaults.

K. Disconnect and remove all electrical items at the abandoned Pump Stations, prior to demolition of same.

L. Disconnect and remove all electrical items at the abandoned Valve Vaults, prior to demolition of same.

M. Disconnect and remove all electrical items at the abandoned Pump Station Flow Metering Vaults, prior to demolition of same.

## 3.04 SALVAGED EQUIPMENT

A. Without intending to limit or restrict the types or quantity of salvaged equipment and solely for the convenience of the CONTRACTOR, the salvaged items shall include the following:

1. Submersible pumps.

2. Pump control panels.

3. Flowmeters.

4. Chart recorders.

## 3.05 REPAIRS AND REPLACEMENT

A. Existing surfaces remaining after removals shall be left in a condition suitable for the application of the new work. Where removals leave holes and/or damaged surfaces that will be exposed in the finished work, these holes and/or damaged surfaces shall

be patched and repaired.

B. All repair and/or replacement work shall be performed in a neat and workmanlike manner by craftsmen skilled in the trades involved and shall be accomplished in accordance with the best practice of the trade.

## 3.06 CLEANING

A. Clean all existing electrical materials and equipment which remain or are reused.

END OF SECTION

# SECTION 16111

# CONDUIT

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Rigid metal conduit and fittings.

B. Liquidtight flexible metal conduit and fittings.

C. Rigid PVC conduit and fittings.

### 1.02 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.

B. ANSI/NEMA FB 1- Fittings and Supports for Conduit and Cable Assemblies.

C. ANSI/NFPA 70 - National Electrical Code.

D. NEMA RN 1 - PVC Externally-Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.

E. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 an EPC-80).

F. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

### 1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.04 PROJECT CONDITIONS

A. Conduit routing shown on drawings is approximate unless dimensioned. Route conduit as required to meet project conditions.

B. Where conduit routing is not shown, and destination only is indicated, determine exact routing and lengths required.

## 1.05 COORDINATION

A. Determine required separation between conduit and other work.

B. Determine conduit routing to avoid interference with other work.

## 1.06 PROJECT RECORD DOCUMENTS

A. Accurately record actual routing of all conduits.

# PART 2 PRODUCTS

## 2.01 RIGID METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit: ANSI C80.1.

B. PVC Externally-Coated Conduit: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal galvanized surface.

C. Fittings and Conduit Bodies: ANSI/NEMA FB1; materials to match conduit, all connections shall be threaded.

## 2.02 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

A. Conduit: Flexible metal conduit with PVC jacket.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1.

## 2.03 PLASTIC CONDUIT AND FITTINGS

A. Conduit: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

## 2.04 CONDUIT SUPPORTS

A. Conduit Clamps, Straps, and Supports: Steel or malleable iron, finish to match conduit.

## PART 3 EXECUTION

### 3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

A. Size conduit for conductor type installed or for Type THWN conductors, whichever is larger; 3/4 inch minimum size.

B. Arrange conduit to maintain headroom and present a neat appearance.

C. Route exposed conduit parallel and perpendicular to walls and adjacent piping.

D. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

E. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized spacers and straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.

F. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

G. Do not fasten conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.

H. Support conduit at a maximum of 7 feet on center.

I. Liquidtight flexible metal conduit shall not exceed 24 inches in length and all runs shall be provided with an appropriate length of ground conductor.

### 3.02 CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipecutter; ream and de-burr cut ends.

B. Bring conduit to the shoulder of fittings and couplings and fasten securely.

C. Use conduit hubs for fastening conduit to cast boxes, and for fastening conduit to cabinets/enclosures in damp or wet locations.

D. Install no more than the equivalent of three 90-degree bends between boxes.

E. Use conduit bodies to make sharp changes in direction, as around beams.

F. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.

G. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

H. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

I. Provide No. 12 AWG insulated conductor or suitable pull string in empty conduit, except sleeves and nipples.

J. Install expansion joints where conduit crosses building expansion joints.

K. Route conduit through roof openings with piping and ductwork, where possible; otherwise, route through roof jack with pitch pocket.

L. Use PVC externally-coated rigid steel factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length.

M. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.

N. All underground conduit shall be concrete encased. The thickness of concrete covering the conduit on all sides and between conduits shall not be less than three inches.

1. Install top of underground conduit a minimum of 36 inches below finished grade.
2. Install underground conduit with minimum grade of 4 inches per 100 feet.
3. Terminate conduit in end bell at hand hole entries.
4. Stagger conduit joints in concrete encasement 6 inches minimum, horizontally.
5. Use suitable separators and chairs installed not greater than 4 feet on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement.
6. Provide minimum 3 inch concrete cover at bottom, top, and sides of conduit.
7. Provide two No. 4 steel reinforcing bars in top of concrete encasement.

O. All rigid steel conduit which is underground or encased in concrete shall be coated with two (2) coats of bituminous mastic paint or shall be PVC externally-coated conduit. The bituminous or PVC coating shall be carried no less than six (6) inches above grade.

P. A plastic warning tape shall be installed over all buried conduit. The tape shall have the warning "Caution--Buried Electric Line" continuously imprinted on a red background or "Caution--Buried Telephone Line" continuously imprinted on a orange background, as appropriate. The tape shall be positioned above the conduit at a point twelve (12") below finished grade.

## 3.03 CONDUIT INSTALLATION SCHEDULE

A. Underground Installation More Than Five Feet From Foundation Wall: Schedule 40 plastic conduit.

B. Installations In or Under Concrete Slab, or Underground Within Five Feet of Foundation Wall: Rigid steel conduit with bituminous or PVC coating.

C. Outdoor Locations: PVC externally-coated rigid steel conduit.

D. Interior Locations: Rigid steel conduit.

E. Flexible Connections: Liquidtight flexible metal conduit.

F. Installations within Wet Wells, Valve Vaults, and Metering Vaults: PVC externally-coated rigid steel conduit. All conduit run into/out of these areas shall be provided with seal fittings.

END OF SECTION

# SECTION 16118

# HAND HOLES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Prefabricated concrete hand holes.

B. Hand hole accessories.

### 1.02 REFERENCES

A. AASHTO H-20 - Standard Specification for Highway Bridges.

B. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

C. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.

D. ANSI/NFPA 70 - National Electrical Code.

E. ASTM A48 - Gray Iron Castings.

### 1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in precast concrete structures with ten years experience.

### 1.04 SUBMITTALS

A. Submit shop drawings and product data as required.

B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.

C. Include product data for hand hole accessories.

D. Submit manufacturer's installation instructions.

## 1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

## 1.06 PROJECT CONDITIONS

A. Provide hand holes for below grade wiring as required for wire pulling and compliance with regulatory requirements and/or as shown on drawings.

# PART 2 PRODUCTS

## 2.01 PRECAST CONCRETE HAND HOLES

A. Precast Concrete: Air-entrained, 5000 psi compressive strength at 28 days.

B. Reinforcing: AASHTO H-20; bridge loading.

C. Construction: Single unit design (Non-sectional).

D. Hand Hole Shape: Rectangular.

E. Inside Dimensions: 3 ft. length; 3 ft. width; 3 ft. depth; minimum.

F. Wall Thickness: 4 inches; minimum.

G. Include two inch (2") diameter drain opening with four inch (4") diameter CI drain pipe and 1-one inch inch (1") diameter ground rod opening in base section.

H. Window for Duct Entry: 10 x 10 inches; nominal.

I. Include cable pulling irons opposite each duct entry window.

J. Include inserts for cable racks.

## 2.02 HAND HOLE ACCESSORIES

A. Hand Hole Frames and Covers: ASTM A48; Class 30B gray cast iron, machine finished with flat bearing surfaces. Frames and covers shall be prime painted and then

finished with a silver-gray epoxy coating. The word "Electric" shall be cast in the top face of the cover.

B. Pulling Irons: 7/8 inch diameter steel bar forming a triangle of 4 inches per side when set. Galvanize to ANSI/ASTM A153.

C. Cable Rack Inserts: Steel insert with minimum load rating of 500 pounds, to match cable rack channel.

D. Cable Racks: ANSI/ASTM A569; steel channel with high-glazed wet-process porcelain insulators.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Excavate, install base material, and compact base material in accordance with manufacturer's instructions.

### 3.02 INSTALLATION - PRECAST CONCRETE HAND HOLES

A. Install and seal precast hand holes in accordance with manufacturer's instructions.

B. Install hand holes plumb.

C. Set the top of each hand hole to 1.5 inches above finished grade elevation.

### 3.03 INSTALLATION - HAND HOLE ACCESSORIES

A. Install drains in hand holes, and connect to 4 inch pipe terminating in 1/3 cu yd crushed gravel bed.

B. Install ground rod with top protruding 4 inches above hand hole floor.

C. Waterproof exterior surfaces, joints, and interruptions of hand holes after concrete has cured 28 days, minimum.

D. Attach cable racks to inserts after hand hole installation is complete.

END OF SECTION

# SECTION 16122

# MEDIUM VOLTAGE CABLE AND ACCESSORIES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Medium voltage cable and accessories.

B. Prior to procurement of cable and accessories, the CONTRACTOR shall be responsible to obtain approval from Conectiv Power Delivery (CPD) to assure compliance with CPD requirements.

### 1.02 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code.

B. ANSI/IEEE C2 – National Electrical Safety Code.

C. IEEE 48 – Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

D. NEMA WC 7 – Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

### 1.03 REGULATORY REQUIREMENTS

A. Confirm to requirements of ANSI/NFPA 70.

B. Conform to requirements of ANSI/IEEE C2.

C. Conform to requirements of CPD.

D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## PART 2 PRODUCTS

### 2.01 MEDIUM VOLTAGE CABLE

A. Cable: Single conductor, insulated, shielded, power cable rated 15 kV with a 100% insulation level.

B. Conductor: Copper, compressed concentric round, stranded, with conductor shield.

C. Insulation: NEMA WC 7; XLPE (Type MV-90).

D. Cable Construction: Cable shall consist of conductor, a semi-conducting thermosetting conductor shield, a thermosetting insulation, a semi-conducting thermosetting insulation shield, a concentric neutral of bare or coated copper wires, and a PVC or polyethylene jacket.

E. Other Compliances: ASTM B231, ICEA S-66-524, and AEIC CS-5.

F. Cable shall be suitable for connection to Conectiv Power Delivery (CPD) aerial or underground lines for grounded neutral operation.

## 2.02 ACCEPTABLE MANUFACTURES – MEDIUM VOLTAGE CABLE

A. Rome.

B. Pirelli.

C. Okonite.

## 2.03 CABLE TERMINATIONS

A. Tape Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including semi-conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.

## 2.04 ACCEPTABLE MANUFACTURERS – CABLE TERMINATIONS

A. Raychem or 3 – M.

## 2.05 CABLE SPLICES

A. Modular Splice: IEEE 48; Class 1. Molded rubber cable splice in kit form with stress relief, conductive shield, and ground connection; suitable for use with cable specified.

## 2.06 ACCEPTABLE MANUFACTURERS – CABLE SPLICES

A. Elastimold or 3 – M.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify that conduits are ready to receive work. Use mandrel to determine if installed conduits are suitable for use.

## 3.02 PREPARATION

A. Thoroughly swab conduits to remove foreign materials before pulling cables.

## 3.03 INSTALLATION

A. Install cable and accessories in accordance with manufacturer's instructions.

B. Ground cable shield at each termination and splice.

C. Pull cables using suitable lubricants and cable pulling equipment. Do not exceed cable pulling tensions and bedding radius recommended by manufacturer.

D. Avoid abrasion and other damage to cables during installation.

## 3.04 FIELD QUALITY CONTROL

A. Inspect cable and accessories for physical damage. Verify the cable and accessories are connected according to drawings and the grounding, cable support, and terminations are properly installed.

B. Perform DC high potential test of each conductor, with other conductors grounded, to NEMA WC 7. Apply test voltage to conductors in at least eight equal increments to maximum test voltage. Record leakage current at each increment, allowing for charging current decay. Hold maximum test voltage for ten minutes.

C. Record results of test in tubular form and in plots of current versus voltage for incremental voltage steps, and current versus time (30 second intervals) at maximum voltage.

D. Provide cable test results to the OWNER.

END OF SECTION

# SECTION 16123

# BUILDING WIRE AND CABLE

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Building wire and cable.

B. Telephone cable.

C. Instrumentation cable.

D. Wiring connectors and connections.

### 1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

### 1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.04 PROJECT CONDITIONS

A. Wire and cable routing shown on drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

B. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

### 1.05 COORDINATION

A. Determine required separation between wiring and other work.

B. Determine wire and cable routing to avoid interference with other work.

# PART 2 PRODUCTS

## 2.01 BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

## 2.02 TELEPHONE CABLE

A. Multiconductor type having solid 20 AWG tinned copper conductors individually insulated. The cable shall have aluminum-polyester shielding providing 100% coverage, a solid 22 AWG tinned copper drain wire, and an overall high density black polyethylene jacket. The cable shall have a nominal capacitance of 23 pf/ft. and a voltage rating of 300 volts. The cable shall be UL listed and labelled.

B. Conductor Quantity: Six (6) single conductors (3 pair); minimum.

## 2.03 INSTRUMENTATION CABLE

A. Multiconductor type having stranded tinned copper conductors individually insulated. The cable shall have aluminum-polyester shielding tape providing 100% coverage, a stranded tinned copper drain wire, and a chrome PVC jacket. The cable shall have a nominal capacitance of 24 pf/ft. and a voltage rating of 300 volts. The cable shall be UL listed and labelled.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

## 3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire or cable.

## 3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Use solid conductor for feeders and branch circuits 10 AWG and smaller.

C. Use stranded conductors for control circuits.

D. Use conductor not smaller than 12 AWG for power and lighting circuits.

E. Use conductor not smaller than 14 AWG for control circuits.

F. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

G. Pull all conductors into raceway at same time.

H. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

J. Clean conductor surfaces before installing lugs and connectors.

K. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

L. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

M. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

N. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

O. Protect exposed cable from damage.

## 3.04 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable.

B. Identify each conductor with its circuit number or other designation indicated on the drawings.

## 3.05 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

END OF SECTION

# SECTION 16130

# BOXES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Outlet boxes.

B. Pull and junction boxes.

### 1.02 REFERENCES

A. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

B. ANSI/NFPA 70 - National Electrical Code.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.04 PROJECT CONDITIONS

A. Verify locations of outlets in work areas prior to rough-in.

B. Electrical boxes are shown on drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

# PART 2 PRODUCTS

## 2.01 OUTLET BOXES

A. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

## 2.02 PULL AND JUNCTION BOXES

A. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.

1. Material: Galvanized cast iron.

2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

## 2.03 PVC-COATED TYPE BOXES

A. All boxes used within the Wet Wells, Valve Vaults, and Metering Vaults shall be of the PVC-coated type, to match conduit coating.

## 2.04 EXPLOSIONPROOF BOXES

A. All boxes used in classified areas shall be suitable for Class I, Division 1 hazardous locations.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements.

B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Do not fasten boxes to suspended ceiling support wires.

D. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

E. Use gang box where more than one device is mounted together. Do not use sectional box.

## 3.02 INTERFACE WITH OTHER PRODUCTS

A. Position outlet boxes to locate luminaries as shown on plan.

END OF SECTION

# SECTION 16141

# WIRING DEVICES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Light switches.

B. Receptacles.

C. Device plates and covers.

### 1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Device Configurations.

### 1.03 SUBMITTALS

A. Submit as required.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Manufacturer's Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
2. Include instructions for storage, handling, protection, examination, preparation, operation, and installation of product.

### 1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years experience.

## 1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

# PART 2 PRODUCTS

## 2.01 LIGHT SWITCHES

A. Description: NEMA WD 1, heavy-duty, AC only general-use snap switch.

B. Device Body: Brown plastic with toggle handle.

C. Voltage Rating: 120-277 volts, AC.

D. Current Rating: 20 amperes.

## 2.02 RECEPTACLES

A. Description: NEMA WD 1; heavy-duty general-use receptacle.

B. Device Body: Brown plastic.

C. Configuration: NEMA WD 6; type as specified and indicated.

D. Convenience Receptacle: Type 5-20.

E. GFCI Receptacle: Convenience receptacle with integral Class A ground fault circuit interrupter.

## 2.03 DEVICE PLATES AND COVERS

A. Interior Cover Plate: Bevelled stainless steel.

B. Weatherproof (WP) Cover Plate - Convenience Receptacle:

1. Gasketed cast metal with individual hinged gasketed device covers.

2. Listed as suitable for use in Wet Locations with covers open.

C. Weatherproof (WP) Operator - Wall Switches:

1. Gasketed cast metal with external operator handle.

2. Furnish with provisions for padlocking.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

### 3.02 PREPARATION

A. Clean debris from outlet boxes.

### 3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

F. Connect wiring devices by wrapping conductor around screw terminal.

### 3.04 INTERFACE WITH OTHER PRODUCTS

A. Install light switches 48 inches above finished floor.

B. In general, install convenience receptacles 30 inches above finished floor.

C. Install exterior convenience receptacles 30 inches above finished grade.

## 3.05 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

## 3.06 ADJUSTING

A. Adjust devices and cover plates to be plumb and square.

END OF SECTION

# SECTION 16160

# CABINETS AND ENCLOSURES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Cabinets and hinged cover enclosures.

B. Terminal blocks and accessories.

C. Telephone terminal cabinets/backboards.

### 1.02 REFERENCES

A. ANSI/NEMA ICS 1 - Industrial Control and Systems.

B. ANSI/NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.

C. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

D. ANSI/NFPA 70 - National Electrical Code.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.03 SUBMITTALS

A. Submit product data and shop drawings as required.

B. Product Data: Provide manufacturer's standard data for cabinets and enclosures.

C. Shop Drawings: Include schematic diagram, wiring diagram, outline drawing and construction diagram as described in ANSI/NEMA ICS 1.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## PART 2 PRODUCTS

### 2.01 CABINETS AND HINGED COVER ENCLOSURES

A. Construction: NEMA 250; Type 4X, stainless steel, unless indicated otherwise.

B. Finish: Manufacturer's standard finish.

C. Covers: Continuous hinge, held closed by door clamps and with hasp and staple for padlock.

D. Panel for Mounting Terminal Blocks or Electrical Components: 14 gage steel, white enamel finish.

### 2.02 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: ANSI/NEMA ICS 4; UL listed.

B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts.

D. Provide ground bus terminal block, with provisions for bonding to enclosure.

### 2.03 TELEPHONE TERMINAL CABINETS/BACKBOARDS

A. Cabinet Boxes: NEMA 250; Type 4X, stainless steel with continuous hinge, held closed by door clamps and with hasp and staple for padlock. Provide plywood backboard inside cabinet for mounting telephone termination devices.

B. Cabinet fronts, steel, screw front cover.

C. Finish: Manufacturer's standard finish.

D. Backboard: Exterior grade plywood, 3/4 inch thick. Paint backboard with two (2) coats of white enamel.

## 2.04 FABRICATION

A. Shop assemble cabinets and enclosures housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

B. Provide conduit hubs on enclosures.

C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

END OF SECTION

# SECTION 16170

# GROUNDING AND BONDING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Power system grounding.

B. Electrical equipment and raceway grounding and bonding.

### 1.02 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to metallic piping and to supplementary grounding electrodes.

B. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

C. Install grounding as indicated on the drawings and as required by the National Electrical Code.

D. Ground each separately derived system neutral to nearest effectively grounded electrode.

### 1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.05 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Ground Rods: Copper-encased steel, 3/4 inch diameter, minimum length 10 feet.

B. Wire: Standard copper, size to meet ANSI/NFPA 70.

C. Exothermic Welds: Cadweld type or equivalent.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

### 3.02 INSTALLATION

A. Provide a separate insulated equipment grounding conductor in feeder and branch circuits. Terminate each end on a grounding lug, bus, or bushing.

B. Connect grounding electrode conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around meters.

C. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

D. All grounding and bonding connections below grade shall be of the exothermic welded type.

E. Install products in accordance with manufacturer's instructions.

### 3.03 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 10 ohms.

END OF SECTION

# SECTION 16180

# EQUIPMENT WIRING SYSTEMS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Electrical connections to and/or installation of equipment specified under other sections of the Contract Documents or existing equipment.

B. All work involved with the Pump Control System/SCADA and associated sub-systems. The Pump Control System/SCADA is a "System Supplier" proprietary Engineered and packaged assembly of equipment, devices, and apparatus. These items are selected by and/or procured at the direction and/or discretion of the System Supplier. As such, each and every detail of the system may not be delineated by the Contract Documents. The specifications and drawings outline the minimum functional requirements and equipment interconnections. The CONTRACTOR and System Supplier shall be responsible to provide a complete and comprehensive system, including all necessary equipment, devices, items, piping, conduit, and wiring as specifically required to accomplish the installation, startup, and operation of this system. The CONTRACTOR's bid shall include all costs involved with this work.

### 1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NEMA WD 1 - General Purpose Wiring Devices.

C. NEMA WD 6 - Wiring Device Configurations.

### 1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.04 ELECTRICALLY OPERATED APPARATUS

A. Unless otherwise noted, the CONTRACTOR shall provide all power and control wiring for all electrically operated apparatus involved in the project, make all final connections, and leave apparatus in approved operating condition. It shall be his responsibility to examine detailed drawings, wiring diagrams, roughing-in drawings, and other information pertaining to the apparatus in question to determine the extent of work to be provided and exact locations of service.

B. The horsepower of motors or wattage of equipment indicated in the Contract Documents is the estimated horsepower or wattage requirement of equipment to be furnished. All feeders, conduit, wiring, motor starters, fuses, circuit breakers and similar items shall be of the sizes and capacities to suit horsepower of the motors or wattage of equipment actually furnished. However, all ratings as shown on the drawings or indicated in the specifications shall not be reduced without specific written approval from the OWNER.

## 1.05 COORDINATION

A. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

D. Sequence electrical connections to coordinate with start-up schedule for equipment.

# PART 2 PRODUCTS

## 2.01 CORDS AND PLUGS

A. Attachment Plug: NEMA WD 1.

B. Attachment Plug Configuration: NEMA WD 6; Match receptacle configuration at outlet provided for equipment.

C. Cord Construction: Oil resistant thermostat insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for extra hard usage in damp locations.

D. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

## PART 3 EXECUTION

### 3.01 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

### 3.02 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

### 3.03 INSTALLATION

A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

B. Make conduit connections to adjustable or vibrating equipment using liquidtight flexible metal conduit.

C. Install pre-finished cord set where connection with attachment plug is indicated, specified, or required. Use attachment plug with suitable strain-relief clamps.

D. Provide suitable strain-relief clamps with kellems for cord connections to outlet boxes and equipment connection boxes.

E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated and/or required.

F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated and/or required. Connect with conduit and wiring as indicated and/or required.

G. Provide interconnecting conduit and wiring between devices and equipment as indicated and/or as required by the manufacturer of the equipment.

## PART 4 EQUIPMENT CONNECTION SCHEDULE

### 4.01 OWNER FURNISHED EQUIPMENT

A. The OWNER intends to furnish equipment for the pumping stations to be used in the work. The electrical CONTRACTOR shall be responsible to install and/or wire this equipment. Without intending to limit or restrict the types or quantity of equipment furnished, and solely for the convenience of the electrical CONTRACTOR, the equipment shall include, but shall not be limited to, the following:

1. Existing Equipment On-Site.

   a. Selected electric utility provisions.

   b. Selected telephone utility provisions.

   c. Main Pump Station – Pump Control Panel, SCADA-PLC (Modicon Model 110 CPU 612-00).

B. The electrical CONTRACTOR shall provide all connections, wiring, and electric power for all of the equipment furnished by the OWNER in accordance with the provisions of this division/section, as recommended by the manufacturer, as shown on the drawings, and as specified.

### 4.02 GENERAL/MECHANICAL CONTRACTOR FURNISHED EQUIPMENT

A. Without intending to limit or restrict the types or quantity of equipment furnished, and solely for the convenience of the electrical CONTRACTOR, the equipment shall include, but shall not be limited to, the following:

1. Equipment furnished and installed by the general/mechanical CONTRACTOR and wired by the electrical CONTRACTOR.

   a. Pumps.

2. Equipment furnished by the general/mechanical CONTRACTOR and installed and

wired by the electrical CONTRACTOR.

a. Pump Control Panels.

b. Upon its delivery to the site, this equipment shall be turned over to the electrical CONTRACTOR for installation. The electrical CONTRACTOR shall install this equipment in accordance with the provisions of this Section and as recommended by the manufacturer.

B. The electrical CONTRACTOR shall provide all connection, wiring, and electric power for all of the equipment furnished by the general/mechanical CONTRACTOR in accordance with the provisions of this division/section, as recommended by the manufacturer, as shown on the drawings and as specified.

4.03 U.S. COAST GUARD FURNISHED EQUIPMENT

A. The OWNER intends to furnish electrical utility provisions (pole line equipment) for the use of the USCG for electric service to their range light facility. The electrical CONTRACTOR shall be responsible to install and/or wire this equipment. Without intending to limit or restrict the types or quantity of equipment furnished, and solely for the convenience of the electrical CONTRACTOR, the equipment shall include, but shall not be limited to, the following:

1. Existing Equipment On-Site.

a. Selected electric utility provisions.

b. Range Light electric service equipment (disconnect switch).

B. The electrical CONTRACTOR shall provide all connections, wiring and electric power for all of the equipment located at the USCG range light facility in accordance with the provisions of this division/section, as recommended by the manufacturer, as shown on the drawings and as specified.

END OF SECTION

# SECTION 16190

# SUPPORTING DEVICES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Conduit and equipment supports.

B. Fastening hardware.

### 1.02 GENERAL

A. The CONTRACTOR shall provide all necessary hangars and supports for equipment and materials. Equipment and materials shall be adequately supported to provide a structurally sound installation.

B. Wiring/raceways and/or equipment fastened to concrete and/or masonry construction shall be secured thereto using approved clamps and/or fittings with expansion anchors and machine screws or concrete inserts with approved fasteners. Wood plugs and plastic anchors shall not be permitted.

C. Where applicable, all raceway, devices, equipment, etc. may be supported and hung by the use of one and five-eights inch (1-5/8") size channel strut system. The channels shall be constructed of mild strip steel which has been hot dipped galvanized conforming to ASTM Specifications A-386 or A-153. The support and hanger system shall be installed following the manufacturer's installation instructions.

D. All screws and nuts used to fasten device covers, enclosure covers, and similar applications where screws must be used for servicing or replacement of equipment shall be stainless steel. All other screws and bolts shall be zinc or cadmium plated or hot-dipped galvanized.

E. Conduit straps shall be of malleable iron construction, hot-dipped galvanized, size and finish to match raceway.

### 1.03 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

## PART 2 PRODUCTS

### 2.01 MATERIAL

A. Support Channel: Galvanized steel.

B. Hardware: Corrosion resistant.

C. All supporting devices installed within the Wet Wells, Valve Vaults, and Metering Vaults shall be of the PVC-coated type.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors. Do not use spring steel clips and clamps.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls.

C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

D. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

E. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall.

END OF SECTION

# SECTION 16195

# ELECTRICAL IDENTIFICATION

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

### 1.02 SUBMITTALS

A. Submit shop drawings as required.

B. Include schedule for nameplates and labels.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Nameplates and Labels: Engraved three-layer laminated plastic of molded phenolic compound, white letters on a black background.

B. Nameplates and labels shall be affixed to items using brass or stainless steel screws. No adhesive types will be allowed.

C. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Degrease and clean surfaces to receive nameplates and labels.

B. Install nameplates and labels parallel to equipment lines.

C. Secure nameplates and labels to equipment fronts using screws.

D. Embossed tape will not be permitted for any application.

## 3.02 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

## 3.03 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates to identify all electrical distribution and control equipment, and loads served. Letter Height: 1/8 inch for individual switches and loads served, 1/4 inch for distribution and control equipment identification.

B. Nameplates and labels shall be provided for but may not be limited to the following items:

1. Cabinets and Enclosures.
2. Switchgear.
3. Disconnect/Safety Switches.
4. Dry Type Transformers.
5. Panelboards.
6. Motor Controls.
7. Control Stations.
8. Transfer Switches.
9. Automatic Telephone Dialer.
10. Instrumentation Equipment.
11. Pump Control/SCADA Equipment.
12. Transient Voltage Surge-Suppression Equipment.

C. Nameplates and labels for other similar items shall be provided by the CONTRACTOR if so deemed necessary by the OWNER.

END OF SECTION

# SECTION 16322

# PAD MOUNTED TRANSFORMERS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Liquid filled pad mounted distribution transformer.

B. Accessories.

### 1.02 REFERENCES

A. ANSI C37.47 - Specifications for Distribution Fuse Disconnecting Switches, Fuse Supports, and Current-Limiting Fuses.

B. ANSI C57.12.22 - Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings; High Voltage, 34500 GrdY/19920 Volts and Below; 2500 kVA and Smaller.

C. ANSI/IEEE C57.12.90 - Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers.

D. ANSI/NFPA 70 - National Electrical Code.

E. NEMA AB 1 - Molded Case Circuit Breakers.

F. NEMA 260 - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas.

### 1.03 SUBMITTALS

A. Submit shop drawings and product data as required.

B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

C. Submit manufacturer's installation instructions.

D. Submit certified factory test reports.

## 1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data on transformers and all accessories.

B. Include procedures for sampling and maintaining fluid, cleaning unit, and replacing components.

## 1.05 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.06 QUALITY ASSURANCE

A. Manufacturer: Company specializing in liquid filled pad mounted transformers with ten (10) years documented experience.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Upon delivery of transformers, inspect for damage.

B. Store transformers in accordance with manufacturer's instructions.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against rain, sleet, or snow if handled in inclement weather.

## 1.08 SPARE PARTS

A. Current Limiting Fuses: Furnish one (1) spare fuse for each one installed to the OWNER.

B. Hook Stick: Furnish one (1) high voltage hook stick compatible with the transformer's primary switch and fuse arrangement to the OWNER.

# PART 2 PRODUCTS

## 2.01 PAD MOUNTED TRANSFORMERS

A. Liquid Filled Transformer: ANSI C57.12.22; three phase, 60 hertz, pad mounted, self cooled, compartmental type transformer unit, configured for loop-feed (feed-thru).

B. Capacity: 150 KVA.

C. Primary Voltage: 12,470V, delta connected; provide primary taps, with externally operated tap changer.

1. Taps: Four (4) - 2½ percent full capacity; two (2) below and two (2) above rated voltage, minimum.

D. Secondary Voltage: 277/480 volts, wye connected.

E. Impedance: 3.75 percent, nominal.

F. Basic Impulse Level.

1. Primary Connection: 95 KV.

2. Secondary Connection: 30 KV.

G. Cooling and Temperature Rise: ANSI C57.12.22; Class OA; 65 degrees C, self cooled.

H. Liquid: Insulating oil.

I. Sound Levels: NEMA TR1; 55 DBa.

J. Primary Switching: ANSI C37.47; fused air switches, load break type, hook stick operated with current limiting fuses. Ratings as indicated and specified.

## 2.02 CONSTRUCTION

A. Transformers shall be compartmental type, self-cooled, tamperproof, and weatherproof for mounting on a concrete pad. They shall consist of a transformer tank, high voltage compartment, and low voltage compartment assembled as an integral unit. There shall be no exposed screws, bolts, or other fastening devices which are externally removable. Transformers shall be of sealed tank

construction with sufficient strength to withstand a pressure of 7 psi without permanent deformation. Cover shall be welded with a tamperproof bolted and gasketed handhole. The transformer shall remain effectively sealed for a top oil temperature range of 50°C to 105°C. Cooling panels shall be provided on the back and/or sides of the tank, if needed. Lifting eyes and jacking pads shall be provided.

B. Transformer tank and compartments shall be shot-blasted, prime painted, and finished in manufacturer's standard color.

C. Core and coil assembly shall be wound core type with aluminum windings. Assembly shall be designed to reduce losses and noise and provide adequate short-circuit strength and heat dissipation. A tap changing mechanism shall be provided for accurate voltage adjustment without opening the transformer tank. Tap changing mechanism shall be externally operated and shall be for de-energized operation only. Core and coil shall be dried by circulating current through the winding, in vacuum drying process and submerged under the insulating fluid without being exposed to air after drying.

D. High and low voltage compartments shall be located side-by-side separated by a steel barrier. When facing the transformer, the low voltage compartment shall be on the right. Terminal compartments shall be full height, air filled with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened. The low voltage door shall have a 3-point latching mechanism with vault type handle having provisions for a single padlock. The doors shall be equipped with lift-off type stainless steel hinges and door-stops to hold the doors open when working in the compartments. The front sill of the compartment shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in each compartment.

1. High Voltage Compartment Configuration: ASNI C57.12.22; live front, loop-feed; primary switch and fuse arrangement, suitable for connection to underground cables.

2. Low Voltage Compartment Configuration: Molded epoxy bushings with NEMA standard hole blade type spade terminals, radial feed; secondary circuit breaker, suitable for connection to underground cables.

E. All terminals shall be clearly marked with numbers.

F. The entire assembly shall be fitted with rodent-proof barrier screens.

G. Safety Labels: NEMA 260; affixed to front of transformer.

## 2.03 ACCESSORIES

A. Standard Accessories: ANSI C57.12.22; located in low voltage compartment.

1. Liquid level gage.

2. Dial type thermometer.

3. Drain valve with sampling device.

4. Pressure relief valve.

5. Upper filter press and filling plug.

6. Grounding clamp.

7. Nameplate: List rated KVA, frequency, primary and secondary voltages, percent taps, manufacturer, serial no., style, form, polarity, impedance, decibel rating, and temperature rise.

B. Secondary Molded Case Circuit Breaker: NEMA AB 1; Thermal-magnetic type with magnetic trip adjustment. Ratings as indicated and specified. Voltage to match or exceed nominal system rating on which circuit breaker is installed. Short circuit current interrupting rating shall be 25,000 RMS symmetrical amperes at 480 volts (minimum).

C. Lighting Arresters: ANSI C62.1; distribution class, one (1) on each phase. Ratings as indicated and specified.

## 2.04 FACTORY TESTS

A. Transformers shall be subjected to the following tests in accordance with ANSI/IEEE C57.12.90. The sequence of this listing does not necessarily indicate the sequence in which these tests should be conducted. Testing sequence shall be determined by the manufacturer.

1. Exciting current at rated voltage on rated voltage tap connection.

2. Impedance and load loss at rated current on the rated voltage tap connection and

on the tap extremes.

3. No load loss at rated voltage on the rated voltage tap connection.

4. Polarity and phase relation on the rated voltage tap connection.

5. Potential Tests:

   a. Applied.

   b. Induced.

6. Ratio tests on rated voltage tap and all tap connections.

7. Insulation Resistance Test.

8. Sound Level (in decibel) Test.

9. Pressure leak test.

B. Submit certified factory test results for review and acceptance, two (2) weeks prior to shipment of transformer from factory.

## 2.05 ACCEPTABLE MANUFACTURERS - PAD MOUNTED TRANSFORMERS

A. Square-D Co. Class 7230 or an acceptable equivalent by one of the following:

1. ABB Power T&D Co., Inc.

2. General Electric Co.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify that concrete pad is suitable and ready for the installation of transformer.

B. Verify that required utilities and/or appurtenances are in place.

## 3.02 INSTALLATION

A. Install transformer and accessories in accordance with manufacturer's instructions.

B. Set transformer plumb and level. Secure transformer to concrete pad.

## 3.03 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure secondary voltage and make appropriate tap adjustments.

END OF SECTION

# SECTION 16421

# ELECTRIC SERVICE

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Arrangement with Conectiv Power Delivery (CPD) for a new permanent electric service, including all cost and work required for same.

B. Underground service entrance conduit.

C. All equipment, materials, and labor as required and as necessary for the installation of the new electric service.

1. CPD Representative:
2. Existing CPD Account Number: 254208299993 (Central Pump Station).
3. Existing CPD Account Number: 254208399991 (East Pump Station).

D. Each and every bidder shall be responsible to contact CPD prior to submitting a proposal and verify all electric service requirements. Additional equipment, materials, and labor required through failure to follow these instructions shall be provided by the CONTRACTOR at no additional cost to the OWNER.

### 1.02 SYSTEM DESCRIPTION

A. Primary System Voltage: 12,470 volts, three-phase, four-wire, 60 Hertz.

B. Secondary System Voltage: 277/480 volts, three-phase, four-wire, 60 Hertz.

C. Metering Arrangement: Single service meter.

### 1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Conform to requirements of CPD.

## 1.05 QUALITY ASSURANCE

A. Electric Utility Company: Conectiv Power Delivery (CPD).

B. Install service entrance in accordance with utility company's rules and regulations.

## 1.06 SUBMITTALS

A. Submit shop drawings and product data as required.

## 1.07 COORDINATION

A. Verify location of service point with CPD, prior to rough-in work.

## 1.08 PROJECT RECORD DOCUMENTS

A. Accurately record location of service entrance conduit.

B. Accurately record location of service equipment foundation, ground ring, and protective barriers.

# PART 2 PRODUCTS

## 2.01 EQUIPMENT

A. Meter: Furnished by CPD, installed by CONTRACTOR, per CPD requirements.

B. Service Equipment and Metering Cabinet: Provided by CONTRACTOR, per CPD requirements.

C. Underground Service Entrance Conduit: Provided by CONTRACTOR, per CPD requirements.

D. Primary Cable: Provided by CONTRACTOR, per CPD requirements.

E. Service Equipment Foundation: Provided by CONTRACTOR, per CPD requirements.

F. Ground Ring, Protective Barriers, and Appurtenances: Provided by CONTRACTOR, per CPD requirements.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Make all arrangements with CPD to obtain a new permanent electric service to the project.

B. Install primary service entrance conduits in concrete envelope, three (3) inch minimum on all sides, from service point to service entrance equipment.

C. Install all equipment and materials per CPD requirements.

D. Obtain from CPD all requirements pertaining to electric service installation.

## PART 4 UTILITIES COORDINATION AND COSTS

### 4.01 ELECTRIC UTILITY (CONECTIV POWER DELIVERY)

A. The CONTRACTOR shall make all arrangements with the electric utility and pay all charges made by the electric utility involved with electric service to the project. These shall include but shall not be limited to pole line and/or underground work, easements and/or right-of-ways, connection and/or installation fees, etc., all as required to obtain service. The CONTRACTOR's bid shall include all costs and utility company charges.

END OF SECTION

# SECTION 16422

# ELECTRIC SERVICE COORDINATION WITH USCG

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Arrangement with Conectiv Power Delivery (CPD) for a new permanent electric service, including all cost and work required for same.

B. New electric service pole line to existing range light.

C. All equipment, materials, and labor as required and as necessary for the installation of the new electric service.

1. CPD Representative:
2. Existing CPD Account Number: (Range Light).

D. Each and every bidder shall be responsible to contact CPD prior to submitting a proposal and verify all electric service requirements. Additional equipment, materials, and labor required through failure to follow these instructions shall be provided by the CONTRACTOR at no additional cost to the OWNER.

E. All coordination with the United States Coast Guard (USCG) for modifications to the electric service for the range light, including all cost and work required for same.

F. Continuous provision of electric power to the range light during temporary de-energization of the electric service as required to make modifications to the service entrance conductors and conduit as necessary for the installation of new service equipment.

G. Each and every bidder shall be responsible to contact the USCG and verify any/all service requirements, including all work and costs involved in modifying the electric service, prior to bidding. Additional work and/or costs required through failure to follow these instructions shall be provided by the CONTRACTOR at no additional cost to the OWNER.

1. USCG Representative: BMC Michael A. Baroco, Jr.
Officer in Charge
U. S. Coast Guard
Aid to Navigation Team
1 Washington Avenue
Philadelphia, PA 19147-4395
(215) 271-4847

## 1.02 SYSTEM DESCRIPTION

A. Primary System Voltage: 12,470 volts, three-phase, four-wire, 60 Hertz.

B. Secondary System Voltage: 120/240 volts, single-phase, three-wire, 60 Hertz.

C. Metering Arrangement: Single service meter.

## 1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

## 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Conform to requirements of CPD.

## 1.05 QUALITY ASSURANCE

A. Electric Utility Company: Conectiv Power Delivery (CPD).

B. Install service entrance in accordance with utility company's rules and regulations.

## 1.06 SUBMITTALS

A. Submit shop drawings and product data as required.

## 1.07 COORDINATION

A. Verify location of service point with CPD, prior to rough-in work.

## 1.08 PROJECT RECORD DOCUMENTS

A. Accurately record location of service entrance conduit.

B. Accurately record location of pole line.

# PART 2 PRODUCTS

## 2.01 EQUIPMENT

A. Meters: Furnished by CPD, installed by CONTRACTOR, per CPD requirements.

B. Meter Box: Provided by CONTRACTOR, per CPD requirements.

C. Pole Line: Provided by CONTRACTOR, per CPD requirements.

D. Underground Service Entrance Conduit: Provided by CONTRACTOR, per CPD requirements.

E. Primary and Secondary Cable: Provided by CONTRACTOR, per CPD requirements.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Make all arrangements with CPD to obtain a new permanent electric service to the project.

B. Install service entrance conduits in concrete envelope, three (3) inch minimum on all sides, from service point to building service entrance equipment.

C. Install all equipment and materials per CPD requirements.

D. Obtain from CPD all requirements pertaining to electric service installation.

E. Obtain from USCG all requirements pertaining to electric service to the range light.

# PART 4 UTILITIES COORDINATION AND COSTS

## 4.01 ELECTRIC UTILITY (CONECTIV POWER DELIVERY)

A. The CONTRACTOR shall make any/all necessary arrangements with the electric utility and pay all charges made by the electric utility involved with any/all modifications to the electric services to the project. These shall include but shall not be limited to pole line an/or underground work, easements and/or rights-of-way, connection and/or installation fees, etc. all as required to obtain service. The CONTRACTOR's bid shall include all utility company charges.

END OF SECTION

# SECTION 16441

# ENCLOSED SWITCHES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Disconnect switches.

B. Fuses.

### 1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. ANSI/UL 198E - Class R Fuses.

C. NEMA KS 1 - Enclosed Switches.

### 1.03 SUBMITTALS

A. Submit product data as required.

B. Include outline drawings with dimensions and equipment ratings for voltage, capacity, horsepower, and short circuit.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.05 SPARE PARTS

A. Fuses: Furnish one (1) spare fuse for each one installed to the OWNER.

## PART 2 PRODUCTS

## 2.01 DISCONNECT SWITCHES

A. Nonfusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

B. Fusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Fuse Clips: Class R fuse type.

D. Enclosures: NEMA KS 1.

1. Exterior (Weatherproof) Locations: Type 4X (stainless steel), unless indicated otherwise.

## 2.02 FUSES

A. Fuses: ANSI/UL 193E, Class RK5, dual element, current limiting, 600 volt.

B. Interrupting Rating: 200,000 rms amperes.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install disconnect switches where indicated or required.

B. In general, mount disconnect switches 48 inches above floor to centerline.

C. Install fuses in fusible disconnect switches.

END OF SECTION

# SECTION 16461

# DRY TYPE TRANSFORMERS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Dry type two winding transformers.

### 1.02 REFERENCES

A. ANSI/NEMA ST 20 - Dry Type Transformers for General Applications.

B. ANSI/NFPA 70 - National Electrical Code.

### 1.03 SUBMITTALS

A. Submit product data as required.

B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

### 1.05 DELIVERY, STORAGE, AND HANDLING

A. Store in a warm, dry location with uniform temperature. Cover openings to keep out dust.

B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

# PART 2 PRODUCTS

## 2.01 DRY TYPE TWO WINDING TRANSFORMERS

A. Dry Type Transformers: ANSI/NEMA ST 20; factory-assembled, totally enclosed, non-ventilated, dry type transformers; ratings as shown on the drawings and/or as specified.

B. Insulation system and average winding temperature rise for rated KVA as follows:

| Rating (KVA) | Class (degree C) | Rise (degree C) |
|---|---|---|
| 15 | 220 | 150 |

C. Case temperature shall not exceed 30 degrees C rise above ambient at its warmest point.

D. Winding Taps: ANSI/NEMA ST 20.

1. Four 2½ percent full capacity taps on primary winding; 2 below and 2 above rated voltage, minimum.

E. Sound Levels: ANSI/NEMA ST 20.

F. Basic Impulse Level: 10 KV.

G. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

H. Mounting: Wall/surface.

I. Coil conductors: Continuous windings with terminations brazed or welded.

J. Enclosure: ANSI/NEMA ST 20; Type 3R/4.

K. Isolate core and coil from enclosure using vibration-absorbing mounts.

L. Nameplate: Include transformer connection data.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify that surfaces are suitable for installing transformer supports.

### 3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set transformer plumb and level.

C. Use flexible conduit, 2 ft. maximum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

### 3.03 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

# SECTION 16470

# PANELBOARDS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Distribution and branch circuit panelboards.

### 1.01 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 1 - Panelboards.

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

### 1.02 SUBMITTALS

A. Submit shop drawings for equipment and component devices as required.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

### 1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purposes specified and shown.

### 1.04 SPARE PARTS

A. Keys: Furnish 2 spare keys for each panelboard installed to the Owner.

# PART 2 PRODUCTS

## 2.01 DISTRIBUTION AND BRANCH CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1; Circuit breaker type.

B. Enclosure: NEMA PB 1.

1. Exterior Locations: Type 4X, stainless steel, unless indicated otherwise.

C. Provide surface mounted cabinet with concealed hinge and lock. Manufacturer's standard finish.

D. All panelboards shall be keyed alike.

E. Provide panelboards with copper bus, ratings as scheduled on drawings. Provide copper ground bus in all panelboards.

F. Minimum Integrated Short Circuit Rating: As indicated on the drawings.

G. Molded Case Circuit Breakers: NEMA AB 1; Provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

1. Provide UL Class A ground fault interrupter circuit breakers where scheduled, or required.
2. Provide UL listed switching duty (SWD) rated circuit breakers where indicated or required.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install panelboards plumb, in conformance with NEMA PB 1.1.

B. Height: 4 ft.-6 in. to centerline.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed circuit directory for each panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

## 3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

END OF SECTION

# SECTION 16476

# ENCLOSED CIRCUIT BREAKERS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Enclosed molded case circuit breakers.

### 1.02 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code.

B. NEMA AB 1 – Molded Case Circuit Breakers.

### 1.03 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Include circuit breaker ratings, trip current and let-through current curves, outline dimensions, and terminal lug sizes.

### 1.04 REGULATORY REQUIREMENTS

A. Confirm to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriter's Laboratories, Inc., as suitable for purpose specified and shown.

## PART 2 PRODUCTS

### 2.01 MOLDED CASE CIRCUIT BREAKERS

A. Circuit Breakers: NEMA AB 1; Thermal-magnetic type with magnetic trip adjustment.

B. Ratings: NEMA AB 1; As indicated and specified.

1. Voltage: To match or exceed nominal system rating on which circuit breaker is installed.

2. Short Circuit Current Interrupting – RMS Symmetrical: As indicated on single-line diagrams and panel schedules for each circuit breaker.

## 2.02 ENCLOSURES

A. Enclosure: NEMA AB 1; Type 4X, stainless steel, unless indicated otherwise.

B. Finish: Manufacturer's standard.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install enclosed circuit breakers where shown on drawings, in accordance with manufacturer's instructions.

B. Mounting Height: 4 ft. – 6 in. to centerline, nominal.

## 3.02 FIELD QUALITY CONTROL

A. Inspect visually and perform several mechanical "ON-OFF" operations on each circuit breaker.

B. Verify circuit continuity on each pole in closed position.

END OF SECTION

# SECTION 16480

# MOTOR CONTROLS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Motor starters.

B. Combination motor starters.

C. Manual motor starters.

### 1.02 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

B. ANSI/NFPA 70 - National Electrical Code.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

### 1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1.

B. Indicate on shop drawings, front and side views of motor control enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components. Provide control wiring diagrams for each unit/section.

C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and overcurrent protective devices.

D. Submit manufacturer's installation instructions.

## 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver individually wrapped for protection, and mounted on shipping skids.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control components, enclosure, and finish.

# PART 2 PRODUCTS

## 2.01 MOTOR STARTERS

A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

1. Full Voltage Starting: Non-reversing type.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Size: NEMA ICS 2; size as shown or as required.

D. Overload Relay: NEMA ICS 2; melting alloy type.

E. Enclosure: NEMA ICS 6.

1. Explosionproof Locations: Type 7, unless indicated otherwise.

2. Exterior (Weatherproof) Locations: Type 4X (stainless steel), unless otherwise indicated.

F. Combination Motor Starters: Combine motor starters with motor circuit protector disconnect in common enclosure.

G. Auxiliary Contacts: NEMA ICS 2; As required to meet control functions; normally open/closed - field convertible contacts.

H. Indicating Lights: NEMA ICS 2; RUN: Red; OFF: Green; ALARM: Amber; in front cover.

I. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.

J. Push Buttons: NEMA ICS 2; RESET, Momentary contact type, in front cover.

K. Relays: Type and quantity as required to meet control functions.

L. Control Power Transformer: 120 volt secondary, capacity as required to meet control functions.

M. Running Time Meters: Non-reset, 6 digit, calibrated in hours, in front cover.

## 2.02 UNIT OVERCURRENT PROTECTION AND DISCONNECTING MEANS

A. Motor Circuit Protector (For Starters); NEMA AB 1; circuit breakers with integral instantaneous magnetic trip in each pole.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's instructions.

B. Select and install heater elements in motor starters to match installed motor characteristics.

C. Motor Data: Provide neatly type label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

D. Height: Individual motor starters; 4 ft.-6 in. to centerline.

END OF SECTION

# SECTION 16495

# TRANSFER SWITCHES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Manual transfer switches.

### 1.02 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NEMA KS 1 - Enclosed Switches.

### 1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in transfer switch equipment with ten years documented experience.

### 1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1.

B. Submit shop drawings and product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, enclosure type, include all auxiliary equipment.

C. Submit manufacturer's installation instructions.

### 1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include instructions for operating equipment.

C. Identify operating limits which may result in hazardous or unsafe conditions.

D. Document ratings of equipment and each major component.

E. Include routine preventive maintenance and lubrication schedule.

F. List special tools, maintenance materials, and replacement parts.

## PART 2 PRODUCTS

### 2.01 MANUAL TRANSFER SWITCH

A. Double-Throw Nonfusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

B. Enclosures: NEMA KS 1.

1. Exterior (Weatherproof) Locations: Type 4X (stainless steel), unless indicated otherwise.

C. Ratings: NEMA KS 1; as follows:

1. Voltage: 480 volts, three phase, four wire, 60 Hz.
2. Switched Poles: 3.
3. Continuous Rating: As noted on the drawings.
4. Interrupting Capacity: 100 percent of continuous rating.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verification that surfaces are ready to receive work.

B. Verify field measurements.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means acceptance of existing conditions.

## 3.02 INSTALLATION

A. Installation in accordance with manufacturer's instructions.

B. Height 4 ft.-6 in. to centerline, nominal.

END OF SECTION

# SECTION 16530

# SITE LIGHTING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Area lighting luminaires and accessories.

B. Poles.

### 1.02 REFERENCES

A. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns.

B. ANSI C82.4 - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

C. ANSI/NFPA 70 - National Electrical Code.

### 1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings: Indicate dimensions and components for each luminaire.

C. Product Data: Provide dimensions, ratings, and performance data.

D. Test Reports: Indicate measured illumination levels.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

F. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of products.

### 1.04 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each luminaire/pole.

## 1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Maintenance Data: Include instructions for maintaining luminaires and replacement parts list.

## 1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in accordance with manufacturer's instructions.

B. Accept products on site. Inspect for damage.

C. Protect poles from finish damage by handling carefully.

## 1.08 COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

## 1.09 SPARE PARTS

A. Lamps: Furnish spare lamps to the OWNER.

1. High Pressure Sodium - 2 of each size and type installed.

# PART 2 PRODUCTS

## 2.01 AREA LIGHTING LUMINAIRES

A. Furnish products as specified in schedule on drawings.

B. Description: Pole mounted "shoe box" cutoff type luminaire. One-piece weatherproof housing with extruded door frame and injection molded ultraviolet stabilized high transmittance acrylic drop lens. Finish shall be electrostatically applied powder coating.

C. Light Distribution: Type V.

D. Installation Conditions: Outdoor use; enclosed and gasketed.

E. Mounting: Provide pole mounting bracket.

F. Wind and Weight Ratings:

1. Luminaire Weight: 25 pounds (maximum).
2. Luminaire Effective Projected Area: 1.5 square foot (maximum).
3. Bracket Weight: 10 pounds (maximum).
4. Bracket Effective Projected Area: 0.5 square feet (maximum).

G. Ballast: Manufacturer's standard, matched to lamp characteristics, rated 120 volts.

H. Lamp: One each, rated 150 watts, high pressure sodium type clear lamp.

I. Accessories: Manufacturer's standard 10 inch mounting arm.

## 2.02 AREA LIGHTING POLES

A. Material and Finish: Aluminum with electrostatically applied powder coating finish.

B. Section Shape and Dimensions: Square, straight, 4 inch (nominal).

C. Height: 14 feet (nominal).

D. Base: Nonbreakaway, cast aluminum plate type.

E. Accessories:

1. Handhole.
2. Baseplate template.
3. Anchor bolts and hardware.

F. Loading Capacity Ratings:

1. Weight: 250 pounds (minimum).
2. Effective Projected Area: 10 square feet (minimum).
3. Steady Wind: 80 miles per hour, minimum (1.3 gust factor).

## 2.03 BALLASTS

A. High Intensity Discharge (HID) Ballast:

1. Description: ANSI C82.4, high power factor type lamp ballast.
2. Provide ballast suitable for lamp specified.
3. Voltage: 120 volts.

## 2.04 LAMPS

A. Acceptable Lamp Manufacturers:

1. General Electric.
2. Phillips.
3. Sylvania.

B. Provide lamp type specified for luminaire.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine excavation and concrete foundation for lighting poles.

B. Examine each luminaire to determine suitability for lamps specified.

## 3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lighting poles at locations indicated.

C. Install poles plumb. Provide double nuts to adjust plumb. Grout around each base.

D. Install lamps in each luminaire.

E. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

## 3.03 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

## 3.04 ADJUSTING

A. Aim and adjust luminaires to provide illumination levels and distribution as directed.

B. Relamp luminaires which have failed lamps at Substantial Completion.

## 3.05 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosure.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION

# SECTION 16741

# TELEPHONE SERVICE

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Arrangement with Verizon for new permanent telephone service to the Cherry Island Landfill leachate pumping stations in order to accommodate the automatic telephone dialers, including all work and costs required for same.

B. Telephone service conduit.

C. Equipment and telephone terminal cabinet.

D. The CONTRACTOR shall be responsible to provide all equipment, devices, material, labor, and all other items required for a complete and operational installation.

E. Each and every bidder shall be responsible to contact Verizon and also to visit the site, prior to submitting a proposal and verify all telephone service/system requirements. Additional materials, equipment, and labor required through failure to follow these instructions shall be provided by the CONTRACTOR at no additional cost to the OWNER.

### 1.02 SYSTEM DESCRIPTION

A. The telephone service/system shall provide service for the automatic telephone dialing equipment.

B. Two (2) new telephone "touch tone type" lines/numbers shall be provided: prefix; XXX-XXXX and shall be dedicated to the automatic telephone dialing equipment.

C. The two (2) new lines/numbers shall be used to evenly divide the pump station automatic telephone dialers.

### 1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

## 1.04 QUALITY ASSURANCE

A. Telephone Utility Company: Verizon.

B. Install work in accordance with utility company's rules and regulations.

## 1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1.

## 1.06 COORDINATION

A. Verify location of service point with Verizon prior to rough-in work.

## 1.07 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Conform to requirements of Verizon.

## 1.08 PROJECT RECORD DOCUMENTS

A. Accurately record location of service conduit.

B. Accurately record the location of all telephone equipment and wiring.

# PART 2 PRODUCTS

## 2.01 TELEPHONE TERMINAL CABINETS

A. Cabinet: See Section 16160 - Cabinets and Enclosures.

## 2.02 TELEPHONE OUTLETS

A. Modular Outlet: Standard four pin jack (RJ-11) mounted in stainless steel cover plate.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install all equipment and material per Verizon requirements, and as indicated on the drawings and as specified.

B. Install telephone service/system conduit as shown on the drawings and as specified in Section 16111.

C. Install all equipment plumb and square in cabinet.

D. Make all arrangements with Verizon to obtain new service for the project.

## PART 4 UTILITIES COORDINATION AND COSTS

### 4.01 TELEPHONE UTILITY (VERIZON)

A. The CONTRACTOR shall make all arrangements with the telephone utility and pay all charges made by the telephone utility for telephone services to the project. These shall include but shall not be limited to pole line and/or underground work, easements and/or right-of-ways, connection and/or installation fees, etc., all as required to obtain service. The CONTRACTOR's bid shall include all costs and utility company charges.

END OF SECTION

# SECTION 16744

# AUTOMATIC TELEPHONE DIALER

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Automatic telephone dialer.

### 1.02 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Submit manufacturer's installation instructions.

C. Submit operation and programming data.

### 1.03 OPERATION AND PROGRAMMING MANUALS

A. Provide three (3) bound and indexed copies of manufacturer's standard manuals.

## PART 2 PRODUCTS

### 2.01 AUTOMATIC TELEPHONE DIALER

A. The automatic telephone dialer shall be a self-contained, automatic solid state device. The dialer shall continuously monitor the presence of AC power and the status of eight (8) independent N.O. or N.C. contact inputs.

B. Description and Phone Number Dialing:

1. The dialer shall be a solid state component capable of dialing up to 16 phone numbers, each up to 24 digits in length. Phone numbers and standard pulse dialing or touch tone DTMF dialing shall be user programmable via the system's keyboard or touch tone phone.

C. Solid State Voice Message Recording and Playback:

1. The unit shall have two different categories of speech message capability, all implemented with permanent non-volatile solid state circuity with no mechanical tape mechanisms.
2. User Field Recorded Messages: The user shall be able to record and re-record his own voice messages, for each input channel and for the station ID. The time for each message shall be adjustable, and recordings may be made at the front panel or from any remote touch tone telephone. Provision shall be included for status only (non-alarmable) messages.
3. Permanent Resident Non-Recorded Messages: Permanent built-in voice messages shall be included to support user programming operations, to provide supplemental warning messages such as advising that the alarms have been disabled, and to allow the unit to be fully functional even when the user or installer has not recorded any messages of his own.

D. Local and Remote Programming Capabilities:

1. The user shall be able to optionally elect to alter the following parameters from their standard normal default values via keyboard entry or remotely from any touch tone phone:

   a. Alarm Response Delay: .1 to 999.9 seconds.
   b. Delay Between Alarm Call Outs: .1 to 9.9 minutes.
   c. Alarm Reset Time: 0.1 to 99 hours or "No Reset".
   d. Incoming Ring Response (Answer) Delay: 1 to 20 rings.
   e. Number of Message Repetitions: 1 to 20 repetitions.
   f. Input Alarm Criteria: Each channel shall be independently configured for Alarm on Open Circuit, Alarm on Closed Circuit, or No Alarm.

2. Autocall Test: When enabled, the unit shall place a single round of test calls, both at the time this function is enabled and also at regular subsequent intervals until this function is disabled at the keyboard.
3. Run Time Meter: Selected inputs shall accumulate and report the number of hours that its input contacts have been closed.
4. Remote System Microphone Activation.
5. Remote and Local Arming and Disarming of System.
6. Pulse Totalizer Function.

E. Nonvolatile Program Memory Retention:

1. User-entered programming and voice messages shall be kept intact even when all power is removed for up to ten years.

F. Acknowledgement:

1. Acknowledgement of an alarm phone call shall be accomplished by pressing a Touch Tone "9" as the alarm call is being received, and/or by returning a phone call to the unit after having received an alarm call.

G. Input Monitoring Function:

1. The unit shall continuously monitor the presence of AC power and the status of eight (8) contact closure inputs. AC power failure, or violation of the alarm criteria at any input, shall cause the unit to go into alarm status and begin dial-outs.

H. Alarm Message:

1. Upon initiating an alarm phone call, the system shall "speak" only those channels that are currently in "alarm status".

I. Speakerphone:

1. The unit shall be capable of dialing any phone number on command and function as a speakerphone.

J. Inquire Message and Function:

1. Inquiry phone calls can be made directly to the unit at any time from any telephone, locally or long distance, for a complete status report of all variable being monitored, including power status.

K. Power Battery Backup:

1. Normal power shall be 105-135 VAC, 15 watts nominal. The product shall contain its own gel cell rechargeable battery which is automatically kept charged when AC power is present. The system shall operate on battery power for a minimum of six continuous hours in the event of AC power failure. The built-in charger shall be precision voltage controlled.

L. Phone Line:

1. The dialer shall use a standard rotary pulse or touch tone "dial-up" phone line and shall be F.C.C. approved. Connection to the telephone shall be through a 4-pin modular jack (RJ-11).

M. Integral Surge Protection:

1. Gas tube and solid state surge protection shall be provided on all inputs, including power, phone, and signal lines. These protectors shall be integrally incorporated into the main circuit board for maximum protection.

N. Warranty:

1. The dialer shall be covered by a two (2) year warranty covering all parts and labor.

O. Modular Upgrades:

1. The system shall include expansion connectors to accommodate field upgrades for additional dry contact inputs.

P. All keyboard and front panel switches shall be sealed to prevent contamination. Front panel LED's shall indicate: Normal Operation, Program Mode, Phone Call in Progress, Status for each channel, AC Power Present, AC Power Failure, and Low Discharging or Recharging Battery. On any inquiry telephone call or on-site status check, the voice shall provide specific warning if no dialout phone numbers are entered, or if the unit is in the "alarm disable" mode, or if AC power is off or has been off since last reset. A built-in microphone shall allow anyone at a remote phone to listen to local sounds and have a two-way conversation with personnel at the dialer.

Q. Enclosure:

1. NEMA Type 4X with condensation heater.

## 2.02 MANUFACTURER

A. The automatic telephone dialer shall be Series VSS "Verbatim" as manufactured by RACO Manufacturing and ENGINEERing Company, 1400 62nd Street, Emeryville, CA 94608, (415) 658-6713 or (800) 722-6999, or an acceptable equivalent.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install dialer plumb and square.

B. Height: 4 ft.-0 in. to centerline.

## 3.02 FIELD QUALITY CONTROL

A. Field testing shall be performed in the presence of the OWNER.

END OF SECTION

# SECTION 16900

# INSTRUMENTATION

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Magnetic flowmeters.

B. Signal converters.

C. Signal cable.

D. Contractor responsibility for providing all equipment, devices, material, labor, and all other items required for a complete and operational installation.

### 1.02 SPARE PARTS

A. Piping Spool Piece: Furnish one (1) spare piping spool piece (fabricated to the dimensions of each size flowmeter and used in place of the flowmeter during periods of repair) to the Owner.

## PART 2 PRODUCTS

### 2.01 MAGNETIC FLOWMETERS

A. Flowmeters shall be of the low frequency electromagnetic induction type and shall operate on a DC pulse signal directly proportional and linear to the liquid flow rate. Flow rate measurement shall be based on liquid velocity and shall be independent of viscosity, density, and temperature. The flowmeters shall be inherently compatible with remote signal converters and both units together shall constitute a stand-alone flowmetering system.

B. Each flowmeter shall be provided with the following design features:

1. Minimum Liquid Conductivity: 5 microsiemens/cm.

2. Liquid Temperature Limitations: -15 degrees F to 266 degrees F.

3. Ambient Temperature Limitations: -15 degrees F to 140 degrees F.

4. Enclosure Rating: NEMA 4X; cast aluminum.

5. Meter Spool: Two inch (2") diameter or three inch (3") diameter (as scheduled per pump station); 304 stainless steel with ANSI Class 150 flanges and Teflon-PFA liner.

6. Electrodes: Flush type; 316 stainless steel, non-incendive type.

7. Grounding Rings: 316 stainless steel; match flange configuration.

C. Manufacturer: Flowmeters shall be ABB (Fischer & Porter) Model Number MFE650371801XX1ER or an acceptable equivalent by Foxboro or Rosemount.

## 2.02 SIGNAL CONVERTERS

A. Signal converters shall be of the microprocessor based, pulsed DC type providing coil energizing current to the magnetic flowmeter. Converters shall provide automatic system monitoring with error diagnostics and alarms including empty pipe detection. The signal converters shall be inherently compatible with flowmeters and both units together shall constitute a stand-alone flowmetering system.

1. Provide an appropriate length of manufacturer's standard signal cable for connection to flow meter.

B. Each signal converter shall be provided with the following design features.

1. Range: 0 - 500 gpm, nominal.

2. Accuracy: ± ½ percent of range.

3. Display: Back lit illuminated liquid crystal type with two (2) lines of 16 alphanumeric characters each, configurable.

4. Data Entry: Pushbutton keypad with membrane cover. All data shall be stored in non-volatile memory and programming shall be protected by a password.

5. Analog Output: Isolated 4-20mA signal directly proportional to range.

6. Digital Output: Relay contact, scaled pulse; 100 gallons per pulse.

7. Low Flow Cutoff: 0 to 10%, configurable.

8. Damping: 1 to 100 seconds, configurable.

9. Response Time: ½ second, nominal.

10. Input Power: 120 volt, 60 hertz.

11. Enclosure Rating: NEMA 4X; cast aluminum, suitable for wall mounting.

C. Manufacturer: Signal converters shall be ABB (Fischer & Porter) Model Number MFE4ER140511 or an acceptable equivalent by Foxboro or Rosemount.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. The instrumentation devices shall be installed in accordance with the manufacturer's instructions.

B. Make wiring interconnections as shown on drawings.

C. The equipment shall be provided with nameplates which shall be securely fastened to same. Nameplates shall consist of Lamicoid plastic, black cut through to white lettering.

### 3.02 FIELD QUALITY CONTROL

A. Provide the services of the instrumentation equipment manufacturer's competent and experienced field service personnel to supervise the initial calibration and final adjustments of the equipment under operating conditions.

B. Field testing shall be performed in the presence of the Owner.

### 3.03 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services as follows:

1. Services of qualified technician to supervise installation, adjustments, final connections, and system testing.

2. Manufacturer's letter certifying that the system testing is acceptable and that the system is operating properly.

B. The Contractor shall make all arrangements with the manufacturer and pay all charges made by the manufacturer for field services involved with the project. The Contractor's bid shall include all manufacturer's charges.

END OF SECTION

# SECTION 16915

# MISCELLANEOUS CONTROL AND ALARM DEVICES

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Float switches.

B. Cable holder assembly.

C. Annunciators.

D. CONTRACTOR responsibility for providing all equipment, devices, material, labor, and all other items required for complete and operational installations.

### 1.02 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/NFPA 70 - National Electrical Code.

C. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

### 1.03 SUBMITTALS

A. Submit shop drawings, product data, installation instructions, and operation and maintenance instructions.

B. Include outline and support point dimensions of enclosures and cabinetry, weight, equipment/device layout, and schematic and point-to-point wiring diagram(s).

C. Include instructions for programming and operating procedures.

D. Include instructions for repair, replacement parts, and troubleshooting diagnostics.

### 1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## PART 2 PRODUCTS

### 2.01 FLOAT SWITCHES

A. Sealed float type switches shall be supplied to provide alarm signals and control.

B. The switches shall be sealed in a solid polyurethane float for corrosion and shock resistance. The support wire shall have a heavy neoprene jacket, and a weight shall be attached to cord above the float to hold the switch in place. The weight shall be above the float to prevent sharp bends in the cord when the float operates underwater.

C. Float switches shall be Hydromatic Model 3900, Flygt Model ENM-10, or an acceptable equivalent.

### 2.02 CABLE HOLDER ASSEMBLY

A. Furnish one (1) cable holder assembly and stainless steel fastening hardware for float switches. Cable holder assembly shall be stainless steel or shall be PVC coated.

B. Cable holder assemblies shall be Flygt Kit No. 14-58-94-05 or an acceptable equivalent.

### 2.03 ANNUNCIATORS

A. Alarm light shall be of the rotating beacon type suitable for outdoor (weatherproof) applications with a red color lens and shall operate on a 120 volt circuit. The unit shall be Edwards (General Signal) Catalog No. 52R-N5 or an acceptable equivalent.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. All devices shall be installed in accordance with the manufacturer's instructions.

B. Install alarm light on the side (near the top) of the site light pole adjacent to the Self-priming Pump Stations.

END OF SECTION

# SECTION 16924

# PUMP CONTROL SYSTEMS – SCADA

## PART 1 GENERAL

### 1.01 RESPONSIBILITY

A. The equipment and material of this Section shall be provided by the Contractor as supplied and turnkey commissioned by a single System Supplier/System Integrator.

B. The work of this Section shall be specifically coordinated with the provisions/requirements of the System Integration.

### 1.02 WORK INCLUDED

A. Provide a complete combination programmable logic controller (PLC) and personal computer (PC) based supervisory control and data acquisition system (SCADA) for six (6) new leachate pump station locations [and to interface with the existing controls for two (2) submersible pumps at the existing North Central Pump Station (NCPS) and with the existing controls for two (2) self-priming pumps at the existing Main Pump Station (MPS)]. The system shall be furnished and installed by the Contractor as supplied and turnkey commissioned by a single System Supplier/System Integrator. The Contractor shall be responsible for the required coordination between the System Supplier/System Integrator and all equipment/device manufacturers such that the correct application of the pump control system – SCADA is assured.

B. The pump control system – SCADA shall include, but shall not be limited to, the following components:

1. Six (6) SCADA control panels including PLC, accessories, and appurtenances for the new leachate pumping station locations.

2. [Two (2) interface SCADA control panels including PLC, accessories, and appurtenances for the existing NCPS and MPS].

3. Personal computer including software, accessories, and appurtenances for

the existing Operator/Administrator Office.

C. The Contractor shall be fully responsible for following the equipment arrangement/layout at the pump stations and the office as indicated on the drawings. The System Supplier/System Integrator shall furnish/fabricate the system equipment so as to meet all space restraints at these locations.

D. All physical equipment design and layout shall be coordinated by the Contractor with the System Supplier/System Integrator and the Owner.

## 1.03 RELATED EQUIPMENT AND PROGRAMMING

A. Inclined Submersible Pumps, Motors, and Accessories.

B. Pre-Engineered Self-Priming Pump Station.

C. Instrumentation.

D. Miscellaneous Control and Alarm Devices.

E. Transient Voltage Surge Suppression Systems.

F. System Integration.

## 1.04 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

B. ANSI/NFPA 70 - National Electrical Code.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

## 1.05 QUALITY ASSURANCE

A. The System Supplier/System Integrator shall be responsible for providing a complete pump control system – SCADA. The system components may be products manufactured by the System Supplier/System Integrator or by equipment manufacturer(s) regularly engaged in the manufacture of said components. However, the System Supplier/System Integrator shall assume unit responsibility for the complete pump control system, including accessories and appurtenances.

B. It is the intent of these specifications to assure a quality product of the manufacturer(s) latest design, meeting as a minimum the standards specified.

C. To ensure a quality pump control system – SCADA, the following conditions shall be satisfied by the equipment manufacturer(s) and System Supplier/System Integrator. Each shall demonstrate acceptable levels of technical, operational, and manufacturing experience. The equipment manufacturer(s) and System Supplier/System Integrator shall demonstrate the following:

1. Experience spanning five (5) continuous years in the design, production, and installation of PLC/PC based control systems for applications similar to those encountered on this project.

2. The qualifications of personnel designated to assist the Contractor during construction and start-up. Among these qualifications, the field service personnel shall be qualified, full-time employees of the equipment manufacturer(s) and System Supplier/System Integrator with adequate background in field service.

3. Evidence that there is an efficient and reliable service organization within 100 miles of the Cherry Island Landfill which carries a stock of spare parts and has a field service staff available to respond to system emergencies and routine service requests.

## 1.06 GENERAL REQUIREMENTS

A. The pump control system – SCADA shall be provided to monitor [and/or control] the following pumping systems:

1. Two (2) new self-priming pumping systems at Pump Station No. 3 (old

South Pump Station – SPS) and Pump Station No. 5 (old East Pump Station – EPS).

2. Six (6) new inclined slope submersible pumping systems at Pump Station No. 1 (old Central Pump Station – CPS), Pump Station No. 2 (old South Central Pump Station – SCPS), Pump Station No. 3 (old South Pump Station – SPS), Pump Station No. 4 (old South East Pump Station – SEPS), Pump Station No. 5 (old East Pump Station – EPS), and Pump Station No. 6 (new North Pump Station – NPS for Manhole No. 13/14).

3. [New submersible pumping system at the existing North Central Pump Station – NCPS.]

4. [Existing self-priming pumping system at the existing Main Pump Station – MPS.]

B. Pumping Systems:

1. New Self-Priming Pump Station (SPPS) Type: Two (2) self-priming suction centrifugal pumps with manufacturer supplied duplex Pump Control Panel (PCP). (See Section 15160 for Pump Specifications.)

2. New Inclined Submersible Pump Station (IPS) Type: Two (2) submersible turbine pumps with manufacturer supplied duplex Pump Control Panel (PCP). (See Section 11620 for Pump Specifications.)

3. [Existing NCPS Pump Type: Two (2) submersible centrifugal pumps; Flygt Model DP 3126 with manufacturer supplied duplex Pump Control Panel (PCP) and existing EG Controls interface control panel (ICP). (See Section 11610 for Pump Specifications.)]

4. [Existing MPS Pump Type: Two (2) self-priming suction centrifugal pumps with EG Controls duplex pump control panel.]

5. General Pump Station Control: All pump stations will operate in a similar fashion. The system shall provide all proper level controls and equipment, so that it operates in the following manner.

a. When the water level rises to the first "Pump On" level, the lead

pump will start.

b. When the water level is lowered to the "Pump Off" level, the lead pump will stop.

c. The alternator will then make the above pump the "lag" pump, and the other pump will then become the "lead" pump.

d. When the water level again rises to the first "Pump On" level, the lead pump will start.

e. The lead pump will then run until the water level is lowered to the "Pump Off" level.

f. If the water level continues to rise and reaches the "Lag Pump On" level, the lag pump will start.

g. If the water level continues to rise to the "High Water Level Alarm" level, an alarm will be activated. A signal shall be transmitted to the SCADA system. A signal shall also be transmitted to an automatic telephone dialer to notify the Owner.

h. Both pumps will continue running until the water level is lowered to the "Pump Off" level.

i. If the water level is lowered to the "Low Water Level Alarm" level, an alarm will be activated. The "Low Water Level Alarm" shall also act as a redundant "Pump Off" control. A signal shall be transmitted to the SCADA system. Furnish provisions so that in the future a signal can also be transmitted to an automatic telephone dialer to notify the Owner.

j. [*--Refer to Part 2.05 of this specification section for additional operational requirements and information.]

6. Existing NCPS Interface Control: The existing North Central Pump Station is supplied by a gravity flow from existing manhole No. 8A. This pump station receives the accumulated leachate flow from the other six (6) leachate pumping locations. It is presently controlled by a stand-alone

duplex pump control panel which shall be replaced by a new Pump Control Panel. The existing interface control panel shall remain and its interface wiring (logic) shall be incorporated into the new Pump Control Panel circuitry. The integrated system shall operate in the following manner.

a. Typically, the new Pump Control Panel shall operate as a stand-alone duplex pump controller. The existing interface control panel wiring will provide enable/disable outputs which shall be incorporated into the logic of the new Pump Control Panel.

b. Interface wiring shall also allow the Owner remote monitoring capability of NCPS from the existing PLC/PC based pump control system (i.e. pump on/off status).

c. The present remote on and off control functions shall continue to be provided from the existing PLC/PC based pump control system via interposing relay output circuitry furnished in the existing interface control panel.

d. [*--Refer to Part 2.05 of this specification section for additional operational requirements and information.]

## 1.07 SUBMITTALS

A. Submit complete shop drawings, product data, manufacturer's literature, installation instructions, and operations and maintenance manuals under provisions of Division 1 and as specified herein.

1. Indicate on shop drawings, front and side views of devices and control enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; phase, neutral, and grounding electrical characteristics including voltage; frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components. Provide control wiring diagrams for each unit/section. Include outline and support point dimensions of enclosures and cabinetry, weight, equipment/device layout, and schematic and point-to-point wiring diagram(s).

2. Provide product data on all major components (e.g., PLC's, PC, controls, starters, contactors, relays, pilot devices, overcurrent protective devices, etc.).

3. Provide a complete system interconnection wiring diagram.

4. Provide a comprehensive narrative description of all proposed programming.

5. Provide plans of the pump station(s) showing any/all proposed revisions to the equipment arrangement/layout. Drawing(s) shall be to scale (e.g., 3/8"=1'-0").

B. Experience: Submit evidence of experience and a list of previous similar installations.

C. Performance Requirements: Submit evidence that the control system will meet the specified requirements.

D. System Supplier/System Integrator shall furnish three (3) instructional books, which shall include the following:

1. Index and tabs.

2. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers. Include instructions for programming and operating procedures. Include instructions for repair and troubleshooting diagnostics.

3. Applicable drawings.

4. Warranties and guarantees.

5. Address and telephone number of nearest manufacturer(s) authorized service facility.

## 1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

## 1.09 DELIVERY, STORAGE, AND HANDLING

A. Delivery individually wrapped for protection, and mounted on shipping skids.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction, debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. The pump control system shall contain the following major components as outlined.

1. Six (6) SCADA panels for the new leachate pump station locations.

2. [One (1) SCADA panel for the existing NCPS.]

3. Personal computer including software for the existing Operator/Administrator Office.

### 2.02 SCADA PANEL

A. The SCADA panel shall provide monitoring [and functional control capability] between the new pump control panels and the new PLC/PC/software based pump control system.

1. Provide one (1) SCADA panel for each of the new leachate pumping locations [and the existing North Central Pump Station].

2. Control features shall be intrinsically safe with intrinsically safe relays and intrinsically safe barriers as required in the SCADA control panel/enclosure.

3. SCADA panel enclosure shall be gasketed, dust-tight, and corrosion resistant. Enclosure shall be NEMA 4X, stainless steel. Enclosure shall be of the door-in-door dead front construction type with all controls and

indicators mounted on the inner door. Enclosure shall be lockable.

4. [*--SCADA panel shall be furnished with the features and functions as specified in Part 2.05 of this specification section.]

5. The following functional features shall be provided.

   a. 120 volt panel pilot circuitry.

   b. Control circuit with disconnect breaker and overload protection, along with connections for external pilot circuitry.

   c. Terminal boards for power supply, interface connections, and level sensing.

   d. [Interposing relays and circuitry to allow on and off control of the pumps.]

   e. Interposing relays and circuitry shall be fail-safe to allow continued operation of the pump controls in the event of a failure or servicing of a new SCADA panel.

   f. Condensation Heater: A properly sized heater shall be supplied in the panel. The heater shall consist of a thermostat, resistance type heating grid and fan to circulate air through the enclosure. The entire unit shall be enclosed with all heater components within the enclosure.

   g. Lightning Arrestor: A lightning arrestor shall be installed in the panel and connected to each line of the incoming side of the power input terminals. The arrestor shall protect the controls against damage due to lightning strikes on the incoming power line.

B. Panel Description.

1. All major components and sub-assemblies shall be identified as to function with laminated, engraved, bakelite nameplates.

2. SCADA panel enclosure shall be suitable for surface/wall mounting.

## 2.03 PERSONAL COMPUTER AND SOFTWARE

A. General System Requirements.

1. Basis of design is a fully integrated hardware and software system designed, written, licensed, and implemented by the System Integrator using a Wonderware platform/package as outlined in this section of the specifications.

2. Supervisory Control and Data Acquisition (SCADA) System with an alarm dialer capabilities package. The system shall contain a fully integrated software and hardware package capable of running on a Microsoft Windows XP - Professional operating system platform. The system shall be supplied fully integrated and in the "Runtime" mode, requiring no additional utilities or "Development" packages. The software shall be capable of monitoring, logging and displaying data as well as alarms for up to twelve (12) stations. Pre-configured software modules capable of handling additional stations shall be available for any future expansion. Call up of station screens shall be "point and click" technology and shall not require complicated menu excursions to accomplish tasks. Interactive software shall allow for direct movement between systems screens through the use of graphical screen identification buttons and "point and click" technology. System shall not require return to the menu for additional screen access. The software shall meet all requirements as described in this section of the specifications. The hardware (e.g. computer, monitor, etc.) shall be of the latest technology as described in this section of the specifications.

B. Hardware & Software Requirements (Minimum).

1. Central Processing Unit: Intel Pentium-4; 2.66 GHz with 512K L2 advanced transfer cache and 533 MHz FSB.

2. Memory: 512 MB 333MHz DDR SDRAM.

3. Storage: 80 GB (minimum) hard drive internal disk.

4. 1.44 MB 3 1/2" floppy diskette drive.

5. DVD-R & CD-R/W drive(s).

6. 17 inch (viewable) LCD flat-screen video monitor.

7. Network Adapter: Integrated 10/100 Ethernet.

8. Dual USB parallel ports.

9. Dual USB serial ports.

10. Dual USB PS/2 ports.

11. Expansion Slots: 3 PCI and 1 AGP.

12. USB optical wheel mouse pointing device.

13. Operating System: Windows XP – Professional or higher with license.

14. Host/remote software with license.

10. Application software with license, including Microsoft Works Suite 2003 (Word, Excel, Outlook, PowerPoint) and Norton AntiVirus (minimum).

11. Laser jet printer (HP LaserJet emulation capability, 8ppm).

12. Terminal keyboard, enhanced 101 IBM compatible, click key style.

13. Two (2) fax/modems with the following capabilities:

    a. Device Type: Voice/FAX-modem.

    b. Device Format: Internal or external.

    c. Data Rate: 56K.

    c. Minimum Fax Speed: 14.4K (send and receive).

    f. Full duplex capability.

    g. Sync/Async operation.

14. Microphone.

15. Speakers (stereo).

16. All specified hardware and software shall be listed with Microsoft as Windows XP approved.

17. PC manufacturer shall be Gateway, Dell, IBM, or Compaq.

C. System Monitoring Screens.

1. The system shall be comprised of the following screens:

   a. Overview Screen.

   b. Set up Screen.

   c. Station Screens.

   d. Trending Screens.

   e. Alarm Log Screen.

   f. Password Screen.

   g. Log File Historical Screen.

2. The Overview Screen shall be capable of monitoring, logging and displaying data and alarms for up to 12 stations. The Overview Screen shall be capable of displaying and monitoring the following information and conditions:

   a. Station Number.

   b. Station Name.

   c. Wet Well Level.

   d. High Level Indication.

   e. Low Level Indication.

f. Pump Identification.

g. Pump Run Condition.

h. Station Configuration.

i. Active Communication Indication.

j. Failed Communication Indication.

3. The Set up Screen shall be capable of adding, deleting or re-configuring pumping stations without the need for additional software or software support. The following information shall be user configurable from this screen:

a. Owner's Name.

b. Number of stations being monitored.

c. Station Name.

d. Station Configuration (No. of pumps).

e. Maximum Sensor Range.

4. Individual Station Screens shall display and graphically represent the following information and pump station conditions.

a. Owner's Name.

b. Station Name.

c. Wet Well Level.

d. Low Level Alarm Indication.

e. High Level Alarm Indication.

f. Station Configuration (number of pumps).

g. Pump Indication.

h. Pump Condition (Off-Run).

i. Trend Screen.

j. Controller Face Plate.

k. Alternation Mode.

l. Alarm Set Points.

m. Pump Start and Stop Set Points.

n. Station Number.

o. Current User.

p. User Access Level.

q. All alarm conditions i.e. low level or high level wet well alarms shall chance the color state in the wet well in a manner that will be immediately recognizable to the operator.

r. Pump run conditions shall be displayed in the following color scheme:

(1) Run - Green.
(2) Stop - Red.

s. System setpoint adjustments shall be from the individual station screens. The following operational parameters shall be adjustable from this screen:

(1) High level alarm set point.
(2) Low level alarm set point.
(3) Pump alternation mode.
(4) Each pump start and stop set point.

t. All adjustments to any of the operational parameters of this system shall require an authorized password entry to accomplish.

u. Interactive graphical screen buttons shall be displayed to allow direct access to the following screens.

(1) Overview Screen.
(2) Alarm Log Screen.
(3) Zoom Trend Screen.
(4) Password Screen.

5. The Trending Screen shall be capable of displaying up to a maximum of 12 analog 4-20mA DC input signals over a user selectable time period.

a. The screen shall be capable of color coding the analog 4-20mA inputs signals in a user configurable manner to insure that each signal can be identified and differentiated from the other signals.

b. The screen shall be capable of displaying and comparing up to 12 analog input signals from separate stations. This selection shall be user configurable and not require additional custom software to accomplish.

6. The Zoom Trend Screen shall be capable of enlarging the trend screen to increase the resolution of the trending when detailed evaluation is required.

a. The Zoom Trend Screen shall allow for the trends to be scrolled back and forward to a particular event so that the event can be isolated and reviewed.

b. Scroll time bars shall be provided so that the specific time of the event can be identified. The scroll time bars shall be capable of bracketing and isolating the event in a manner that will display the time the event began and the time the event ended.

c. The screen shall allow for the trends to be updated at any time during the review process.

d. The screen shall be capable of downloading information to save to file. The information shall be compatible with an Excel spreadsheet

and capable of displaying this information in date/time stamped columns for future evaluation.

e. The system shall have the capability of displaying the down loaded information in various user selectable manners to aid the user in the evaluation process. The selectable displays shall include bar graphs and pie charts as a minimum.

7. The System Login/Logout Screen shall provide for the following entries:

a. User name entry.

b. Password entry.

c. Logout entry.

d. Adding or deleting authorized personnel entry.

e. The system shall ensure through the screen that only authorized personnel have the capability to make operational set point changes to the individual pumping stations.

8. The Alarm Log Screen shall be capable of displaying as a minimum the last 17 alarm conditions experienced by the system. The Alarm Log shall include the following information:

a. Month.

b. Day.

c. Year.

d. Time in hours and minutes.

e. Comments.

f. Name of the alarm.

g. Alarm state ( acknowledged or unacknowledged).

9. The Log File Historical Screen shall display on a continuous basis, in date order, the following information upon logging in or logging out entry's:

   a. Alarm annunciation.

   b. Alarm acknowledgment.

   c. Name of operator acknowledging.

   d. System software activation.

   e. System software deactivation.

   f. Status of DDE saver.

   g. Operation changes.

   h. Operational parameters changed.

   i. Name of operator changing parameter's.

   j. The Log File Historical Screen shall display the day, date, and time of all recorded information.

10. The Extended Station Monitoring Screen shall be user configurable and allow for the following inputs and outputs:

   a. 16 digital inputs.

   b. 12 digital outputs.

   c. 2 analog outputs.

   d. 4 analog inputs.

   e. The screen shall display the normal state of its digital inputs/outputs On or Off.

   f. The screen shall display what condition of the digital input/output On or Off will constitute an alarm.

g. Each display input/output shall be assigned a description of its item. (e.g. Read Fail, Entry Alarm , Generator Run). These descriptions shall be field configurable.

h. The On/Off state of these inputs shall be configurable if the state (On or Off ) is an alarm condition. These alarm conditions should also appear within the software's Alarm Log.

i. Each analog input/output shall be field configurable as to its description (e.g. flow, level, etc.) and its engineering value (e.g., GPM, PSI, %). A bar graph shall be associated with each of these analog inputs and outputs. These inputs and outputs shall also be capable of being displayed on the trending screens.

D. Alarm Annunciation System.

1. The telephonic alarm dialing system shall perform alarm notification, paging, data acquisition, and remote control functions for DDE-aware Human Machine Interface (HMI) or Supervisory Control And Data Acquisition (SCADA) software systems.

2. The software-based telephonic communications package shall contain a fully integrated software and hardware system, capable of running on Windows XP.

3. Upon activation of alarm(s), the system shall annunciate the alarm(s) via the following methods:

a. Local Annunciation: Display alarms on the computer screen. The system shall provide a means to acknowledge alarms from the computer.

b. Telephone Dial-out Verbal Annunciation (Voice Call): Verbally annunciate alarms over standard voice-grade telephone lines. The telephone numbers called and the order in which they are called shall be pre-configured by the operator. The system shall allow for password protected acknowledgment of alarms from any DTMF (touch tone) phone.

c. Alphanumeric or Numeric-only Paging (Pager Call): Notify operator(s) of alarms via alphanumeric or numeric-only pager messages. The system shall operate with commercially available paging systems.

d. Verbal annunciation of alarms shall utilize custom recorded voice files. These files shall be easily recorded and re-recorded using hardware provided with the system.

e. The system shall have an integrated control scheduler that will allow the operator to enable or disable any or all of the three methods of annunciation at any time of day, weekend, or holidays.

f. The system shall allow the operator to select which operators are "On-Call", and the order in which they are to be notified by the system in the event of an alarm.

g. The system shall log all system events (e.g. alarms, operator actions, etc.) directly to a printer or log file.

h. The system shall be network compatible (i.e., the HMI/SCADA system DDE server can reside on a different computer than the telephonic alarm dialing system).

4. The software shall be capable of running on Windows XP. The number of alarm tags and voice scripts allowed shall be limited only by the size of the computer's mass storage device.

5. An easily configurable tag database shall be integral to the system. The tags in the HMI/SCADA system for which annunciation is desired will have a corresponding tag in the telephonic alarm dialing system database. The current value of the tag as read from the HMI/SCADA system shall be available for display while configuring the system. The system shall have a "Test" button that provides an easy method for generating test alarms.

6. The voice scripts used for verbal annunciation (both local and over the telephone) shall be recordings of human voices and shall be easily recorded and re-recorded utilizing the supplied voice modem and microphone. Voice scripts shall be easily re-recordable in any language.

7. Upon alarm, the system shall incorporate a pop-up alarm annunciator window that displays all new alarm tagnames and text descriptions of each new alarm. The pop-up alarm annunciator window shall have an "Acknowledge All" button which, if chosen, will acknowledge the active alarms and prevent (or stop) the system from calling out. The pop-up annunciator window can be inhibited, in which case the alarm can be acknowledged locally via the HMI/SCADA software.

   a. The local annunciation function shall be enabled or disabled from the system's Control Scheduler.

8. The system shall be capable of dialing an operator(s) over a telephone, cellular telephone, or Personal Communication System (PCS) telephone. The system shall be compatible with both pulse-dial and tone-dial systems. Upon alarm, the system shall perform dial-out functions based on the order of operators on-call, and their respective telephone number. The system shall be configured with up to three different telephone numbers for each operator. These telephone numbers shall be called in the order the administrator dictates. The number of times that the system dials an operator before moving on the next on-call operator shall be easily adjustable.

   a. Once the telephone has been answered, the system shall announce itself and ask for an operator identification number and security Personal Identification Number (PIN). After a successful login, the system shall greet the operator with a personal recording for each operator.

   b. After the personal greeting, the system shall play a menu voice prompt file describing the functions of the telephone buttons for each menu. From the main menu, the operator shall be capable of listening to each active alarm or unacknowledged alarm by listening to the alarm's verbal alarm script. The alarm script may be a combination of custom recorded voice files and automatic script functions. The voice files shall be capable of being recorded in any

language or voice. The automated functions include speaking alarm states, speaking numeric values, offering remote acknowledgement of active or unacknowledged alarms, and inputting numeric data entry from any DTMF telephone to the HMI/SCADA system.

c. Upon alarm, the system shall also be capable of notification via pager.

9. The system shall allow operators to obtain information from the HMI/SCADA software system via any DTMF (touch tone) telephone. After an operator has successfully logged-in after receiving a telephone call from or placing a telephone call to the system, data acquisition and control functions shall be accessed by navigating through menu trees, similar to conventional voice-mail systems. The administrator shall be able to organize information to be into group scripts, so that operators can listen to multiple data values by pressing a single button on the telephone keypad. The system shall be configurable to allow two levels of access: Administrator and Non-Administrator, which allow some functions to be segregated into "Administrator only" menus.

a. Operators shall be able to manipulate user input values, using the telephone keypad as a data entry pad. With proper security clearance, operators shall be able to change variables such as setpoint values, or change discrete states like on or off, stop or start, open or close, etc.

b. The verbal dial-out function shall be enabled or disabled from the system's Control Scheduler.

10. Alphanumeric and numeric alarm messages shall be sent to any alphanumeric paging system supporting the TAP protocol, or any numeric paging system. Upon alarm, the system shall construct an alphanumeric or numeric page, using current values and states in the message. The automatic pages can be written and configured in a pager script, which allows multiple variables to be included in any alphanumeric or numeric page. Administrators shall be able to build a pager script which places alarm names, alarm states, numeric values, return telephone numbers, and operator's names in the page automatically. Administrators shall be able to

build and test alphanumeric and numeric paging scripts easily.

a. The paging function shall be enabled or disabled from the system's Control Scheduler.

11. The telephonic alarm dialing system shall also function as an alphanumeric and numeric paging terminal, allowing operators to type in an alphanumeric or numeric message and send it directly to any operator with a pager.

12. The system shall allow selection of modes for alarm acknowledgement:

a. When an alarm is acknowledged from the telephonic alarm dialing system (either from the pop-up alarm annunciator window or over the telephone), this acknowledgement shall be sent to the HMI/SCADA system to acknowledge the alarm in that system.

b. When an alarm is acknowledged from the HMI/SCADA system, this acknowledgement shall be sent to the telephonic alarm dialing system. This will acknowledge the active alarms and prevent (or stop) the system from calling out.

13. The system shall include an event logger capable of logging all of the system's events and interactions with operators. The logger shall be capable of logging events directly to a printer or directly to the computer's hard drive in the form of a text log file. The event log shall include date, time, operator, and event information. The entire telephonic alarm dialing system's configuration shall be dumped on demand to a log file, and be completely documented automatically. Log comments can be entered manually as well, simply by typing the comment and submitting it from the system.

14. The Control Scheduler shall be configurable to enable/disable system operation based on the hour of the day, day of the week, and holiday schedule. The scheduler shall control when local annunciation, voice call-out, and paging functions are enabled or disabled. Unlimited schedules can be constructed and saved, and an administrator will select a schedule from a simple pull-down menu.

15. The system shall be capable of connecting to a Dynamic Data Exchange (DDE) server, with a server and topic name. Data shall pass to and from the

server (HMI/SCADA system), and a warning shall pop-up if the DDE server is not responding.

16. The system shall have a status window for testing and diagnostics. The system status window shall display the time and date, the last event, DDE action, modem state, and scheduler state.

## 2.04 SUBMERSIBLE LEVEL TRANSDUCER

A. The Submersible Pressure Transducer shall incorporate an isolated diaphragm sensor which is specifically designed for use with landfill leachate fluids and gasses. The sensor will utilize a silicon pressure cell that has been fitted into a stainless steel housing with an integral, compliant stainless steel barrier diaphragm.

B. The sensor assembly shall be housed in a rugged 316 SS case that provides for a variety of pressure inputs as well as electrical output connections.

C. It shall have a static accuracy of +/- 1% FS.

D. Construction shall be welded 316 SS construction.

E. It shall be controller compatible.

F. The transducer shall be fully temperature compensated.

G. The Submersible Pressure Transducer shall be manufactured by Keller PSI or an acceptable equivalent.

## 2.05 SYSTEM OPERATION

A. Level Transmitter Systems for the new Pump Stations.

1. The level transmitter system shall sense the head pressure caused by varying levels in the wet well.

2. The level transmitter shall send a level hardwired signal to the SCADA panel.

3. Should the wet well level reach High Level (set point shall be adjustable) a

hardwired dry contact closure shall send an alarm signal.

4. The wet well level shall be viewable via a digital readout on the SCADA panel and at the PC.

B. SCADA Panels for the new Pump Stations:

1. The SCADA panel shall be furnished with provisions to operate the station as previously described in this section as a stand-alone unit.

2. The SCADA panel shall also provide compatibility for monitoring and remote control of the pump station by the PC.

3. The SCADA panel shall receive up to four (4) level or flow signals (4-20mA) from the sensing element signal converters. These signals shall be processed and transmitted to the PC.

4. The SCADA panel shall furnished with circuitry for a hardwire connections to the new Pump Control Panels.

5. The SCADA panel shall receive up to 24 digital (dry contact) inputs from the various control and alarm devices. These signals shall be processed and transmitted to the PC.

## PART 3 EXECUTION

### 3.01 DESIGN

A. The System Supplier/System Integrator shall be responsible for the design, fabrication, and operation of the complete pump control system, including all logic programming/software.

B. The System Supplier/System Integrator shall be responsible for the integration of the new pump control system with the existing MPS and NCPS pump control panels using the existing EG Controls SCADA Express System and/or new Interface

Control Panels.

C. The Contract Drawings indicate the required locations of the control systems equipment. The Contractor shall notify the Owner and the Engineer, in writing, if the System Supplier/System Integrator designed equipment will not fit in the indicated locations. The Contractor/System Supplier/System Integrator shall be responsible for any revised equipment arrangement/layout subject to the approval of the Owner and the Engineer. The System Supplier/System Integrator shall provide appropriate enclosures to fit within the confines of the pump stations and Operator/Administrator office with such layout to be detailed and subject to the approval of the Engineer. All such accommodations shall be designed and provided by the System Supplier/System Integrator and shall not void nor impact any equipment warranties as required under this Contract. Any additional costs, including engineering costs, resulting from changes in the structure, piping, electrical system, etc., arising from the need to accommodate the control systems equipment, shall be borne by the Contractor.

D. As part of the control system work the Contractor/System Supplier/System Integrator shall determine the need (if any) and location for all/any other items required for the system but not specifically detailed in the Contract Documents, subject to the Owner's and Engineer's approval. Any such items shall become a contractual obligation of the Contractor/System Supplier/System Integrator and shall be provided at no additional cost to the Owner.

## 3.02 INSTALLATION

A. The pump control system - SCADA shall be installed in accordance with the System Supplier/System Integrator and equipment manufacturer(s) instructions and the Contract Documents.

B. The start-up and testing of the control systems for this project shall be coordinated with the Owner. Start-up and testing shall be conducted and scheduled such that this activity shall not disrupt or interfere with the Owner's existing leachate pumping system operation.

## 3.03 FIELD SERVICE

A. General:

1. The following services for the control systems shall be provided by the System Supplier/System Integrator at no additional cost to the Owner.

2. All system optimization programming shall be provided by the System Supplier/System Integrator.

B. Construction Assistance:

1. On-site assistance of personnel competent in all necessary fields shall be provided by the System Supplier/System Integrator during the construction period to assist in the installation and erection of the components. Also provide consultation services including, but not limited to, specification and drawing interpretation, storage of equipment prior to installation, and electrical terminations.

C. Checkout:

1. Preliminary field testing of the entire system following installation shall be performed by the Contractor with the assistance of the System Supplier/System Integrator. Sufficient tests shall be conducted to demonstrate to the Owner that all system components are fully operational, that all control and instrumentation components have been calibrated and properly adjusted, and that the entire system is ready for continuous, safe operation. The purpose of checkout shall be to insure that each individual system component has been correctly installed, will operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation.

D. Start-Up:

1. When all equipment tests have been satisfactorily performed, reported upon, and functionally accepted by the Owner, the control systems shall be started up. The Owner shall supply a sufficient number of qualified personnel to operate the control systems and related equipment with the assistance of a competent representative of the System Supplier/System Integrator. Start-up operations shall be continued until it is satisfactorily demonstrated that the

control systems are operating as specified. The System Supplier/System Integrator shall recommend all adjustments necessary during the start-up period for proper efficient and safe operation of the control systems.

E. Training:

1. The System Supplier/System Integrator shall provide training for the Owner's personnel. Training shall be conducted by knowledgeable, competent personnel who are thoroughly familiar with the theory, design, operation, and maintenance of the control systems.

2. Training shall comprise, but shall not be limited to the following:

   a. Eight (8) hours of "classroom work", minimum.

   b. Sixteen (16) hours of "hands-on" work in the field, minimum.

3. Training shall be coordinated by the Contractor with the Owner and the System Supplier/System Integrator. Training periods shall be scheduled for dates and times to match the Owner's normal activities at the project site.

## 3.04 WARRANTY

A. All equipment and programming/software provided by the System Supplier/System Integrator shall be guaranteed for a period of two (2) years from the date of final project acceptance by the Owner against defective materials, design, workmanship or performance. During the warranty period, the System Supplier/System Integrator shall inspect the control systems a minimum of every three (3) months. The System Supplier/System Integrator representative shall submit a written report to the Owner outlining the findings of the field inspections and make recommendations for any system adjustments. Reports shall be submitted within seven days of the inspection. The Contractor shall make any adjustments recommended by the System Supplier/System Integrator in order to restore the equipment to the specified tolerances. All work shall be performed at no additional cost to the Owner.

B. At no additional cost to the Owner, an inspection of each control system shall be performed by the System Supplier/System Integrator qualified field service representative approximately 45 days prior to the date of warranty expiration. The following shall be ascertained, completed, and approved.

1. Status of equipment and installation after normal usage.

2. Adherence to manufacturer's recommended operation and maintenance instructions.

3. Make adjustments, as necessary, to restore equipment to the required tolerances. Adjustments shall be made at no additional cost to the Owner.

4. Submit a report within seven (7) days to the Owner covering all inspection items including recommendations if applicable.

C. Upon receipt of notice from the Owner of a failure of any part of the control systems during the warranty period, the affected part or parts shall be repaired and/or replaced promptly by the Contractor/System Supplier/System Integrator at no additional cost to the Owner.

D. Warranties shall not begin until final project acceptance by the Owner.

E. The warranties shall be in printed form and shall be submitted for review prior to delivery of the SCADA panels, PC, and ancillary systems.

## 3.05 SYSTEM SUPPLIER/SYSTEM INTEGRATOR WRITTEN CERTIFICATION

A. The System Supplier/System Integrator shall submit four (4) copies of written certification to the Owner verifying that the complete system including level transmitters, controls, programming, and appurtenances provided for this contract has been successfully factory tested has been installed and is operating in accordance with the Contract Documents and the manufacturer(s) specifications, and has been successfully field tested by the manufacturer(s) or his appointed representative(s).

END OF SECTION

# SECTION 16926

# TRANSIENT VOLTAGE SURGE SUPPRESSION SYSTEM

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Transient voltage surge suppression (TVSS) systems. The systems shall be connected in parallel with the power supply.

### 1.02 REFERENCES

A. ANSI/IEEE C62.11.

B. ANSI/IEEE C62.41.

C. ANSI/IEEE C62.45.

D. NFPA 70 - National Electrical Code.

E. UL 1449 - Standard for Transient Voltage Surge Suppressors.

F. UL 1283.

### 1.03 REGULATORY REQUIREMENTS

A. The system shall be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments as tested by ANSI/IEEE C62.45.

B. Conform to the requirements of NFPA 70 - National Electrical Code.

C. The system shall be UL listed.

### 1.04 SYSTEM DESCRIPTION

A. Environmental Requirements:

1. Operating Temperatures: -40° to +50°C.
2. Relative Humidity: 0% to 95% non-condensing.
3. Audible Noise: Less than 45 dBA at 5 feet.
4. Altitude: Less than 3000 feet.

B. Electrical Requirements:

1. Nominal system operating voltage shall be 480 volts, 3-phase.
2. Maximum continuous operating voltage (MCOV) shall be greater than 110% of the nominal system operating voltage.
3. The operating frequency range of the system shall be 47 to 63 Hz.

C. Performance Ratings

1. The surge current capacity, based on an 8 x 20 microsecond waveform, shall be a minimum of 120 Kamps per phase.
2. The system performance ratings shall be based on the UL 1449 listing ratings for IEEE C62.41 category B impulse waveforms of 6000V 1.2 x 50 microseconds, 3000A 8 x 20 microseconds equipment.
3. The maximum UL 1449 clamping voltage ratings shall not exceed 800 volts.
4. The TVSS system shall provide a joule rating that meets or exceeds the requirements of IEEE C62.41 Category C delivery capability.

D. This specification is based on a Liebert Model No. LCG-277YC3D. The Contractor may offer a substitute subject to the approval of the Engineer. In the event that a substitute is approved the Contractor will be responsible for the costs associated with any re-engineering required.

## 1.05 DOCUMENTATION

A. The manufacturer shall furnish an installation manual with installation, start-up, and operating instructions for the system.

B. Shop drawings shall be provided which show unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring diagram.

C. Documentation of UL 1449 listing and clamping voltage rating shall be required product data submitted with the shop drawings.

## 1.06 WARRANTY

A. The manufacturer shall provide a full five (5) year warranty from date of delivery against any part failure.

## 1.07 QUALITY ASSURANCE

A. The system shall be thoroughly factory tested before shipment. Testing shall include but not be limited to, "Hi-Pot" tests at two times rated voltage plus 1000 volts per UL requirements, IEEE C62.41 Category B surge tests, UL ground leak test, and operational and calibration tests.

B. The system shall be capable of withstanding 1000 sequential Category C surges of 10,000 AMPS without failure.

C. The system shall be provided with computer generated graphs or ascillograms demonstrating the systems clamping voltage and operability. The test shall follow procedures outlined in ANSI/IEEE C62.45.

## 1.08 SPARE PARTS

A. Surge Current Diversion Modules: Furnish 2 spare modules to the Owner.

# PART 2 PRODUCTS

## 2.01 COMPONENTS

A. The system shall be symmetrically balanced, multiple (redundant) metal oxide varistor (MOV) array systemof not less than two (2) modules per phase and neutral. Each module shall consist of mulitple gap-less metal oxide varristors, with each MOV individually fused. No gas tubes or silicon avalanche diodes shall be used. The status of each varistor shall be monitored and a green LED shall be illuminated if the module is in full working order. When module performance is degraded, such as if one or more fuses or varistors have failed, the LED shall indicate a failed module.

## 2.02 CONNECTIONS

A. Terminals shall be provided for all of the necessary power and ground connections. The terminals shall accommodate wire sizes of #14 to #2/0 AWG. The units shall use standard parallel wiring techniques.

## 2.03 INTERNAL CONNECTIONS

A. All surge current diversion module intra-unit connections shall be by way of low impedance plated busbars. Surge current diversion modules shall use bolted connections to the plated busbars for reliable low impedance connections. All module mounting hardware and power wiring shall be captive or remain in place when a module is removed or replaced.

## 2.04 ENCLOSURE

A. The specified system shall be provided in a heavy duty NEMA 4X enclosure. The cover of the enclosure shall be hinged on the left side and require a tool for access to internal components. A drawing pocket shall be provided inside the door for storage of unit drawings and an installation/operation manual. Indication of surge current module status shall be visible without opening the door.

B. The unit shall be furnished with an integral disconnect switch which shall de-energize all TVSS components prior to opening the hinged front cover of the enclosure.

C. The unit shall be furnished with an OFF-ON switch, a Press-To-Test switch, and an Audible Alarm (with silence switch) mounted on the hinged front cover of the enclosure.

## 2.05 UNIT STATUS INDICATORS

A. Red and green solid state indicators shall be provided on the hinged front cover to redundantly indicate unit module status. The absence of the green light and the presence of the red light shall reliably indicate that one or more surge current diversion modules has failed and that service is needed to restore full operation. Additionally, a Form C summary alarm contact rated for at least 120 VAC and 1 ampere shall be provided for remote annunciation of unit status. The summary alarm contact shall change state if any one or more of the surge current division modules has failed.

## 2.06 TRANSIENT COUNTER

A. A transient voltage surge counter shall be included to totalize transient voltage surges which deviate from the sinewave envelope by more than 125 volts. The readout shall be at least a six digit LCD located on the unit's hinged front cover. The counter shall be equipped with a battery back-up to retain memory when input power is not present. A pushbutton switch on the display's faceplate shall be provided for manual counter reset.

## PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install the parallel TVSS with short and straight conductors as practically as possible. The Contractor shall twist the TVSS input conductors together to reduce input conductor inductance. The contractor shall follow the TVSS manufacturer's recommended installation practices and comply with all applicable codes.

END OF SECTION

# SECTION 16970

# TESTING AND COMMISSIONING

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Testing and Commissioning.

### 1.02 TESTS

A. All work shall be tested regularly during its progress. The Owner shall have the authority to require testing of any portion of the work at any time. The Contractor shall provide all labor and material as necessary in making such tests. The foreman in charge of work shall give his personal attention, together with any other assistance required, in order to investigate any portion of the work. As a minimum, the following tests shall be performed: insulation resistance, load balancing in switchboards and panelboards, correct rotation of motors.

B. Perform all tests in the presence of the Owner. Furnish labor, materials, and instruments necessary to conduct the tests.

C. On completion, the work is to be inspected and must satisfactorily pass tests against short circuits and grounds.

D. Motor rotation shall be checked and corrected if necessary.

E. The electrical Contractor shall be present during the test operation of all process and mechanical equipment to which electrical connections have been made.

F. After all the work is completely installed, the Contractor shall operate the systems and equipment in the presence of the Owner's personnel and shall demonstrate the proper operation of all controls.

G. The Contractor shall demonstrate the proper operation of all alarm devices.

## 1.03 RESPONSIBILITY DURING TESTS

A. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

## 1.04 FAILURE OF TESTS

A. Any defects in the equipment, or deviations from the requirements of the Contract Documents shall be promptly corrected by the Contractor by replacements or otherwise. If the Contractor fails to correct any defects or deviations, or if the replaced equipment when retested shall fail again to meet the contract requirements, the Owner (notwithstanding having made partial payment for work and materials) may reject the equipment and order the Contractor to remove it from the project at the Contractor's expense.

# PART 2 PRODUCTS

Not Used

# PART 3 EXECUTION

Not Used

END OF SECTION

# SECTION 16990

# SYSTEM INTEGRATION

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. New stand alone programmable controller software and hardware for new pumping control system – SCADA at new leachate Pump Stations PS1 (CPS), PS2 (SCPS), PS3 (SPS), PS4 (SEPS), PS5 (EPS), and PS6 (NPS).

B. [Modifications to the existing programmable controller software as required to support the new pump control system – SCADA and new pumping equipment installation at the existing North Central Pump Station (NCPS) and at the existing Main Pump Station (MPS)].

### 1.02 SUMMARY

A. This section covers programmable logic controller (PLC) and personal computer (PC) software programming requirements and the integration of monitoring and control software and hardware to provide a complete PLC/PC pump control system - SCADA for six (6) new pump stations (PS1, PS2, PS3, PS4, PS5, and PS6) at the Delaware Solid Waste Authority (DSWA) Cherry Island Landfill (CILF) in Wilmington, Delaware.

B. The existing operation of the NCPS and MPS are controlled by an EG Controls – Scada Express central control system consisting of Square D Company Modicon PLC processors and a PC using a Wonderware software platform. This central control system presently operates these two (2) pump stations in the plant via remote Input/Output (I/O) devices. An objective of this project is to provide modifications to this existing control system that will be compatible with the new system as developed by the System Integrator.

C. A downloaded software disk of the existing PLC/PC program may be obtained during the bidding process for the System Integrator to review prior to the bid.

D. The System Integrator shall provide any/all temporary PLC programming to control the existing pump stations during construction.

## 1.03 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems.

B. NEMA ICS 3 - Industrial Systems.

C. NFPA 70 - National Electrical Code.

## 1.04 SUBMITTALS

A. Submit system integration programming, shop drawings, and product data.

B. Shop Drawings: Indicate electrical characteristics and connection requirements, including layout of completed assemblies, interconnecting cabling, dimensions, weights, and external power requirements.

C. Product Data: Provide data for each component specified showing electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

## 1.05 PROJECT RECORD DOCUMENTS

A. Submit as required.

B. Record actual locations of controller cabinets and input and output devices connected to system. Include interconnection wiring and cabling information, and terminal block layouts in controller cabinets.

## 1.06 OPERATION AND MAINTENANCE DATA

A. Submit as required.

B. Operation Data: Include bound copies of operating and programming instructions.

C. Maintenance Data: Include card replacement, adjustments, and preventative maintenance procedures and materials.

D. Provide hard (paper) copy and software copy (on disk) of final PLC/PC programming, including license and original program from PLC/PC software manufacturer(s).

## 1.07 QUALIFICATIONS

A. System Integrator: Company specializing in PLC/PC control systems with a minimum five years documented experience with Industrial and/or Municipal wastewater pumping station and/or treatment plant control systems and with service facilities within 100 miles of the Project.

## 1.08 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish Products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

## 1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to avoid damage.

B. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

## 1.10 MAINTENANCE SERVICE

A. Furnish service and maintenance of programmable controllers and software for these pumping stations for two (2) years from final project acceptance by the Owner.

B. Also see paragraph 3.4 of this section.

# PART 2 PRODUCTS AND SERVICES

## 2.01 SYSTEM INTEGRATORS

A. Subject to compliance with requirements with these specifications, System Integrators include, but are not limited to, the following:

1. Sigma Controls, Inc., 514 W. Walnut Street, Perkasie, PA 18944 (215) 257-3412.

2. Trijay Systems, Inc., 10 Maple Avenue, Line Lexington, PA 18932 (215) 997-5833.

3. Tri-Star, Inc., 300 Vine Street, Middletown, PA 17057 (717) 944-1234.

## PART 3 EXECUTION

### 3.01 DESIGN

A. The System Integrator shall be responsible for the design and operation of the complete PLC/PC control systems, including all logic programming/software.

B. The Contract Documents indicate the required control systems performance. The Contractor shall notify the Owner and the Engineer, in writing, if the System Integrator's design will not match the indicated requirements. The Contractor/System Integrator shall be responsible for any revised equipment arrangement/layout and/or programming subject to the approval of the Owner and the Engineer. All such accommodations shall be designed and provided by the Contractor/Integrator System and shall not void nor impact any equipment warranties as required under this Contract. Any additional costs, including engineering costs, resulting from changes in the structure, piping, electrical system, etc., arising from the need to accommodate the control systems, shall be borne by the Contractor.

C. As part of the control system work the Contractor/System Integrator shall determine the need (if any) and location for all/any other items required for the system but not specifically detailed in the Contract Documents, subject to the Owner's and Engineer's approval. Any such items shall become a contractual obligation of the Contractor/System Integrator and shall be provided at no additional cost to the Owner.

### 3.02 INSTALLATION

A. The PLC/PC control systems shall be installed and/or modified in accordance with the System Integrator, System Supplier, and equipment manufacturer(s) instructions and the Contract Documents.

B. The installation, start-up, and testing of the PLC/PC control systems for this project shall be coordinated with the modification [and/or demolition and removal] of the existing controls. The Contractor/System Supplier/System

Integrator shall keep the existing pump stations in normal and continuous operation during the installation of the new control systems. Not less than two (2) pumps at each pump station shall be operable at all times throughout the duration of the project, except for short duration, intermittent, interruptions as necessary for the work. The Contractor shall notify the Owner prior to any work which may interrupt the pumping operation and shall receive approval from the Owner before commencement of this work.

## 3.03 FIELD SERVICE

A. General:

1. The following services for the PLC/PC control systems shall be provided by the System Integrator at no additional cost to the Owner.

2. All system optimization programming shall be provided by the System Integrator.

B. Construction Assistance:

1. On-site assistance of personnel competent in all necessary fields shall be provided by the System Integrator during the construction period to assist in the installation and programming of the systems. Also provide consultation services including, but not limited to, specification and drawing interpretation, storage of equipment prior to installation, and electrical terminations.

C. Checkout:

1. Preliminary field testing of the systems following installation shall be performed by the Contractor with the assistance of the System Integrator. Sufficient tests shall be conducted to demonstrate to the Owner that all system features are fully operational and that the systems are ready for continuous, safe operation. The purpose of checkout shall be to insure that each individual system component has been correctly installed and programmed, will operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation.

D. Start-Up:

1. When all equipment tests have been satisfactorily performed, reported upon, and functionally accepted by the Owner, the control systems shall be started up. The Owner shall supply a sufficient number of qualified personnel to operate the control systems and related equipment with the assistance of a competent representative of the System Supplier/System Integrator. Start-up operations shall be continued until it is satisfactorily demonstrated that the control systems are operating as specified. The System Supplier/System Integrator shall recommend all adjustments necessary during the start-up period for proper efficient and safe operation of the control systems.

E. Training:

1. The System Supplier and System Integrator shall provide training for the Owner's personnel. Training shall be conducted by knowledgeable, competent personnel who are thoroughly familiar with the theory, design, operation and maintenance of the PLC's, PC's, and control systems.

## 3.04 WARRANTY

A. All equipment and programming provided by the System Integrator shall be guaranteed for a period of two (2) years from the date of final project acceptance by the Owner against defective materials, design, workmanship or performance. During the warranty period, the System Integrator shall inspect the PLC's, PC's, and control systems a minimum of every three (3) months. The System Integrator representative shall submit a written report to the Owner outlining the findings of the field inspections and make recommendations for any system adjustments. Reports shall be submitted within seven days of the inspection. The System Integrator shall make any adjustments in order to restore the systems to the specified tolerances. All work shall be performed at no additional cost to the Owner.

B. At no additional cost to the Owner, an inspection of the control systems shall be performed by the System Integrator's qualified field service representative approximately 45 days prior to the date of warranty expiration. The following shall be ascertained, completed, and approved.

1. Status of equipment and programming after normal usage.

2. Adherence to manufacturer's recommended operation and maintenance instructions.

3. Make adjustments, as necessary, to restore the systems' to the required tolerances. Adjustments shall be made at no additional cost to the Owner.

4. Submit a report within seven (7) days to the Owner covering all inspection items including recommendations if applicable.

C. Upon receipt of notice from the Owner of a failure of any part of the PLC's, PC's, and control systems during the warranty period, the affected part or parts shall be repaired and/or replaced promptly by the Contractor/System Integrator at no additional cost to the Owner.

D. Warranties shall not begin until final project acceptance by the Owner.

E. The warranties shall be in printed form and shall be submitted for review.

## 3.05 SYSTEM INTEGRATOR'S WRITTEN CERTIFICATION

A. The System Integrator shall submit four (4) copies of written certification to the Owner verifying that the completed system including programming, controls, and appurtenances provided for this contract have been successfully tested and are operating in accordance with the Contract Documents and the manufacturer(s) specifications.

END OF SECTION

# APPENDIX VIb-M

# CONSTRUCTION QUALITY ASSURANCE PLAN

*Prepared for:*

**DELAWARE SOLID WASTE AUTHORITY**
1128 South Bradford Street
Dover, Delaware 19903

# CONSTRUCTION QUALITY ASSURANCE PLAN

# CHERRY ISLAND LANDFILL EXPANSION CONSTRUCTION PROJECT

## CHERRY ISLAND LANDFILL
## Contract No. S01445NC

*Prepared by:*

**GEOSYNTEC CONSULTANTS**
10015 Old Columbia Road, Suite A-200
Columbia, Maryland 21046

Project No: ME0250

April 2003

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# 1. INTRODUCTION

## 1.1 Purpose of the Construction Assurance Quality Plan

This Construction Quality Assurance Plan (CQA Plan) establishes the construction quality assurance monitoring and documentation activities that will be implemented during construction of the liner and final cover systems, and related facilities (erosion control structures, leachate transmission and landfill gas management systems, access roads, etc.) at the Cherry Island Landfill, located in Dover, Delaware (Site). The purpose of the CQA Plan is to provide specific procedures that will be followed by CQA personnel in order to assure the Owner that the construction was performed in accordance with the Drawings and Technical Specifications. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geomembrane, and other geosynthetic components.

## 1.2 Construction Quality Assurance and Construction Quality Control

This CQA Plan is a site-specific document which addresses the following: (i) CQA personnel responsibilities and authorities; (ii) monitoring and testing activities that will be performed during construction; and (iii) CQA documentation requirements. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of the construction with the requirements of the Drawings, Technical Specifications, and CQA Plan. CQA is provided by a consultant who is independent of the Owner, Contractor, Manufacturer, and Geosynthetics Installer.

- Construction Quality Control (CQC) refers to those actions taken by the Contractor, Manufacturers, or Suppliers, including their designated representatives, to ensure that the materials and workmanship meet the requirements of the Drawings, Technical Specifications, CQA Plan, and all components of the Contract Documents.

## 1.3 Applicable References

Organizations whose standards are referenced in the CQA Plan and Technical Specifications include: (i) American Association of State Highway and Transportation Officials (AASHTO); (ii) American Society for Testing and Materials (ASTM); (iii) Geosynthetic Research Institute (GRI); (iv) Delaware Department of Transportation (DELDOT); (v) Occupational Safety and Health Administration (OSHA); (vi) Plastic Pipe Institute (PPI); and (vii) American Concrete Institute (ACI).

## 1.4 Organization of the Construction Quality Assurance Plan

The remainder of the CQA Plan is organized as follows:

- Section 2 describes the personnel associated with the Project;
- Section 3 describes project meetings involved with the CQA;
- Section 4 describes CQA surveying requirements;
- Section 5 describes CQA documentation;
- Section 6 describes CQA for erosion and sediment controls;
- Section 7 describes CQA for prefabricated vertical drain installation;
- Section 8 describes CQA for mechanically stabilized earth berm construction;
- Section 9 describes CQA for earthwork construction;
- Section 10 describes CQA for high-density polyethylene geomembrane;
- Section 11 describes CQA for geotextile;
- Section 12 describes CQA for geosynthetic clay liner;
- Section 13 describes CQA for geocomposite installation;
- Section 14 describes CQA for pipe installation; and
- Section 15 describes CQA for mechanical and electrical systems.

# 2. PROJECT PERSONNEL

## 2.1 Overview

The project organization chart depicting the key roles and lines of communication for the Cherry Island Landfill Expansion Construction Project (Project) is presented in Figure 1. The duties and responsibilities of the CQA individuals identified in Figure 1 are described below.

## 2.2 Owner

In this CQA Plan and Technical Specifications, the term "Owner" refers specifically to the Delaware Solid Waste Authority (DSWA).

## 2.3 Project Manager

The Project Manager is the official representative of the Owner (i.e., Owner's Representative) and is responsible for the coordination and management of activities associated with construction of the Project.

## 2.4 Engineer

The Engineer is the firm that prepared the Drawings, Technical Specifications, and CQA Plan for the Project. GeoSyntec Consultants (GeoSyntec) of Columbia, Maryland, is the Engineer for the Project.

## 2.5 Contractor

The Contractor is responsible for constructing the prescribed design in accordance with the Drawings and Technical Specifications. The Contractor may retain the services of specialty subcontractors (e.g., material suppliers, Geosynthetics Manufacturer, Geomembrane Installer). The Contractor must have experience in

successful geosynthetic installation, general earthwork, and shall have current local, state, and federal licenses as appropriate.

## 2.6 Geosynthetics Manufacturer

The Geosynthetics Manufacturer is the firm or firms responsible for the production of geosynthetics (i.e., geomembrane, geosynthetic clay liner, geogrid, etc.) to be used on this Project and its delivery to the Site. The Geosynthetics Manufacturer(s) must be able to provide sufficient production capacity and qualified personnel to meet the project schedule. The Geosynthetics Manufacturer(s) must be approved by the Project Manager and Engineer, in accordance with the requirements of the Technical Specifications.

## 2.7 Geosynthetics Installer

The Geosynthetics Installer is responsible for performing all aspects of the geosynthetics installation. The Geosynthetics Installer may also be responsible for specialized construction tasks (e.g., field construction of pipe boots, etc.). The Geosynthetics Installer will be trained and qualified to install the geosynthetics proposed for this Project. The Geosynthetics Installer, in particular, must be approved and/or licensed by the various Geosynthetics Manufacturer(s) for installation of the various geosynthetic components. Further, the Geosynthetics Installer must be approved by the Project Manager and Engineer. The qualifications required of the Geosynthetics Installer are listed in the Technical Specifications.

## 2.8 Surveyor

The Surveyor must be a registered Land Surveyor in the State of Delaware, independent from the Owner and the Contractor. However, the Surveyor will be a subcontractor of the Contractor. The Surveyor is responsible for construction layout and producing as-built documentation (record drawings) for the Project. The qualifications required of the Surveyor and surveying requirements are provided in the Technical Specifications.

## 2.9 CQA Consultant

### 2.9.1 Overview

The CQA Consultant is a party, independent from the Owner, the Contractor, the Manufacturer(s), and the Geosynthetics Installer. The CQA Consultant will be a team of individuals who are experienced in the provision of CQA services for similar projects. The CQA team must be experienced in monitoring the construction of the various components of the Project and must include a qualified engineer licensed as a Professional Engineer in the State of Delaware.

The CQA team will include the CQA Managing Engineer, a CQA Site Manager, and the CQA Soils and Geosynthetics Monitor(s). The CQA Managing Engineer will lead the CQA team. The CQA team may utilize the services of other qualified individuals to assist with the assignments. Together, the CQA team will perform several assignments during construction. These assignments will include performing CQA for earthwork construction, geosynthetics installation, and all other related components of the Project. The CQA team is responsible for observing and performing field testing and documentation activities related to the performance of the various components of the design. Field and laboratory testing are to be performed in accordance with applicable standards and specifications. The CQA Consultant is also responsible for issuing a final report to the Delaware Department of Natural Resources and Environmental Control (DNREC) after the completion of work for the Project.

### 2.9.2 CQA Managing Engineer

The CQA Managing Engineer will be a registered Professional Engineer in the State of Delaware and manage the CQA activities. He will review all clarifications and changes, which may affect the design and will serve as technical reviewer of the final report. He will also be directly accessible to the Project Manager, Engineer, and CQA personnel for technical direction during construction. The CQA Managing Engineer must provide clear documentation demonstrating construction experience on at least five previous landfill projects.

Other responsibilities of the CQA Managing Engineer include:

- becomes familiar with the Drawings, Technical Specifications, and CQA Plan;
- attends the preconstruction meetings, progress meetings, and any resolution meetings when requested;
- administers the CQA program (i.e., assigns and manages all CQA personnel, reviews all field reports, and provides engineering review of all CQA-related issues);
- provides quality control of the CQA personnel, including site visits;
- reviews all changes to the Drawings, Technical Specifications, and CQA Plan; and
- with assistance from the CQA Site Manager, prepares the final report, including a review of the as-built record drawings provided by the Contractor.

### 2.9.3 CQA Site Manager

The CQA Site Manager will interact on a frequent basis with all project personnel, and will have authority over the field CQA personnel. The responsibilities and duties of the CQA Site Manager include the following:

- becomes familiar with the concepts used to develop the Drawings and Technical Specifications;
- acts as the on-site (resident) representative of the CQA Consultant;
- evaluates conformance of materials and construction with the requirements of the Drawings and Technical Specifications;
- familiarizes the CQA Monitors with the Site and CQA requirements for the Project;
- reports any unresolved deviations from the CQA Plan to the Engineer and/or Project Manager;
- manages the daily activities of the CQA Monitors;

- attends the CQA-related meetings (e.g., resolution, preconstruction, daily, weekly);
- assists the Project Manager in preparing documentation for Requests for Information (RFI) or other clarifications to the Drawings and/or Technical Specifications;
- administers the CQA program (i.e., assigns and manages CQA personnel, reviews field reports, and provides review of CQA-related issues);
- reviews the as-built survey information submitted by the Contractor;
- verifies the calibration and condition of all CQA equipment;
- reviews all CQA Monitors' daily reports and logs;
- reports to the Project Manager, and logs in his daily reports and relevant observations reported by the CQA Monitors;
- prepares his own daily and weekly reports;
- oversees the collection and shipping of laboratory test samples;
- reviews and reports results of all laboratory testing;
- periodically checks stockpile or borrow pit sources for variability of the soils, and ensures that conformance testing is performed;
- reviews the work for the Contractor's equipment operators, to ensure that care is taken to protect other portions of the work;
- establishes additional test requirements beyond those required in the CQA Plan, when necessary;
- reviews all Supplier, Manufacturer, and Installer certifications, when necessary;
- reviews the Geosynthetics Installer's personnel qualifications for conformance with those pre-approved for work on-site;
- notes any on-site activities that could result in damage to the geosynthetics;
- designates a senior CQA Monitor to act on his behalf whenever he is absent from the Site while operations are on-going; and
- prepares the final report with the CQA Managing Engineer.

### 2.9.4 CQA Monitors

The duties of the CQA Soil Monitor(s) and CQA Geosynthetic Monitor(s) are assigned by the CQA Site Manager and include monitoring, logging, and/or documenting associated earthwork construction and geosynthetics installation.

The duties to be performed and activities to be monitored by the CQA Soils Monitor(s) specifically include:

- observing and documentation of soil delivery, stockpiling, and placement;
- observing and documentation of soil moisture content and moisture conditioning, if required;
- observing and documentation of collection of soil samples for laboratory testing;
- testing the in-situ moisture and density of compacted earthen materials;
- observing and documentation of operations to protect completed areas before the covering materials are placed;
- examining of the soil surfaces for signs of excessive wetting, desiccation, or other disturbance prior to placement of any other cover materials; and
- observing and documentation of scarification, rewetting, recompaction, or proof rolling required to repair deteriorated areas.

The operations to be monitored by the CQA Geosynthetic Monitors include, for all geosynthetics:

- observing and documentation of material delivery;
- observing and documentation of material unloading and on-site transport and storage;
- observing and documentation of all geosynthetic placement operations;
- observing and documentation of all joining and/or seaming operations;
- observing and documentation of condition of panels as placed;
- sampling for conformance testing by the Geosynthetics CQA Laboratory;

- marking samples for conformance testing; and
- observing and documentation of repair operations.

## 2.10 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in the physical testing of soils and concrete, and be familiar with, and properly equipped to perform the geotechnical testing required by the CQA Plan. The Soils CQA Laboratory must be certified by the American Association of State Highway and Transportation Officials (AASHTO).

## 2.11 Geosynthetics CQA Laboratory

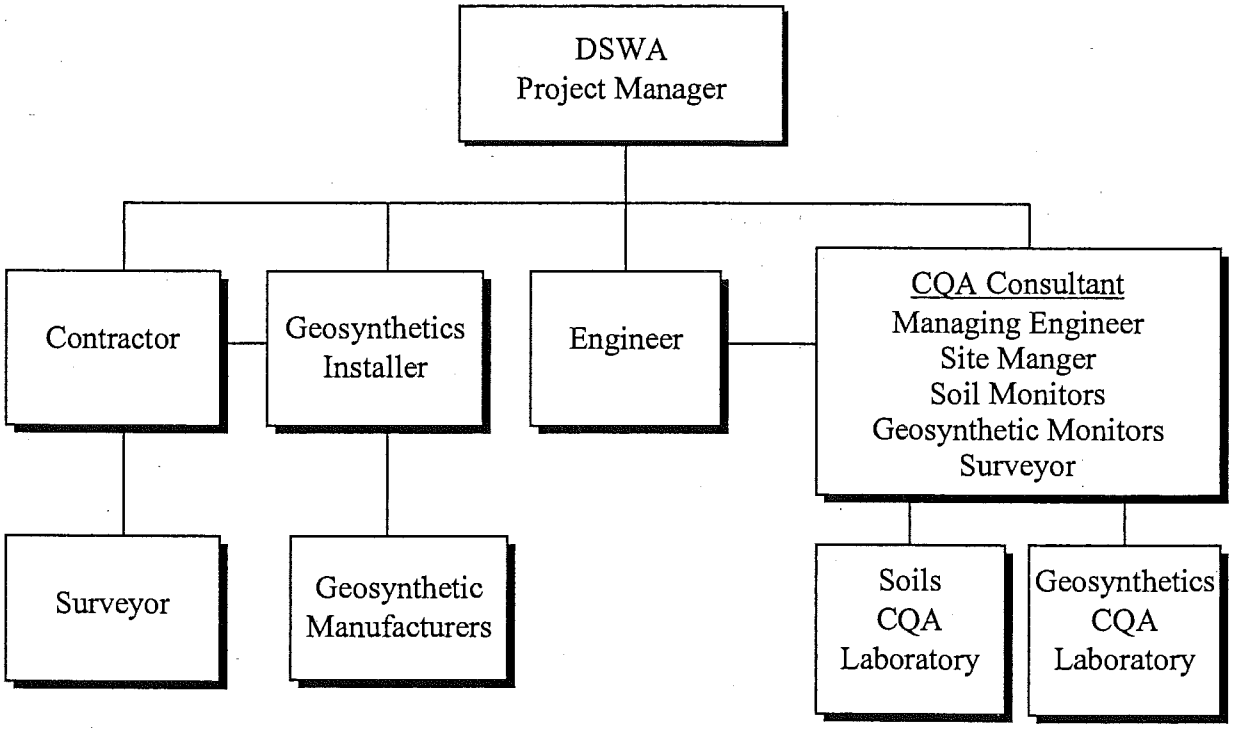
The Geosynthetics CQA Laboratory will have experience in testing the types of geosynthetics to be used on the Project, and be familiar with, and properly equipped to perform the testing required by the CQA Plan. The Geosynthetics CQA Laboratory must be certified by the Geosynthetic Research Institute (GRI).

## 2.12 CQA Surveyor

A CQA Surveyor will be a Professional Land Surveyor registered in the State of Delaware and employed by a well established surveying firm incorporated (or otherwise registered) in the United States. The Surveyor will provide survey data to verify as-built documentation of the Contractor's work. Responsibilities of the CQA Surveyor are presented in Section 4.

**FIGURE 1**

**LINES OF COMMUNICATION**
**CHERRY ISLAND LANDFILL EXPANSION CONSTRUCTION PROJECT**
**WILMINGTON, DELAWARE**



# 3. PROJECT MEETINGS

## 3.1 Introduction

Meetings with key project personnel are necessary to assure a high degree of quality during construction, and promote clear, open channels of communication. Therefore, preconstruction meetings for the major portions of the construction are essential for the success of the Project. Preconstruction meetings will be held prior to all major construction components of the Project including, but not be limited to: (i) mobilization; (ii) prefabricated vertical drain (PVD) installation; (iii) geotechnical instrumentation installation; (iv) temporary landfill gas and transmission construction; (v) mechanically stabilized earth (MSE) berm construction; and (vi) geosynthetics installation. These meetings and weekly progress meetings are described below.

The preconstruction meeting should include discussion of the following activities:

- reviewing the responsibilities of each party;
- confirming the lines of authority and communication;
- communicating to all parties any relevant documents;
- reviewing critical design details of the Project;
- addressing any appropriate modifications to the Drawings or Technical Specifications so that the fulfillment of design or performance standards can be achieved;
- establishing an understanding by the parties of the CQA Plan, and CQA and CQC procedures to be followed during the Project;
- establishing work area security and safety protocol in accordance with the Owner's and the Contractor's health and safety plans;
- describing soil borrow source locations;
- establishing soil stockpiling locations;
- confirming the methods for documenting and reporting, and for distributing documents and reports;

- confirming acceptance and approval process for task completion prior to schedule sequence advancement; and
- establishing procedures for processing applications for payment.

Items discussed during the preconstruction meeting will be documented by a person designated at the beginning of the meeting, and minutes will be transmitted to all parties within one week of the meeting.

## 3.2 Progress Meetings

A progress meeting (via teleconference or at the Site) will be held each week during construction between select CQA personnel, the Contractor, and the Project Manager. In addition, a representative from DNREC's Solid and Hazardous Waste Management Branch (SHWMB) will be notified and invited to participate in construction and progress meetings at the site. The CQA Managing Engineer and Engineer will participate in the weekly meetings when appropriate. Current progress, planned activities for the upcoming week, and any new business or revisions to the work will be discussed at this meeting. Minutes of the progress meetings will be recorded by a member of the CQA team and will document in the meeting minutes any problems, decisions, or questions arising at this meeting. Any matters requiring action which are raised in this meeting will be reported to the appropriate parties. Minutes of weekly progress meetings will be distributed to each party present at the meeting and other designated parties and will be transmitted to all parties within three days of the meeting.

Daily progress meetings will be held between the CQA Site Manager and the Contractor prior to the start of work or following the completion of work. The purpose of these meetings will be to review the previous day's activities, review the upcoming day's activities, and identify any needs or potential construction problems. Major items discussed during these meetings will be documented in the CQA Site Manager's daily field reports.

## 3.3 Problem or Work Deficiency Meetings

Special meetings will be held by the Project Manager when and if problems or deficiencies are present or judged likely to occur. At a minimum, these meetings will be attended by the Contractor, the Project Manager, and select CQA personnel. The purpose of these meetings will be to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

Items discussed during these meetings will be documented by the Project Manager, and if deemed necessary, minutes will be transmitted to the appropriate parties.

## 4. CQA SURVEYING

CQA Surveying of lines and grades will be performed on an on-going basis during construction to independently verify the work for the Contractor, as requested by the Project Manager and/or CQA Consultant. The overall responsibilities of the Contractor's Surveyor are described in Section 01721 of the Technical Specifications. The CQA Surveyor will use existing control monuments at the Site and the control monuments established by the Contractor's Surveyor during construction. The CQA Consultant will coordinate the CQA Surveyor's fieldwork for all aspects of construction, as needed.

The scope of CQA surveying will include, but not necessarily be limited to:

- verifying the horizontal and vertical coordinates of selected construction control points;
- verifying layer thickness, especially of soil components of the liner system or final cover system;
- verifying information regarding the horizontal alignment and vertical profile of leachate-collection pipes, leachate transmission piping, MSE berm, prefabricated vertical drains, and site drainage features, etc.; and
- providing sufficient survey information of interim conditions such that, if requested by the Project Manager, material quantities can be calculated.

It will be the responsibility of the CQA personnel and the CQA Surveyor to coordinate the CQA surveying work such that areas are promptly surveyed, interim results are reviewed, and approval is granted for the Contractor to proceed with subsequent work in the areas. The CQA Site Manager will report any nonconformancies or inconsistencies to the Project Manager and Contractor promptly to minimize delays in the construction.

# 5. DOCUMENTATION

## 5.1 Introduction

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant will document that the quality assurance requirements have been addressed and satisfied.

The CQA Site Manager will provide the CQA Managing Engineer and Project Manager with signed descriptive remarks, data sheets, and logs to verify that the monitoring activities have been performed. The CQA Site Manager will also maintain at the job site a complete file of the Drawings, Technical Specifications, CQA Plan, checklists, test procedures, daily logs, and other pertinent documents. The CQA Site Manager will also ensure that the Contractor maintains a current set of red-line drawings and Contract Documents. These red-line drawings and Contract Documents will be kept up-to-date by the Contractor, at all times, with the latest changes to the Drawings and Technical Specifications. The red-line drawings and Technical Specifications will be transmitted to the Project Manager at the conclusion of the Project.

## 5.2 Daily Recordkeeping

### 5.2.1 Overview

Standard reporting procedures will include preparation of a daily CQA report which, at a minimum, will consist of: (i) field notes, including memoranda of meetings and/or discussions with the Contractor, Geosynthetics Installer, or the Project Manager; (ii) CQA monitoring logs and testing data sheets; and (iii) construction problem and solution summary sheets. This information will be regularly submitted to and reviewed by the CQA Managing Engineer.

### 5.2.2 Memorandum of Discussion with Contractor or Installer

The CQA Site Manager will prepare a memorandum (i.e., daily field report) each day, summarizing their discussions with the Contractor and/or Geosynthetics Installer, and construction operations, as well as CQA activities. Daily field reports will also be prepared by each member of the CQA Consultant team. At a minimum, the daily field report will include the following information:

- arrival and departure time of CQA personnel;
- field time charges for all CQA personnel;
- weather conditions (temperature, sky conditions, precipitation, etc.);
- site conditions with specific reference and personnel involved in the Project;
- a detailed description of worked performed;
- a record of all meeting minutes and telephone conversations;
- decisions made regarding acceptance of work, and/or corrective actions to be implemented for instances of substandard quality; and
- results of laboratory testing as reported or received by CQA personnel on-site.

### 5.2.3 Monitoring Logs and Test Data Sheets

Monitoring logs and test data sheets will be prepared daily. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced-scale site plan showing the work areas and test locations;
- descriptions and locations of on-going construction;
- equipment and personnel in each work area, including subcontractors;

- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- delivery schedule of off-site materials received, including quality control documentation;
- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
- signature of the CQA Site Manager and/or the CQA Monitor(s).

In any case, all logs must be completely filled out with no items left blank.

### 5.2.4 Construction Problem and Solution Data Sheets

Construction problem and solution data sheets describing special construction situations will be cross-referenced with specific observation logs and testing data sheets, and must include the following information, when available:

- an identifying sheet number for cross-referencing and document control;
- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of any responses;
- any measures taken by the Contractor to prevent a similar situation from occurring in the future; and
- the signature of the CQA Site Manager and/or CQA Monitor, and signature of the CQA Managing Engineer indicating concurrence.

The Project Manager and Engineer will be made aware of any significant recurring non-conformance with the Technical Specifications. The Project Manager and/or Engineer will then evaluate the cause of the non-conformance and recommend appropriate changes in procedures or Technical Specifications. These changes will be submitted to the Engineer for approval. When this type of evaluation is made, the results will be documented, and any revision to procedures or Technical Specifications will be approved by the Project Manager and Engineer.

A summary of the supporting data sheets, along with final testing results and the CQA Site Manager's approval of the work, will be required upon completion of construction in which the construction situation, deficiency and/or defect was satisfactorily repaired and completed.

## 5.3 Photographic Documentation

Photographs will be taken in order to serve as a pictorial record of work progress, problems, and mitigation activities. The file will contain color prints. Negatives will also be stored in a separate file in chronological order. These records will be presented to the Project Manager upon completion of the Project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s).

## 5.4 Design and/or Technical Specifications Changes

Changes to the design and/or Technical Specifications may be required during construction. In such cases, the CQA Site Manager will notify the Project Manager and Engineer. Design and/or Technical Specifications changes will be made only with the written agreement of the Project Manager and Engineer, and will take the form of an addendum to the Contract Documents.

## 5.5 Progress Reports

The CQA Consultant will prepare a summary progress report each week, or at time intervals established at the preconstruction meeting. As a minimum, this report will include the following information:

- a unique identifying sheet number for cross-referencing and document control;
- the date, project name, location, and other information;
- a summary of work activities during the progress reporting period;
- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;
- a summary of test results, failures and retests; and
- the signature of the CQA Managing Engineer and the CQA Site Manager.

## 5.6 Final Report

At the completion of the work, the CQA Consultant will submit to the Owner a signed and sealed final report. The final report will certify: (i) that the work has been performed in substantial compliance with the Drawings, Technical Specifications, and CQA Plan; (ii) physical sampling and testing, except as properly authorized, have been performed at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting documentation.

At a minimum, this final report will include: (i) a narrative of construction activities; (ii) observation logs and testing data sheets including sample location plans; (iii) construction problems and solutions data sheets; (iv) changes from the design and Technical Specifications; (v) record drawings; and (vi) a summary statement sealed and signed by a Professional Engineer registered in the State of Delaware.

The record drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thickness, etc.). All surveying and base maps required for development of the record drawings will be prepared the Contractor's

Surveyor in accordance with Section 01721 of the Technical Specifications. The CQA Consultant will include these record drawings as part of the final report.

## 5.7 Storage of Records

Original handwritten data sheets, especially those containing signatures, must be stored by the Project Manager and/or CQA Consultant or his designee in a safe on-site repository. Other reports may be stored by any standard method, which will allow for easy access.

# 6. EROSION AND SEDIMENT CONTROLS

## 6.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to erosion and sediment controls. The following CQA activities are discussed in the remainder of this section:

- Preconstruction Qualifying of Material Sources;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

## 6.2 Preconstruction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the CQA Site Manager and/or Engineer with the quality control information and certification from the supplier(s) of temporary seed, mulches or matting, and silt fence required in Section 02370 of the Technical Specifications.

The CQA Site Manager and/or Engineer will examine all of the suppliers' certifications to verify that the property values listed on the certifications meet or exceed the Technical Specifications, and that proper and complete documentation has been provided by the Contractor for the temporary and permanent erosion and sedimentation materials that will be used at the Site. The CQA Site Manager will report any deviations from the above requirements to the Contractor prior to approving installation of the materials.

## 6.3 Field Evaluation/Monitoring of Construction Techniques

The CQA Site Manager will observe the Contractor's work activities and will verify that, prior to initiating work in any given area, temporary erosion and sediment controls, as required in the Drawings and Technical Specifications have been installed. The CQA Site Manager will routinely verify that the Contractor keeps the site free from excessive sediment and in as neat a condition as possible. This includes the project

area, haul roads, borrow areas, stockpile areas, and the entrance area to the Cherry Island Landfill facility. The CQA Site Manager and/or Engineer will verify that the Contractor selects the appropriate erosion and sediment controls from the "*Delaware Erosion and Sediment Control Handbook*", most recent version.

The CQA Site Manager will perform weekly inspections of the Contractor's temporary erosion and sediment controls, and will perform an inspection of the controls within one working day of any rain event exceeding 1 in. The Contractor may accompany the CQA Site Manager during these inspections, or may perform independent inspections required in the Drawings and Technical Specifications. The CQA Site Manger will be responsible for reviewing the Contractor's erosion control inspection checklist forms within one working day of the Contractor submitting the forms.

The CQA Site Manager will verify that stockpiles are located as shown on the Drawings or as approved by the Project Manager, and that the Contractor has installed and is frequently maintaining all erosion and sedimentation control measures around these areas, as required in the Technical Specifications.

## 6.4 Deficiencies, Problems, and Repairs

The CQA Site Manager will report any deficiencies and noncompliances in the erosion and sedimentation controls to the Contractor. The extent of the deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the CQA Site Manager and/or Project Manager. The Contractor will promptly correct any deficiency to the satisfaction of the CQA Site Manager, or as directed by the Project Manager.

# 7. PREFABRICATED VERTICAL DRAINS

## 7.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the prefabricated vertical drains (PVDs) that will be installed prior to the construction of the MSE berm. The PVD material will be supplied and installed by the Contractor or its Subcontractor. The following CQA activities are discussed in the remainder of this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

## 7.2 Preconstruction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the CQA Consultant and/or Engineer with the quality control information and certifications from the PVD manufacturer as required in Section 02621 of the Technical Specifications. The CQA Consultant or Engineer will examine all PVD Manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Technical Specifications, and that proper and complete documentation has been provided by the Contractor for all PVDs that will be installed at the Site. Prior to construction, the Contractor will be required to provide the CQA Consultant with manufacturer's literature for a sample of the PVD material. The CQA Consultant will examine the submittal and verify the proposed PVD meets or exceeds the Technical Specifications. The CQA Consultant will report any deviations from the above requirements to the Contractor prior to approving installation of the PVDs.

## 7.3 Material Conformance Testing

Conformance sampling of the PVDs will be performed by the CQA Consultant prior to or upon delivery of rolls to the Site, as requested by the Project Manager and/or

Engineer. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Unless otherwise specified, samples will be 10-ft. long by the full roll width. The CQA Consultant will mark each sample with the following information:

- date sampled;
- project number;
- conformance sample number; and
- CQA Consultant personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the PVDs will be performed in accordance with the Technical Specifications, but at one half of the frequency. All conformance test results will be reviewed by the CQA Consultant before installation of the PVDs. Any nonconformance of the material's physical properties will be promptly reported to the Contractor. The following procedure will apply whenever a PVD sample fails a conformance test conducted by the CQA Consultant:

- The Contractor will be required to replace all of the PVD rolls within the batch from which the non conforming sample was obtained.
- Alternatively, if the Contractor, PVD Manufacturer, and the Project Manager all agree, the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample maybe obtained from every roll from the batch/lot and conformance tested by the Geosynthetics CQA Laboratory. The CQA Consultant will implement a more stringent testing protocol in agreement with the Project Manger and Engineer.

During conformance testing, the CQA Consultant will also verify that the PVD Manufacturer has identified all rolls of PVDs with the following information:

- name of manufacturer;
- product identification; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the PVD material.

## 7.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or its subcontractor will be required to keep the PVDs off the ground and protect the PVDs from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Contractor. Any damaged rolls will be rejected by the CQA Consultant, Project Manager, and by the Contractor. The Contractor and/or the Subcontractor will be required to handle and install the PVDs in accordance to Section 02621 of the Technical Specifications.

## 7.5 Deficiencies, Problems, and Repairs

The CQA Consultant will report to the Contractor and/or the PVD Subcontractor any unresolved deficiencies in the underlying subgrade prior to PVD installation, and will not approve of PVD installation until the deficiencies are resolved to the satisfaction of the CQA Consultant and in accordance with the Drawings and Technical Specifications.

The CQA Consultant will verify that any damage (e.g., holes or tears) in the PVDs are repaired in accordance with the Technical Specifications, and that care is taken by the Contractor to remove any soil or other material which may have contaminated or otherwise detrimentally affected the performance of the PVDs.

The CQA Consultant will document deficiencies or noncompliance with the specified requirements and report them to the Contractor and/or the PVD Subcontractor. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the CQA Consultant and/or Engineer.

The Contractor and/or the PVD Subcontractor will correct the deficiency to the satisfaction of the CQA Consultant. If a Technical Specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant will develop and present to the Project Manager and Engineer a suggested alternative solution for approval. All retests or subsequent re-evaluations recommended by the CQA Consultant must verify that the deficiency has been corrected before any additional work is performed by the Contractor and/or its subcontractor in the area of the deficiency.

# 8. MECHANICALLY STABILIZED EARTH BERM

## 8.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with construction of the MSE berm for the Project. The following CQA activities are discussed in the remainder of this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

## 8.2 Preconstruction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the Engineer with the quality control information and certifications for earthen materials, geogrid, and MSE berm facing required in the Drawings and Technical Specifications. The Engineer will review manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Technical Specifications, and that proper and complete documentation has been provided by the Contractor for all earthen materials, geogrid, and MSE facing materials used at the Site. The CQA Consultant will report any deviations from the above requirements to the Contractor prior to approving installation of the MSE berm components.

## 8.3 Material Conformance Testing

Conformance sampling and laboratory testing of the soil components used for constructing the MSE berm will be performed in accordance with the Technical Specifications, but at one-half of the frequency. The CQA Consultant will obtain the soil samples, which will be tested by the Soils CQA Laboratory to verify that the soils meet the requirements of Section 02055 of the Technical Specifications. If, a preconstruction sample fails to meet the requirements of the Technical Specifications,

then the CQA Consultant will notify the Contractor. Use of the material will not be allowed until the material is pre-qualified by further tests. Additional tests, if necessary, will be performed by the CQA Consultant at the request of the Project Manager and/or Engineer.

Conformance sampling of the high-strength geotextile and geogrid will be performed by the CQA Consultant prior to, or upon delivery of rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of Sections 02071 and 02076 of the Technical Specifications, respectively, and the manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant and will not include the first 3 ft. along the width of the roll. Unless otherwise specified, samples will be 10-ft. long by the full roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.

The laboratory test methods for the high-strength geotextile and geogrid will be the same as stated in Sections 02071 and 02076 of the Technical Specifications, respectively, but at one-half of the frequency.

The CQA Consultant will review all conformance test results of the soil, high-strength geotextile, and geogrid prior to the Contractor initiating construction of the MSE berm. Any nonconformance of the material's physical properties will be promptly reported to the Contractor. The following procedure will apply whenever a high-strength geotextile or geogrid sample fails a conformance test performed by the CQA Consultant.

- The Contractor will be required to replace all non-conforming, high-strength geotextile and geogrid rolls within the lot/batch from which the sample was obtained, respectively.
- Alternatively, if the Contractor, Manufacturer, and Project Manager all agree, then the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, then samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the CQA Consultant. These ten samples must pass the conformance tests property values provided in the Technical Specifications. If any of these samples fail, then a sample maybe obtained from every roll from the lot/batch and conformance tested by the Geosynthetics CQA Laboratory. The CQA Consultant will implement a more stringent testing protocol in agreement with the Project Manager and Engineer.

During conformance testing, the CQA Consultant will also verify that the Manufacturer has identified all high-strength geotextile and geogrid rolls with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the high-strength geotextile and geogrid.

## 8.4 Field Evaluation/Monitoring of Construction Techniques

Field evaluation/monitoring of soil used for constructing the MSE berm will be performed as described below.

- The CQA Consultant will visually observe placement and compaction of the soil to assure displacement and/or damage to the high-strength geotextile and geogrid does not occur.
- Moisture-density testing will be performed, at a minimum for each horizontal lift of soil berm constructed, as follows: one test will be performed for every 100 linear feet of MSE berm. The CQA Consultant should identify test locations using the MSE berm station numbers.

The CQA Consultant will provide the results of the moisture-density test results to the CQA Managing Engineer and Engineer, at a minimum, after every 50 tests have been performed on the soil during MSE berm construction.

During unloading and storage, the Contractor will be required to keep the high-strength geotextile and geogrid off the ground and protect the materials from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. The Contractor and/or Geosynthetics Installer will handle the high-strength geotextile and geogrid rolls in accordance to the Technical Specifications and manufacturer's guidelines.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Contractor. Any damaged rolls will be rejected by the CQA Consultant and the Project Manager, and be replaced by the Contractor and/or Manufacturer.

The Contractor and/or Geosynthetics Installer will be required to handle and deploy all high-strength geotextile and geogrid in such a manner as to ensure the material is not damaged and that the MSE berm is constructed in accordance with the Drawings and Technical Specifications. The CQA Consultant will verify compliance with the following:

- the locations of all buried work (e.g., the conveyance pipes, aggregate trenches, geotechnical instrumentation, etc.) are clearly marked so as to preclude disturbance or damage by subsequent activities;
- the subgrade is firm and stable for placement of the first lift of soil and/or the leveling pad; evaluation of the subgrade stability will be accomplished by proof-rolling or other methods as agreed upon by the Contractor and CQA Consultant;
- immediately prior to placing the first lift of MSE berm soil, the subgrade is graded in accordance with the Drawings and Technical Specifications, and is free of obstructions and protrusions that could affect the high-strength geotextile and geogrid;
- efforts are made to minimize the presence of wrinkles in the high-strength geotextile and geogrid and all overlaps are in accordance with Sections 02071 and 02076 of the Technical Specifications;
- care is taken by the Contractor not to entrap stones, soil, dust, or moisture that could damage the high-strength geotextile and geogrid;
- a visual examination of the high-strength geotextile and geogrid layers is performed frequently during installation, to verify that no potentially harmful foreign objects, such as debris, rocks, or tools, are present; and
- the high-strength geotextile and geogrid are not left exposed for longer than the maximum allowable period (as set forth in the Technical Specifications) after placement unless a longer exposure period is approved by the Engineer.

The CQA Consultant will verify that the components of the high-strength geotextile and geogrid are spliced to like-components of adjacent rolls, MSE berm facing, and material as required in the Drawings and Technical Specifications.

## 8.5 Deficiencies, Problems, and Repairs

The CQA Consultant will report to the Contractor any unresolved deficiencies in the underlying subgrade prior to MSE berm construction, and will not allow construction to continue until the deficiencies are resolved to the satisfaction of the Project Manager and Engineer.

The CQA Consultant will verify that any damage (e.g., holes or tears) in the high-strength geotextile and geogrid and/or MSE facing material are repaired in accordance with the Technical Specifications, and that care is taken by the Contractor to remove any soil or other material which may have contaminated or otherwise detrimentally affected the performance of the MSE berm.

The CQA Consultant will document deficiencies or noncompliance with the specified requirements and report them to the Contractor. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the CQA Consultant.

The Contractor will correct the deficiency to the satisfaction of the CQA Consultant. If a Technical Specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant and Contractor/Geosynthetics Installer will develop and present to the Engineer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the CQA Consultant must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

# 9. EARTHWORK

## 9.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to general earthwork. General earthwork consists of placement and compaction of all soil or aggregate components of the work, with the exception of MSE berm soils components, which are addressed in Section 8. The following CQA activities are discussed in this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

## 9.2 Preconstruction Qualifying of Material Sources

Prior to construction with any given soil or aggregate material, the CQA Consultant will receive test results from the Contractor for a sample of each material taken from the proposed source. The CQA Consultant will review the test results to ensure that each material meets the requirements of the Technical Specifications. Results of the preconstruction tests may be counted toward the conformance testing frequency requirements, provided the results meet the specified material properties. The CQA Consultant may also request that the Contractor provide a sample of each material for additional testing, if further preconstruction qualification testing by the CQA Consultant is warranted.

If a preconstruction qualifying sample fails to meet the requirements of the Technical Specifications, then the CQA Consultant will notify the Contractor. Use of the material will not be allowed until the material is pre-qualified by further tests. Additional tests, if necessary, will be performed by the CQA Consultant at the request of the Project Manager and/or Engineer.

## 9.3 Material Conformance Testing

During construction, a conformance testing program will be implemented by the CQA Consultant to verify that the physical properties of the earthwork materials meet the specified material properties. The CQA Consultant will obtain soil samples for conformance testing from the borrow source, on-site stockpiles, or from trucks as they unload material in the work area. Conformance sampling and laboratory testing of soil and aggregate will be performed in accordance with the Technical Specifications, but at one-half of the frequency.

If a sample fails a conformance test, then the CQA Consultant will notify the Contractor and use of the material represented by that sample will not be allowed. Additional tests will be performed by the CQA Consultant as directed by the Project Manager, or the Contractor will use material from a different source.

## 9.4 Field Evaluation/Monitoring of Construction Techniques

The CQA Consultant will monitor and document the earthwork activities. Monitoring the construction work for the earthwork materials will include the following:

- monitoring the thickness of lifts as loosely placed and after being compacted;
- documenting the type of construction equipment and methods used to place and compact the material;
- observing the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.) to detect inadequate compaction;
- verifying that proper equipment and methods are used to place soil or aggregate over geosynthetic components of the liner system or final cover system, and that wrinkles or excess tensile stresses to underlying geosynthetics are minimized; and
- verify that only low-ground pressure equipment traverses over lined areas unless an approved thickness of protective soil is first placed.

## 9.5 Field Testing of Work Products

### 9.5.1 Routine Field Testing

Conformance field testing (primarily density and moisture content testing) of placed/compacted earthwork materials will be performed by the CQA Consultant during construction to confirm that the requirements of the Technical Specifications are met. Conformance field testing will be performed according to test methods provided in the Technical Specifications, but at one-half of the frequency. The CQA Consultant will select the test locations.

Moisture/density testing will be performed primarily using a nuclear gauge (in accordance with ASTM D 3017 and ASTM D 2922). The CQA Consultant will perform several oven moisture content tests (ASTM D 2216) on any given material at the outset of construction to evaluate requirements for moisture offsets for the nuclear gauge and during construction at a minimum frequency of one per 50 nuclear moisture/density tests. The CQA Consultant will also routinely verify the dry density calibration of the nuclear gauge throughout construction using methods such as Sand Cone (ASTM D 1556) and/or Drive Cylinder (ASTM D 2937) density testing.

The CQA Consultant will be responsible for submitting enough samples to the Soils CQA Laboratory to meet the minimum testing frequency. It is also the responsibility of the CQA Consultant to monitor placement and compaction of soil in the liner system anchor trench. The CQA Consultant will verify that the backfilling techniques do not damage the geosynthetics in or near the anchor trench. Moisture and density testing of the backfill should be performed by the CQA Consultant at a frequency of one test per 100 linear feet of constructed anchor trench per lift of soil.

### 9.5.2 Special Testing

A special testing frequency will be used at the discretion of the CQA Consultant when initial testing or visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the compactor rollers slip during compaction operations;
- the lift thickness is greater than specified;
- the material is at a highly variable moisture content;
- dirt-clogged rollers are used to compact the material;
- the materials properties are highly variable;
- the degree of compaction is doubtful; or
- as directed by the CQA Consultant or Project Manager.

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

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- if the material initially fails to meet compaction requirements; or
- the work area is reduced.

## 9.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance is discovered, then the CQA Consultant will promptly evaluate the extent and nature of the defect. The extent of the deficient area will be evaluated by additional tests, observations, a review of records, or other means deemed appropriate (e.g., proof-rolling by the Contractor).

After defining the extent and nature of a defect, the CQA Consultant will notify the Contractor, and at times, the Project Manager, to schedule appropriate retests after the work deficiency is corrected.

If a specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant will develop and present to the Project Manager or Engineer suggested alternative solutions for approval. All retests recommended by the CQA Consultant must verify that the deficiency has been corrected before additional work is performed by the Contractor in the area of the deficiency.

# 10. GEOMEMBRANE

## 10.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to installation of the high-density polyethylene (HDPE) geomembrane. Detailed geomembrane installation requirements are presented in Section 02075 of the Technical Specifications. The geomembrane will be supplied and installed by the Geosynthetics Installer, under direct contract with the Contractor.

## 10.2 Geomembrane Monitoring

The CQA Consultant will monitor geomembrane installation. Specific monitoring activities include, but are not limited to:

- review the required submittals to verify that the resin used to manufacture the geomembrane and the geomembrane itself meet the requirements of Section 02075 of the Technical Specifications;
- collecting conformance samples of the geomembrane at the manufacturing facility or after delivered to the Site and forwarding the samples to an approved off-site testing laboratory for testing;
- collecting and reviewing the Geosynthetic Manufacturers' quality control (MQC) documentation to verify that the certifications comply with the requirements of the Technical Specifications;
- tracking inventory of the geomembrane rolls delivered to the Site;
- observing geomembrane rolls that had been delivered to the Site to observe whether the materials had been damaged during transportation and, if damaged, marking damaged locations for repair or replacement;
- observe and document material unloading and on-site transport and storage;
- reviewing and evaluating laboratory CQA conformance test results for the geomembrane to verify that the test results met the requirements of the Technical Specifications;

- monitoring deployment and installation of geomembrane and marking locations for replacement or repair;
- monitoring overlapping of adjacent geomembrane panels;
- monitoring geomembrane trial seaming operations and field testing of trial seams (both fusion and extrusion);
- monitoring geomembrane production seaming operations (both fusion and extrusion);
- monitoring nondestructive testing (both air pressure and vacuum) of geomembrane seams and repairs;
- selecting geomembrane destructive seam sample locations, monitoring sample collection, distributing samples to the Geosynthetics Installer and Owner, and destructively testing the samples at an approved off-site laboratory to verify compliance with the requirements of the Technical Specifications and CQA Plan;
- monitoring repairs to portions of the geosynthetics that were observed to have defects or that failed the criteria for destructive or nondestructive testing;
- observe and document repair operations;
- note on-site activities that could result in damage to the geomembrane; and
- monitoring placement of the geosynthetics in the anchor trench.

## 10.3 Conformance Testing

Conformance sampling of the geomembrane may be performed by the CQA Consultant either at the manufacturing facility or upon delivery of the rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the Geomembrane Manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft. of material. Unless otherwise specified,

samples will be 3-ft. long by the roll width. Samples will be taken at a minimum frequency of one sample per 200,000 $ft^2$ with a minimum of one sample per lot. Conformance tests will be performed in accordance with laboratory test methods presented in Section 02075 of the Technical Specifications, but at one-half of the frequency.

The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA personnel identification.

The CQA Consultant will review all CQA and MQC conformance test results before approving deployment of the geomembrane. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a geomembrane sample fails a conformance test performed by the CQA Consultant:

- The Geosynthetic Installer will be required to replace all of the rolls of geomembrane within the lot/batch from which the nonconforming sample was obtained.
- Alternatively, if the Geosynthetic Installer, Geomembrane Manufacturer, and the Project Manager all agree, the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance test requirements. If either of these samples fails to meet the requirements, then samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the CQA Consultant. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of geomembrane from the

batch/lot on-site maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geomembrane Manufacturer has identified all rolls of geomembrane with the following information:

- name of manufacturer;
- product identification;
- thickness;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record the above information for each roll delivered to the Site using a Material Inventory Log form for the geomembrane.

# 11. GEOTEXTILE

## 11.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the installation of the geotextile. Detailed geotextile installation requirements are presented in Section 02071 of the Technical Specifications. The geotextile will be supplied and installed by the Contractor and/or Geosynthetics Installer, under direct contract with the Contractor.

## 11.2 Geotextile Monitoring

The CQA Consultant will monitor geotextile installation. Specific monitoring activities include, but are not limited to:

- review the required submittals to verify that the geotextile meets the requirements of Section 02071 of the Technical Specifications;
- collecting conformance samples of the geotextile at the manufacturing facility or after delivered to the Site and forwarding the samples to an approved off-site testing laboratory;
- collecting and reviewing the Geosynthetic Manufacturers' quality control (MQC) documentation to verify that the certifications comply with the requirements of the Technical Specifications;
- tracking inventory of the geotextile rolls delivered to the Site;
- observing geotextile rolls that had been delivered to the Site to observe whether the materials had been damaged during transportation and, if damaged, marking damaged locations for repair or replacement;
- observe and document material unloading and on-site transport and storage;
- reviewing and evaluating laboratory CQA conformance test results for the geotextile to verify that the test results met the requirements of the Technical Specifications;
- immediately prior to geotextile placement, the subgrade is free of sharp protrusions or other obstructions that could potentially damage the geotextile;

- in the presence of wind, the geotextile is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with an overlying layer;
- efforts are made to minimize the presence of wrinkles in the geotextile, and if necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles;
- a visual examination of the geotextile is performed over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geotextile is not left exposed for longer that the maximum allowable period (as set forth in the Technical Specifications) after placement unless a longer exposure period is approved by the Engineer.

The CQA Consultant will verify that the Contractor places all soil and aggregate materials on top of the geotextile such that:

- the geotextile and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geotextile.

## 11.3 Conformance Testing

Conformance sampling of the geotextile will be performed by the CQA Consultant upon delivery of rolls to the Site, unless otherwise directed by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft. of material. Unless otherwise specified, samples will be 3-ft. long by the roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.

Conformance testing will be performed in accordance with the test methods presented in the Technical Specifications, but at one-half of the frequency.

All conformance test results will be reviewed by the CQA Consultant before installation of the geotextile. Any nonconformance of the material's physical properties will be promptly reported to the Contractor and/or Geosynthetic Installer. The following procedure will apply whenever a geotextile sample fails a conformance test performed by the CQA Consultant.

- The Contractor and/or Geosynthetic Installer will be required to replace all of the rolls of geotextile within the lot/batch from which the non-conforming sample was obtained.
- Alternatively, if the Contractor and/or Geosynthetic Installer, Geotextile Manufacturer, and the Project Manager all agree, then the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, then samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of geotextile from the batch/lot on-site may be conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geotextile Manufacturer has identified all rolls of geotextile with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the geotextile.

# 12. GEOSYNTHETIC CLAY LINER

## 12.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the geosynthetic clay liner (GCL). The GCL will be supplied and installed by the Geosynthetics Installer under direct contract with the Contractor.

## 12.2 GCL Monitoring

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the GCL off the ground and protect the GCL from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Technical Specifications require that the GCL rolls be shipped and stored in opaque and watertight wrappings.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls will be rejected by the CQA Consultant and the Project Manager, and be repaired or replaced by the Geosynthetic Installer.

The Geosynthetic Installer will be required to handle and deploy all GCL in such a manner as to ensure the GCL is not damaged. Prior to GCL deployment directly on the subgrade, the CQA Consultant will observe the area, and will confirm that the soil subgrade surface has been fully approved by the Geosynthetic Installer. During installation, the CQA Consultant will verify compliance including but not be limited to:

- immediately prior to GCL placement, the underlying subgrade is free of moisture or obstructions that could potentially damage the GCL;
- the GCL is installed with the correct orientation (i.e., with the correct side up);
- efforts are made to keep the GCL placed to minimize the presence of wrinkles in the GCL, and if necessary, the GCL is positioned by hand after being unrolled to minimize wrinkles;

- excessive amounts of bentonite do not ravel out along the edges of the GCL;
- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage the GCL;
- in the presence of wind, the GCL is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with the overlying geomembrane;
- a visual examination of the GCL is performed over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present;
- prior to geomembrane deployment, the CQA Consultant grants approval for the GCL to be covered;
- verify that any holes or tears in the GCL are repaired in accordance with the Technical Specifications, and that care is taken by the Contractor and/or Geosynthetic Installer to remove any soil or other material, which may have penetrated the torn GCL;
- no more GCL is deployed during each day than can be covered by the end of the day with seamed geomembrane; and
- the GCL is not left exposed for longer than the maximum allowable period (as set forth in the Technical Specifications) after placement unless the Engineer approves a longer exposure period.

The CQA Consultant will verify that the GCL panels are overlapped as required in the Technical Specifications. The CQA Consultant will also confirm that the Engineer is made aware of any end-to-end GCL seams on slopes, and that any special overlapping or connecting methods required by the Engineer are implemented by the Geosynthetic Installer.

The CQA Consultant will verify that the Geosynthetics Installer places the geomembrane on top of the GCL such that:

- the GCL and underlying materials are not damaged;
- wrinkles are minimized;

- excess tensile stresses are not produced in the GCL; and
- the geomembrane extends at least 2 ft. beyond the underlying GCL, and the leading edge of the geomembrane has adequately ballast to avoid wind uplift and reduce the likelihood of surface water running under the geomembrane and hydrating the GCL.

## 12.3 Material Conformance Testing

Conformance sampling of the GCL may be performed by the CQA Consultant either at the manufacturing plant or upon delivery of rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC across the entire width of the roll and will not include the first 3 ft. along the length of the roll. Unless otherwise specified, samples will be 3-ft. long by the full roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.

The conformance testing of the GCL will be performed in accordance with the test methods presented in the Technical Specifications, but at one-half of the frequency. All conformance test results will be reviewed by the CQA Consultant before installation of the GCL. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a GCL sample fails a conformance test performed by the CQA Consultant.

- The Geosynthetic Installer will be required to replace all of the rolls of GCL within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, GCL Manufacturer and the Project Manager all agree, then the CQA Consultant will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, then a sample from every roll of GCL from the batch/lot on-site and maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the GCL manufacturer has identified all rolls of GCL with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the GCL.

# 13. GEOCOMPOSITE

## 13.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to the geocomposite component of the liner system or final cover system. The geocomposite will be supplied and installed by the Geosynthetics Installer, under direct contract with the Contractor. The following CQA activities are discussed in the remainder of this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

## 13.2 Preconstruction Qualifying of Material Sources

Prior to construction, the Geosynthetics Installer will provide the CQA Consultant with the quality control information and certifications from the Geocomposite Manufacturer required in Section 02620 of the Technical Specifications.

The CQA Consultant will examine the Geocomposite Manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Technical Specifications and that proper and complete documentation has been provided by the Geosynthetics Installer for all geocomposite used at the Site. The CQA Consultant will also verify that the manufacturer of the non-woven geotextile component(s) of the geocomposite provides certification that the geotextile is continuously inspected for the presence of needles using a metal detector during the manufacturing process. The CQA Consultant will report any deviations from the above requirements to the Geosynthetics Installer prior to approving installation of the geocomposite.

## 13.3 Material Conformance Testing

Conformance sampling of the geocomposite may be performed by the CQA Consultant either at the manufacturing plant or upon delivery of rolls to the Site, as requested by the Project Manager. The CQA Consultant will obtain samples and forward them to the Geosynthetics CQA Laboratory for testing to evaluate whether the material meets the requirements of the Technical Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the CQA Consultant across the entire width of the roll and will not include the first 3 ft along the length of the roll. Unless otherwise specified, samples will be 3-ft long by the full roll width. The CQA Consultant will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- CQA Consultant personnel identification.

Conformance testing will be performed in accordance with the test methods presented in the Technical Specifications, but at one-half of the frequency. All conformance test results will be reviewed by the CQA Consultant before installation of the geocomposite. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetics Installer. The following procedure will apply whenever a geocomposite sample fails a conformance test conducted by the Geosynthetics CQA Laboratory.

- The Geosynthetics Installer will be required to replace all of the rolls of geocomposite within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetics Installer, Geocomposite Manufacturer, and the Project Manager all agree, the CQA Consultant will obtain additional

conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite from the batch/lot on-site maybe conformance tested by the CQA Consultant for the failing property test.

During conformance testing, the CQA Consultant will also verify that the Geocomposite Manufacturer has identified all rolls of geocomposite with the following information:

- name of manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The CQA Consultant will record all of the above information for each roll delivered to the Site using a Material Inventory Log form for the geocomposite.

## 13.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the geocomposite off the ground and protect the geocomposite from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Technical Specifications require that the geocomposite rolls be shipped and stored in opaque and watertight wrappings.

The CQA Consultant will observe rolls upon delivery at the Site and any deviation from the above requirements will be reported to the Geosynthetics Installer. Any damaged rolls will be rejected by the Project Manager and CQA Consultant, and required to be repaired or replaced by the Geosynthetics Installer.

The Geosynthetics Installer will be required to handle and deploy all geocomposite in such a manner as to ensure the geocomposite is not damaged. The CQA Consultant will verify compliance with the following:

- immediately prior to geocomposite placement, the underlying geomembrane surface is free of moisture or obstructions that could potentially damage the geocomposite;
- in the presence of wind, the geocomposite is weighted with sandbags (or equivalent ballast weight approved by the CQA Consultant), and that sandbags remain until replaced with the overlying protective cover soil layer;
- efforts are made to minimize the presence of wrinkles in the geocomposite, and if necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles;
- care is taken by the Geosynthetics Installer not to entrap stones, soil, dust, or moisture that could damage or cause clogging to the geocomposite;
- a visual examination of the geocomposite is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geocomposite is not left exposed for longer than the maximum allowable period (as set forth in the Technical Specifications) after placement unless a longer exposure period is approved by the Engineer.

The CQA Consultant will verify that the components of the geocomposite (i.e., geotextile-geonet-geotextile) are sewn, joined, and/or overlapped to like-components in adjacent geocomposite panels, as required in the Technical Specifications.

The CQA Consultant will verify that the Contractor and/or Geosynthetics Installer places soil or geosynthetic materials on top of geocomposite such that:

- the geocomposite and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geocomposite.

## 13.5 Deficiencies, Problems, and Repairs

The CQA Consultant will report to the Geosynthetics Installer any unresolved deficiencies in the underlying geomembrane prior to geocomposite placement, and will not approve of geocomposite deployment until the geomembrane deficiencies are resolved to the satisfaction of the CQA Consultant and in accordance with the Technical Specifications.

The CQA Consultant will verify that any holes or tears in the geocomposite are repaired in accordance with the Technical Specifications, and that care is taken by the Contractor to remove any soil or other materials, which may have penetrated the torn geocomposite.

The CQA Consultant will document deficiencies or noncompliance with the specified requirements and report them to the Geosynthetics Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the CQA Consultant. The Geosynthetics Installer will correct the deficiency to the satisfaction of the CQA Consultant. If a Technical Specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant will develop and present to the Project Manager and Engineer suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the CQA Consultant must verify that the deficiency has been corrected before any additional work is performed by the Geosynthetics Installer in the area of the deficiency.

# 14. HDPE PIPE AND FITTINGS

## 14.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to installation of HDPE pipe and fittings for the leachate collection and transmissions systems. Items in this section include the HDPE pipe, fittings, and associated accessories. The following CQA activities are discussed in this section:

- Preconstruction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

## 14.2 Preconstruction Qualifying of Material Sources

The leachate collection and transmission systems will include perforated and solid-wall HDPE collection pipes and fittings. The pipes and fittings must be prequalified as described below. Prior to the shipment of the HDPE pipes and fittings to the Site the Contractor will be required to provide the CQA Site Manager and/or Engineer the quality control information and certifications from each manufacturer as required in Sections 02081 and 15060 of the Technical Specifications.

The CQA Consultant will examine all of the HDPE pipe and fitting manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Technical Specifications, and that proper and complete documentation has been provided by the Contractor for all HDPE pipe, fittings, and pipe-accessories used at the Site. The CQA Consultant will report any deviations from the above requirements to the Contractor prior to approving installation of the materials.

The CQA Consultant will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the HDPE pipe used on the project:

- name and/or trademark of the pipe manufacturer;
- nominal pipe size, wall thickness, and SDR;
- manufacturing standard reference (e.g., ASTM D 2513); and
- production code from which the date and place of manufacture can be determined.

If, during preconstruction qualifying, any of the HDPE piping, fittings, and/or accessories that fails to meet the requirements of the Drawings and Technical Specifications, the CQA Consultant will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Engineer.

## 14.3 Material Conformance Testing

Material conformance testing of the HDPE pipes will not be required unless aspects of the prequalifying information are deficient or suspect, or if requested by the Engineer. If deemed necessary by the Engineer, the CQA Consultant will remove a minimum 3-ft long section of pipe and deliver it to the Geosynthetics CQA Laboratory for testing to evaluate whether the pipe meets the required properties of the Technical Specifications. The conformance test requirements will be determined at that time by the Project Manager and/or Engineer.

## 14.4 Field Evaluation/Monitoring of Construction Techniques

The CQA Consultant will verify that the HDPE pipe and fittings are stored on clean level ground, free of conditions which could damage the pipe; and where necessary (e.g., due to muddy or sloping ground conditions) the pipe is stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During construction, the CQA Consultant will verify compliance with the following:

- the perforated pipe has the proper amount, correct size, and spacing of perforations, and that the perforations are oriented properly after the pipe is installed;
- handling of the pipe is conducted in such a manner that the pipe is not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed aggregate for the leachate collection and transmission systems are carefully placed under and around the pipe in accordance with the Drawings and Technical Specifications;
- pipe segments are not brought into position until preceding lengths have been bedded and secured in its final position;
- pipe sections are properly joined using procedures recommended by the Manufacturer and/or allowed for in the Technical Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- blocking is not used under the pipe unless pre-approved by the Engineer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Technical Specifications, and in a manner that will not damage the pipe.

## 14.5 Field Testing of Work Products

The CQA Consultant will verify that the Contractor has performed the applicable pre-testing procedures required Sections 02081 and 15060 of the Technical Specifications prior to initiating any hydrostatic or low-pressure air testing of the solid HDPE pipes during installation. The CQA Consultant will monitor the Contractor's activities associate with all testing activities and will confirm that the Contractor follows the procedures required in the specifications. The CQA Consultant will either

record the test results or will observe the Contractor recording the results and review the results upon submittal by the Contractor.

## 14.6 Deficiencies, Problems, and Repairs

The CQA Consultant will report any deficiencies or noncompliance in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the CQA Consultant and Engineer.

The Contractor will correct the deficiency to the satisfaction of the CQA Consultant and Engineer. If a Technical Specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA Consultant will develop and present to the Project Manager and Engineer suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the CQA Consultant must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

# 15. MECHANICAL AND ELECTRICAL SYSTEMS

## 15.1 Overview

This section of the CQA Plan addresses the CQA program to be implemented with regard to installation of mechanical and electrical systems for the Project. The following CQA activities are discussed in this section:

- Preconstruction Qualifying of Equipment and Systems;
- Field Evaluation/Monitoring of Construction Techniques;
- Performance Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

## 15.2 Preconstruction Qualifying of Equipment and Systems

The electrical and mechanical systems must be prequalified as described below. Prior to shipment of the electrical and mechanical systems to the Site the Contractor will be required to provide the CQA Site Manager and/or Engineer the quality control information and certifications from the manufacturer's as required in the Drawings, and Divisions 15 and 16 of the Technical Specifications, respectively.

The CQA Consultant and/or Engineer will examine manufacturer's certifications to verify that the proposed mechanical and electrical equipment meet or exceed the requirements presented in the Drawings and Technical Specifications. The CQA Consultant will report any deviations from the above requirements to the Contractor prior to approving installation of the mechanical and electrical systems.

The CQA Consultant will verify that each piece of equipment is provided with a stainless steel name plate that is securely fastened and clearly inscribed with the equipment manufacturer's name, year of manufacturer, serial number, and principal rating data. The CQA Consultant and/or Engineer will also review the information associated with submittals and shop drawing including, but not be limited to:

- manufacturer's literature and catalog cut sheets of all proposed equipment;
- certified outline dimension drawings;
- bill of materials;
- parts list;
- electrical wiring and control diagrams;
- piping and/or duct work;
- performance data;
- location of equipment;
- sleeves and chases;
- installation instructions; and
- operating and maintenance instructions.

If any of the mechanical and electrical systems fails to meet the requirements of the Drawings and Technical Specifications, the CQA Consultant and/or Engineer will notify the Contractor. Use of the equipment and/or systems will not be allowed until the equipment and mechanical and electrical systems are accepted by the Project Manager and/or Engineer.

## 15.3 Field Evaluation/Monitoring of Construction Techniques

The CQA Consultant will verify that the mechanical and electrical systems are installed in accordance with the Drawings and Technical Specifications, and to the satisfaction of the Project Manager and Engineer.

## 15.4 Performance Testing of Work Products

The CQA Consultant will verify that the Contractor has performed the applicable performance and startup tests for the electrical and mechanical systems in accordance to the Drawings and Technical Specifications. The CQA Consultant will either record the

test results or will observe the Contractor recording the results and review the results upon submittal by the Contractor.

## 15.5 Deficiencies, Problems, and Repairs

The CQA Consultant will report any deficiencies or noncompliance in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the CQA Consultant and Engineer. The Contractor shall repair any deficiencies or noncompliant work to the satisfaction of the Project Manager and Engineer.