DOW

The Dow Chemical Company
Midland, Michigan 48667
USA

February 11, 2016

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RE: THE DOW CHEMICAL COMPANY - SALZBURG LANDFILL – CELLS 20-22 FINAL COVER DESIGN SUBMITTAL
EPA MID 980 617 435

The Dow Chemical Company (Dow) is pleased to provide the attached Design Submittal for the final closure of Cells 20 through 22 at the Salzburg Hazardous Waste Landfill (SLF) for your review and approval. Cells 20 through 22 have received their final volume of waste in December, 2015 and final closure must, therefore, commence in accordance with Part 111 Rules R299.9613 and R299.9619(6). The attached Design Submittal entails the design of the final closure system for Cells 20 through 22, and Dow requests your approval of the attached design so that construction of the final closure system may begin in May, 2016.

Please contact Brent Gaudreau at either btgaudreau@dow.com or at 989-636-6503, if you have any questions or need additional information.

Sincerely,

Scott Bemis
Responsible Care Leader
Environment, Health, & Safety
The Dow Chemical Company, Michigan Operations
1790 Building, Washington Street
Midland, MI 48674

SALZBURG HAZARDOUS WASTE LANDFILL
MIDLAND, MICHIGAN
EPA IDENTIFICATION (ID) NUMBER: MID 980 617 435

BASIS OF DESIGN

FINAL COVER FOR CELLS 20 THROUGH 22

Prepared for

The Dow Chemical Company
Michigan Operations
1790 Building
Midland, MI 48674

January 18, 2016

Prepared by

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APPENDICES

1. INTRODUCTION

The Salzburg Hazardous Waste Landfill (SLF) is located in Midland, Michigan and is owned and operated by The Dow Chemical Company (Dow). The SLF is currently licensed under the provisions of Part 111, Hazardous Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Part 111) for the operation of a hazardous waste landfill. The facility provides disposal services for hazardous solid wastes from Dow. The landfill consists of ten closed units, two open units, and three future units not yet constructed. The closed units are as follows:

- Cells 1 – 2
- Cells 3 – 5
- Cells 6 – 8
- Cells 9 – 10
- Cells 11 – 12
- Cells 13 – 14
- Cells 15 – 16
- Cells 17 – 19
- Cells 38 – 39
- Cells 40 – 43

The open units consist of the following:

- Cells 20 – 22 (intermediate cover in place)
- Cells 23 – 26 (currently receiving waste)

The future units consist of the following:

- Cells 27 – 28
- Cells 30 – 37
- Cells 44 – 53

Cells 20 – 22 underwent an approved vertical expansion in 2009. This expansion increased the final waste grades from elevation 643.6 feet to 650.3 feet, and increased the slope of the top of the landfill from 1% to 2%. The revised designed waste capacity of Cells 20 – 22 was approximately 271,800 cubic yards. Cells 20 – 22 received their final waste volume in December, 2015. An intermediate cover was installed in December, 2015 to prevent erosion of the daily cover and manage storm water in the interim period prior to final closure.

1.1 PROJECT DESCRIPTION

Since Cells 20 – 22 have received their final volume of waste in December, 2015, final closure must commence in accordance with Part 111 Rules R299.9613 and R299.9619(6). This project entails the design of the final closure system for Cells 20 – 22.

Existing site features, utility location, topographic mapping, and survey information have been provided by Dow. This information is based upon ground surveys conducted by Wade-Trim and AECOM in November and December, 2015. While this information is assumed to be the best available for the site, additional ground survey of current site conditions may be necessary to verify existing conditions.

The design will meet requirements found in Part 111 Rule R299.9619(6) with the exception of one condition. The excepted condition is the decrease in slope from the required 4% per R299.9619(6)(a)(iv) to 2% that was previously approved with the vertical expansion in 2009 and will be held in the current design.

Additionally, this design requests an approval for an alternate final cover design which is allowed per Rule R299.9619(7). The proposed alternate design is the elimination of the compacted clay liner component per R299.9619(6)(a)(i) and replaced with two (2) layers of geosynthetic clay liner (GCL). Equivalent environmental protection is demonstrated in this design and the supporting analyses are provided as an attachment to this Report.

The following sections provide discussion of the engineering design of the final cover system. The Engineering Plan Set is included as Appendix A to this Report.

2. Final Cover Design

The Cells 20 – 22 will be covered by a final cover system as described below. The final cover grading plan is shown within the attached Engineering Plan Set. The final contours consist of two percent grades on the top areas, and 4:1 grades on the side slope areas within the expansion area. The proposed final grades will effectively promote runoff from the top and side slopes of the final cover to prevent ponding of water on top of the final cover system. These final grades will be capable of supporting vegetation to minimize erosion, site infiltration and site maintenance.

Establishment of vegetative growth will minimize wind and water erosion of the final protective cover. Vegetative growth established in diversion berms also aids in minimizing erosion. The seed mixture will consist of a diverse mix of native and introduced species consistent with the post closure land use. This seed mix will be compatible with local climatic conditions and will be self-sufficient type of vegetation that will require little maintenance. Upon completion of seeding, areas shall be adequately mulched with straw to retain moisture. Erosion control such as netting, soil stabilization, etc. shall also be provided where needed to minimize erosion of soils.

Vegetation stress caused by landfill gas is not anticipated, as the composite cover (specifically the two layers of GCL and geomembrane) should prevent outward gas migration; therefore, the vegetation will not be affected by landfill gas. Nevertheless, a landfill gas management system comprised of two gas vent trenches approximately 18-inch deep by 24-inch wide trench, cut through the foundation layer and into the daily-cover material for the approximate full length of the cell will be installed. The trench is filled with pea stone to collect any gas generated. A vent pipe fabricated from 4-inch SDR-11 HDPE pipe is installed at the highest elevation of the trench. The bottom of the vent pipe is embedded in the pea stone, and the pipe extends upward through the other cap layers to a minimum of two (2) feet above the top of cap elevation. A HDPE water stop is welded to the vent pipe exterior and embedded in the cover soil layer to prohibit storm water infiltration. The geomembrane is also welded to the vent pipe for this reason.

The final cover is designed to minimize surface water infiltration (thus minimizing leachate generation), support vegetation, and minimize the effects of changes in climate and to provide an aesthetically acceptable final surface. The selected final cover system consists of a low permeability layer and final protective layer. The permitted final cover system configuration for Cells 20 – 22 consists of the following components, from top to bottom:

- 6-inch Topsoil Layer
- 18-inch Protective Soil Layer
- Single bonded (2% slopes) or double bonded (side slopes) Geocomposite Drainage Layer
- 40 mil LLDPE Geomembrane
- 2 layers GCL

- 12-inch Foundation Soil Layer

The 12-inch Foundation Soil Layer will be constructed out of the existing Intermediate Cover soil that was installed in December 2015. This soil layer will require that approximately 3-inches or more Intermediate Cover soil be removed to build to the lines and grades shown on the drawings. Since the Intermediate Cover soil was installed at approximately 82% compaction, based on Modified Proctor (ASTM D-1598), the soil will require compaction to meet the project specifications. If upon removal of the upper 3-inches of Intermediate Cover soil the materials are excessively wet or unstable then the soils will be scarified, dried and compacted, or removed and replaced with soil materials that meet the project specifications.

Each of the final cover system components will be installed as required by the facility's Construction Quality Assurance (CQA) Plan, included as a separate Attachment to this Report. A complete discussion of final cover for the entire facility is included in the Closure and Post-Closure Care Plans, Attachment 6 of the Hazardous Waste Management Facility Operating License issued September 25, 2015.

2.1 Final Cover Stability

A stability analysis was performed to demonstrate the stability of the proposed final cover system pursuant to Rule 299.9505(d)(iii), which states the slope stability analysis must calculate final cover stability and long-term post closure stability. The analysis is performed by use of force equilibrium to balance the driving forces due to gravity pulling on the cover soils and the resistance to sliding due to friction between the underlying subsurface and cover material as presented by Koerner and Soong (Koerner and Soong, 2005). The analysis is provided in Appendix C of this report and presents calculations of the factor of safety against sliding for all critical interfaces under various conditions. The critical interfaces analyzed include the following:

- Protective Soil Layer/Geocomposite Drainage Layer
- Geocomposite Drainage Layer/Textured LLDPE Geomembrane
- Textured LLDPE Geomembrane/GCL
- GCL/GCL
- GCL/Foundation Soil Layer

The analyses indicate that acceptable factors of safety against sliding are present for all conditions based on the laboratory results of the peak interface shear strength for the materials being proposed. Additionally, the critical interface between the Protective Soil Layer/Geocomposite Drainage Layer, which demonstrated the lowest peak interface shear strength result, was analyzed simulating an outside force acting on the cap which causes post-peak strength to be mobilized. In this case an acceptable factor of safety against sliding is present under residual/large displacement condition. Based on the results of the analyses, the proposed final cover configuration was determined to be stable using the materials proposed in the project specifications for all conditions evaluated.

2.2 EQUIVALENT ENVIRONMENTAL PROTECTION

Dow is proposing an alternative final cover design as allowed under Rule R299.9619(7) of Part 111. Rule R299.9619(6)(a)(i) requires a minimum of 90 centimeters (approximately 3 feet) of compacted clay soil with a permeability less than $1x10^{-7}$ cm/sec. Dow previously requested, and was granted conditional approval for, an alternative final cover design which included a single layer of GCL overlying 12-inches of compacted clay liner (CCL). This proposed design incorporates two (2) layers of GCL in lieu of the 90 centimeter layer of CCL. The proposed final cover design is as follows from top to bottom:

- 6-inch Topsoil Layer
- 18-inch Protective Soil Layer
- Single bonded (2% slopes) or double bonded (side slopes) Geocomposite Drainage Layer
- 40 mil LLDPE Geomembrane
- 2 layers GCL
- 12-inch Foundation Soil Layer

In order to satisfy the design requirements specified in Rule R299.9619(6)(a)(i) Dow must demonstrate that the proposed final cover system is at least as protective against leakage through the final cover as 90 centimeters of CCL with a permeability less than $1x10^{-7}$ cm/sec. Additionally, the horizontal hydraulic conductivity of the overlapping seams of adjacent GCL panels must be measured and compared against the vertical hydraulic conductivity of the GCL panel itself. These results are provided in Appendix D of this Report.

The equivalent environmental protection analysis was performed by first measuring the horizontal seam permeability and vertical permeability of representative samples of GCL proposed for the final cover. The results of these tests indicated a horizontal seam permeability of $6.02x10^{-10}$ cm/sec and a vertical permeability of $3.41x10^{-10}$ cm/sec. Both of these results exceeded the vertical permeability value published by the manufacturer of the GCL materials used in this analysis which was $5.0x10^{-9}$ cm/sec. For the purposes of completing the equivalent environmental protection demonstration the more conservative, published value, of the GCL permeability was utilized.

The leakage rate through the final cover was then estimated under different head conditions for both the CCL and the two layers of GCL using an equation developed by J.P. Giroud (Giroud, 1997). The first condition assumed that the head on the composite liner system was contained within the thickness of the overlying geocomposite drainage layer. The second condition assumed that the head had built up to 1 foot over the composite liner system. Once the leakage rates were calculated a comparison was made to determine if the two layers of GCL were at least as protective as the 90 centimeters of CCL. Under the first condition the two layers of GCL were seven (7) times more protective than 90 centimeters of CCL. Under the second condition the two layers of GCL were more than three (3) times more protective than 90 centimeters of CCL. Therefore, the two layers of GCL are substantially more protective against leakage through the final cover system than the thickness of 90 centimeters of CCL as prescribed under Rule R299.9619(6)(a)(i) of Part 111. The results of the equivalent environmental protection analyses are provided in Appendix D of this Report.

2.3 Soil Erosion and Sedimentation Control

Permanent diversion berms along the east, west and south side slopes of Cells 20 – 22 will be installed upon placement of the final cover system as a means of controlling and diverting storm water runoff from the landfill. In addition, each site area will be seeded upon the completion of final cover placement in accordance with the plans and specifications. Straw mulch blankets will be placed to protect the seed against erosive velocities, allowing the grass seed sufficient time to germinate. A soil loss demonstration for the erosion layer is described below.

According to Part 111, R299.9619(6)(b), the proposed landfill final cover design must limit erosion to less than 2 tons/acre-year of soil erosion based on the Universal Soil Loss Equation. For the purposes of the evaluation, the Revised Universal Soil Loss Equation (RUSLE) was utilized. The calculation is provided in Appendix E. Results of these calculations are summarized in Table 1 below:

Table 1 - Final Cover Soil Loss

Soil Loss (tons/acre-year)	R factor	C factor	K factor	Slope Length (ft)	Slope (%)	Slope Factor	LS Factor
0.91	90	0.014	0.2	91	25	2.95	3.61

Based on the analyses soil loss is estimated to be less than 2 tons/acre-year as required in Part 111. Therefore, no additional diversion berms are necessary to reduce slope length and erosion.

During site development, Best Management Practices (BMPs) will be employed to control erosion. BMPs may include the use of temporary rock rip rap, silt fences, straw bales, check dams, interceptor swales and berms, temporary and permanent seeding and sodding, surface roughening, matting and mulching, sediment traps, and surface wetting for dust control.

2.4 Final Cover Drainage Layer

The final cover drainage layer consists of a single bonded geocomposite drainage material (GDM) on the 2% slopes and a double bonded GDM on the steeper side slopes. As discussed in Section 2.1 of this report, the critical interface of the final cover stability analysis was between the protective soil layer and GDM on the steeper side slopes. The primary destabilization mechanism is the excessive head buildup in the drainage layer. In order to ensure that the steeper side slopes do not encounter the condition where the final cover system destabilizes due to excessive head build up in the drainage layer, the flow through the GDM must be separated between the upstream, 2% slope flow, and the steeper side slope flow. Additionally, the flow through the GDM on the steeper side slope must be conveyed within the thickness of the GDM.

In order to separate the flow along the upstream 2% slope from the downstream steeper side slope a drainage layer collection tile will be installed at the downstream reach of the 2% slope and diverted via pipe to the perimeter ditch on the north end as shown on the plans. This design element effectively separates the flow from the upstream 2% slope from the downstream steeper side slope.

To determine the long term capacity of the GDM along the steeper side slopes an analysis was performed using the Single Slope Giroud Equation (Giroud, Zornberg, and Beech, 2000). The Single Slope Giroud Equation determines the maximum thickness of head on an impermeable liner system using the anticipated infiltration rate through the final cover and is adjusted for long-term effects through a series of reduction factors. Based on the analysis a GDM with a laboratory transmissivity rate equal to, or greater than, $9.2x10^{-4}$ m^2/sec can convey the anticipated infiltration rate within the thickness of the GDM. Calculations pertaining to this design are provided in Appendix F.

Based on the proposed design the flow through the drainage layer can be effectively managed using a single bonded GDM on the 2% slope and a double bonded GDM on the steeper side slope provided that a drainage layer collection tile be installed at the downstream reach of the 2% slope and the GDM has a minimum laboratory transmissivity of $9.2x10^{-4}$ m^2/sec.

3. HYDRAULIC AND HYDROLOGIC (H&H) ENGINEERING

H&H modeling was conducted to ensure the safe routing of storm water during a 100-year flood event on this site. Final proposed grading was designed to prevent storm water from overtopping the asphalt and gravel roadways to the north and south of cells 20-22.

3.1 HYDROLOGIC ANALYSIS

Hydrologic analysis began with the delineation of watershed boundaries. These boundaries were drawn based upon proposed grading and topographic data for the existing site. Watershed boundaries are shown in red in Figure 2. The site is generally split with diversion berms collecting flow from the fill slopes of the cap and conveying runoff to either the north (D2) or south roadside ditch (D1). These ditches are drained by culverts to the southeast (CV1) and the north (CV3) and ultimately drain to outfalls 001D and 001B. A full site storm water plan can be found in Appendix G.

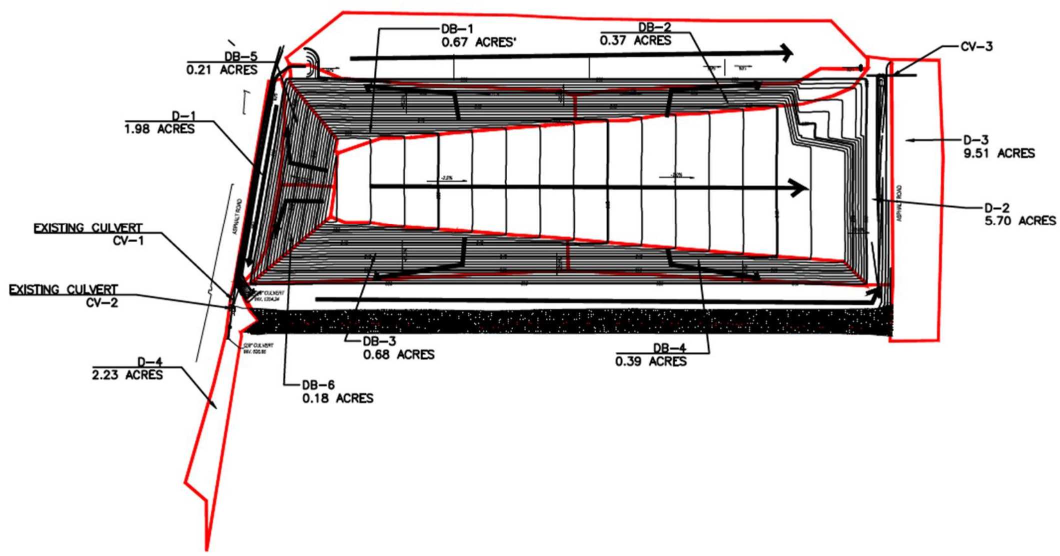

Figure 2 Watershed delineations for cells 20-22 and surrounding areas.

Peak runoff flows from each of the drainage areas was calculated using the rational method formula. The rational method is a simplistic and conservative method for estimating peak flows using the equation:

$$Q = CIA$$

where,

Q= flow (cfs)
C= runoff coefficient (unitless)

I= rainfall intensity (inches/hour)
A= total drainage area (acres)

A weighted runoff coefficient was calculated for each drainage area based on the following uses and their corresponding runoff coefficients:

Table 1 Runoff coefficients from MDOT Drainage Manual, Chapter 3.

Surface Type	Coefficient
Impervious	0.90
Steep Slope	0.50
Shallow Slope	0.30
Gravel Roadway	0.70

The coefficients used were found in the Michigan Department of Transportation (MDOT) Drainage Manual, Chapter 3 on Hydrology.

To determine rainfall intensity, the site zone was determined based on site location. The site is in Midland, MI which places it in zone 6. Furthermore, a minimum time of concentration of 15 minutes was chosen, which is consistent with industry standards. Using this information, the rainfall intensities for the 10, 50 and 100-year storm events were obtained from the Rainfall Intensity Final Report compiled by MDOT, producing the following values: $I_{10=}$ 3.44 inches/ hour, $I_{50=}$ 4.38 inches/ hour, $I_{100=}$ 4.76 inches/ hour.

Resulting peak flows are shown in the tables below for the 10, 50 and 100 year storm events. For detailed calculations, see Appendix G.

Table 2 Q10, Q50, and Q100 for all diversion berms.

Flow	DB-1	DB-2	DB-3	DB-4	DB-5	DB-6
Q_{10} (cfs)	1.15	0.64	1.17	0.67	0.37	0.31
Q_{50} (cfs)	1.47	0.82	1.49	0.85	0.47	0.40
Q_{100} (cfs)	1.59	0.89	1.62	0.92	0.51	0.43

Table 3 Q10, Q50, and Q100 for roadside ditches.

Flow	D-1	D-2	D-3	D-4
Q_{10} (cfs)	3.25	11.53	15.69	3.57
Q_{50} (cfs)	4.14	14.68	19.98	4.55
Q_{100} (cfs)	4.50	15.95	21.71	4.94

3.2 Ditch Capacity Analysis

To ensure that the peak flows from the site are safely conveyed to the two primary outfalls, hydraulic analyses were performed for the ditches. Ditch capacity calculations were completed using the Manning's equation:

$$Q = VA = \left(\frac{1.49}{n}\right) * A * R^{\frac{2}{3}} * S^{\frac{1}{2}}$$

where,

Q=flow, cfs
V= velocity, ft/s
A= cross sectional area, ft^2
1.49=unit conversion factor, unitless
n= Manning's Roughness coefficient
R=Hydraulic Radius, ft
S= Channel slope, ft/ft

The manning's n value was determined to be 0.027 for the diversion ditches and 0.040 for the roadside ditches. 0.027 represents the value for excavated or dredged channels with short grass and few weeds and 0.040 represents the value for excavated or dredged channels with cobble bottom and clean sides. These values were selected based on field observations of existing ditches on site. Ditch geometry and slopes are based on design grades and existing topography. Calculated velocity, depth of flow and freeboard values are provided in the tables below. For detailed calculations, see Appendix G.

Table 4 Calculated velocities and flows based on the Manning's equation for diversion berms.

Variable	DB-1	DB-2	DB—3	DB-4	DB-5	DB-6
V (ft/s)	2.15	1.88	2.17	1.88	1.61	1.55
Depth of Flow (ft)	0.54	0.44	0.55	0.44	0.35	0.33
Freeboard (ft)	2.46	2.56	2.46	2.56	2.65	2.67
Q (cfs)	1.57	0.91	1.61	0.91	0.49	0.42
Q capacity (cfs)	152.00	152.00	152.00	152.00	152.00	152.00

Table 5 Calculated velocities and flows based on the Manning's equation for roadside ditches.

Variable	D-1	D-2	D-3	D-4
V (ft/s)	1.69	2.33	2.51	1.73
Depth of Flow (ft)	1.15	2.72	2.08	1.19

Freeboard (ft)	1.85	0.28	0.92	1.81
Q (cfs)	4.47	15.95	21.71	4.90
Q capacity (cfs)	57.67	57.67	57.67	57.67

3.3 CULVERT ANALYSIS

Culvert analysis was conducted in HY-8, a culvert hydraulic analysis program provided by the Federal Highway Administration. Three sets of culverts were evaluated as part of this analysis; CV-1 which is comprised of two parallel eight inch pipes, DS-outlet which is the 24 inch culvert downstream of CV-1, and CV-3 which is proposed dual 18 inch concrete pipes. The parameters for each of these crossings include design flows, tail water conditions, pipe size, material, inverts, and lengths. This information is reported in further detail in Appendix G.

The following table reports the findings of the culvert analysis. All of the design flows were found to be contained within the site. However, minimal freeboard is available for the 100-year flows. Berms were required for the north and south ditches to meet the head requirements for passing peak flows through the culverts.

Table 6 Culvert descriptions and results from HY8.

	CV-1	CV-2	CV-3
Culvert Location	South end of site	South end of site	North of site
Description	8” PVC Pipe	8” PVC Pipe	2, 18” Concrete Pipes
100-year flow	4.49 cfs	4.49 cfs	14.34 cfs
Headwater Depth	630.99	630.99	627.27
Freeboard	0.01’	0.01’	0.73’

3.4 SHEAR STRESS ANALYSIS

Shear stress analyses were completed by using equations provided in Hydraulic Engineering Circular No. 15, Third Edition: Design of Roadside Channels with Flexible Linings (HEC-15), a MDOT publication.

Firstly, the applied shear stress was found for each ditch using equation 2.3 from HEC-15:

$$\tau_o = \gamma R S_o \qquad (2.3)$$

where,

τ_o = mean boundary shear stress, N/m^2 (lb/ft^2)
γ = unit weight of water, 9810 N/m^3 (62.4 lb/ft^3)
R = hydraulic radius, m (ft)
S_o = average bottom slope (equal to energy slope for uniform flow), m/m (ft/ft)

Figure 3 Equation 2.3 from HEC-15.

The hydraulic radius value used in equation 2.3 corresponds to the depth of channel flow calculated for the 100-year flow, listed above. The mean boundary shear stresses found are listed in the table below. For detailed calculations, see Appendix G.

Table 7 Mean boundary shear stress values for diversion berms.

	DB-1	DB-2	DB-3	DB-4	DB-5	DB-6
τ_0 (lb/ft^2)	0.15	.012	0.15	0.12	0.10	0.09

Table 8 Mean boundary shear stress values for roadside ditches.

	D-1	D-2	D-3	D-4
τ_0 (lb/ft^2)	0.16	.025	0.29	0.17

The permissible shear stress for non-cohesive soils was then determined. According to HEC-15, for fine-grained, non-cohesive soils that are less than 0.05 inches in diameter, the permissible soil shear stress is relatively consistent and conservatively estimated at 0.02 lb/ft^2. Since our soil is assumed to be a mixture of coarse silt and very fine sand, this value is appropriate for the permissible soil shear stress.

The permissible shear stress on the vegetative lining was then determined using equation 4.7 in HEC-15:

$$\tau_p = \frac{\tau_{p,soil}}{(1 - C_f)}\left(\frac{n}{n_s}\right)^2 \quad (4.7)$$

where,

τ_p = permissible shear stress on the vegetative lining, N/m² (lb/ft²)
$\tau_{p,soil}$ = permissible soil shear stress, N/m² (lb/ft²)
C_f = grass cover factor
n_s = soil grain roughness
n = overall lining roughness

Figure 4 Equation 4.7 from HEC-15.

The permissible soil shear stress was taken to be 0.02 lb/ft^2 for each ditch. The overall lining roughness is equivalent to the Manning's n coefficient which was 0.027 for diversion ditches, and 0.040 for roadside ditches. The soil grain roughness value was input at 0.016 which is appropriate when the soils are less than 0.05 inches. The grass cover factor was determined to be 0.90 based on a good growth form for uniform stands of grass. Calculated values for the permissible shear stress on the vegetative lining are summarized in the following table. For detailed calculations, see Appendix G.

Table 9 Permissible shear stresses on vegetative lining values+ for diversion ditches.

	DB-1	DB-2	DB-3	DB-4	DB-5	DB-6
τ_p (lb/ft^2)	0.57	0.57	0.57	0.57	0.57	0.57

Table 10 Permissible shear stress on vegetative lining values for roadside ditches.

	D-1	D-2	D-3	D-4
τ_p (lb/ft^2)	1.25	1.25	1.25	1.25

Values for the calculated applied shear stress are then compared to both the permissible shear stress for soils and vegetation. For all diversion ditches, the applied shear stress values are higher than the permissible shear stress for soils, but lower than the permissible shear stress for vegetation. It is therefore recommended that a temporary lining be installed in all diversion ditches. Similarly, for all roadside ditches, the applied shear stress values are higher than the permissible shear stress for soils, but lower than the permissible shear stress for vegetation. It is recommended that a temporary lining be installed in all roadside ditches.

The recommended temporary lining is the C-125 manufactured by North American Green. This product is recommended for landfill caps, slopes of 1:1 and greater, a permissible shear stress of 2.25 lb/ft^2 or less, and a max flow velocity of 10 ft/s or less all of which fulfill requirements for our site.

Appendix B

Construction Quality Assurance Plan

CONSTRUCTION QUALITY ASSURANCE PLAN

Final Cover for Cells 20 through 22

SALZBURG LANDFILL

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN

1. Introduction

In accordance with Michigan Public Act 241, Part 111, R 299.9505(2), this document describes the quality assurance steps that will be implemented during the construction of the Final Cover of Cells 20 through 22 at the Salzburg Hazardous Waste Landfill (SLF). This plan describes the organizational responsibilities, personnel involved, project communication meetings and the general requirements for inspection, sampling and documentation for the various components of the cell construction.

The specific testing protocols and sampling frequency to be used for each closure component are not included in this document. The testing and sampling requirements are an integral part of the final cover construction and, therefore, are included in the project specifications for each closure component. The construction contractors must know exactly what testing and sampling will be required for the project since their personnel and equipment will be involved in obtaining samples and/or scheduling work around the sampling and testing process. Therefore, detailing the testing and sampling requirements in the project specifications is the appropriate location for this information.

2. QA/QC Program

Although they are related, there is a significant difference between Quality Assurance and Quality Control. These elements are often confused and interchanged because they are interdependent. Quality Assurance (QA) relies on the Quality Control (QC) feedback and both work to deliver good quality products and services. Although this plan is focused on construction quality assurance, it necessarily also contains items associated with quality control.

2.1. Quality Assurance

Quality Assurance starts at the beginning of the project during preparation of the engineering plans and specifications. At this stage, the CQA Plan outlines means and actions to be employed by the Owner through the CQA team to evaluate and measure conformity with the design, production (manufacture and fabrication), and installation of equipment and materials in accordance with this CQA Plan as well as with the plans and specifications.

2.2. Quality Control

Quality Control includes actions taken by all parties including the designer, manufacturer, fabricator, and/or Contractor, to ensure that their methods, materials, and workmanship are accurate and correct and meet the project requirements, in accordance with the approved plans and specifications. QC is provided by each party for its own work, product, or service.

3. Roles and Responsibilities

3.1. Owner and Operator

The plant and its ancillary functions are owned and operated by The Dow Chemical Company (Owner). The Owner will be responsible for overall management of construction activities including contracting and administration. The Owner will designate an on-site representative to serve as Construction Manager (CM).

3.2. Construction Manager

The role of the Construction Manager (CM) is solely dependent on the needs and preferences of the Owner. Comprehensive construction managers provide a wide range of services and can be involved in both the design and construction phases of a project. In general, a Construction Manager provides leadership to the construction team, and coordinates between the Owner, CQA Consultant, and Contractor to plan and oversee the completion of a project. Responsibilities of the Construction Manager may include managing the budget, construction progress, schedule, and settling any disagreements between the Resident Engineer and the Contractor on issues that arise during CQA activities.

3.3. Contractor

The Contractor for this project will be selected by the Owner. The Contractor is responsible for construction activities associated with this project including meeting all of the requirements for project quality as defined in the construction plans and specifications for his/her work as well as that of his/her Subcontractors.

3.4. CQA Consultant

The CQA Consultant is responsible for making observations and performing field tests to provide written documentation that a facility is constructed in accordance with the applicable plans, specifications, and CQA Plan. The CQA Consultant may contract with third party testing firms to conduct on-site and laboratory testing, as necessary. The CQA Consultant is responsible for preparing the Construction Certification Report and record drawings for the project unless otherwise directed by the Construction Manager. The following section provides a description of the typical CQA Consultant team, including each member's roles and responsibilities.

3.5. Certifying Engineer

The CQA Certifying Engineer is responsible for certifying to the Owner and the permitting agency that the facility has been constructed in accordance with the applicable plans, specifications, and CQA Plan. The Certifying Engineer serves as the Professional Engineer for the project and properly certifies the as-built construction record document. Certifications will bear the seal of a Professional Engineer registered in the state in which the work is being performed. The Certifying Engineer may also function as the Project Engineer.

3.6. Project Engineer

The CQA Project Engineer is responsible for providing engineering and technical support to the field CQA team throughout the construction process. The Project Engineer works closely with the Construction Manager to assist with calculations and complete take-offs in support of as-built quantities for payment. The Project Engineer also reviews submittals and Requests For Information (RFI) from the Contractor, reviews and maintains QA/QC data, and coordinates all supplementary laboratory testing of geosynthetics and soils. The Project Engineer will provide the following on-site QA personnel as needed and as directed by the Construction Manager:

- Resident Engineer
- CQA Inspector
- Third-party CQA testing firm
- Project Surveyor

3.7. Resident Engineer

The Resident Engineer (RE) will monitor work to evaluate conformance with the construction plans and specifications. Specific duties include the following:

- Coordinate submittal reviews with the Project Engineer for compliance with contract documents.
- Coordinate between the Construction Manager, Contractor and Project Engineer to resolve design issues.
- Coordinate responses to RFIs and other technical issues with the Project Engineer.
- Monitor construction progress and review Contractor's Construction Quality Control (CQC) and as-built documentation on a daily basis.
- Represent the Project Engineer at on-site meetings.
- Plan, schedule and provide oversight of QA/QC testing and surveying Subcontractors.
- Document construction progress and QA/QC activities with daily reports and photographs.
- Notify the Dow Construction Manager and Project Engineer of any deficiencies or non-conformance observed.

The Resident Engineer will distribute copies of test reports and other QA/QC documentation as directed by the Construction Manager. In absence of the Resident Engineer, the Project Engineer will be responsible for these tasks.

3.8. CQA Inspector

The CQA Inspector will observe and document construction activities for compliance with the contract documents. Specific duties of the CQA inspector include:

- Observe and document all construction related activities.
- Observe and document geosynthetic installation activities.
- Coordinate testing with CQA Subcontractor
- Monitor delivery, handling and on-site storage of construction materials.
- Evaluate conformance of all borrow source materials.
- Observe material placement and testing.
- Observe the installation and testing of all mechanical and electrical systems.
- Coordinate material sampling and shipping for laboratory testing.

Other duties and responsibilities of the CQA Inspector will be determined by the Resident Engineer and the Construction Manager as the work progresses.

3.9. Subconsultant

The CQA Consultant will subcontract with a construction materials testing and inspection firm for field and laboratory testing as needed. The CQA Subcontractor will provide technicians for testing and observance including:

- Specialty geotechnical services

Laboratory testing may include:

- Soil testing
- Concrete testing
- Geosynthetic testing

3.10. Stop Work Authority

The CQA Consultant will advise the Construction Manager that the Contractor should stop work in situations of recognizable stability issues, deviations from design and significant cost or schedule impacts. The Construction Manager will obtain approval from the Owner or his representative prior to stopping the Contractor's work. In situations where personnel safety is concerned, the CQA Consultant will advise the Contractor to stop work and notify the Construction Manager and the Owner or his representative as soon as possible of that action.

4. Project Meetings

To achieve a high degree of quality during installation, clear, open channels of communication are essential. The following meetings should be held when appropriate.

4.1. Pre-Construction Meetings

Following the completion of the contract documents and selection of a CQA Consultant for the project, a Pre-Construction Meeting may be held. At a minimum, the meeting should be attended by the Project Manager, the CQA Consultant's Certifying Engineer, the CQA Consultant's Resident Engineer, the Geosynthetics Installer's Superintendent, the Earthwork Contractor's Superintendent, the Design Engineer, the Permitting Agency and other involved parties. Two Pre-Construction Meetings may be held, one prior to earthwork construction and one prior to geosynthetic placement.

4.2. Daily Meetings

A daily meeting will be held, as necessary, between the CQA Consultant, the Geosynthetic Installer, the Contractor, the Construction Manager, and other involved parties. Those attending will discuss, plan, and coordinate the work and CQA activities to be completed that day.

4.3. Progress Meetings

Progress meetings will be held weekly, or as determined to be necessary by the CQA Consultant and Construction Manager. Attendees should include the Construction Manager, the CQA Consultant, the Geosynthetic Installer, the Contractor, and other involved parties. Those attending will discuss current progress, planned activities for the next week, submittals, and new business or revisions to the work. The CQA Consultant will log problems, decisions, or questions arising at this meeting.

4.4. Problem or Work Deficiency Meeting

A special meeting may be held when and if a problem or deficiency, which would impact the construction schedule or other project requirements, is present or likely to occur. At a minimum, the meeting should be attended by the affected Contractors, the Project Manager, and the CQA Consultant. The purpose of the meeting is to define and resolve the problem or work deficiency.

4.5. Safety Meetings

The Contractor will hold safety meetings in accordance with the Contractor’s Site Health and Safety Plan. The Contractor’s Site Health and Safety Plan must be submitted to the Owner for approval prior to commencing construction activities. Meetings will be held at the start of construction and then periodically as conditions change or as determined by the Construction Manager.

4.6. Geosynthetics Pre-Construction Meeting

A meeting will be held at the project site prior to the installation of any geosynthetics components of the composite liner or final cover system. The Geosynthetics Pre-Construction Meeting will be attended by the Contractor, Geosynthetics Installer, the Resident Engineer or other representative of the Project Engineer, the Construction Manager and any other Owner representatives as determined by the Owner. These meetings will be held to discuss submittals, materials, installation procedures, and project coordination.

5. Documentation

An effective CQA plan depends largely on recognition of construction activities that should be monitored, and assigning monitoring responsibilities. This is most effectively accomplished and verified through quality assurance activities. The CQA Consultant will document that quality assurance requirements have been addressed and satisfied.

The CQA Consultant will prepare and provide to the Construction Manager periodic signed reports which summarize construction activities and the results of observations and tests including descriptive remarks, data sheets, and logs to verify that all quality assurance monitoring activities have been carried out.

5.1. Reports

Progress reports will be prepared at regular time intervals to document the status of the work by the CQA Consultant. Certifications will be prepared at the completion of major construction activities. At the completion of the work, final documentation will be prepared and will include a professional engineer's seal along with supporting field and laboratory test results.

5.2. Daily Summary Report

Standard reporting procedures must include preparation of a daily report which, at a minimum, will consist of:

- An identifying sheet number for cross referencing and document control
- Date, project name/number, location, and other identification
- A summary report including memoranda of meetings and/or relevant discussions with the Owner, Construction Manager, and/or site contractors, observation logs, test data sheets, decisions reached, activities planned and their schedule
- Other forms of daily recordkeeping to be used as appropriate including construction problem and solution data sheets and photographic reporting data sheets

The daily summary report will also include the following information as needed:

- Weather conditions
- A reduced-scale site plan showing all proposed work areas and test locations
- Descriptions and locations of ongoing construction
- Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented
- Locations where tests and samples were taken or reference to specific observation logs and/or test data sheets where such information can be found
- A summary of field/laboratory test results or reference to specific observation logs and/or test data sheets
- Calibrations or recalibration of test equipment and actions taken as a result of recalibration, or reference to specific observation logs and/or test data sheets
- Off-site materials received, including quality verification documentation
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality
- The CQA Consultant's signature

This information must be regularly submitted to and reviewed by the Construction Manager.

5.3. Observation Logs and Test Data Sheets

Observations of construction and QA-related activities will be recorded on project-specific logs and data sheets by the CQA Consultant. At a minimum, the logs and data sheets will include the following information:

- An identifying sheet numbered for cross referencing and document control
- Date, project name, location, and other identification; Description or title of activity monitored
- Location of activity and locations of samples collected
- Locations of field tests performed and their results
- Results of laboratory tests received
- Results of monitoring activity in comparison to specifications
- The CQA monitor's signature

This information will be submitted with the Daily Summary Report during construction projects.

5.4. Construction Certification Report

At the completion of the work, a signed Construction Certification Report will be prepared by the CQA Consultant prepared in accordance with the project requirements.

The Construction Certification Report will be prepared and signed and sealed by a professional engineer skilled in the appropriate discipline(s) and registered in the state in which the work was performed.

At a minimum, the Construction Certification Report will include:

1. A narrative section that identifies the engineered components that were constructed that includes the following:
   - A summary of the design and construction specifications and a comparison with the components that were constructed during the construction event
   - A summary of how construction was impacted by weather and equipment limitations and other difficulties encountered
2. All alterations and other changes that relate to the installation of any of the components to be certified and presented as follows:
   - A listing of all applicable alteration requests/changes that were previously concurred with
   - All alteration requests/changes and supporting documentation which are proposed for concurrence
   - A list of any other changes made by the owner or operator which do not require regulatory concurrence but which affect construction or the record drawings

The alteration request will be equivalent or more protective than the applicable regulation or authorizing document.

3. Results of all tests and QA/QC data including manufacturers' certifications in accordance with the project specifications.
4. Results of all surveys in accordance with the project specifications. Unless otherwise specified, the survey data will be reported in a table(s) displaying the northing and easting for each designated survey point established to be no more than one hundred feet apart based on the grid system coincident with the design drawings. Additional points will be established at grade breaks and other critical locations.
5. Record drawings of the constructed facility components showing the following:
   - The location of all survey control points.

- Plan views with topographic representation of all engineered components depicted along with critical elevations such as pipe inverts, sump elevations, ditch flow lines, tops and toes of berms, locations of repairs, etc.
- The location and as-built detail drawings of all components to be certified.
- If the Certification Report is submitted for the composite final cover system, cross sections showing the top elevations of the existing waste, top elevation of the composite cap system, and the elevations of the surface water management system components (where applicable). The cross sections will be taken at the same locations and using the same scale as in the approved permit to install. Otherwise, the cross sections will be taken at an interval no greater than every three hundred feet of length and width.

6. Qualifications of testing personnel that provided construction oversight and conducted all the testing on the engineered components for which the Certification Report is submitted including a description of the experience, training, responsibilities in decision making, and other relevant qualifications.
7. A notarized statement that, to the best of the knowledge of the owner or operator, the Certification Report is true, accurate, and contains all information required by this rule and by the CQA plan.

5.5. Progress Reports

Progress reports at time intervals established at the Pre-Construction Meeting will be completed and submitted to the Construction Manager and Owner by the CQA Consultant. At 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 progress reporting period
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period
- The signature of the CQA Consultant's representative

Copies of progress reports will be distributed as decided at the Progress Meetings and as determined necessary by the Construction Manager.

5.6. Photographic Log

Photographic logs will be used to assist in documenting general construction progress and other specific items of work. The photographic log will include a brief summary description of the picture, the orientation and perspective from which the picture was taken, the date the picture was taken and the identity of the person who took the picture. The photographic log will be used in conjunction with the Daily Summary Report and will be included with the Construction Certification Report.

5.7. Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Consultant will notify the Construction Manager and Project Engineer. The Construction Manager will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications to the Owner. These changes will be submitted to the Project Engineer for approval and if necessary, the Permitting Agency.

When this type of evaluation is made, the results will be documented with a description of the changes by the CQA Consultant and cross-referenced to specific observation logs and test data sheets.

These reports must include the following information:

- 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 identified or located
- Documentation of the corrective action taken to address the situation or deficiency
- Any measures taken to prevent a similar situation from occurring in the future
- The signature of the CQA Consultant, Construction Manager, and Certifying Engineer indicating concurrence

Design and/or specifications changes will be made only with the written agreement of the Owner and the Project Engineer, and will take the form of an addendum to the specifications.

6. Documentation Management

The Contractor and Resident Engineer will submit project documentation to the CQA Consultant on a weekly basis or an alternate frequency established by the project requirements.

Complete project CQA documentation must be collected and maintained on-site by the CQA Consultant in a safe repository. This includes (but is not limited to):

- A complete set of construction drawings and specifications
- The CQA Plan

- Project checklists, test procedures, and standards
- Project test procedures, daily logs, pertinent regulatory documents, and other necessary documents.

6.1. Storage of Records and Records Retention

All data sheet originals related to the CQA and Certification process, test results, daily logs, memorandums, etc., will be stored by the CQA Consultant in a safe repository on-site during the construction project.

Upon completion of the construction project, records will either be retained at the facility or alternately stored at the CQA Consultants or Certifying Engineer's office and be readily accessible by the facility if requested. Records will be maintained for a minimum period of three years from the project completion.

7. Failed Test Procedures and Alterations

A "failed test" occurs when a test performed on an engineered component yields a result that does not meet the specifications outlined in the applicable plans or specifications. Testing performed on an engineered component which does not meet the specifications is not considered a failed test if the engineered component is undergoing construction or installation at the time of testing and the testing is performed for the purpose of gauging the effectiveness or completeness of construction.

An “alteration” or “field change” is a change in construction materials, specifications, or CQA procedures from the project requirements that is necessary to perform the work or meet project requirements.

7.1. Failed Test Prior To Certification Report Submittal

If, prior to submission of the Construction Certification Report for the engineered component, the CQA Consultant determines that there is a "failed test," the CQA Consultant will perform all the following:

- Retest or otherwise assess the engineered component or portion of the facility to determine if construction is in compliance with the construction plans and specifications or other project requirements and include the final results in the Certification Report.
- Implement measures to attain compliance with the construction plans and specifications or other project requirements. An area with a verified failure must be reconstructed. Reconstructed areas must be retested at a frequency acceptable to the CQA Consultant and at a frequency and location(s) sufficient to demonstrate that compliance has been achieved.

7.2. Alteration Prior to Submittal of Certification Report

If, prior to submission of the Construction Certification Report the CQA Consultant and/or Construction Manager determines that an alteration or field change is necessary to the plans or specifications, the CQA Consultant will do all of the following:

- Include the applicable testing results and an assessment and justification for the necessary change(s) in an appropriate section of the Certification Report where the change is clearly identified.
- Provide a demonstration in the Certification Report that the change(s) are at least equivalent to the project requirements, the construction plans and specifications, and are at least as protective to human health and the environment.
- Submit the Certification Report as required by the Construction Manager.

7.3. Detection of the Change after Submittal of the Certification Report

If, after submission of the Construction Certification Report the CQA Consultant and/or Construction Manager determines that the Certification Report is in error due to improper documentation of an alteration or field change of the plans or specifications, the CQA Consultant will do all of the following:

- Notify the Owner and/or Construction Manager as determined by the Certifying Engineer of the change within twenty-four hours after discovery, by phone and within seven days after discovery in writing.
- Within fourteen days of submitting the written notification required above, do either of the following:
    a. Implement the failed test procedures outlined above (Section 7.1) and amend and resubmit the Construction Certification Report to explain the circumstances and how compliance was achieved.
    b. Submit the Alteration information outlined above (Section 7.2).

8. Surveying

Surveying of lines and grades will be conducted on an ongoing basis during construction of soil layers, geosynthetics placement, and other engineered components. Surveying will be performed to provide documentation for record plans, verifying quantities, and assist the Contractor in complying with the required grades. Surveying conducted at the site must be part of the CQA program. The purpose of the survey is to verify that actual thickness and grades of the construction components are in accordance with the plans and specifications. Surveying of lines and grades will be conducted during construction of the soil layers. Review of the surveys conducted at the site will be part of the CQA program. The permanent benchmarks at the facility will be used for survey control. Surveying will be performed under the supervision of a qualified, professional Land Surveyor licensed in Michigan.

Based on the control points provided by the Owner, the Contractor is to provide all temporary and permanent benchmarks, monuments, and increments needed to control work. If during the work, control points set by the Owner are disturbed by the Contractor, the Contractor will replace the control points.

8.1. Survey Control

The permanent benchmarks at the facility will be used for survey control. One or more temporary benchmarks will be established for the site at a location convenient for daily tie-in. Temporary benchmarks are to be considered as accurate as third order benchmarks. The vertical and horizontal controls for this benchmark will be established within normal land surveying standards.

All benchmarks established at the facility will comply with the following requirements:

- At least three permanent survey marks, with each located on separate sides of the facility, will be established prior to any construction and within easy access to the limits of waste.
- Survey marks will be referenced to the same horizontal and vertical datum used on the design plans.
- Survey marks will be at least as stable as a poured concrete monument 10-inches in diameter installed to a depth of 42-inches below the ground surface. Each constructed survey mark will include a corrosion resistant metallic disk which indicates horizontal and vertical coordinates of the survey mark and will contain a magnet or ferromagnetic rod to allow identification through magnetic detection methods.

Survey control standards for the survey marks will be in accordance with the following:

- For the first facility survey mark established from the known control point, minimum horizontal distance accuracy will be one foot horizontal to two thousand five hundred feet horizontal (1’ Horiz : 2500’ Horiz).
- For each facility survey mark established from the first facility survey mark, minimum horizontal accuracy will be one foot horizontal distance to five thousand feet horizontal (1’ Horiz : 5000’ Horiz).
- For the first facility survey mark established from the known control point and for each facility survey mark established from the first facility survey mark, minimum vertical accuracy will be one inch to five thousand feet horizontal (1” Vert : 5000’ Horiz).

8.2. Precision and Accuracy

The survey instruments used for this work will be precise and accurate to meet the needs of the project. Survey instruments will be capable of reading to a precision of 0.01 of a foot (3.1 mm) and with a setting accuracy of 10 seconds.

A vertical tolerance of for elevation and slope of - 0.1 feet and - 10%, respectively, will apply to each of the following components as they are constructed:

- Top of foundation layer
- Top of protective cover layer
- Top of topsoil layer
- Invert of pipes

Note: These tolerances are meant to assure that the required layer thickness and design intent can be met upon final certification. A Professional Surveyor registered in Michigan will certify results of the survey. Results will be included in the Certification Report provided to the Owner.

8.3. Frequency and Spacing

Surveying will be performed as soon as possible after completion of a given installation to facilitate progress and avoid delaying the next installation. In addition, spot checks during construction will be necessary to assist the Contractor in complying with the required grades.

The as-built thickness of various components of the facility (protective covers and compacted clay liners) will be determined by non-destructive methods, i.e., comparison of the survey data for the underlying materials with that of the component of interest. As-built survey data will be obtained at locations having a typical on center spacing of 100-feet maximum, at all toe, midpoint, and top of slope locations as well as grade breaks. Locations will be, to the maximum extent possible, at the same coordinates as the survey data for the underlying materials.

8.4. Lines and Grades

When required, the extent of the following components will be surveyed to determine the lines and grades achieved during construction:

- Original ground surface/Existing conditions
- Surface of excavation
- Alignment and inverts of gas vent trenches and vent piping
- Foundation layer
- Protective cover layer
- Topsoil cover layer

- Geomembrane including anchor trenches, panel layout, destruct locations, repairs, and penetrations
- Geosynthetics (other than geomembrane) including anchor trenches
- Surface water structure details including profiles, cross sections, and inverts for ditches, culverts, catch basins, swales, benches, ditches, and sedimentation basins
- Alignment and inverts of piping
- As-built line and grade of all other piping structures

8.5. Surveying Personnel

8.6. Surveying for construction certification and record documentation purposes will be performed under the supervision of a qualified, licensed Professional Land Surveyor registered in the state of Michigan. The survey crew will consist of a Senior Surveyor and as many Surveying Assistants as required to satisfactorily undertake the work. Surveying personnel will be experienced in the provision of these services, including detailed, accurate documentation.

Certification

Survey results will be certified by a licensed Professional Land Surveyor licensed in the state where the work is performed and submitted to the CQA Consultant for review.

8.7. Surveys by Owner or Engineer

The Owner or Project Engineer may request additional surveys to monitor, verify, or document the work.

9. Submittals

9.1. Submittal Procedure

Submittals include shop drawings, material data, and samples. Product data submittals, samples, and shop drawings are required to verify that the correct products will be installed on the project. The shop drawing submittal is a drawing or set of drawings produced by the Contractor, Supplier, Installer, Manufacturer, Subcontractor, or Fabricator typically for pre-fabricated components or construction procedures. The product data submittal usually consists of the manufacturer's product information. The sample submittal is a physical portion of a specified product, often required when several products are acceptable, to confirm the quality and aesthetic level of the material. The size or unit of sample material usually is specified.

Submittals shall be submitted electronically and will be initially submitted to the Resident Engineer by the Contractor for review. After review, one copy of the submittal will be returned to the Contractor. The Contractor will include a letter of transmittal along with each submittal and include the following information at a minimum.

- Owner's Name
- Project Name
- Contract No.
- Transmittal No.
- Specification Section or Drawing Reference

Shop drawings will be submitted well in advance of the need for the material or equipment for construction by the Contractor and with ample allowance for the time required for engineer review and to accept delivery of material or equipment afterward in accordance with the project schedule.

9.2. Submittal Review

After the Resident Engineer completes his/her review, submittals will be returned to the Contractor indicating whether or not the materials meet the project requirements along with further instructions.

10. Requests For Information (RFI)

The purpose of this procedure is to formalize and detail requests for clarification or additional information relative to the design drawings, construction specifications, or other construction related issues. RFIs are to be processed expeditiously in order to avoid the possibility of delay to the project. RFIs cannot be used as a substitute for items specifically requiring a submittal from the Contractor or to change the design. If a change in the design is needed (i.e., based on an RFI response), then a change order must be issued. Responses to RFIs are not authorizations for such change orders or payments.

RFI submittals will be submitted by the Contractor on forms specified by the Construction Manager. The form must be completed using sequential numbers and submitted by the Contractor to the Resident Engineer for review.

The Project Engineer will review and respond to the RFI or assign to the Resident Engineer to obtain a response. If the RFI will lead to a Change Order, the Project Engineer will submit to the Construction Manager for review. If the RFI does not lead to a Change Order, the Project Engineer will sign and return the RFI to the Contractor.

11. Project Schedule

A detailed project schedule will be required to be provided by the Contractor to the Construction Manager for review and approval prior to the preconstruction meeting. The schedule must be generated using Primavera P6 software, or other similar program, and composed of detailed activities logically tied together. The Contractor will construct the schedule to have the following attributes at a minimum:

- Schedule narrative describing the logic for the work planned
- Clearly defined starting point
- Clearly defined completion date
- Project Milestones
- Mobilization and demobilization activities
- Critical paths identified
- Tasks that represent the performance of the work, including tangible deliverables or products
- Specifies the resources required to perform the work (This will include labor, equipment, and materials)
- Can be easily measured during the performance of the detailed activity relating to the work

All details in the project schedule will be logically tied to other activities. As a general guideline for generating schedules, the duration of an activity should be limited to 14 calendar days. In no case should an individual work activity be scheduled for a duration longer than 45 calendar days without approval from Dow. If any portion of the project is to be accomplished during a plant outage, those scheduled activities should be incorporated into a separate hourly schedule. The work should be broken down into sufficient enough detail to allow the maximum use of finish-to-start relationships. In addition, start-to-start, finish-to-finish, or start-to-finish relationships will be used at a minimum. In no case will negative lag values be allowed for any relationships. In all cases, any exceptions to the above criteria must have Dow construction management's approval.

Individual activities in the project schedule requiring identifiable labor to complete the project will be resource loaded with all necessary engineering labor hours, project support labor hours and/or craft labor hours consistent with the Contractor's estimate, scope of work and work assignments. Progress for scheduled tasks will be tracked using physical percent complete. All significant reductions in physical percent complete will be reported in the weekly report along with an explanation.