



Stantec Consulting Services Inc.
One Carlson Parkway North, Suite 100
Plymouth MN 55447-4440

March 5, 2026

Project/File: 227708272

Mr. Mike Smith

Iowa Department of Natural Resources
Land Quality Bureau
502 East 9th St.
Des Moines, Iowa 50319

Reference: Dickinson Landfill, Inc. (30-SDP-01-75P) – Permit Renewal Application Response to IDNR Comment Letter

Dear Mr. Mike Smith,

Dickinson Landfill Inc. (DLI), the owner and operator of the Dickinson Landfill, received technical comments from the Iowa Department of Natural Resources (IDNR) dated December 19, 2025, regarding the solid waste permit renewal application dated November 25th, 2025. On behalf of DLI, Stantec Consulting Services Inc. (Stantec) has prepared this letter responding to the INDR's comments and requests for additional information. For ease of review, the IDNR's comments are excerpted below and provided in *italicized font*. Stantec's responses to INDR comments follow in plain font.

Engineering Technical Review Comments

Comment #1

Permit Application Form 50 is missing the second page (Section 2). Please provide the missing page.

Response:

Please find included in Attachment 1 the complete Form 50.

Comment #2

A 5% overfill is proposed. However, limited supporting documentation was provided to support the request. As noted in the submittal, settlement of waste is highly variable, thus, it is probable that the overfill will not settle to exactly the permitted final grades. Therefore, a plan showing the proposed overfill progression for the overfill shall be provided along with supporting calculations to show settlement to the permitted final grades. If the final grades cannot be met through settlement after overfilling, then alternative final grading, stormwater management, etc. will need to be developed. Further, the DNR is concerned with additional loading on the pipe, potential changes in settlement of the landfill base, and slope stability. Please provide the supporting documentation for our consideration.

Reference: Dickinson Landfill, Inc. (30-SDP-01-75P) – Permit Renewal Application Response to IDNR Comment Letter

Response:

The proposed 5% overfill will be an interim condition during active fill operations. Final closure of each disposal unit will be completed at maximum, to the permitted grades and profile. If, at the time of closure, the 5% overfill has resulted in waste above permitted closure grades, the waste will be relocated during the closure construction activities, as outlined in Section 3.4.1 of the Development and Operations Plan. Since the proposed 5% overfill is considered an interim condition and will not result in deviations from the permitted final cover grades, an overfill progression plan has not been prepared.

An additional pipe strength calculation has been provided in Attachment 2 which considers the 5% overfill elevation. Note that the allowable compressive yield strength has been revised and is in accordance with the Plastic Pipe Institute (PPI) Chapter 5 Standard Specifications, for consistency with the technical specifications for HDPE piping.

Additional slope stability modeling has been completed to ensure the 5% overfill will not adversely impact the stability of the waste mass during the interim waste disposal operations. The 5% overfill stability analysis is included in Attachment 3.

Potential changes in settlement at the landfill base are not anticipated as the 5% overfill is a function of total waste thickness and the additional fill height will be a maximum of 8 feet. Considering the typical landfill environment, equipment loading, and variability in compacted density, an additional 8 feet of fill is not a significant impact to loading at the base of the landfill. Also, the pipe strength calculations and slope stability modeling indicate that the additional fill has a nominal impact on the landfill performance.

Comment #3

The Construction Quality Assurance Plan in Attachment 4 shall address compliance with 567 IAC 113.7(6)"c"(4) ... [and] "Be based on statistically significant sampling techniques and establish criteria for the acceptance or rejection of materials and constructed components of the MSWLF unit". Please update the plan accordingly, especially for the hydraulic conductivity of the compacted clay layer.

Response:

The Construction Quality Assurance (CQA) Plan has been revised to include statistically significant sampling technique requirements. Modifications to the previously submitted CQA Plan were limited to Section 4 and Table 1. A complete copy of the updated CQA Plan is included in Attachment 4.

Comment #4

The permit holder proposed shutting off the groundwater underdrain system under portions of the site based on a favorable evaluation of no liner uplift (Section 5.3 Groundwater Underdrain Monitoring in Attachment 10 Hydrologic Monitoring System Plan in the Solid Waste Permit Renewal document). The DNR is concerned about contaminant movement with and without an operating underdrain and the potential change in slope stability of the liner system. Please provide additional supporting information for our consideration

Reference: Dickinson Landfill, Inc. (30-SDP-01-75P) – Permit Renewal Application Response to IDNR Comment Letter

Response:

Stantec completed a review of published sources related to the potential for contaminant transport at landfill's with conventional Subtitle D liner systems in the memorandum included in Attachment 5. Based on the review, it is believed that the potential contaminant mass flux from the Landfill would be reduced by decommissioning groundwater underdrains GU-B and GU-C. This reduction in potential contaminant mass flux relates largely to the reduced potential for advective contaminant transport at landfills which have inward hydraulic gradients (i.e., hydraulically contained landfill). Based on a review of existing environmental data from the Landfill, it is understood that an inward hydraulic gradient would be present in Cells B and C if DLI were to shut off each cell's respective underdrain. This conclusion is consistent with the published sources referenced in the attached memorandum, and also follows prior precedence established by Barker Lemar Engineering Consultant's 2018 letter for the Metro Park East Landfill (IDNR Doc. DNA # 91213).

Slope stability modelling considering shutting off the underdrain system was performed to confirm stability of the waste mass. A technical memo summarizing the stability analyses is included in Attachment 3. The memo also includes discussion of subsequent phased decommissioning of the temporary operational dewatering systems. Based on the analyses provided, the proposed decommissioning sequence exceeds the minimum long-term factor of safety of 1.5 for the modelled scenarios. An additional analysis was performed for a short-term scenario where the operational dewatering pump(s) is temporarily non-operational for maintenance etc., resulting in a short-term factor of safety greater than 1.2.

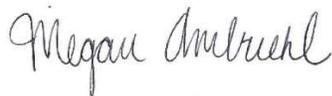
Closing

Should you have any questions regarding the information provided herein, feel free to contact us at the information provided below.

We appreciate your continued engagement and look forward to advancing the permit renewal process.

Regards,

Stantec Consulting Services Inc.



Megan Ambuehl PE
Principal, Business Center Practice Lead
Phone: (763) 479 5155
Megan.ambuehl@stantec.com



Paul Schmidt
Civil Engineer
Phone: (763) 479 5130
Paul.schmidt2@stantec.com

stantec.com

Attachment:

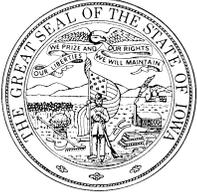
- Attachment 1 – Revised Form 50
- Attachment 2 – Pipe Strength Calculations
- Attachment 3 – Slope Stability Modeling
- Attachment 4 – Revised Construction Quality Assurance Plan

Reference: Dickinson Landfill, Inc. (30-SDP-01-75P) – Permit Renewal Application Response to IDNR Comment Letter

- Attachment 5 – Contaminant Movement Memo

c. George Fletcher, Andrew McCain, Tyler Fields, Erin Bulson, John Reynolds

Attachment 1 – Revised Form 50



IOWA DEPARTMENT OF NATURAL RESOURCES



Municipal Solid Waste Landfill

PERMIT APPLICATION FORM 50

Permit type selection: New Permit, Permit Renewal (30 - SDP - 01 - 75P MLF), Closure Permit

SECTION 1: PERMIT APPLICATION REQUIREMENTS

Owner of site

Name: Dickinson Landfill, Inc. Phone: 712-336-3980
Address: 2575 190th St Fax:
City, State, Zip: Spirit Lake, IA 51360 E-mail:

Certified Operator Responsible for Operation at Facility

Name: John Reynolds Phone: 712-331-6025
Address: 2575 190th St Fax:
City, State, Zip: Spirit Lake, IA 51360 E-mail: jreyno11@wm.com

Permit Applicant

Name: John Reynolds Phone: 712-331-6025
Address: 2575 190th St Fax:
City, State, Zip: Spirit Lake, IA 51360 E-mail: jreyno11@wm.com

Design Engineer (PE)

Name: Megan Ambuehl Phone: 763-479-5155
Address: One Carlson Parkway, Suite 100 Fax:
City, State, Zip: Plymouth, MN, 55447 E-mail: megan.ambuehl@stantec.com
Iowa Engineer License #: P22598 Expiration Date: 12/31/2026

Responsible Official for the Facility

Name: John Reynolds Phone: 712-331-6025
Address: 2575 190th St Fax:
City, State, Zip: Spirit Lake, IA 51360 E-mail: jreyno11@wm.com

Agency and Responsible Official of Agency Served (if any)

Name:
Address:
City, State, Zip:
E-mail:
Phone:
Fax:

Facility

Name: Dickinson Landfill, Inc.
Address: 2575 190th St City, State, Zip: Spirit Lake, IA 51360
Legal Description:
See executive summary (due to Form 50 spatial constraints)

Landfill is part of the following solid waste comprehensive planning area:

Planning Area Name: Dickinson County Sanitary Landfill Planning Area
Date of Last Approved Plan: 12/8/2021

Service area of the landfill (include unincorporated areas and out of state generators):

See executive summary (due to Form 50 spatial constraints)

Population Served: ~20,000

SECTION 2: PERMIT APPLICATION SUPPORTING DOCUMENTATION

PLANS AND SPECIFICATIONS

Checking the appropriate boxes below certifies that the documents submitted in conjunction with this application form are complete and in compliance with the applicable chapters of the Iowa Administrative Code. While some of the documents below may have been submitted previously, updated copies of each are required to be provided with each permit renewal application, unless a prior document remains current and is identified by Doc ID#, Section, and Page.

Required Plans and Specifications

- Executive Summary
An executive summary shall address the following:
- Summary of modifications, if any, to the approved plans and specifications that occurred during the current permit cycle.
 - Summary of each special provision of the current permit to determine if it is to remain the same, be revised or be removed.
 - Provide documentation and certification as required for new permit amendment requests, if any.
 - Provide documentation and certification as required for equivalency review requests, if any.
 - Provide documentation and certification as required for new variance requests from Iowa Administrative Code requirements, if any.
- An organizational chart in accordance with Iowa Administrative Code 567 paragraph [113.5\(1\)“b”](#).
No Revision Required - See Doc ID#, Section, and Page: _____
- A site exploration and characterization report for the facility that complies with the requirements of subrule [113.6\(4\)](#).
No Revision Required - See Doc ID#, Section, and Page: See Executive Summary
- Design plans and specifications for the facility, and quality control and assurance plans, that comply with the requirements of rule [113.7\(455B\)](#).
No Revision Required - See Doc ID#, Section, and Page: _____
- A development and operations (DOPS) plan for the facility, an emergency response and remedial action plan (ERRAP), and proof of MSWLF Operator Certification that comply with the requirements of rule [113.8\(455B\)](#).
No Revision Required - See Doc ID#, Section, and Page: _____
- An environmental monitoring plan that complies with the requirements of rules [113.9\(455B\)](#) and [113.10\(455B\)](#).
No Revision Required - See Doc ID#, Section, and Page: _____
- The project goals and time lines, and other documentation as necessary to comply with subrule [113.4\(10\)](#) and other requirements of the Department if an RD&D permit is being requested or renewed.
No Revision Required - See Doc ID#, Section, and Page: NA
- Proof of financial assurance in compliance with rule [113.14\(455B\)](#).
No Revision Required - See Doc ID#, Section, and Page: See Executive Summary, Doc #112678
- A closure and postclosure plan that complies with the requirements of rules [113.12\(455B\)](#) and [113.13\(455B\)](#).
No Revision Required - See Doc ID#, Section, and Page: _____
- Comprehensive plan requirements. Attach a copy of the most recent comprehensive plan approval or amendment letter.
No Revision Required - See Doc ID#, Section, and Page: See Executive Summary

In addition to the documents required above, the permit holder shall comply with the implementation plan requirements of subrule [113.2\(9\)](#), the public notice requirements of subrule [113.4\(12\)](#), and the record-keeping and reporting requirements of rule [113.11\(455B\)](#).

If the department finds the permit application information to be incomplete, the department shall notify the applicant of that fact and of the specific deficiencies. If the applicant fails to correct the noted deficiencies within 30 days, the department may reject the application and return the application materials to the applicant. The applicant may reapply without prejudice.

SECTION 3: APPLICANT SIGNATURE

Signature of Permit Applicant:  Date: 11-23-25
Printed Name: James Reynolds Title: District Manager

Applications for sanitary disposal projects must be accompanied by the plans, specifications and additional information required by the applicable solid waste rules under Iowa Administrative Code.

Send completed applications with attached information to the DNR project officer via email or file sharing platform.

For questions concerning this application contact Brian Rath at 515-537-4051, brian.rath@dnr.iowa.gov

Attachment 2 – Pipe Strength Calculations

**Waste Management, Inc.- DLI
IDNR Comment Response**

**Deflection Determination - Method 1
Pipe Evaluated: 6" HDPE SDR 17
MSW Cell Leachate Collection Pipe**

References: "Modulus of Soil Reaction Values for Pipeline Design",
J Jeyapalan and R Watkins

Solution: **1. Determine Vertical Stress**

Material	Density (pcf)	Depth (ft)	Load (psf)
Final Cover Soils	110	2	220
Buffer Soils	110	1	110
Refuse	75	160	12000
Refuse (+5%)	75	8	600
Drainage Layer	120	1	120
Intermediate Filter	120	0.5	60
Coarse Aggregate	130	2	260
Total Load =			13370 psf
Total Vertical Load (P) =			92.8 psi

2. Determine Dynamic Stress (DL) on Pipe

Assume Caterpillar D4 dozer or equivalent is placing materials.

From Caterpillar performance handbook ground pressure of D4
580 psf x 1.3 dynamic factor = 754 psf

DL = dynamic pressure (psf) / 144 psi/psf =	5.2 psi
---	---------

3. Determine Total Vertical Stress on Solid Pipe (TP)

Total Vertical Stress (TP) = Static Stress + Dynamic Stress =	98.1 psi
--	-----------------

4. Determine Strain in Aggregate Envelope using Hookes Law

Hookes Law
Stress / Strain = Elastic Modulus

Therefore the elastic strain in the soil/pipe system is equal to the stress applied to the aggregate envelope divided by E'

Determine Soil Reaction Modulus

Assume bedding is coarse aggregate (USCS Classification GP or GW) compacted to 90% of standard proctor density.

Adjustment is 25 psi at 85% compaction and 100 psi at 100% compaction.

Adjust E' by 50 psi for every foot of additional soil cover above 5'.

Initial E' for 5' of soil cover =	1000 psi
Adjust E' above 5' =	8475 psi
Total E' =	9475 psi

Assume FS = 2.0, then E' = 4737.5

Therefore the strain in the soil/pipe system is equal to TP/E' x 100% =	2.07%
--	--------------

**Waste Management, Inc.- DLI
IDNR Comment Response**

Deflection Determination - Method 1

Pipe Evaluated: 6" HDPE SDR 17
MSW Cell Leachate Collection Pipe

5. Determine Safety Factor Against Wall Crushing

Determination of stress in pipe S_a

$$S_a = (SDR-1) \times TP / 2$$

S_a = Stress in Pipe

SDR = Standard Dimension Ratio = 17

Sa = 785 psi

Allowable S_a = 1600 psi, where 1600 psi is the compressive yield strength according to Plastic Pipe Institute (PPI) Chapter 5

$$FS = 1600/S_a$$

FS = 2.0 ≥ 2.0 O.K.

4. Determine Safety Factor Against Wall Buckling

$$P_c = 5.65[(B' E_p E_s I)/D_m^3]^{1/2}$$

P_c = Critical collapse pressure (psi)

B' = Dimensionless Vertical Stress Factor

$$B' = 1/(1+4e^{(-.065H)})$$

H = Height of Soil Cover above Pipe = 174.5 Ft

$$B' = 1.000$$

E_p = Modulus of Elasticity = 28,200 psi

E_s = Modulus of soil reaction = 3800 psi

OD = 6 inch SDR 17 = 6.625

D_m = mean diameter = OD - t = 6.235 in

I = Moment of Inertia = $t^3/12$ = 0.0049 in³

t = wall thickness = 0.39 in

Pc = 264 psi

$$FS = P_c/TP$$

FS = 2.7 ≥ 2.0 O.K.

Attachment 3 – Slope Stability Modeling

To: George Fletcher, PE
Site Engineer

From: Megan Ambuehl, PE
Paul Schmidt, PE_(MN)

Project/File: 227708272

Date: Original December 1, 2025
Revised March 5, 2026

Reference: Dickinson landfill (30-SDP-01-75) – Operational Dewatering Decommissioning and 5% Overfill Slope Stability Modeling

This technical memorandum summarizes the slope stability analyses performed for the worst case cross sections considering the decommissioning sequence of the operational dewatering system(s) at the Dickinson Landfill (the Facility) which is regulated under Iowa DNR Solid Waste Disposal Permit 30-SDP-01-75. The analyses also include consideration of a 5% overfill at the site.

As outlined in the 2025 permit renewal application, the Facility's dewatering system used to maintain groundwater separation within the base liner system will be discontinued once sufficient ballast is placed atop the impermeable base liner system. As such, the slope stability analyses herein confirm that the proposed discontinuation of the dewatering system will not adversely affect the stability of the waste mass. Additionally, stability modelling was also performed for the proposed 5% overfill in active disposal areas. The standard minimum factor of safety (FS) for long-term slope stability has been exceeded within the proposed phasing development scenarios.

Methods and Material Properties

The global slope stability analyses were performed using SlopeW, a two-dimensional limit-equilibrium slope stability program. This limit-equilibrium calculation considers the driving and resisting forces in the respective materials to determine the worst-case factor of safety within each modelled section. An acceptable long-term factor of safety (FS) greater than or equal to 1.5 is the recognized minimum design criteria according to the US Army Corp of Engineers and thus has been utilized herein as the minimum acceptable FS. The typical location of the cross section modelled can be found in Attachment 1.

Soil data from previously completed site work at the Facility was utilized to determine typical properties of the material onsite. Previously completed site work that has information regarding soil types include groundwater monitoring well boring logs, cell construction documentation reporting, and the 2016 Field Investigation and Borrow Soil Analysis Summary Memo completed by Wenck Associates, Inc. It is noted that subsurface soils can be variable, however, the typical native soils are assumed to be primarily sandy clay with traces of gravel and silty soils. The material properties of each material utilized within the stability modelling is provided in Table 1.

Reference: Dickinson landfill (30-SDP-01-75) – Operation Dewatering Decommissioning and Five Percent Overfill Slope Stability Modeling

Table 1 Soil Strength Parameters for Geotechnical Modeling

Material¹	Unit Weight (pcf)	Friction Angle (deg)
Native Soils	105	24
Waste	75	26
Liner	1	10
Drainage Aggregate	120	30

A potentiometric surface was applied to each modelled scenario representing soil pore pressure in the native soils as the temporary dewatering systems are turned off. Pore water pressure is determined by the weight of the water column above a given point. For the purposes of the model, the pore water pressure in the native soils is represented as a potentiometric surface. This surface reflects the equivalent pressure of groundwater in the native soils that would exist when the temporary operational dewatering system beneath the active cells is turned off. Although part of the surface appears in the waste material in the model, the pore water pressure generated by the potentiometric surface is only applied to the underlying native soils and not the waste.

Model Scenarios

There were four model scenarios completed to depict the phased development and decommissioning of the dewatering system. One additional scenario was modelled to depict the global stability considering the proposed 5 percent overfill within active filling areas. These scenarios are depictions of the worst-case uplift area which is within proposed disposal Cell D1. A phased plan of shutting off the temporary dewatering system within existing and future cells are discussed throughout. The worst-case cross section used for the modelling scenarios is included in Attachment 1.

Construction of Cell D1

This analysis was performed to determine the slope stability of the existing waste mass given that the Cell B operational dewatering system is discontinued. As discussed above, the excess pore water pressure is accounted for within the model below the impermeable liner system. Additionally, the existing grades of the working face are reflected within the model. The proposed base grades for Cell D1 are shown with a temporary stormwater pond abutting Cell D1 via a separation berm along the western cell limits. The slope stability model considering decommissioning the Cell B dewatering system based on existing grades is shown in Attachment 2 with a calculated FS of 1.84.

Construction of Cell D1 – Temp Pump Failure

This scenario is intended to serve as a worst-case short-term condition where the Cell B temporary operations dewatering system is turned off, and a temporary pump failure occurs within Cells C and D1 prior to waste placement in Cell D1. Due to an assumed temporary failure of the operational dewatering system in Cells C and D1, the model depicts a buildup of excess pore water pressure below the

Reference: Dickinson landfill (30-SDP-01-75) – Operation Dewatering Decommissioning and Five Percent Overfill Slope Stability Modeling

impermeable liner system in these areas. Attachment 3 provides the model output and cross section utilizing the existing grades of the working face along with the proposed base grades for Cell D1. A temporary stormwater pond abutting Cell D1 via a separation berm along the western cell limits is also included. The US Army Corp of Engineers identifies a minimum factor of safety of 1.2 for short-term loading conditions. The calculated FS for this worst-case short-term loading condition is 1.22.

Interim Filling Within Cell D1

After construction of Cell D1 and waste placement has commenced, the Facility plans to decommission the dewatering system within Cell C. Decommissioning of the Cell C dewatering system will not occur until a minimum of 21-ft of waste has been placed within Cell D1 as shown in Attachment 4. As discussed above, the excess pore water pressure is accounted for within the model below the impermeable liner system in addition to a temporary stormwater pond abutting Cell D1 via a separation berm along the western cell limits. The calculated FS, in regard to decommissioning the Cell C dewatering system, upon 21-feet of waste placement within Cell D1 is 1.82.

Full Buildout of Cell D1

Reflected within the stability model for full buildout of Cell D1 is the 3H:1V working face at the full buildout condition with the temporary stormwater pond along the western limits of the cell. This model assumed that there will be no terraces along the working face at full-buildout and the Cell D temporary dewatering system remains in operation until the construction of Cell E. The full buildout stability model for Cell D1 is included in Attachment 5. The calculated FS for this model scenario is 1.51.

Full Buildout of Cell E With Proposed 5% Overfill

Attachment 6 includes the slope stability cross-section and model output to confirm the slope integrity in consideration of a 5% overfill. As outlined in the Facility's 2025 permit renewal application, the proposed 5% overfill is a temporary overfill to accommodate anticipated settlement prior to final closure of disposal areas. At the time of closure, any waste above the permitted final cover grades will be relocated to achieve permitted grades for closure. The maximum depth of waste at the Facility is within Cells D1, C, and B with a waste thickness of approximately 160 feet. An overfill of 5% would result in a maximum of 8 additional feet of waste. Given the necessary fill geometry to maintain a maximum working face side slope profile of 3H:1V, the maximum 5% overfill condition would not be achieved until Cell E has been developed and filled. When considering the worst case maximum 5% overfill, the calculated FS is 1.52.

Conclusion

There were four analyses performed herein to determine the long-term slope stability considering the phased decommissioning of the temporary operational dewatering systems and the proposed 5% overfill plan. Based on the analyses provided herein the proposed decommissioning sequence and overfill plan exceeds the minimum long-term factor of safety of 1.5 for the modelled scenarios. An additional analysis was performed for a short-term scenario where the operational dewatering pumps in Cells C and D1 are temporarily non-operational for maintenance etc. resulting in a short-term factor of safety greater than 1.2.

Reference: Dickinson landfill (30-SDP-01-75) – Operation Dewatering Decommissioning and Five Percent Overfill Slope Stability Modeling

Given the calculated factors of safety and discussion provided herein it is determined that the phased decommissioning of the operational dewatering system and overfill plans provide sufficient slope integrity.

Regards,

Stantec Consulting Services Inc.

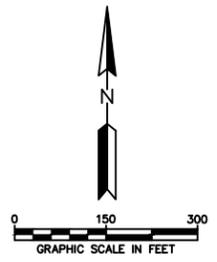
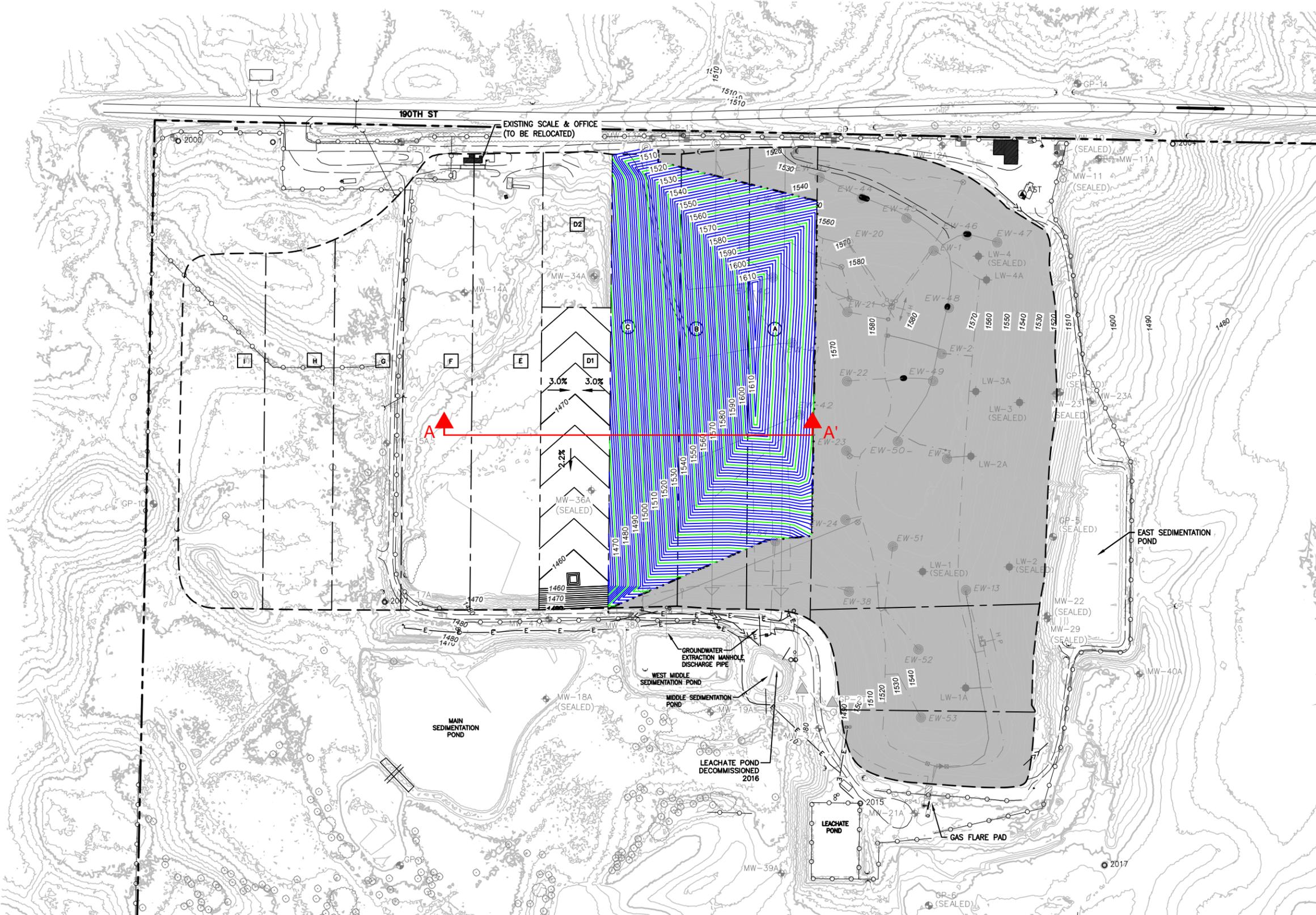
stantec.com

Attachment:

- Attachment 1 – Cross-Section Location
- Attachment 2 – Cell D1 Construction with No Dewatering in Cell B
- Attachment 3 – Cell D1 Construction Temp Pump Failure
- Attachment 4 – Decommissioning Cell C Dewatering
- Attachment 5 – Cell D1 Global Stability at Final Buildout
- Attachment 6 – Cell E Full Buildout With 5% Overfill Global Stability

c. Tyler Fields, Andrew McCain

Attachment 1
Cross-Section Location



- LEGEND**
- EW-1 ● EXISTING GAS EXTRACTION WELL
 - MW-21A ● MONITORING WELL LOCATION AND NUMBER
 - LW-1 ● LEACHATE MONITORING WELL PIEZOMETER
 - GP-1 ● GAS PROBE
 - GP-B ● GAS PROBE DISCONTINUED
 - ▲ TEMPORARY GAS PROBE (INSTALLED APRIL 2022)
 - - - CLOSURE LIMIT
 - █ EXISTING CLOSED AREA
 - - - PERMITTED WASTE LIMITS
 - - - PHASE LIMITS
 - - - PROPERTY BOUNDARY
 - - - EXISTING LEACHATE FORCEMAIN
 - EXISTING OUTFALL
 - ⊙ EXISTING SURVEY CONTROL POINT
 - Ⓐ PHASE ID
 - ⓓ FUTURE PHASE ID
 - PROPOSED TOP OF CLAY MAJOR CONTOUR
 - PROPOSED TOP OF CLAY MINOR CONTOUR
 - OPERATIONAL TOP OF CLAY MAJOR CONTOUR
 - OPERATIONAL TOP OF CLAY MINOR CONTOUR

- SURVEY NOTES:**
- HORIZONTAL DATUM IS IOWA STATE PLANE COORDINATE SYSTEM, NORTH ZONE, NORTH AMERICAN DATUM NAD83(2011), US SURVEY FEET.
 - VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM 88 (NAVD88), CONTOUR INTERVAL IS TWO FEET.
 - TOPOGRAPHY SURVEY COMPLETED BY TETRATECH IN MARCH 19, 2025.
 - PROPOSED CONTOURS SHOWN IN CELL D1 ARE TOP OF CLAY BARRIER LAYER.
 - OPERATIONAL GRADES SHOWN IN CELLS A - C ARE TOP OF CLAY FOR FINAL COVER SYSTEM.

HORIZONTAL AND VERTICAL CONTROL POINT LOCATIONS				
POINT ID.	NORTHING SPCS NAD83(2011) (FEET)	EASTING SPCS NAD83(2011) (FEET)	ELEVATION (FT-NAVD88)	DESCRIPTION
1	3,966,660.45	4,499,614.05	1496.275	REBAR
2000	3,966,663.58	4,499,340.25	1494.057	REBAR
2004	3,966,655.42	4,502,218.34	1520.534	REBAR
2007	3,965,333.43	4,499,937.44	1470.796	REBAR
2010	3,964,182.39	4,499,283.55	1454.470	REBAR
2015	3,964,752.63	4,501,313.87	1493.670	REBAR
2017	3,964,573.95	4,502,020.64	1483.964	REBAR



SEAL	I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF IOWA. MY LICENSE RENEWAL DATE IS 12/31/2026.		
PRINT NAME	MEGAN AMBUEHL		
SIGNATURE	<i>Megan Ambuehl</i>		
DATE	11-25-2025	LICENSE #	P22598
REV	ISSUED FOR PERMITTING	DWN	JJT MMA 11/25/25
REV	REVISION DESCRIPTION	DWN	APP REV DATE

PRIME CONSULTANT

PROJECT TITLE
2025 PERMIT RENEWAL APPLICATION

DICKINSON LANDFILL, INC.
WASTE MANAGEMENT

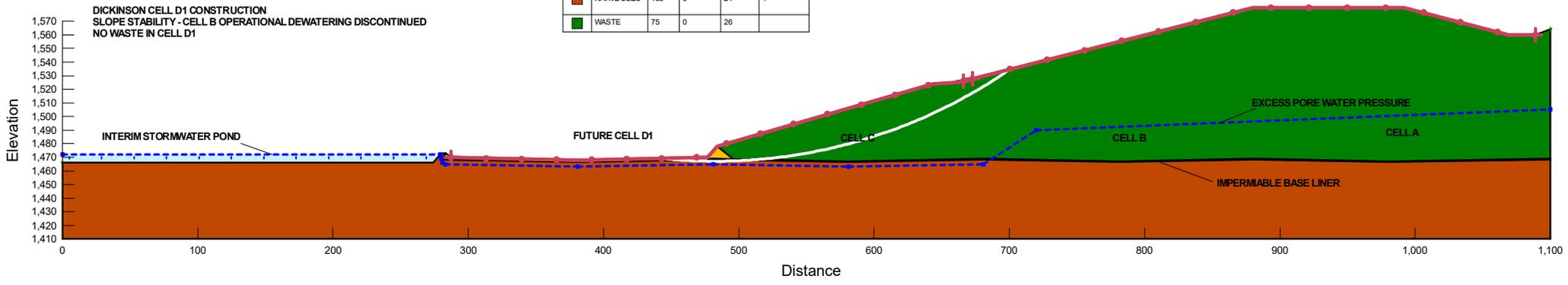
SPIRIT LAKE, IOWA

SHEET TITLE
PHASING PLAN - CELL D1

DWN BY	CHK'D	APP'D	DWG DATE	NOV. 2025
JJT	PDS	MMA	SCALE	AS SHOWN
PROJECT NO.	SHEET NO.	REV NO.		
227708272	C-104	0		

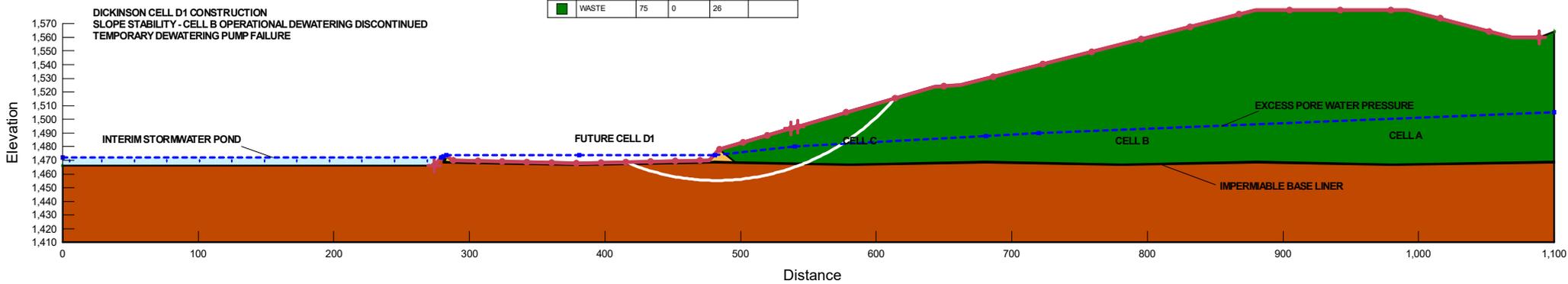
Attachment 2
Cell D1 Construction with No Dewatering in Cell B

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
Orange	Compacted Clay	115	0	24	
Yellow	DRANAGE AGGREGATE	120	0	30	
Black	LINER	1	0	10	
Brown	NATIVE SOILS	105	0	24	1
Green	WASTE	75	0	26	

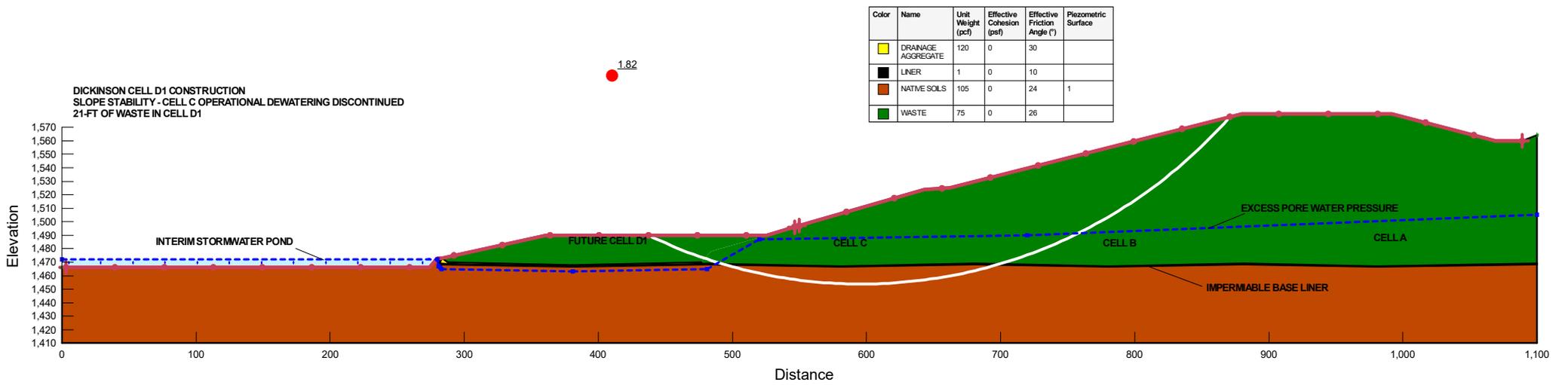


Attachment 3
Cell D1 Construction Temp Pump Failure

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
Orange	COMPACTED CLAY	115	0	24	
Yellow	DRAINAGE AGGREGATE	120	0	30	
Black	LNER	1	0	10	
Brown	NATIVE SOILS	105	0	24	1
Green	WASTE	75	0	26	



Attachment 4
Decommissioning Cell C Dewatering

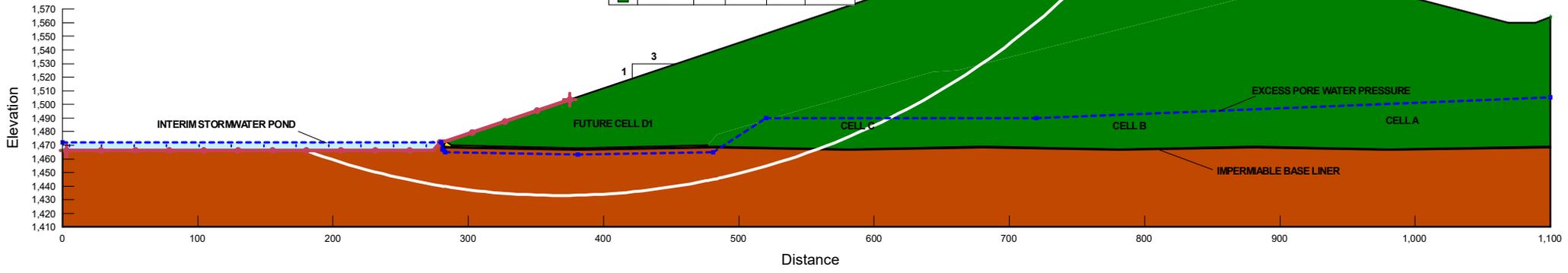


Attachment 5
Cell D1 Global Stability at Final Buildout

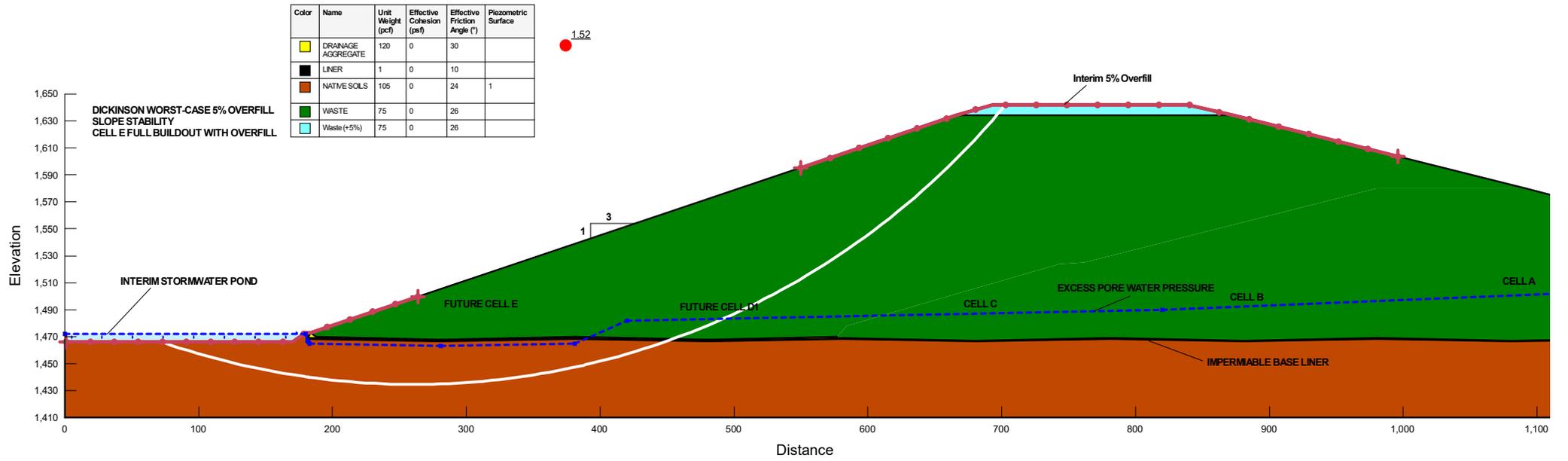
1.51

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Piezometric Surface
Yellow	DRAINAGE AGGREGATE	120	0	30	
Black	LINER	1	0	10	
Brown	NATIVE SOILS	105	0	24	1
Green	WASTE	75	0	26	

DICKINSON CELL D1 CONSTRUCTION
SLOPE STABILITY
FULL BUILDOUT



Attachment 6
Cell E Full Buildout With 5% Overfill Global Stability



Attachment 4 – Revised Construction Quality Assurance Plan

Construction Quality Assurance Plan

Landfill Cell Development and Closure
Dickinson Sanitary Landfill, Inc.



Prepared for:
Dickinson Sanitary Landfill, Inc.
2575 190th St.
Spirit Lake, IA 51360

Prepared by:
Stantec Consulting Inc.
One Carlson Pkwy
Plymouth, MN 55447

Date:
November 2025; Revised February 2026

Project/File:
227708272

Table of Contents

1	Introduction	1
1.1	Scope	1
1.2	Definitions	1
1.3	Parties	1
2	Documentation	3
2.1	General.....	3
2.2	Documentation Report	3
3	Foundation and Berms	5
3.1	General.....	5
3.2	Material Quality Control.....	5
3.3	Observation and Documentation	5
3.4	Testing.....	5
3.5	Survey	5
4	Low Permeability Soil Liner	6
4.1	General.....	6
4.2	Material Quality Control.....	6
4.2.1	Statistically Significant Sampling Procedures	6
4.3	Subgrade.....	6
4.4	Observation and Documentation	7
4.5	Testing.....	7
4.6	Damage and Repair	9
4.7	Survey	9
4.8	Conformance with Project Specifications.....	9
5	Geomembrane	10
5.1	General.....	10
5.2	Material Quality Control.....	10
5.2.1	Raw Material	10
5.2.2	Geomembrane Material Specifications	10
5.3	Subgrade.....	11
5.4	Observations and Documentation.....	11
5.4.1	Roll Inspections	11
5.4.2	Placement	11
5.4.3	Trial Seams	12
5.4.4	Field Seaming	13
5.5	Testing.....	14
5.5.1	Non-Destructive Seam Continuity Testing	14
5.5.2	Destructive Testing	15
5.6	Defect and Repairs	17
5.6.1	Evaluation	17
5.6.2	Repair Procedures	17
5.6.3	Verification of Repairs	18
5.7	Final Acceptance.....	18
5.8	Conformance With Project Specifications.....	18
5.9	Interface Friction Testing (Optional).....	18
6	Geonet/Geotextile Geocomposite	19
6.1	General.....	19



Construction Quality Assurance Plan

Table of Contents

6.2	Material Quality Control.....	19
6.3	Subgrade.....	19
6.4	Observation and Documentation	19
6.4.1	Roll Inspections.....	19
6.4.2	Placement	20
6.4.3	Seaming	20
6.5	Damage and Repairs	20
6.6	Conformance With Project Specifications.....	20
7	Geotextile.....	21
7.1	General.....	21
7.2	Material Quality Control.....	21
7.3	Observation and Documentation	21
7.3.1	Roll Inspection.....	21
7.3.2	Placement and Seaming	21
7.3.3	Damage and Repairs	21
7.4	Conformance with Project Specifications.....	22
8	Granular Drainage Media.....	23
8.1	General.....	23
8.2	Material Quality Control.....	23
8.3	Observation and Documentation	23
8.4	Testing.....	23
8.5	Damage and Repairs	23
8.6	Survey	24
8.7	Conformance With Project Specifications.....	24
9	Piping Systems	25
9.1	General.....	25
9.2	Material Quality Control.....	25
9.3	Observation and Documentation	25
9.3.1	Installation	25
9.3.2	Pressure Testing	25
9.4	Damage and Repairs	26
9.5	Survey	26
9.6	Conformance With Project Specifications.....	26
10	Pumps and Controls	27
10.1	General.....	27
10.2	Material Quality Control.....	27
10.3	Observation and Documentation	27
10.4	Testing.....	27
10.5	Damage and Repair	27
10.6	Conformance With Project Specifications.....	27
11	Vegetative Soils.....	28
11.1	General.....	28
11.2	Observation and Documentation	28
11.3	Damage and Repair	28

List of Tables

Table 1 – Soil Quality Assurance Testing Requirements

Table 2 – Geosynthetics Quality Assurance Testing Requirements



Construction Quality Assurance Plan
Table of Contents

Table 3 – Geomembrane Quality Assurance Testing Requirements
Table 4 – Grade Tolerances



1 Introduction

1.1 Scope

This Construction Quality Assurance (CQA) Plan outlines the necessary procedures, standards, and methods for appropriate monitoring and documentation of landfill construction projects associated with landfill cell development, closure construction, and general gas improvement projects. The overall goal of this construction quality assurance program is to ensure that proper construction techniques and procedures are implemented and to verify that materials and installation techniques used meet the project design requirements. At the completion of the work, the program will culminate in a certification report which documents that the grading, liner, and piping systems have been constructed in general accordance with design standards and specifications with any deviations noted.

This plan also outlines the responsibilities of the various key parties involved in construction. This plan shall be implemented in conjunction with the project drawings, specifications, and other project documents to comprise the CQA program.

1.2 Definitions

Quality Assurance: Means and actions employed by OWNER to assure conformity of the lining system production and installation with the approved drawings, specifications and other project requirements.

Quality Control: Actions taken by the liner manufacturer, installer, and earthwork contractor to ensure that materials and workmanship meet the requirements of the drawings, specifications, and other project requirements.

Technical Specifications: A document produced by the Designer declaring minimum values of performance of construction materials.

Certification Report: A report documenting that construction was carried out according to approved drawings, specifications, and this CQA plan.

1.3 Parties

The parties discussed in this section are associated with the ownership, design, supply, manufacture, transportation, installation, and quality assurance of a lining system. The parties involved and their functions are described below:

OWNER: The party that owns and operates the facility that is responsible for the overall coordination of CQA activities. The OWNER is also responsible for selecting the necessary parties associated with construction.

Designer: The firm responsible for preparing the engineering design, associated plans, and specifications for the facility. The Designer for the project shall be a registered professional engineer in the State of Iowa.



Construction Quality Assurance Plan

1 Introduction

The Designer may provide clarification necessitated during construction. The Designer may also be referred to as the ENGINEER in the Technical Specifications.

Quality Assurance Contractor (QAC): A person designated by OWNER to observe tests and document construction activities on behalf of the OWNER. The QAC will identify and notify the OWNER of any deviations or problems that arise during construction and assist in resolution. The QAC is also responsible for preparation of the construction certification report required for submittal to the Iowa DNR. The QAC will have an individual identified as the CQA Officer. The CQA Officer will be a registered professional engineer in the State of Iowa. The QAC may also be denoted as the ENGINEER in the Technical Specifications.

Earthwork Contractor (EC): This firm is mainly responsible for the earthwork preparation and construction of the soil components of the lining system. The EC typically prepares the subgrade or foundation soil on which the geosynthetics are placed. The EC is also responsible for placing the soil materials over the lining system. In addition, the EC may install piping and backfill material.

Geosynthetic Manufacturer (GM): The GM is the firm or firms responsible for the production and supply of the various geosynthetic components. The geosynthetic manufacturer will be responsible for providing Quality Control (QC) documentation that the materials meet the requirements of the drawings, specifications, and other project requirements. The GM is responsible for the condition of the product until the material is accepted by the OWNER on-site.

Geosynthetic Installer (GI): The GI is responsible for field handling, storing, placing, seaming, loading, and other aspects of the installation of geosynthetics.

Quality Assurance Laboratory (QAL): Firm which performs necessary testing on samples taken from the site.

Land Surveyor (LS): Responsible for documenting the subgrade and cover system component thicknesses. The QAC may also serve in this role.



2 Documentation

2.1 General

The QAC will be on site to document construction activities. The QAC will prepare the daily activity logs, assemble the test reports, prepare the record drawings, and prepare the certification report. This section addresses the content of the various reports.

2.2 Documentation Report

Daily Activity Log: The QAC will prepare daily activity logs, for the days they are present on-site, which will typically contain the following:

- Name and title of construction supervisor; contractor(s) personnel and equipment onsite
- Date of activity
- Weather, including maximum and minimum temperatures and amount of precipitation, if any
- Type of activity conducted.
- Summary of all quality assurance tests conducted, indicating which tests passed and failed specifications.

Photographs: The QAC shall create a photographic record of key construction activities to document the overall progress of construction.

Test Reports: The quality assurance laboratory will prepare a test report for each sample tested and provide copies to the QAC.

The test reports will typically contain the following information.

- Date
- Sample I.D.
- Project name and location
- Sample size and description
- Test being performed.
- Applicable ASTM standards
- Method of sample preparation
- Test results, including a statement that the test either passed or failed the project requirements.

The laboratory shall certify the accuracy of the test reports and compliance with relevant standards.

The geomembrane installation record drawing will be provided by the GI. The QAC will work closely with the GI to ensure that panel numbers, seam locations, and destructive test numbers and locations are correctly located on the record drawing.

Certification Report: The QAC will prepare a certification report that documents construction and includes certification from a professional engineer registered in the State of Iowa that the construction was in general accordance with this CQA plan, engineering drawings, and specifications.



Construction Quality Assurance Plan

2 Documentation

The report shall include:

- A schedule of major events during construction, including start and finish dates, as appropriate.
- A list of the contractor and subcontractors involved.
- A summary description of the procedures and equipment used during each phase of construction (a summary of the daily activity logs).
- Base liner system and/or final cover soils records
 - sampling and testing results as applicable dependent on material
 - thickness verification information
- Geomembrane installation records: including panel layout record (to be supplied by the GI)
- Piping system records
- Record drawings containing the information previously listed.
- Select photographs, appropriately labeled



3 Foundation and Berms

3.1 General

This section is intended to apply to foundation and berms that serve as the components on which the liner systems are constructed or perimeter grading adjacent to a lined system for construction of accessory infrastructure (i.e. stormwater management systems, leachate management systems, gas management systems, etc.).

3.2 Material Quality Control

Material for foundation and berms may either be on-site or imported, depending on use and material availability. Testing may be required prior to use, depending on the source and the designated use. On-site soils are suitable for use as long as there are no foreign objects visible and no organic soils are encountered, which must be removed and replaced with suitable soil.

3.3 Observation and Documentation

No unsuitable material will be used in structural berms or in the subgrade of the liner system. Unsuitable soils may include organic materials, saturated soils, frozen soils, or any other soil type observed that may impact the structural integrity of the foundation or berm. Construction activities will be documented. The QAC shall document the grades and elevations after surface preparation.

3.4 Testing

The material will be tested in accordance with the project requirements. The surface will be prepared to be capable of supporting construction of the overlaying layers. Soil material specifications are provided in Table 1.

3.5 Survey

The survey of specific locations will provide the basis for record drawings. The survey will be performed by the QAC. The survey will be conducted on a grid and at major breaks. Grading tolerances are provided in Table 4.



4 Low Permeability Soil Liner

4.1 General

The low permeability soil liner serves as the earthen barrier in a base liner or final cover system. This layer is often referred to as the clay barrier layer or Compacted Clay Liner.

4.2 Material Quality Control

Samples of the material will be tested for USCS classification, moisture density, relationship, and hydraulic conductivity. Testing parameters and frequencies are listed in Table 1. In-place permeability data shall be evaluated based on statistical significant sampling techniques to confirm clay layer performance. The EC is responsible for the import of clay barrier layer material to complete construction or selection of appropriate material from on-site excavation areas or stockpiles, as applicable. Source testing on soil materials will be in accordance with the Specifications.

4.2.1 Statistically Significant Sampling Procedures

Laboratory hydraulic conductivity tests shall be performed on at least 5 and up to 8 Shelby tube samples or one field hydraulic conductivity test shall be performed on the clay component of the new cell liner system. For final covers, laboratory hydraulic conductivity tests shall be performed on at least 5 and up to 8 Shelby tube samples for each 10-acres or one field hydraulic conductivity test shall be performed on the clay component of the final cover. If the mean values of the laboratory hydraulic conductivity test results plus 2 standard deviations is equal to or less than the regulatory threshold hydraulic conductivity of 1×10^{-7} cm/sec (ASTM D2434 or ASTM D5084), statistical significance will be demonstrated. The remaining 3 Shelby tube samples may be analyzed and the results incorporated into the statistics, if needed. The geometric mean (geomean) may be applied instead of the mean. The use of a geomean "normalizes" the number ranges being averaged, so that no range dominates the weighting. For a failed test, the representative area shall be retested. If the retest fails, then the proposed soils and/or the equipment and construction methods need to be modified. Modifications may include the use of different soil that is more suitable for construction or the use of better performing compaction equipment. Once modifications have been applied, the tested area shall be reconstructed, or a new test area shall be constructed and the above process repeated.

4.3 Subgrade

The EC shall be responsible for preparing the subgrade for the soil liner. Once complete, the QAC shall examine the surface and verify the adequacy of the survey data provided. When the QAC deems the surface acceptable, the QAC shall prepare an acceptance certificate. The acceptance certificate shall state the following at a minimum:

1. The required survey has been performed and the results meet the specifications
2. The subgrade has been tested and meets the project requirements.

The EC must prepare and grade the soils below the liner area to create a smooth, stable subgrade. The surface must be free of foreign objects, wood, organic materials, and must not have objects protruding above the surface. At any time during construction of the soil liner, the QAC shall inform the OWNER of any



areas that are unacceptable. Such defects in the subgrade shall be corrected by the EC such that repaired areas meet the project specifications. Subgrade testing will be completed as identified in Table 1.

4.4 Observation and Documentation

The QAC shall document the following during the construction of the soil liner:

Excavation: The QAC shall document the slope and the depth of the excavation and document that the subgrade surface meets specification.

Borrow Sources: For each borrow source, the QAC shall document the following:

1. Location;
2. Description of soil;
3. Moisture-density-hydraulic conductivity relationship;
4. Removal of deleterious or off-specification material;
5. Placed and compacted volume of soil.

The laboratory test requirements are given in Table 1.

Compaction: The following will be documented during compaction of the soil:

- Type of compaction equipment;
- Method of surface preparation;
- Method of adjusting soil moisture and controlling desiccation;
- Compacted lift thickness;
- Repair;
- Observation of the thickness of lifts as loosely placed and as compacted;
- Observation of the action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc.);
- Verification that all frozen soil is removed prior to placement of subsequent material;
- Verification that frozen soil is not placed.

4.5 Testing

Source tests for low permeable soils shall be completed per the technical specifications. In-Place low permeable soil laboratory testing methods and frequencies will be as provided in Table 1. Hydraulic conductivity of installed low permeable soils shall be statistically significant.

Soil liner material will be thoroughly and uniformly compacted at a moisture content that is greater than or equal to optimum and shall be compacted to greater than or equal to 95% of standard proctor at 0 to +5% of the optimum moisture content as outlined in the project specifications. Each lift (maximum of 6-inch compacted lifts) will be integrated into the previous lift by techniques such as scarifying each lift and by using compaction equipment that is capable of penetrating the thickness of each compacted lift. EC shall compact with sheepsfoot roller, or similar kneading-type compactor. The feet of the compactor shall be greater in length than the thickness of each lift. EC shall compact the layers of clay to form continuous monolithic material with excessively dry or wet soil removed before placement of additional lifts; knead each lift into previously placed lift. Nuclear density methods will be preferred for moisture and density testing due



Construction Quality Assurance Plan

4 Low Permeability Soil Liner

to the ease of testing and the relatively large number of tests which can be run in a given period of time. Areas that are not sufficiently compacted, but are within the specified moisture range, must be re-worked and re-compacted over an area that extends one-half of the distance in all directions to the nearest passing test locations. Areas where the moisture is below the specified range must be watered evenly and re-worked to distribute the added moisture evenly. Areas where the moisture is above the specified range must be dried and re-compacted prior to re-testing. Questions concerning the accuracy of any single test will be addressed by retesting in the same location until a passing test is obtained.

Final surface shall be smooth-rolled prior to geosynthetic placement. Finished surface will be smooth and even with no sheepsfoot roller indentations. Surface must be smooth and free of debris, roots, and stones or rocks larger than 3/8 inch in diameter or angular stone of any size or any other material that would be deleterious to the overlying geomembrane liner. EC shall be responsible for the integrity of the low permeability clay liner and shall not allow the surface to dry or desiccate and make repairs, as needed, until the geosynthetic materials are placed, tested, and approved by the OWNER. CQA testing will be conducted on samples taken from the material during the course of construction. Sampling locations will be selected by the QAC according to the number of required tests. Locations of tests will be documented for report purposes.

A special testing frequency may be used when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- Lift thickness is greater than specified;
- Earthen fill is at variable moisture content;
- Dirt-clogged rollers are used to compact the material;
- Rollers may not have used optimum ballast;
- The degree of compaction is questionable.

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;
- Material fails to meet specifications;
- The size of the work area is increased.

Perforations in the soil liner will occur during construction due to in-place testing. The perforation would be caused by:

1. Nuclear density test probe locations.
2. Permeability sampling locations.

Unless otherwise directed by the QAC or OWNER, all perforations of the soil liner by probe or sample tube shall be backfilled with a soil-bentonite mixture. The mixture shall be compacted in-place with a tamping rod or hand tamper, depending on the size of the perforation.

Hydraulic conductivity testing will be performed at the frequencies provided in Table 1. The test locations will be on a grid that will maximize the coverage of the construction area, or as directed by the QAC to test



suspect areas. Soil density and moisture content will be documented for each lift on an offset grid to provide adequate coverage of the construction.

4.6 Damage and Repair

Should the subgrade become damaged during construction, the unsuitable material will be removed, and the OWNER may choose to either; replace the removed material with native fill and document the grades; or, replace the material with the same material used in the soil liner documenting the additional thickness in the affected area.

Areas of the low permeability soil liner that become damaged due to precipitation or desiccation will be reworked and retested until satisfactory results are obtained. If it appears unlikely to correct the damage by reworking the soil, the affected area will be removed and replaced.

4.7 Survey

The survey of specific locations will provide the basis for the record drawings and provide documentation of soil liner thicknesses. The major components of the survey will include the following at a minimum:

1. Top of subgrade.
2. Top of low permeability soil liner.

The survey will be conducted on a grid with survey points at major breaks in slope (i.e., top and toe of slope) and top and base of sumps. The grid will be extended vertically to enable calculation of vertical thicknesses of the liner or cover component. Grading tolerances are provided in Table 4.

4.8 Conformance with Project Specifications

The QAC shall document that the low permeability soil liner installation was done in accordance with the project specifications.



5 Geomembrane

5.1 General

Geomembranes are the geosynthetic component of the leachate storage, base liner, and or final cover systems. This section is applicable to the Polyethylene (PE) geomembranes used in the geomembrane systems applications. Material specifications for the geomembrane are displayed in Table 2.

5.2 Material Quality Control

5.2.1 Raw Material

The resin used to make geomembrane sheet shall be tested in accordance with the manufacturer's guidelines. Material ingredients of the geomembrane shall be randomly sampled by the manufacturing plant to ensure compliance with these specifications. Test reports of quality control tests, such as specific grading, melt flow index and carbon black content will be provided.

5.2.2 Geomembrane Material Specifications

The GI shall provide the QAC with the following:

1. A quality control certificate including the specified measure using test methods indicated at a frequency to meet conformance with the Geosynthetics Research Institute's (GRI) GM 17 for LLDPE and GRI GM 13 for HDPE.
2. Certification that property values given in the properties sheet are guaranteed by the GI.

The GI shall provide the following information to the QAC for each roll delivered to the site:

- Name of the manufacturer and fabricator
- Name and type of liner
- Thickness of liner
- Batch code
- Date of fabrication
- Physical dimensions
- Roll number
- Location and method of storage at the site

This information shall accompany each roll delivered to the job site.

The QAC will examine results and report any nonconformance to OWNER. QC results will be reviewed and accepted or rejected by the QAC prior to deployment.



5.3 Subgrade

When the geomembrane is placed on a soil subgrade, the EC shall be responsible for preparing the subgrade for the geomembrane. When the geomembrane is placed over another geosynthetic, the GI is responsible for the subgrade. Once complete, the QAC shall examine the surface, and verify the adequacy of the survey data provided. When the QAC deems the surface acceptable the QAC shall certify at a minimum:

1. The required subgrade survey has been completed and the results meet the specifications.
2. The subgrade has been inspected and meets the project requirements.

The GI will also inspect the subgrade and will sign the subgrade acceptance forms.

At any time during installation of the geomembrane, the QAC shall inform the OWNER of any areas that are unacceptable. Such defects in the subgrade shall be corrected by the appropriate contractor such that repaired areas meet the project specifications. If additional work is required on a soil subgrade it is the GI's responsibility to notify the EC and OWNER of such work and also provide this notification to the QAC.

5.4 Observations and Documentation

5.4.1 Roll Inspections

Prior to placement of any lining material, rolls shall be observed for defects and damage by both the QAC and the GI. Storage of the rolls shall be in a location that minimizes on-site handling and the possibility of damage.

Each roll shall have a roll label which clearly identifies the manufacturing information. This information, along with the panel number and location/method of on-site storage, shall be recorded by the QAC.

The QAC shall also visually observe each roll for imperfections or damage including holes, cracks, thin spots, tears, punctures, blisters, or the presence of foreign material.

5.4.2 Placement

5.4.2.1 Equipment

Equipment is not to be driven directly on the geomembrane material unless previously approved by the OWNER. The GI shall use equipment that does not damage the geomembrane by handling, trafficking, excessive heat, leakage of oils or other means. The method and equipment used to unroll the material shall not cause scratches, crimps or any damage to the underlying geosynthetics, or excessive rutting of the soil subgrade.



5.4.2.2 Method of Deployment

No personnel working on the geosynthetic liner shall smoke, wear damaging shoes or engage in other activities that could damage the geomembrane. The method used to place the panels shall minimize wrinkles.

Adequate temporary loading and/or anchoring shall be provided to prevent uplift of the liner by wind. The anchoring system shall not damage the liner.

The GI shall inspect each panel after placement and prior to seaming for damage. Damaged panels or portions of damaged panels that have been rejected shall be marked and their removal from the work area recorded.

5.4.2.3 Crest Anchorage System

An anchor trench may not be required dependent on the footprint of the cover system and tie-in locations. If required, the anchor trench shall be excavated to the lines and widths shown on the drawings, prior to geomembrane placement. The trench shall be drained to prevent ponding or softening of adjacent soils where trench is open. The corners of the trench shall be slightly rounded to avoid sharp bends in the geomembrane. The trench shall be backfilled and compacted by light compaction equipment to the required grade.

Since backfilling the anchor trench can affect material bridging at the toe of slope, or at the drainage terraces, consideration should be given to backfilling the liner at its most contracted state, preferably during the cool of the morning or extended period of overcast skies. Care should be taken when backfilling the trenches to prevent damage to the geosynthetics.

5.4.3 Trial Seams

To verify that seaming conditions are adequate, trial seams shall be performed on fragmented pieces of geomembrane. Trial seams shall be made as follows:

1. Approximately every 4-hours at the beginning of each seaming period (usually morning and afternoon)
2. Anytime equipment is turned off.
3. For each seaming apparatus
4. Other times as deemed necessary by the QAC.

A test weld, long enough to obtain required samples shall be run at the frequency described above (typically approximately 6 feet long).

The test weld shall be recorded on the GI's trial weld log with date, ambient temperature, and welding machine number. Testing shall be completed in accordance with the project specifications. The QAC will observe and document results of trial seam procedures.

Three adjoining specimens each 1-inch wide shall be cut from the trial seam sample. The specimens shall be tested respectively in shear and in peel using a field tensiometer and they shall not fail in the seam. If



any specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial welds are achieved. The QAC will observe and document results of trial seam procedures.

5.4.4 Field Seaming

5.4.4.1 Seam layout

Prior to liner installation, panel layout drawings shall be submitted and approved by the QAC and OWNER. Seams should typically be oriented parallel to the line of maximum slope. All seam-numbering and panel-numbering systems shall be agreed upon prior to installation. Individual liner panels shall be laid out and overlapped as required prior to welding. The area to be welded shall be cleaned prior to welding. Panel locations shall be recorded by the GI/QAC.

5.4.4.2 Seam Equipment and Accessories

The fusion welding apparatus will be an automated, vehicle-mounted device that produces a double seam enclosing a void. This apparatus shall be equipped with gauges permitting a direct reading of the applicable temperatures.

The extrusion welding apparatus shall be equipped with gauges giving the temperatures of the apparatus at the nozzle.

5.4.4.3 Weather Conditions for Seaming

Seaming shall not take place during precipitation, in the presence of excess moisture or in the presence of excessive winds. Excessive moisture is a condition where condensation or other moisture on the sheet is the cause of poor seams or seams failing non-destructive or destructive testing. Excessive winds shall be determined by the GI, but if the QAC feels panel deployment poses a safety concern with the wind or that the geomembrane cannot be adequately held in place with sandbags, deployment shall cease until wind conditions allow further seaming. Seaming shall not take place when panel temperatures are less than 32°F or more than 170°F unless authorized by the OWNER and QAC.

5.4.4.4 General Seaming Procedures

The rolls of geomembrane shall be overlapped as required by the manufacturer's specifications. The overlap shall be completed in the direction of drainage flow to provide unimpeded drainage of liquids above the geomembrane.

A base T-seam shall not be closer than 10 feet from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and "fish mouths". Excessively large wrinkles and all fish mouths shall be relieved and cap stripped.

The QAC shall document field seam locations and panel overlaps. Panels that are factory fabricated or factory seamed will undergo the same observation and documentation as panels that are field seamed.



5.5 Testing

5.5.1 Non-Destructive Seam Continuity Testing

The GI shall nondestructively test all field fusion seams over their full length by air-pressure testing. Extrusion-welded seams shall be tested by vacuum gauge.

Air pressure testing will be performed on most of the seams, since the double fusion-seaming method is the method of choice. Vacuum testing will be performed on extrusion welded seams. Air pressure and vacuum testing shall be in accordance with the project specifications.

5.5.1.1 Air Pressure Testing

This type of testing will be performed on most of the seams as the double fusion-seaming method is the method of choice.

Generally, the equipment shall be comprised of the following:

- An air pump capable of providing a pressure at a minimum of 30 pounds per square inch (psi);
- A rubber hose with fittings and connections;
- A sharp hollow needle or other approved pressure-feed device.

The following procedures shall be followed:

1. Seal both ends of the seam to be tested.
2. Insert needle or other approved pressure-feed device into the tunnel created by the fusion weld.
3. Energize the air pump to a minimum 30 psi; close the valve and sustain pressure for a minimum of five minutes.
4. If loss of pressure exceeds 2 psi or does not stabilize, locate the faulty area, repair, and retest (either vacuum or air test).

5.5.1.2 Vacuum Testing

The equipment shall be comprised of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a gauge to indicate chamber vacuum;
- A pump assembly equipped with a pressure controller and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections;
- A bucket and wide brush or spray assembly;
- A soapy solution.

The following procedures will generally be followed:

1. Wet a strip of geomembrane approximately 12 x 48 inches with the soapy solution.
2. Place the box over the wetted area.
3. Close the bleed valve and open the vacuum valve.
4. Ensure that a leak-tight seal is created.



5. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
6. For a period of approximately 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 1-inch overlap, and repeat the process. Areas where soap bubbles appear shall be marked and repaired in accordance with Section 5.6.

The QAC shall document the following for each non-destructive seam test:

- Date
- Seam number
- Welder I.D.
- Seamer
- Air Pressure

5.5.2 Destructive Testing

Destructive seam tests shall be performed every 500 lineal feet of seam. This requirement will apply to all seams with the exception of the seam connecting the base liner to the cover system liner. The purpose of these tests is to check that welds are fully integrated with each other and to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of field seaming. Destructive samples shall be taken from seams along the slopes of the base liner system and not from the floor.

5.5.2.1 Location and Frequency

The QAC shall select locations where seam samples will be cut. These locations shall be estimated as follows:

- a) A minimum frequency of one test location per 500 feet of seam length. This minimum frequency is to be determined as an average taken throughout the entire facility.
- b) The seaming technician shall not be informed in advance of the locations where the seam samples will be taken.

5.5.2.2 Sampling Procedure

Sampling shall be cut by the GI as the seaming progresses in order to have timely laboratory test results. The GI shall:

- a) Cut samples.
- b) Assign a number to each sample that is to be based upon seam and sample number and mark it accordingly.
- c) Record sample location on construction record drawings.
- d) All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with the project specifications. The continuity of the new seams in the repaired area shall be tested accordingly.



5.5.2.3 Size of Samples

Samples shall be approximately 16 X 44 inches for testing to be distributed in accordance with the project specifications for field documentation testing, OWNER independent laboratory testing, and OWNER archive storage.

Final determination of the sample sizes shall be determined prior to liner installation at the preconstruction meeting.

5.5.2.4 Field Testing

For field testing, the GI shall cut 10 identical 1-inch wide replicated specimens from the sample. The GI shall test five specimens for seam shear strength and five for peel strength. Peel tests shall be performed on both inside and outside weld tracks. To be acceptable 5 out of 5 specimens must pass the test criteria with less than 10% separation. If any field test sample fails to pass, then the procedures outlined in the specifications shall be followed.

5.5.2.5 Laboratory Testing

Passing tensiometer testing in the field qualifies the sample for laboratory testing.

Destructive test samples shall be packaged and shipped to the geomembrane testing laboratory consultants by overnight mail. The laboratory shall provide test results to the QAC.

Destructive testing involves two techniques: 1) shear testing, and 2) peel testing. Shear testing applies a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing peels the top sheet back against the overlapped edge of the bottom sheet in order to observe how separation occurs. The peel test indicates whether the sheets are continuously and homogeneously connected through the seam. A total of 10 coupons will be subject to testing, for which five will be tested in shear and 5 in peel (ASTM D6392). Fusion seam specimens will have both tracks tested in peel.

Both tests (shear and peel) must have a Film Tearing Bond (FTB) type of separation to pass. With an FTB, the polymer material tears indicating a fully integrated connection between top and bottom sheets. It is important that no weld bead/sheet or sheet/sheet interface exists as such an interface might be separated by absorbed chemicals, causing failure of the seam. The criteria for pass/fail are outlined in Table 3; 5 out of 5 specimens must meet the requirements.

The QAC shall document the following for each destructive seam test:

- Location
- Seam number
- Welder I.D.
- Seamer
- Sample I.D.



5.5.2.6 Procedures for Destructive Test Failure

Procedures for destructive test failure are outlined in the specifications.

The GI and QAC shall document all actions taken in conjunction with destructive test failures; e.g., capping of failed seam area.

5.6 Defect and Repairs

All seams and non-seam areas of the geomembrane shall be examined by the GI and QAC for identification of defects, holes, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.

5.6.1 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in this section as appropriate. Each location that fails the nondestructive testing shall be marked by the GI and repaired. Work shall not proceed with any materials that will cover locations that have been repaired until non-destructive test results are recorded.

5.6.2 Repair Procedures

All portions of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired in accordance with the project specifications. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the QAC, GI, and OWNER. The procedures available include:

1. Patching: Used to repair large holes, tears, and contamination by foreign matter.
2. Buffing and re-welding: Used to repair small sections of extruded seams.
3. Spot welding or seaming: Used to repair small tears, pinholes, or other minor localized flaws.
4. Capping: Used to repair areas of inadequate seams that have an exposed edge.

In addition, the following provisions shall be satisfied:

1. Surfaces of the geomembrane that are to be repaired shall be abraded no more than one hour prior to the repair.
2. Surfaces must be clean and dry (extrusion welding will not be allowed in the presence of excess moisture above or below the geomembrane) at the time of repair.
3. Seaming equipment used in repairing procedures must be approved.

The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the QAC.

Patches or caps shall extend at least six (6) inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least three (3) inches.



5.6.3 Verification of Repairs

Each major repair requiring a patch or cap shall be identified in the GI's repair log. Each repair shall use nondestructive test methods described in this section as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be re-done and re-tested until passing test results are obtained. The QAC may choose to take a destructive test in an area of repair. The QAC shall document the location of each type of repair and the type of repair made.

5.7 Final Acceptance

The geomembrane must be observed for completion of liner construction activities. The final inspection shall be performed by the QAC, GI and OWNER. The QAC and GI shall document completion or incompleteness. The GI shall repair or complete any testing that has been determined incomplete. The QAC and GI shall then re-inspect the repairs and observe testing to complete final inspection.

Geomembrane material shall be final inspected prior to being covered by overlying geosynthetic materials or soil layers.

5.8 Conformance With Project Specifications

The QAC shall document that the installation and necessary repairs were done in accordance with the project specifications.

5.9 Interface Friction Testing (Optional)

At the request of the OWNER, if geomembrane is installed on a slope greater than 10%, samples may be collected for interface friction testing. Testing will be completed and results reviewed prior to installation of the geosynthetic components. Material interfaces to be analyzed will be identified by the OWNER based on the liner system profile(s) for the designated project.



6 Geonet/Geotextile Geocomposite

6.1 General

A geonet/geotextile geocomposite consists of a HDPE geonet with a geotextile heat-bonded to one or both sides. Geocomposite shall be used as indicated on the Drawings and are typically used in the leachate collection system sump(s) and/or final cover system. The geotextile prevents clogging of the geonet by the overlying granular materials.

6.2 Material Quality Control

The manufacturer shall provide a list of guaranteed minimum average roll value properties for the specified geotextile and geonet components and the combined geocomposite material to be installed. Each roll of geocomposite shall bear a label which identifies the properties listed.

The QAC will examine results and report any nonconformance to OWNER. QC results will be reviewed and accepted or rejected by the QAC prior to deployment.

6.3 Subgrade

The GI shall be responsible for preparing the subgrade for the geocomposite. Once complete, the QAC shall examine the surface, and verify the adequacy of the documentation completed and any test data required. When the QAC deems the surface acceptable, the QAC shall prepare an acceptance certificate for the OWNER. The acceptance certificate shall state the following at a minimum:

1. Documentation of the underlying geosynthetics is complete, and any necessary tests show satisfactory results.

At any time during installation of the geocomposite, the QAC shall inform the OWNER of any areas which are unacceptable. Such defects in the subgrade shall be corrected by the GI such that repaired areas meet the project specifications. The subgrade for the geocomposite will be clear of any soil, stones, or other debris which could clog or damage the geocomposite.

6.4 Observation and Documentation

6.4.1 Roll Inspections

Prior to placement, rolls shall be inspected for damage and defects by the QAC and GI.

During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Consistent with these objectives, geocomposite rolls shall be shipped and stored in relatively opaque and watertight wrappings. The GI shall be responsible for proper on-site storage of all geosynthetic materials.



6.4.2 Placement

The geocomposite material shall be handled in such a manner as to ensure there is not damaged. On slopes, material shall be anchored in the anchor trench; then rolled down the slope in such a manner as to minimize wrinkles.

In the presence of wind, the materials shall be weighted with sandbags until final covers are installed. Care shall be taken to ensure that any underlying liners/layers are not damaged during placement of geocomposite. Vehicle use directly over a geocomposite that overlies a geomembrane is prohibited as a standard means of deployment.

Care shall be taken to ensure that stones, mud, dirt and debris are not entrapped beneath the geocomposite during placement and seaming operations which cause damage.

6.4.3 Seaming

The geocomposite may be butt-jointed or lapped according to manufacturer's specifications. Polymer cable ties shall be applied to the net edge at five (5) foot intervals along the edge. End splices shall be made as follows: On slopes, the ends shall overlap two (2) feet, in a shingle configuration, and two (2) rows of cable ties applied at each overlap.

The QAC shall document that the panel overlap meets the project specifications and that there are no excessive folds or wrinkles in the geocomposite.

6.5 Damage and Repairs

Any holes or defects in geocomposite shall be repaired by patching with the same geocomposite. The patch shall be a minimum of 24 inches larger than the area to be repaired in all directions. The patch shall be tied in place using a minimum of four nylon cable ties.

The QAC shall document that any holes or defects were repaired.

6.6 Conformance With Project Specifications

The QAC shall document that the installation and necessary repairs were done in accordance with the project specifications.



7 Geotextile

7.1 General

This section addresses geotextiles that may be used as part of a synthetic drainage system, gas collection systems, and/or for puncture protection.

7.2 Material Quality Control

The manufacturer shall provide a list of guaranteed minimum average roll value properties for the specified geotextile to be installed. Each roll of geotextile shall bear a label that identifies the properties. The QAC will examine results and report any nonconformance to OWNER. QC results will be reviewed and accepted or rejected by the QAC prior to deployment.

7.3 Observation and Documentation

7.3.1 Roll Inspection

Prior to placement, rolls shall be inspected for damage and defects by the QAC. During shipment and storage, geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Consistent with these objectives, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. The EC or GI shall be responsible for proper on-site storage of geotextile materials and geotextiles shall be handled in such a manner as to ensure they are not damaged.

7.3.2 Placement and Seaming

On slopes, material shall be anchored in the anchor trench; then rolled down the slope in such a manner as to minimize wrinkles. In the presence of wind, the materials shall be weighted with sandbags. Care shall be taken to ensure that stones, mud, dirt and debris are not entrapped beneath the geotextile during placement and seaming operations that could cause damage.

Geotextiles shall be sealed by overlapping 4 inches and sewing or by an alternate method as approved by the QAC and OWNER. Manufacturers recommended overlap lengths will be followed for slope applications. Sewing threads shall be a polymeric material with chemical resistance similar to the geotextile. The QAC shall observe and document that the panel overlap meets the project specifications and that there are no excessive folds or wrinkles in the geotextile.

7.3.3 Damage and Repairs

Any holes or tears in geotextiles shall be repaired by patching with the same geotextile materials. The patch shall be a minimum of 24 inches larger than the area to be repaired in all directions and shall be thermally



spot-bonded (lystered) or stitched in accordance with the technical specifications. The QAC shall document that any holes or defects were repaired.

7.4 Conformance with Project Specifications

The QAC shall document that the installation and necessary repairs were done in accordance with the project specifications.



8 Granular Drainage Media

8.1 General

The granular drainage media consists of natural material used as a drainage layer in the base liner and/or cover liner systems.

8.2 Material Quality Control

Samples of the granular drainage media will be tested in-place or during placement for grain size distribution and hydraulic conductivity. Frequencies are provided in Table 1 and acceptability criteria are listed in the technical specifications. Source testing requirements are identified in the technical specifications. It should be noted that the acceptable grain size distribution is variable based on the liner system profile selected by the OWNER for use.

The QAC shall examine the results and report any nonconformance to the OWNER. QC results shall be reviewed and accepted or rejected by the QAC prior to installation.

8.3 Observation and Documentation

Observations of the construction work by QAC or OWNER include the following:

- Hauling of material to ensure no damage to underlying geosynthetics
- Spreading of granular drainage media material to ensure excess wrinkling of underlying geosynthetics does not occur. **Spreading of granular drainage material may be conducted up slope only.**
- Placement of pipes to ensure proper bedding and coverage and protection of underlying geosynthetics per the Construction Drawings.
- Documentation will include; laboratory test data, material information, placement methods and thicknesses.
- Observation of installation method of which considerations must be taken to prevent migration of fines by run-off into the granular drainage media.

8.4 Testing

CQA testing will be conducted on samples taken from the material during construction. Sampling locations will be selected by QAC or OWNER according to the number of required tests. Locations of all tests will be documented for report purposes. Laboratory test methods and frequencies required for in-place testing are provided in Table 1. Source testing requirements are identified in the technical specifications.

8.5 Damage and Repairs

Granular drainage media that does not meet the requirements of the CQA Plan or the Specifications will be removed by the EC and replaced with suitable material.



8.6 Survey

The minimum thickness of soil drainage media shall be as shown on the drawings and extending over the lining system. The thickness of granular drainage media shall be verified on a grid spacing and tolerances as specified in Table 4.

For closure constructions, settlement verification locations will be used to account for settlement with correction factors applied to document appropriate thickness of granular drainage placed. The settlement verification locations will be determined by the QAC prior to granular drainage media placement.

8.7 Conformance With Project Specifications

The QAC shall document that the granular drainage media installation was done in accordance with the project specifications.



9 Piping Systems

9.1 General

This section addresses the HDPE piping installed for the gas extraction, leachate collection, stormwater management, and other systems that may be constructed.

9.2 Material Quality Control

The EC (or other piping contractor, if applicable) shall inspect all piping and fittings received at the site and shall verify that piping materials are:

- 1) In accordance with drawings and specifications (size, SDR ratio, material)
- 2) Free of material defects
- 3) Undamaged

EC shall be responsible for storing piping materials in a protected location where they will not be damaged.

The EC shall provide material testing results per the project specifications; QAC shall examine the results and report any nonconformance to the OWNER. QC results shall be reviewed and accepted or rejected by the QAC prior to installation.

9.3 Observation and Documentation

9.3.1 Installation

EC shall install piping at locations and elevations as shown on drawings. All piping connections shall be made in accordance with manufacturer's recommendations and with the technical specifications. Installation of backfill around piping shall be done carefully to ensure damage to the piping does not occur. QAC will document piping types installed, methods of connection/fitting types, and backfilling procedures. Documentation of the piping will include information on the method used to join sections of the pipe.

9.3.2 Pressure Testing

Pressure testing will be used to test all sections of HDPE forcemain and non-perforated gas collection piping. Testing must be performed in the presence of the QAC. Testing will be performed on pipe sections prior to backfilling. Any leaks or defects shall be corrected by the EC and retest the section at no additional cost to the OWNER.

The QAC will witness and document the final test of all piping. The test report for each piping system tested and for each tank testing shall include the following information at a minimum:

- Date of test
- Description and identification of piping system tested



- Type of test performed
- Test pressure
- Type and location of leaks detected, if any
- Corrective action taken to repair leaks
- Results of retesting
- Video inspection results, if applicable

Following the final pressure tests, the OWNER may choose to have the entire gas or leachate piping system video inspected using standard service inspection and equipment. If shavings or debris are found, a water (jet) flush of the entire system is required. The use of a video inspection will be at the sole discretion of the OWNER.

9.4 Damage and Repairs

Damaged or defective portions of the piping, as determined by QAC, will be removed and replaced.

9.5 Survey

The piping will be surveyed to verify minimum required grade and alignments. Pipe tolerances are provided in Table 4.

9.6 Conformance With Project Specifications

The QAC shall document that the piping installation was done in accordance with the project specifications.



10 Pumps and Controls

10.1 General

This section addresses the collection of sump side slope riser pumps, meters, and associated electrical controls for the leachate management system.

10.2 Material Quality Control

The EC (or other contractor, if applicable) shall inspect pumps, meters, and associated electric controls received at the site and shall verify that materials are:

- 1) In accordance with drawings and specifications.
- 2) Free of material defects.
- 3) Undamaged.

EC shall be responsible for storing materials in a protected location where they will not be damaged.

The QAC shall examine the results and report any nonconformance to the OWNER. QC results shall be reviewed and accepted or rejected by the OWNER prior to installation.

10.3 Observation and Documentation

EC shall install materials in accordance with engineering plans and specifications. All connections shall be made in accordance with manufacturer's recommendations. The pumping system equipment, especially related to the leachate removal/detection system, will be documented by the QAC, including: material and equipment, coatings and electrical/mechanical requirements.

10.4 Testing

The pump system and controls shall be tested for proper operation in accordance with manufacturer's requirements. This test will be observed by the QAC or OWNER.

10.5 Damage and Repair

Damaged or defective materials, as determined by QAC, will be removed and replaced.

10.6 Conformance With Project Specifications

The QAC shall document that the installation of pumps and controls was done in accordance with the project specifications.



11 Vegetative Soils

11.1 General

The vegetative layer will be topsoil capable of sustaining vegetative grasses over areas disturbed during construction.

11.2 Observation and Documentation

The QAC will observe and document the placement methods of the vegetative soils. The EC (or other contractor, if applicable) shall ensure conformance to the project requirements regarding topsoil quality and placement, fertilizer content and application, seed mixture, seeding operations, mulching, and reseeding/repair work to sustain vegetation.

The QAC shall examine the results and report any nonconformance to the OWNER. QC results shall be reviewed and accepted or rejected by the QAC prior to installation.

Topsoil thickness shall be documented to verify conformance with the Drawings and in accordance with the specifications and Table 4.

11.3 Damage and Repair

Seeded areas must be guaranteed by the EC to be alive and in satisfactory growth for a period of 1 year. If areas of non-growth or spotty growth are present, they will be reseeded.



Tables

Table 1 – Soil Quality Assurance Testing Requirements

Table 2 – Geosynthetics Quality Assurance Testing Requirements

Table 3 – Geomembrane Quality Assurance Testing Requirements

Table 4 – Grade Tolerances



TABLE 1
Soils Quality Assurance Testing Requirements

Subgrade / Controlled Fill			
Test	Method	Number of Tests	Pass/Fail Criteria
Standard Proctor	D698	Minimum 1	NA -
USCS Classification	D2487		
Dry Density	D6938 (nuclear)	1/Acre (Cell Subgrade) 1/3,000 CY Placed, minimum 1 per placed lift (Subgrade and Berm Construction/Embankment)	95% Standard Proctor

Clay Barrier Layer Testing			
Test	Method	Number of Tests	Pass/Fail Criteria¹
Grain Size	D6913, D7928, and D1140	1/3,000 cubic yards	≥50% passing the #200 sieve; max 10% gravel; max particle size 1 inch (minimum 98% passing)
Atterberg Limits	D4318		LL≥25% PI≥12
USCS Classification	D2487		CL, CH, SC
Standard Proctor	D698		NA
Permeability ²	D5084	Min. 5 and up to 8 (each cell development or for each 10-acres of closure)	(Max. 1×10^{-7} cm/sec) ³
Dry Density and Moisture Content	D6938 (nuclear)	≥95% Standard Proctor and 0-5% of OMC	Test on 100-foot grid pattern Offset every lift-min 5 tests/acre/lift

Note 1: A bag sample will be collected for testing at each permeability sample location; however, not all bag samples will be tested. Grain size distribution and Atterberg limits are indicator parameters and results will be reviewed to confirm material consistency; per rule requirements, the in-place permeability is the ultimate performance standard.

Note 2: A duplicate thin wall tube (TWTs) will be collected at each permeability sample location.

Note 3: Passing/fail criteria for hydraulic conductivity of in-place clay shall be statistically significant as outlined within Section 4 of the CQA Plan.

TABLE 1 - cont.
Soils Quality Assurance Testing Requirements

Granular Drainage Layer Testing (Cell Construction)			
<i>Granular Drainage Layer Testing</i>			
Test	Method	Number of Tests	Pass/Fail Criteria
Grain Size	D6913 and D1140	1 per acre	Min. 99% passing 3/8" sieve; Max 5% passing #200 sieve
USCS Classification	D2487		Per Grain Size
Permeability	D2434		1×10^{-2} cm/sec
<i>Alternate Granular Drainage Layer Testing¹</i>			
Grain Size ²	D6913 and D1140	1 per acre	Min. 99% Passing 2" sieve; Max 5% passing #200 sieve
USCS Classification	D2487		Per Grain Size
Permeability	D2434		1×10^{-2} cm/sec

¹ – Alternate granular drainage layer will be installed with a designed protective geotextile underlayment.

² – Grain size is dependent on the design of the protective geotextile underlayment and may vary at time of construction.

Granular Drainage Layer Testing (Closure Construction)			
Test	Method	Number of Tests	Pass/Fail Criteria
Grain Size	D6913	1/2,000 cubic yards Min. 1/source Min. 3 tests	<5% passing No. 200 Max. 3/8" (99% passing)
USCS Classification	D2487	1/2,000 cubic yards Min. 1/source Min. 3 tests	-
Hydraulic Conductivity	D2434	1/5,000 cubic yards Min. 1/source Min. 3 tests	$\geq 1 \times 10^{-2}$ cm/sec at 90% standard proctor dry density

TABLE 1 – cont.
Soils Quality Assurance Testing Requirements

Leachate Collection Coarse and Intermediate Aggregate Testing (Cell Construction Only)			
Test	Method	Number of Tests	Pass/Fail Criteria
Grain Size	D6913	1/2000 CY (Min. 3)	Per Specification
USCS Classification	D2487	1/3000 CY (Min. 3)	Per Specification

Rooting Zone & Topsoil			
Test	Method	Number of Tests	Pass/Fail Criteria
Visual Observation	--	--	Particle size and material limitations per the specifications.

TABLE 2
Geosynthetic Quality Assurance Testing Requirements

Geonet Geocomposite		
Test	Reference	Frequency
Material Properties	Spec Section 02921 02924	By manufacturer Every Roll Provided
Visual Inspection of Material and Seams	Spec Section 02921 02924	Entire installation

Geotextile		
Test	Reference	Frequency
Material Properties	Spec Section 02921	By manufacturer Every roll provided
Visual Inspection of Material and Seams	Spec Section 02921	Visual Inspection of Material and Seams

TABLE 3
Geomembrane Quality Assurance Testing Requirements
Dickinson Construction Quality Assurance Plan

Geomembrane Testing		
Test	Reference	Frequency
Material Properties	GRI GM 13 (LLDPE) GRI GM 17 (HDPE) (Latest Edition)	By manufacturer Every roll provided
Visual Inspection	Tech Spec 02920 02922	Entire sheet
Trial Seam Welding	Tech Spec 02920 02922	Start of seaming process, any time equipment turned off, at the end of each work day, twice per day minimum, each seamer or seaming apparatus
Non-Destructive Seam Testing	Tech Spec 02920 02922	All seams/patches
Destructive Seam Strength Test	ASTM D6392 / GRI GM 19a (Latest Edition)	1 test per 500 L.F. seam minimum

TABLE 4
Grading Tolerances
Dickinson Construction Quality Assurance Plan

Grading Tolerance Cell Construction				
Soil Layer/Surface	Measurement	Method	Pass/Fail Criteria	Frequency
Top of Subgrade	Elevation	Survey	-0.2' to 0.0'	50' grid ¹
Top of Soil liner (base grade)	Thickness	Survey	0.0' to +0.2', 2' minimum thickness	50' grid ¹
Granular drainage layer	Thickness	Survey	0.0' to +0.2', 1' minimum thickness	50' grid ¹
Leachate Collection System Piping / Other Piping	Elevation	Survey	±0.1', minimum slope	50' and changes in direction and all pipe fittings

Grading Tolerance Closure Construction				
Soil Layer/Surface	Measurement	Method	Pass/Fail Criteria²	Frequency
Top of Subgrade	Elevation	Survey	+ 0.2'	50' Grid and Breaklines ²
Top of Drainage Layer	Thickness	Survey or Hand Probe	12-inch minimum (if used) ³	50' Grid
Top of Rooting Zone Layer	Thickness	Survey or Hand Probe	6-inch or 18-inch minimum ³	50' Grid
Top of Final Cover	Elevation & Thickness	Survey	+0.2' 6-inch minimum topsoil	50' Grid and Breaklines ²
Surface Water Drainage System Piping/ Gas System Piping/ Other Piping	Elevation	Survey	Minimum required slope/grade per Drawings	Fittings, changes of direction, and every 50' along piping

¹ Also breaks in grade and bases of sump

² Final cover grades may be lower than permit elevations; therefore, a maximum tolerance only is listed for soil layer elevations.

³ If geocomposite is utilized in the final cover system, the granular drainage layer would be eliminated and the required minimum thickness for the rooting zone layer would be 18".



With every community, we redefine what's possible.



Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

Stantec Consulting Services Inc.
One Carlson Parkway North, Suite 100
Plymouth MN 55447-4440
stantec.com

Attachment 5 – Contaminant Movement Memo

To: George Fletcher, PE
Spirit Lake, IA

From: Christopher Kaiser
Plymouth, MN

Project/File: 227708272

Date: February 24, 2026

Reference: Groundwater Underdrain Contaminant Movement Potential at the Dickinson Landfill (30-SDP-01-75P)

On behalf of Dickinson Landfill, Inc. (DLI), the owner and operator of the Dickinson Landfill (Landfill), this memo provides supporting information on the potential for contaminant movement at the Landfill with and without an operational underdrain and a potential change in slope stability of the liner system. DLI proposed decommissioning of its current groundwater underdrain system in *Attachment 10* of the *Solid Waste Permit Renewal Application* for the Landfill, dated November 25, 2025 (Renewal Application), which currently acts to lower the natural groundwater table in cells B and C of the Landfill. This proposal was made based on Iowa Department of Natural Resources (IDNR) correspondence indicating that changes to Iowa Administrative Code (IAC) Chapter 113 are forthcoming and that precedence for approval of similar proposals in the State of Iowa exist. In support of this proposal, information related to the potential for uplift at the Landfill was provided as *Appendix B of Attachment 6 (Development and Operations Plan)* in the Renewal Application.

The IDNR comment letter, dated December 19, 2025, requested additional information on the implications of contaminant movement at the Landfill if groundwater underdrains were to be decommissioned at the Landfill. This memo provides a review of available information related to the potential for contaminant transport in traditional, subtitle D, composite liner systems (CLS) with varying separation distances from the groundwater table. In general, available information indicates that the potential for contaminant transport in submerged CLS is similar to, or less than, those with the standard 5-feet of separation.

Landfill Liner System

The Landfill's CLS is consistent with the standard Subtitle D liner system, and includes a 60-mil high density polyethylene (HDPE) geomembrane liner that is underlain by a two-foot thick compacted clay liner that has a hydraulic conductivity less than 1×10^{-7} cm/sec. IAC Chapter 113 requires that there be five-feet of separation between the base of waste and the seasonal high groundwater table. Based on the design of the Landfill's CLS, a minimum two-foot separation between the base of the clay liner and the groundwater table (often referred to as an "attenuation layer" in literature) is required to be present at all municipal solid waste landfills (MSWLF) in Iowa. At the Landfill, this attenuation layer in Cell B and C is maintained through operation of the Landfill's underdrains GU-B and GU-C, respectively.

Reference: Groundwater Underdrain Contaminant Movement Potential at the Dickinson Landfill (30-SDP-01-75P)

Contaminant Transport Potential at the Landfill

Contaminant transport at landfills is largely a function of the advective and diffusive flux of contaminants (Shackelford & Rowe, 1998). Advective flux is related to the leakage of a contaminant (i.e., landfill leachate) through a landfill's CLS, whereby it would eventually reach the underlying groundwater table. Diffusive flux relates to the flow of contaminants from high concentrations to low concentrations and is governed by the environmental and physical properties of the CLS and attenuation layer. Advective flux can be impacted by imperfections (e.g., punctures, weak seams, etc.) in the geomembrane or degradation of the clay liner, while diffusive flux is largely controlled by the specifics of the contaminant and the surrounding environment. In addition, diffusive flux relates largely to transport of the volatile fraction of a contaminant, while the non-volatile contaminant fraction is traditionally assumed to be transported via advective processes (Celik, et. al, 2009). In a traditional Subtitle D CLS, advection is mitigated through the geomembrane component of the CLS, while diffusion is mitigated through the compacted clay component of the CLS and, in theory, the minimum two-foot thick attenuation layer.

The performance of subtitle D CLSs is difficult to quantify, however, Katsumi, et al. and others have developed equations to estimate the diffusive and advective mass fluxes of varying CLS configurations (Katsumi, et al., 2001). These calculations are based on scenarios where there is an outward hydraulic gradient between the MSWLF and the surrounding hydrologic environment (i.e., advective transport of contaminants is possible). It is noted that this potential for advective transport is theoretically eliminated when an inward hydraulic gradient between an MSWLF and the hydrologic environment exists (i.e., leachate heads lower than potentiometric head). Based on available environmental monitoring information and the provided uplift analysis, such a scenario would exist at Cells B and C of the Landfill should the underdrain system be decommissioned.

The removal of advective transport potential significantly reduces the potential contaminant flux that can arise from a landfill, as discussed further in the case study summarized below. Under this scenario, the potential for contaminant movement is primarily related to the potential for the diffusive transport of volatile compounds. Hydraulically contained MSWLFs are commonplace in other parts of the world, such as in the United Kingdom where MSWLFs are intentionally designed below the water table to eliminate advective contaminant transport (Buss et al., 2004). Design of a MSWLF with an inward hydraulic gradient therefore mitigates potential advective contaminant fluxes which can occur at a MSWLF due to holes in a geomembrane, and which can be exacerbated by imperfections in liner installation (e.g., wrinkles, poorly/variably compacted clay liner, etc.), as explained by Giroud and others (Giroud et al, 1989/1990/1997; Giroud, 1997).

Case Study – Metro Park East Landfill 2018 Request to Eliminate Groundwater Separation

A comparison of contaminant transport under varying CLS configurations was provided to the IDNR in a letter prepared for the Metro Park East (MPE) Landfill by Barker Lemar Engineering Consultants (Barker Lemar), dated January 4, 2018 (IDNR Document DNA # 91213). Within the letter, Barker Lemar presented a case that an attenuation layer (as required for MSWLFs by IAC Chapter 113), while theoretically leading to lessened diffusive transport potential, equally provides for increased potential for advective transport of

Reference: Groundwater Underdrain Contaminant Movement Potential at the Dickinson Landfill (30-SDP-01-75P)

contaminants via groundwater. The information presented in Barker Lemar's letter was based on the comparison of the modeled output of contaminant fluxes under varying CLS configurations. The Barker Lemar letter concluded that there is a potential for increased rates of contaminant transport through at Subtitle D CLS with a two-foot thick attenuation layer when compared to a Subtitle D CLS with no attenuation layer, or one that is submerged (Barker Lemar, 2018).

The Barker Lemar letter provides for a general case study for the efficacy of a Subtitle D CLS with two-foot attenuation layer's ability to protect against the advective and diffusive transport of contaminants. Based on the conclusions of the letter, inclusion of the minimum two-foot attenuation layer, as required by IAC, may not necessarily provide for a more protective CLS. Many of the conclusions reached in the Barker Lemar letter are believed to also be applicable to the Landfill, and collectively support DLI's request to decommission the underdrain system at the Landfill.

Summary and Closing

Based on a review of published sources and the environmental conditions at the Landfill, it is Stantec's opinion that the potential contaminant mass flux from the Landfill would be reduced by decommissioning GU-B and GU-C. This reduction in potential contaminant mass flux relates largely to the theoretical elimination of advective contaminant transport potential due to the inward hydraulic gradient which would be present in Cells B and C after shutting off each cell's respective underdrain. This understanding is consistent with the published sources referenced in this memo and also follows precedence set by Barker Lemar's letter for the MPE Landfill. A reference list for sources cited herein is provided with this letter as **Attachment 1**.

Regards,

Stantec Consulting Services Inc.



Christopher Kaiser PG (MN)
Hydrogeologist
Phone: (763) 479-5107
chris.kaiser@stantec.com

stantec.com

Attachment: Attachment 1 – References Cited

c. Tyler Field, Erin Bulson, Cory Anderson, Megan Ambuehl, Paul Schmidt

Attachment 1 – References Cited

- Giroud, J.P. Equations for calculating the rate of liquid migration through composite liners due to geomembrane defects. *Geosynthetics International*, 4(3-4), 335-34 (1997a)
- Giroud, J.P., Badu-Tweneboah, K., and Bonaparte, R. Rate of leakage through a composite liner due to geomembrane defects. *Geotextiles and Geomembranes*, 8, 71-111. (1990)
- Giroud, J.P., Badu-Tweneboah, K., and Soderman, K.I. Comparison of leachate flow through compacted clay liners and geosynthetic clay liners in landfill liner systems. *Geosynthetics International*, 4(3-4), 391-431. (1997b)
- Giroud, J.P., and Bonaparte, R. *Leakage through liners constructed with geomembranes– Part I*. *Geotextiles and Geomembranes*, 8, 27-67. (1989a)
- Giroud, J.P., and Bonaparte, R.. *Leakage through liners constructed with geomembranes– Part II. Composite Liners*. *Geotextiles and Geomembrane*. (1989b)
- Buss, S.R., Herbert, A.W., Green, K.M., Atkinson, C. *Contaminant fluxes from hydraulic containment landfills - a review*. Environment Agency Science Report SC0310/SR (2004).
- Katsumi, T. Benson, C.H., Foose, G.H., Kamon, M. *Performance-Based Design of Landfill Liners*. *Engineering Geology* 60: 139-148 (2001).
- Celik, B. Rowe, R.K., Unlu, K. *Effect of Vadose Zone on the Steady-State Leakage Rates from Landfill Barrier Systems*. *Journal of Waste Management* 29: 103-109 (2009).
- Shackelford, C.D. & Rowe, R.K. *Contaminant transport modeling*. Proceedings of the 3rd International Congress on Environmental Geotechnics. Rotterdam: Balkema. (1998)
- Barker Lemar Engineering Consultants. *Request to Eliminate 5-Foot Groundwater/Waste Separation Requirement*. IDNR Document DNA ID Number 91213 (2018).