Attachment G

Information for Separation to Bedrock and Separation to Water Table and Revised Underdrain Calculations and Surface Comparison Maps

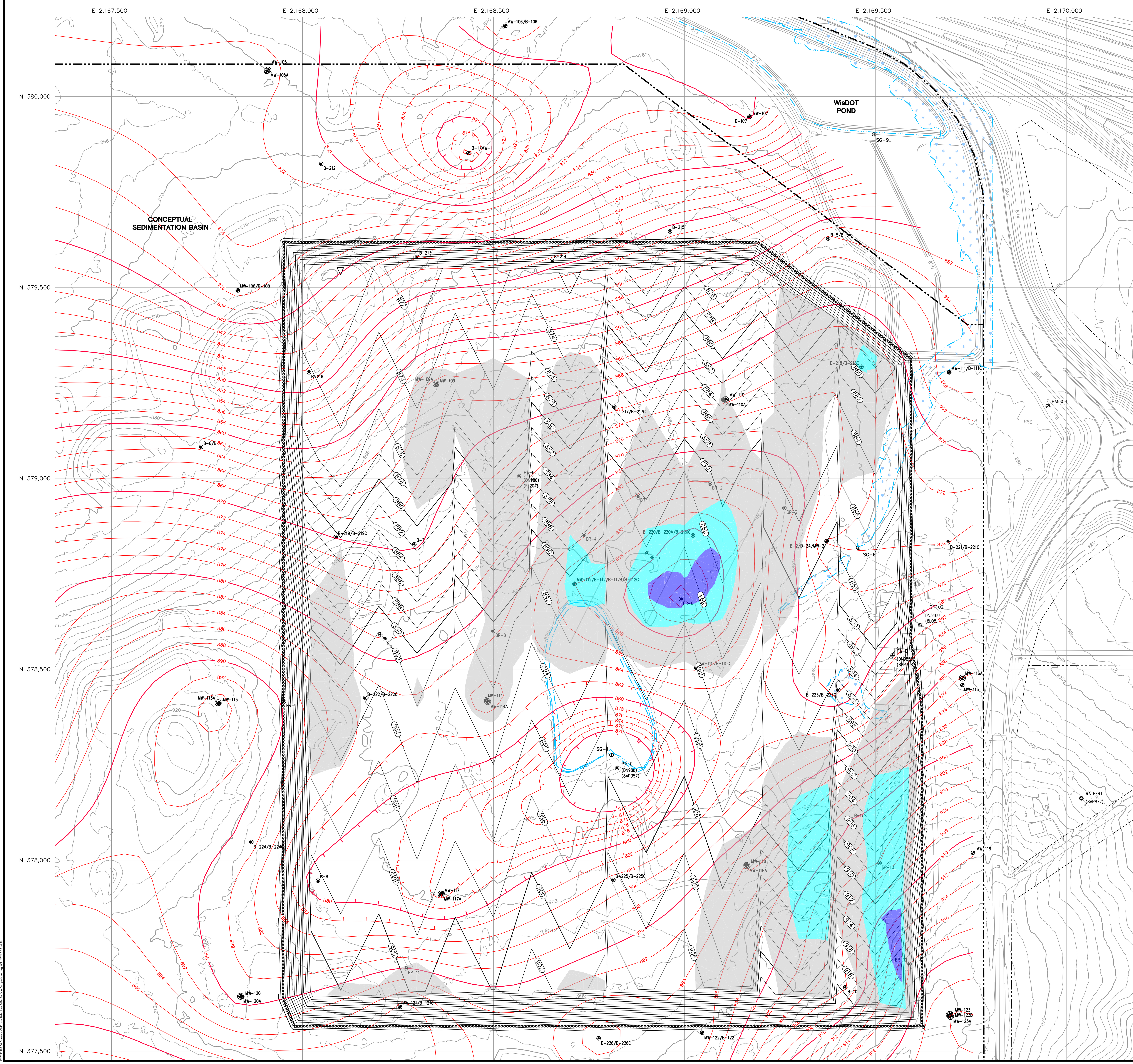
Attachment G1 – Drawings

Surface Comparison Map – Subbase Grades to Bedrock

Surface Comparison Map – Base Grades to Seasonal High Water Table

Surface Comparison Map – Base Grades to Seasonal Low Water Table

Engineering Cross Section with Underdrain



LEGEND
PROJECT PROPERTY LINE
PROPERTY PARCEL LINE
PROPOSED LIMITS OF WASTE
EXISTING GRADE (2' CONTOUR)
EXISTING GRADE (10' CONTOUR)
DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM/EDGE OF WATER
EXISTING WETLAND
EXISTING SMALL WETLAND AREA
EXISTING SOIL BORING
EXISTING MONITORING WELL
EXISTING PIEZOMETER
EXISTING STAFF GAUGE
TOP OF BEDROCK (2' CONTOUR)
TOP OF BEDROCK (10' CONTOUR)
SUBBASE GRADE (2' CONTOUR)
SUBBASE GRADE (10' CONTOUR)

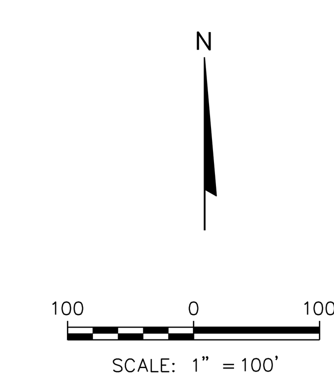
NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT BOTTOM OF CLAY LINER (SUBBASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. BEDROCK SURFACE AND SUBBASE GRADES FROM FEASIBILITY REPORT ADDENDUM NO. 1, PLAN SHEETS 6 AND 23. SEE SHEETS 5 AND 23 FOR ADDITIONAL NOTES.

Separation to Bedrock			
Number	Minimum Separation	Maximum Separation	Color
1		<0.0	pink
2	0.0	1.500	purple
3	1.500	4.0	cyan
4	4.0	10.0	light gray
5	>10.0		

AVERAGE SEPARATION TO BEDROCK = 14.4'

AREA WITH LESS THAN 10 FEET OF SEPARATION = 25.8 ACRES



PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	11/16/2023	CHECKED BY:	MRH/BLP
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

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1919 ALLIANT ENERGY CENTER WAY
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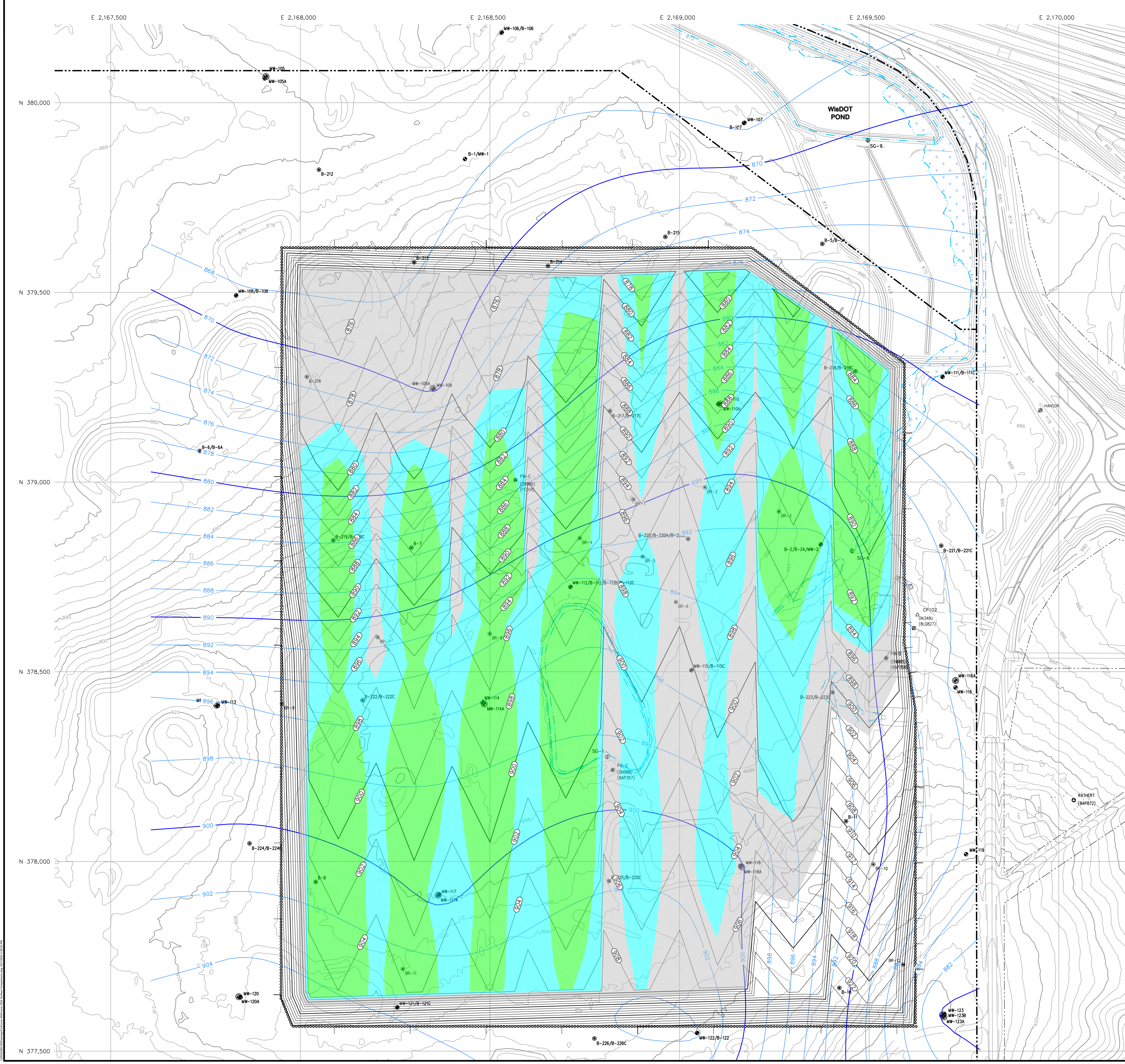
SITE
FEASIBILITY REPORT – ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
US HWY 12/18
MADISON, WISCONSIN

SHEET
TOP OF BEDROCK / SUBBASE GRADES (JULY 2024)



LEGEND

- PROJECT PROPERTY LINE
- PROPERTY PARCEL LINE
- PROPOSED LIMITS OF WASTE
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM/EDGE OF WATER
- EXISTING WETLAND
- EXISTING SMALL WETLAND AREA
- EXISTING SOIL BORING
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING STAFF GAUGE
- BASE GRADE (2' CONTOUR)
- BASE GRADE (10' CONTOUR)
- SEASONAL HIGH WATER TABLE (2' CONTOUR)
- SEASONAL HIGH WATER TABLE (10' CONTOUR)

NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT TOP OF CLAY LINER (BASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED MARCH 29, 2023.
4. WATER TABLE SURFACE AND BASE GRADES FROM FEASIBILITY REPORT ADDENDUM NO. 1, PLAN SHEETS 3 AND 24.

SEPARATION TO WATER TABLE (FEET)			
Number	Minimum Separation	Maximum Separation	Color
1	0.0	2.0	
2	2.0	4.0	
3	4.0	10.0	
4		>10.0	

BASE GRADES ARE ABOVE SEASONAL HIGH WATER TABLE.

FUTURE CONTROLLED WATER TABLE WILL BE BELOW SUBBASE GRADES WITH CONSTRUCTION OF UNDERDRAIN.

N

100 0 100

SCALE: 1" = 100'

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	04/05/2024	CHECKED BY:	MRH/BLP
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

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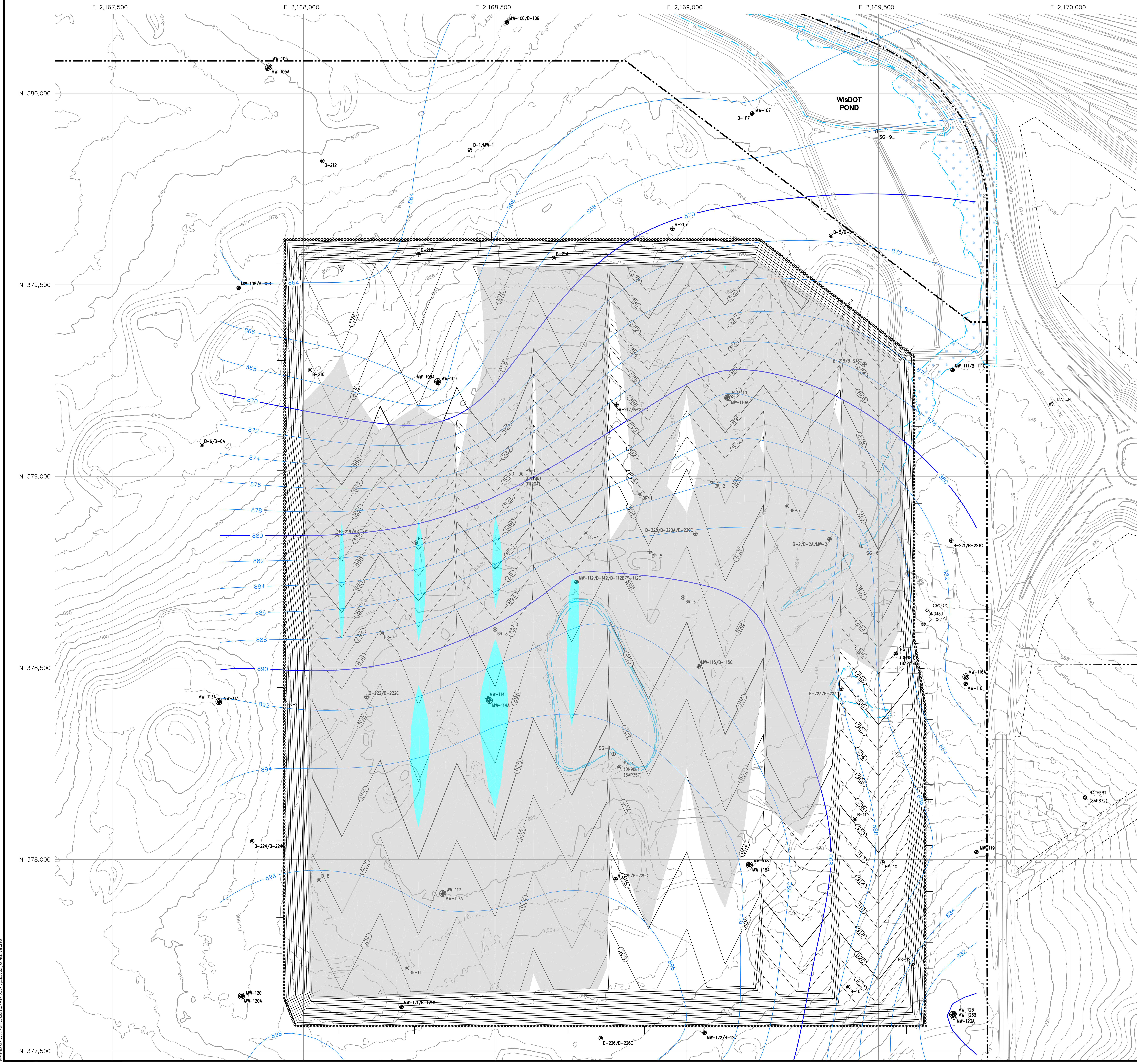
ENGINEER

FEASIBILITY REPORT - ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
US HWY 12/18
MADISON, WISCONSIN

SITE

BASE GRADES (JULY 2024) / SEASONAL HIGH WATER TABLE

SHEET



LEGEND

- PROJECT PROPERTY LINE
- PROPERTY PARCEL LINE
- PROPOSED LIMITS OF WASTE
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM/EDGE OF WATER
- EXISTING WETLAND
- EXISTING SMALL WETLAND AREA
- EXISTING SOIL BORING
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING STAFF GAUGE
- BASE GRADE (2' CONTOUR)
- BASE GRADE (10' CONTOUR)
- SEASONAL LOW WATER TABLE (2' CONTOUR)
- SEASONAL LOW WATER TABLE (10' CONTOUR)

NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT TOP OF CLAY LINER (BASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED DECEMBER 4, 2023.
4. WATER TABLE SURFACE AND BASE GRADES FROM FEASIBILITY REPORT ADDENDUM NO. 1, PLAN SHEETS 4 AND 24.

SEPARATION TO WATER TABLE (FEET)			
Number	Minimum Separation	Maximum Separation	Color
1	3.0	4.0	cyan
2	4.0	10.0	gray
3		>10.0	

BASE GRADES ARE ABOVE SEASONAL LOW WATER TABLE.

FUTURE CONTROLLED WATER TABLE WILL BE BELOW SUBBASE GRADES WITH CONSTRUCTION OF UNDERDRAIN.

N

100 0 100

SCALE: 1" = 100'

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	04/05/2024	CHECKED BY:	MRH/BLP
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

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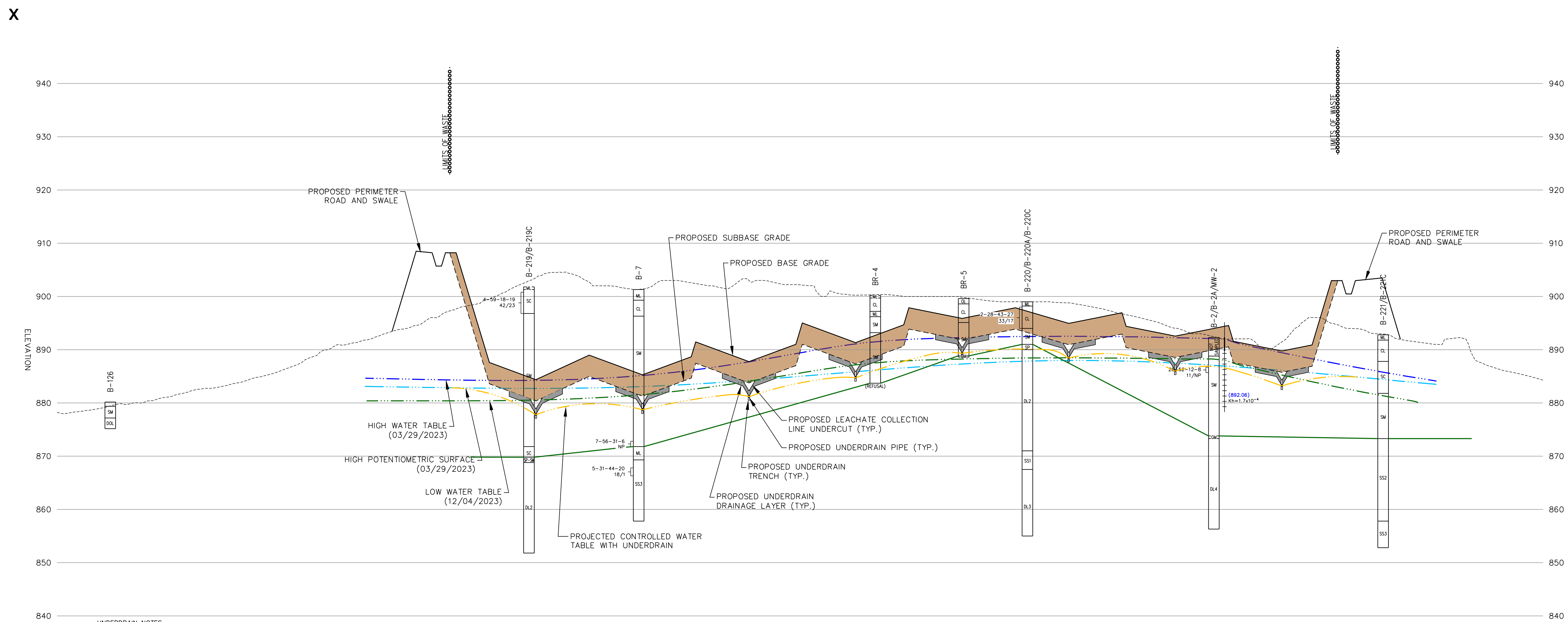
SITE: FEASIBILITY REPORT – ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
US HWY 12/18
MADISON, WISCONSIN

SHEET: BASE GRADES (JULY 2024) / SEASONAL LOW WATER TABLE



UNDERDRAIN NOTES:

1. PARTIAL UNDERDRAIN DRAINAGE LAYER TO BE INCLUDED AS NECESSARY BASED ON PLAN OF OPERATION DESIGN CALCULATIONS. GEOCOMPOSITE MAY BE USED AS AN ALTERNATIVE TO GRANULAR FILL.
2. DEPTH OF COLLECTION PIPE BELOW BOTTOM OF CLAY TO BE BASED ON PLAN OF OPERATION DESIGN CALCULATIONS.
3. PROJECTED CONTROLLED WATER TABLE WITH UNDERDRAIN BASED ON UNDERDRAIN DISCHARGE AND MOUND HEIGHT CALCULATIONS IN FR ADDENDUM 1, ATTACHMENT G.
4. FOR CLARITY, GEOLOGIC UNIT NAMES AND CONTACTS ARE NOT SHOWN. SEE GEOLOGIC CROSS SECTION E-E' (FEASIBILITY REPORT ADDENDUM NO. 1 PLAN SHEET 10) FOR GEOLOGIC UNITS AND CONTACTS.

SYMBOLS AND TEST RESULTS

40.7/22.6	LIQUID LIMIT/PLASTICITY INDEX
NP	NON-PLASTIC
Kv	LABORATORY VERTICAL HYDRAULIC CONDUCTIVITY (cm/sec)
Kh	FIELD HORIZONTAL HYDRAULIC CONDUCTIVITY (cm/sec)
0-30-42-28	PERCENT GRAVEL, SAND, SILT, AND CLAY
0-87-13	PERCENT GRAVEL, SAND, AND SILT PLUS CLAY
72-5	PERCENT GRAVEL AND SAND
NS	NOT SAMPLED
(1,036.67)	GROUNDWATER ELEVATION ON 03/29/2024 (FEET ABOVE MEAN SEA LEVEL)
(NM)	NOT MEASURED
	WATER TABLE (SEE NOTE 8)
	POTENTIOMETRIC SURFACE (SEE NOTE 9)
	EXISTING GROUND (SPRING 2017)
	GEOLOGIC CONTACT
	UNCERTAIN GEOLOGIC CONTACT
	INFERRED GRADATIONAL GEOLOGIC CONTACT
	TOP OF BEDROCK (SEE NOTE 10)
	PROPOSED COMPOSITE LINER SYSTEM

USCS CLASSES

CL	LEAN CLAY
CL-ML	SILTY CLAY
CH	FAT CLAY
GP	POORLY-GRADED GRAVEL
GP-GM	POORLY-GRADED GRAVEL WITH SILT
GM	SILTY GRAVEL
GW	WELL-GRADED GRAVEL
GW-GM	WELL-GRADED GRAVEL WITH SILT
ML	SILT
SC	CLAYEY SAND
SM	SILTY SAND
SP	POORLY-GRADED SAND
SP-SM	POORLY-GRADED SAND WITH SILT

BEDROCK STRATIGRAPHIC UNITS

SINNIPEE GROUP

DL1 – GALENA FORMATION
SH – DECORAH FORMATION
DL2 – PLATTEVILLE FORMATION
DL6 – SINNIPEE GROUP, UNDIFFERENTIATED

ANCELL GROUP

SS1 – GLENWOOD FORMATION
SS2 – ST. PETER FORMATION, TONTI MEMBER
SS3 – ST. PETER FORMATION, READSTOWN MEMBER
SS4 – ANCELL GROUP, UNDIFFERENTIATED

PRAIRIE DU CHIEN GROUP

DL3 – SHAKOPEE FORMATION
DL4 – ONEOTA FORMATION
DL5 – PRAIRIE DU CHIEN GROUP UNDIFFERENTIATED

UNDIFFERENTIATED

DOL – DOLOMITE
SS – SANDSTONE

GENERAL DESCRIPTION OF MAJOR GEOLOGIC UNITS

PLEISTOCENE SEDIMENTS

LOESS – GRAYISH BROWN, OR YELLOWISH BROWN, MOSTLY SILT WITH SOME CLAY AND FINE SAND, LEAN CLAY (CL), UNIFORM, MASSIVE. DEPOSITED PRIMARILY BY WIND DURING DEGLACIATION. CONTAINS THE MODERN SOIL PROFILE.

TILL – HORICON MEMBER OF THE HOLY HILL FORMATION – BROWN, OR YELLOWISH RED, MOSTLY FINE SAND WITH MEDIUM AND COARSE SAND, AND GRAVEL. SILTY SAND (SM) MATRIX, UNIFORM, WITH SOME COBBLES AND BOULDERS. DEPOSITED BY OR FROM GLACIAL ICE.

OUTWASH – HORICON MEMBER OF THE HOLY HILL FORMATION – BROWN OR YELLOWISH BROWN, FINE TO COARSE SAND AND SOME GRAVEL, GENERALLY POORLY-GRADED SAND WITH SILT (SP-SM), OR SILTY SAND (SM), MASSIVE TO STRATIFIED, DEPOSITED BY FLUVIAL PROCESSES NEAR GLACIAL ICE.

DRIFT (NOT A MAJOR GEOLOGIC UNIT)– UNDIFFERENTIATED PLEISTOCENE SEDIMENTS, LOESS, TILL, AND/OR OUTWASH.

ORDOVICIAN BEDROCK UNITS

SINNIPEE GROUP – DOLOMITE AND SHALY DOLOMITE, YELLOW BROWN TO LIGHT BROWNISH YELLOW AND GRAY; MASSIVE OR MEDIUM TO THICK BEDDED, BEDDING IS WAVY OR MOTTLED WITH SHALY LAYERS, MINOR WHITE CHERT, FOSSILIFEROUS.

GALENA FORMATION – DOLOMITE TO CHERTY DOLOMITE, GRAY TO BEIGE, AND YELLOW BROWN TO LIGHT BROWNISH YELLOW, MASSIVE TO MEDIUM-BEDDED WITH DISTINCTIVE MOTTLED WEATHERING PATTERN, BASE IS LIGHT GRAY AND SHALY, FOSSILIFEROUS. BIOGENIC CARBONATES.

DECORAH FORMATION – SHALY AND SILTY DOLOMITE. DARK GRAY, THIN BEDDED, MINOR CHERT AND PYRITE. REWORKED SHALLOW WATER OR LAGOONAL DEPOSITS.

PLATTEVILLE FORMATION – DOLOMITE TO SHALY DOLOMITE, YELLOW, BEIGE, AND GRAY TO LIGHT BROWNISH YELLOW. GRAY WEATHERING IS TYPICAL OF SHALY INTERVALS. MASSIVE, PLANAR-LAMINATED, OR MEDIUM TO THICK BEDDED, INTERBEDDED WITH THIN, WAVY BEDDED SHALE/SILT LAMINATIONS, MINOR CHERT, FOSSILIFEROUS. BIOGENIC CARBONATES.

ANCELL GROUP – MARINE AND AEOLIAN SANDSTONES, SHALES, RESIDUUM. HIGH-RELIEF UNCONFORMABLE CONTACT WITH THE UNDERLYING PRAIRIE DU CHIEN GROUP.

GLENWOOD FORMATION – SANDSTONE, DOLOMITIC (CARBONATE-CEMENTED), SILTY, AND/OR SHALY, POORLY SORTED, YELLOW-BROWN TO GREEN, WITH BLUE-GREEN SHALE OR SANDY DOLOMITE. REWORKED SHALLOW WATER OR LAGOONAL DEPOSITS.

ST. PETER FORMATION, TONTI MEMBER – SANDSTONE, LIGHT BROWNISH YELLOW, WHITE, RED, GRAY, ORANGE, OR BROWN (IF CEMENTED BY IRON OXIDES), MEDIUM TO COARSE GRAINED, WELL ROUNDED AND WELL SORTED, POORLY CEMENTED, LOW TO HIGH ANGLED CROSS-BEDDING OR MASSIVE, POORLY CEMENTED BY DOLOMITE, LOCALIZED SULFIDE MINERALIZATION DISSEMINATED THROUGH THE MATRIX AND CONCENTRATED ALONG BEDDING PLANES AND FRACTURES, LOCALIZED THIN LAYERS OF PALE GREEN SHALE/SILT. MARINE AND AEOLIAN QUARTZ SANDSTONE.

ST. PETER FORMATION, READSTOWN MEMBER – SANDSTONE, SILTY SANDSTONE, CLAYEY SANDSTONE, GRAY, RED, PURPLE, GREEN SHALY LAYERS, INTERBEDDED WITH CLAY AND OR SILT, CONTAINS CLASTS OF CHERT OR DOLOMITE. PARTIALLY REWORKED RESIDUUM ON THE PRAIRIE DU CHIEN EROSIONAL SURFACE.

PRAIRIE DU CHIEN GROUP – DOLOMITE AND SANDY DOLOMITE, YELLOW, LIGHT BROWN, AND GRAY. MASSIVE TO MEDIUM BEDDED, SANDY, CHERTY, VUGGY, AND OOLITHIC.

SHAKOPEE FORMATION – DOLOMITE AND SANDY DOLOMITE, GRAY, BEIGE, AND RED (SANDY DOLOMITE IS PREDOMINANTLY RED), INTERBEDDED WITH COARSE GRAINED WELL ROUNDED SANDSTONE, AND/OR GREEN TO GRAY SILTSTONE OR CLAY. MASSIVE, PLANAR, OR LOW-ANGEL CROSS-BEDDING; OOLITHIC, VUGGY, CHERTY, AND GLAUCONITIC. BIOGENIC CARBONATES.

WILLOW RIVER MEMBER – SANDY, GLAUCONITIC DOLOMITE, GRAY, LIGHT GRAY. BIOGENIC CARBONATES.

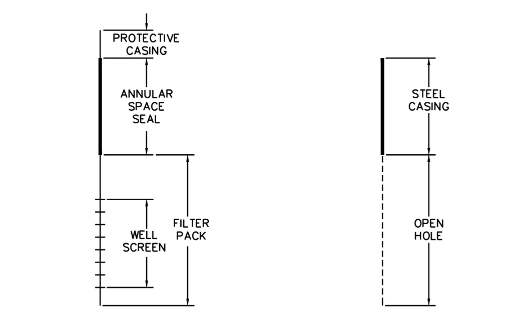
NEW RICHMOND MEMBER – SANDSTONE, DOLOMITIC SANDSTONE. YELLOW AND LIGHT GRAY, FINE TO COARSE SAND, MASSIVE TO BEDDED, CHERT AND GLAUCONITE. REWORKED SHALLOW WATER OR LAGOONAL DEPOSITS.

ONEOTA FORMATION – DOLOMITE AND SANDY DOLOMITE, GRAY TO BEIGE, MASSIVE, PLANAR, AND WAVY-LAMINATED BEDDING, OOLITHIC, VUGGY, CHERTY, AND GLAUCONITIC. BIOGENIC CARBONATES.

DOLOMITE – UNDIFFERENTIATED CARBONATE ROCK. LITTLE OR NO SAMPLE RECOVERED. LIKELY WEATHERED AND/OR POORLY INDURATED.

SANDSTONE – UNDIFFERENTIATED SILICLASTIC ROCK. LITTLE OR NO SAMPLE RECOVERED. LIKELY POORLY INDURATED.

NOTE: FILL IS UNCONSOLIDATED SEDIMENT, INCLUDING MIXTURES OF SAND, SILT, CLAY, GRAVEL, AND POSSIBLY BEDROCK FRAGMENTS OF VARIOUS SIZES, THAT HAS BEEN RELOCATED ON THE SITE OR HAS BEEN BROUGHT TO THE SITE FROM OFFSITE SOURCES. FILL IS NOT A GEOLOGIC UNIT.



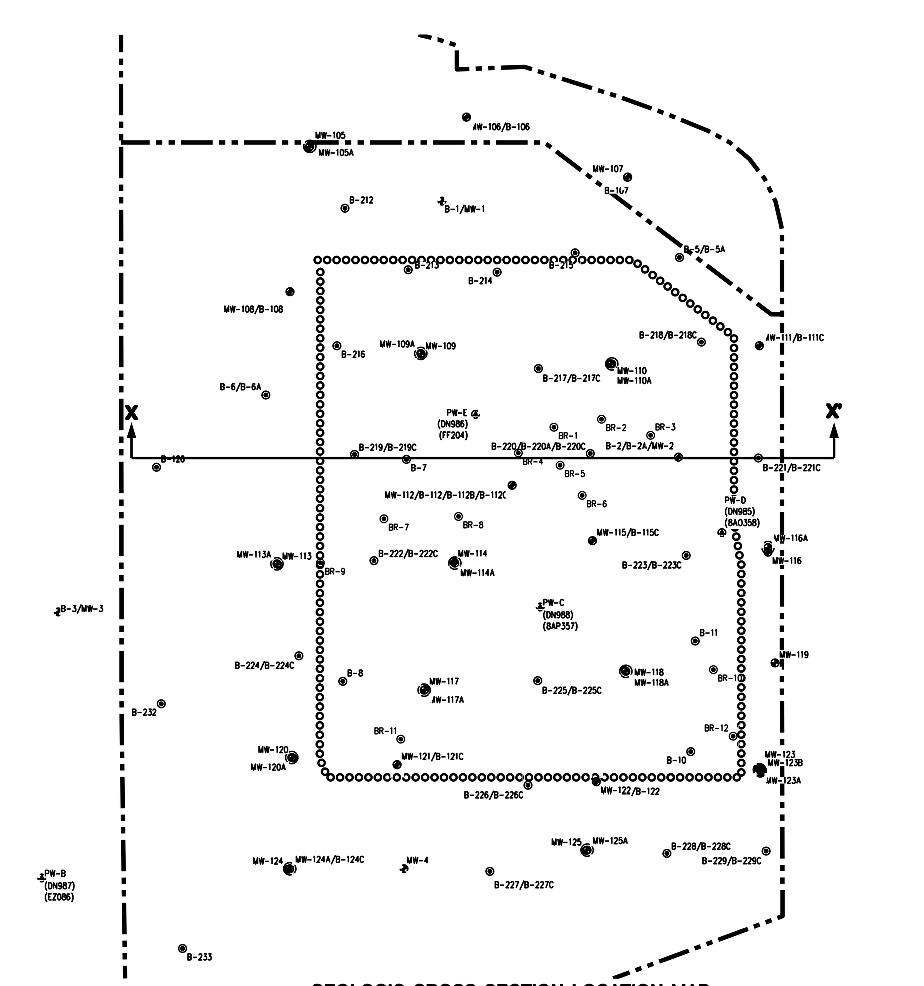
MONITORING WELL DETAIL
NOT TO SCALE

SUPPLY WELL DETAIL
NOT TO SCALE

0 100
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION = 10X

NOTES

1. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH BORING LOCATION.
2. FOR WELL NESTS, THE GEOLOGIC LOG IS POSTED AT THE LOCATION OF THE WATER TABLE WELL AND INCLUDES GEOLOGIC INFORMATION FROM ALL BORINGS AT THE NEST LOCATION.
3. FOR LOCATIONS WITH MORE THAN ONE BORING, THE GEOLOGIC LOG IS POSTED AT THE LOCATION OF THE SHALLOWEST BORING AND INCLUDES GEOLOGIC INFORMATION FROM ALL BORINGS AT THE DRILLING LOCATION.
4. REFER TO BORING LOGS IN APPENDIX F OF THE FEASIBILITY REPORT FOR DETAILED DESCRIPTIONS OF GEOLOGIC CONDITIONS AT INDIVIDUAL BORING LOCATIONS.
5. REFER TO APPENDIX F (OF 02/13/2024 FEASIBILITY REPORT) FOR MONITORING WELL CONSTRUCTION DETAILS.
6. EXISTING GROUND SURFACE WAS TAKEN FROM SHEET NUMBER 2.
7. ELEVATIONS ARE REFERENCED TO USGS DATUM.
8. THE POSITION OF THE WATER TABLE BETWEEN WELLS IS BASED ON THE WATER TABLE CONTOUR MAP, SHEET NUMBER 3.
9. THE POSITION OF THE POTENTIOMETRIC SURFACE BETWEEN WELLS IS BASED ON THE POTENTIOMETRIC SURFACE CONTOUR MAP, SHEET NUMBER 5.
10. THE BEDROCK SURFACE SHOWN BETWEEN BORINGS ON THE CROSS-SECTION IS THE STRAIGHT-LINE CONNECTION OF THE UPPERMOST ROCK SURFACES OBSERVED AT THE DRILLING LOCATIONS OR IS BASED ON GEOLOGIC INTERPRETATION OF AN EROSIONAL SURFACE BETWEEN BORING LOCATIONS. THE BEDROCK SURFACE CONTOURS SHOWN BETWEEN BORINGS ON FEASIBILITY REPORT ADDENDUM NO. 1 PLAN SHEET 6, BEDROCK SURFACE MAP, ARE BASED ON INTERPOLATION USING KRIGING WITH THE PROGRAM "SURFER".
11. BORINGS WITH DESIGNATION "BR" WERE DRILLED 02/12-13/2024 AND ADDED TO THE FEASIBILITY REPORT ADDENDUM NO. 1 CROSS SECTION. SEE FEASIBILITY REPORT-ADDENDUM NO. 1 FOR BORING LOGS.
12. REFER TO THE RESPONSE TO WDNR INCOMPLETENESS COMMENT #4 IN THE FR ADDENDUM NO. 1 TEXT FOR EXEMPTION REQUESTS FOR SEPARATION TO WATER TABLE AND BEDROCK AND THE BASIS OF DESIGN IN RELATION TO THOSE.
13. SOIL BORINGS AND WELLS ARE PROJECTED VARIOUS DISTANCES ONTO THE CROSS SECTION. REFER TO THE CROSS-SECTION LOCATION MAP FOR ACTUAL LOCATIONS.



GEOLOGIC CROSS SECTION LOCATION MAP
SCALE: 1" = 500'

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	07/16/2024	CHECKED BY:	MRH/BLP
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

CLIENT: DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES, 1919 ALLIANT ENERGY CENTER WAY, MADISON, WI 53713

ENGINEER: SCS ENGINEERS, 2830 DAIRY DRIVE MADISON, WI 53718-6751, PHONE: (608) 224-2830

SITE: FEASIBILITY REPORT – ADDENDUM NO. 1, DANE COUNTY LANDFILL SITE NO. 3, 4402 BRANDT ROAD, MADISON, WISCONSIN

ENGINEERING CROSS-SECTION WITH UNDERDRAIN

SHEET

Attachment G2 – Previous Approval Examples with Less than 10-foot Separation to Water Table

Table G-1
Previous Approval Examples with Less than 10-foot Separation to Water Table
(coarse-grained environment, not considered zone-of-saturation)

			Base Grades vs Water Table (Zone-of-Saturation Definition, NR 500.03(263), NR 504.06(4))		**Subbase Grades vs Water Table (Separation Distance, NR 504.06(2)(b))**		
Site	POO Approval	Exemption to 10 ft separation from water table	Pre-development seasonal high water table below proposed base grades?	Post-development controlled water table below proposed base grades under gravity-drained conditions?	Pre-development seasonal high water table below proposed subbase grades?	Post-development controlled water table below proposed subbase grades under gravity-drained conditions?	Comments
Approved Landfills or Expansions							
Glacier Ridge LF Expansion (now closed North Landfill)	1997	Yes	No	Yes (no control needed)	No	Yes (no control needed)	Water table was above base grades but expected to drop due to landfill construction. Approval required documentation of separation before liner construction.
Cranberry Creek LF (Phases 4 and 5)	2002	Yes	Yes, except at leachate undercuts and sumps	Yes	No	Yes, except at leachate undercuts and sumps	Design similar to Cranberry Creek LF Phases 1-3 (approved 1986). Monitoring indicates gradient control system has maintained water table below bottom of clay iner.
Glacier Ridge LF South Expansion	2005	Yes	Yes, except at leachate undercuts and sumps	Yes	No	Yes, except at leachate undercuts and sumps	FR approval conditions based on controlled WT. POO drawings only show controlled WT. Monitoring indicates gradient control system has maintained water table below bottom of clay iner.
Hickory Meadows LF (East Side)	2012	Yes	Yes, except at leachate undercuts and sumps	Yes	No	Yes, except at leachate undercuts and sumps	Design includes a full underdrain drainage blanket due to low permeability of soils.
Glacier Ridge LF Southeast Expansion	2013	Yes	No	Yes	No	Yes, except at leachate undercuts and sumps	Water table was above base grades but expected to drop due to landfill construction and operation of underdrain. FR approval conditions were based on controlled water table. POO shows controlled water table. Monitoring indicates gradient control system has maintained water table below bottom of clay iner.
Proposed Landfill							
Dane County Landfill No. 3	Proposed	Requested	Yes, except at leachate undercuts and sumps	Yes	No	Yes, except at leachate undercuts and sumps	

FR = Feasibility Report
POO = Plan of Operation
LF = Landfill

Attachment G3 – Preliminary Underdrain Calculations

Preliminary Underdrain Discharge Calculations *(Replaces calculations in Appendix 02 in the original FR)*

Preliminary Underdrain Mound Height Calculations

Supporting Information

- Hydraulic Conductivity Data (FR Table 5-6, FR Addendum 1 Tables 10-3b and 10-4)
- Surface Comparison Map– Subbase Grades to Seasonal High Water Table
- Surface Comparison Map – Subbase Grades to Seasonal Low Water Table
- Figure - Assumed Underdrain Conditions for Preliminary Underdrain Discharge and Mound Height Calculations
- Underdrain Area Map – Seasonal High Water Table
- Underdrain Area Map – Seasonal Low Water Table

Job No. 25222268.00	Job: Landfill Site No. 3	By: SCC	Date: 7/14/2024
Client: Dane County	Subject: Underdrain Discharge	Chk'd: EO	Date: 7/22/2024

Preliminary Underdrain Groundwater Discharge Estimates

Purpose: To develop a preliminary estimate of the flow rate for groundwater that will be collected by and discharged from the underdrain system at Landfill Site No. 3.

Approach: Estimate the flow to the underdrain using the equation for water table flow to a well in an unconfined aquifer, assuming the entire system acts as a single well with a large radius.

References: *Construction Dewatering* , J. Patrick Powers, 1992, Table 6.1, Section 6.5, Section 6.6, and Table 4.2.

SCS Engineers, Feasibility Report, Dane County Landfill Site No. 3, February 2024, Table 5-6 (Hydraulic Conductivity Test Results).

SCS Engineers, Feasibility Report Addendum 1, Dane County Landfill Site No. 3, June 2024, Sheet 3 (High Water Table Map - March 29, 2023), Sheet 4 (Low Water Table Map - December 4, 2023), and Sheet 23 (Proposed Subbase Grades).

Assumptions:

- The underdrain system can be represented approximately by a well with the same enclosed area.

- Flow in the water table aquifer is horizontal, and the well is assumed to fully penetrate the aquifer. (Actual flow would be significantly reduced due to partial penetration.)

- The water table aquifer includes the glacial deposits (primarily till) and underlying Ordovician dolomite and sandstone, based on similar slug test results in these materials and similar head levels in the monitoring wells and piezometers at well nests.

- The hydraulic conductivity (K) of the water table aquifer can be estimated as the geometric mean of the slug test results for the monitoring wells and piezometers. For sensitivity analysis, discharge estimates were also calculated for a low K scenario (geometric mean slug test result for till) and a high K scenario (geometric mean slug test for highest K bedrock unit).

- The base of the water table aquifer is 50 to 200 feet below the current water table. The 50-foot depth is based on the approximate depth to which the piezometers were installed. The 200-foot depth is based on the approximate depth to a layer of shale or shaly dolomite observed in logs for the golf course water supply wells.

Results: The preliminary estimate of the long term average discharge rate from the underdrain system is approximately 60 gallons per minute (gpm) based on current average water table conditions. For low and high hydraulic conductivity scenarios, the average discharge ranges from approximately 40 to 120 gpm

Preliminary estimates of the discharge rate from the underdrain system range from approximately 50 to 110 gpm for the peak flow shortly after construction of the final phase, for the base scenario (geometric mean hydraulic conductivity) and the seasonal low and high water table conditions. Taking into account the low and high hydraulic conductivity scenarios, the short-term post-construction peak discharge ranges from approximately 40 to 220 gpm.

Calculations Approach

Total flow from the underdrain is estimated as:

$Q = \pi K (H^2 - h_w^2) / \ln (R_o/r_w)$ (Reference: Powers, Table 6.1)

where,

Q = Discharge (cubic feet/day)

K = Hydraulic conductivity (feet/day) = K (cm/sec) x (86,400 sec/day / 30.48 cm/foot)

H = Original saturated thickness (feet)

h_w = Head at the well (feet)

R_o = Radial distance to source of water, or to pseudo-steady state conditions (feet)

r_w = Radius of well (feet)

Assumed values are:

K = 6.0E-04 cm/sec = 0.52 meters/day

H = 50 to 200 feet

h_w = H - s, where s = drawdown. S is estimated based on the average difference between the current seasonal high water table and the projected controlled water table in the area where the underdrain collection pipe is below the water table.

s = 6 feet maximum, assuming drawdown at underdrain trench = 4 ft clay thickness + 1.5 ft undercut + 1 ft to pipe flow depth - 0.5 x (1 foot groundwater mound height between underdrain pipes). For low water table, subtract 3 ft (typical difference). See Figure - Assumed Underdrain Conditions for Preliminary Underdrain Discharge and Mound Height Calculations

r_w = radius of the underdrain system acting as a well, calculated as the square root of the area of the subbase where the underdrain collection pipe is below the water table, divided by π.

Based on comparison of the water table surface to the subbase grade surface using AutoCAD Civil 3D:

	Subbase Below Water Table (acres)	Equivalent Radius, r_w (ft)	Average Drawdown, s (ft)
Seasonal high water table (March 29, 2023)	59.4	908	6
Seasonal low water table (December 4, 2023)	37.4	720	3

R_o varies with time as the zone of influence for the underdrain expands, as:

$R_o = r_w + ((T\ t)/(640 \times C_s))^{0.5}$ (Reference: Powers, Section 6.6 and Table 4.2)

where,

C_s = Storage coefficient, assumed = 0.2 for unconfined aquifer

T = Transmissivity (square meters/day) = K x b

b = Aquifer thickness (meters) = H for unconfined aquifer

K = Hydraulic conductivity (meters/day)

t = Time since pumping began (minutes)

R_o = Radial distance to source of water, or to pseudo-steady state conditions (meters)

r_w = Radius of well (meters)

Calculations

ESTIMATE R_0 BASED ON DURATION OF DRAINAGE

Base Scenario, K = 6.0 x 10-4 cm/sec, Rw based on subbase grades and seasonal high water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-high (ft)	rw-high (m)	t (days)	t(min)	Ro (m)	Ro (ft)
6.00E-04	5.18E-01	200	60.96	3.16E+01	908	277	30	43,200	380	1247
6.00E-04	5.18E-01	200	60.96	3.16E+01	908	277	90	129,600	456	1495
6.00E-04	5.18E-01	200	60.96	3.16E+01	908	277	365	525,600	637	2090
6.00E-04	5.18E-01	200	60.96	3.16E+01	908	277	1825	2,628,000	1082	3550

Base Scenario, K = 6.0 x 10-4 cm/sec, Rw based on subbase grades and seasonal low water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-low (ft)	rw-low (m)	t (days)	t(min)	Ro (m)	Ro (ft)
6.00E-04	5.18E-01	200	60.96	3.16E+01	720	220	30	43,200	323	1059
6.00E-04	5.18E-01	200	60.96	3.16E+01	720	220	90	129,600	398	1307
6.00E-04	5.18E-01	200	60.96	3.16E+01	720	220	365	525,600	580	1902
6.00E-04	5.18E-01	200	60.96	3.16E+01	720	220	1825	2,628,000	1025	3363

ESTIMATE UNDERDRAIN DISCHARGE

High water table scenarios, K = 6.0 x 10-4 cm/sec, Rw and s based on subbase grades and seasonal high water table

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
6.00E-04	1.70	200	6	194	908	30 days	1247	207	0.46
6.00E-04	1.70	200	6	194	908	90 days	1495	132	0.29
6.00E-04	1.70	200	6	194	908	1 year	2090	79	0.18
6.00E-04	1.70	200	6	194	908	5 years	3550	48	0.11

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
6.00E-04	1.70	50	6	44	908	30 days	1247	49	0.11
6.00E-04	1.70	50	6	44	908	90 days	1495	31	0.07
6.00E-04	1.70	50	6	44	908	1 year	2090	19	0.04
6.00E-04	1.70	50	6	44	908	5 years	3550	11	0.03

Low water table scenarios, K = 6.0 x 10-4 cm/sec, Rw and s based on subbase grades and seasonal low water table.
Assumed aquifer thickness reduced by 5 feet based on average change in water table from March to December 2023.

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
6.00E-04	1.70	195	3	192	720	30 days	1059	84	0.186
6.00E-04	1.70	195	3	192	720	90 days	1307	54	0.120
6.00E-04	1.70	195	3	192	720	1 year	1902	33	0.074
6.00E-04	1.70	195	3	192	720	5 years	3363	21	0.047

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
6.00E-04	1.70	45	3	42	720	30 days	1059	19	0.042
6.00E-04	1.70	45	3	42	720	90 days	1307	12.1	0.027
6.00E-04	1.70	45	3	42	720	1 year	1902	7.5	0.017
6.00E-04	1.70	45	3	42	720	5 years	3363	4.7	0.0105

Sensitivity Analysis - Low Hydraulic Conductivity Scenarios

ESTIMATE R_o BASED ON DURATION OF DRAINAGE

Low K Scenario, K = 3.9 x 10-4 cm/sec, based on geometric mean for slug tests in till
Rw based on subbase grades and seasonal high water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-high (ft)	rw-high (m)	t (days)	t(min)	Ro (m)	Ro (ft)
3.90E-04	3.37E-01	200	61.0	2.05E+01	908	277	30	43,200	360	1181
3.90E-04	3.37E-01	200	61.0	2.05E+01	908	277	90	129,600	421	1381
3.90E-04	3.37E-01	200	61.0	2.05E+01	908	277	365	525,600	567	1861
3.90E-04	3.37E-01	200	61.0	2.05E+01	908	277	1825	2,628,000	926	3038

Low K Scenario, K = 3.9 x 10-4 cm/sec, based on geometric mean for slug tests in till
Rw based on subbase grades and seasonal low water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-low (ft)	rw-low (m)	t (days)	t(min)	Ro (m)	Ro (ft)
3.90E-04	3.37E-01	200	61.0	2.05E+01	720	220	30	43,200	303	993
3.90E-04	3.37E-01	200	61.0	2.05E+01	720	220	90	129,600	364	1193
3.90E-04	3.37E-01	200	61.0	2.05E+01	720	220	365	525,600	510	1673
3.90E-04	3.37E-01	200	61.0	2.05E+01	720	220	1825	2,628,000	869	2851

ESTIMATE UNDERDRAIN DISCHARGE

High water table scenarios, K = 3.9 x 10-4 cm/sec, Rw and s based on subbase grades and seasonal high water table

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
3.90E-04	1.11	200	6	194	908	30 days	1181	162	0.36
3.90E-04	1.11	200	6	194	908	90 days	1381	102	0.23
3.90E-04	1.11	200	6	194	908	1 year	1861	59	0.13
3.90E-04	1.11	200	6	194	908	5 years	3038	35	0.08

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
3.90E-04	1.11	50	6	44	908	30 days	1181	39	0.09
3.90E-04	1.11	50	6	44	908	90 days	1381	24	0.05
3.90E-04	1.11	50	6	44	908	1 year	1861	14	0.03
3.90E-04	1.11	50	6	44	908	5 years	3038	8	0.02

Low water table scenarios, K = 3.9 x 10-4 cm/sec, Rw and s based on subbase grades and seasonal low water table.
Assumed aquifer thickness reduced by 5 feet based on average change in water table from March to December 2023.

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
3.90E-04	1.11	195	3	192	720	30 days	993	65	0.145
3.90E-04	1.11	195	3	192	720	90 days	1193	41	0.092
3.90E-04	1.11	195	3	192	720	1 year	1673	25	0.055
3.90E-04	1.11	195	3	192	720	5 years	2851	15	0.034

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
3.90E-04	1.11	45	3	42	720	30 days	993	15	0.033
3.90E-04	1.11	45	3	42	720	90 days	1193	9.3	0.021
3.90E-04	1.11	45	3	42	720	1 year	1673	5.6	0.012
3.90E-04	1.11	45	3	42	720	5 years	2851	3.4	0.0076

Sensitivity Analysis - High Hydraulic Conductivity Scenario

ESTIMATE R_o BASED ON DURATION OF DRAINAGE

High K Scenario, K = 1.8 x 10-3 cm/sec, based on geometric mean slug test result for Sinnipee Group (highest K formation)
Rw based on subbase grades and seasonal high water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-high (ft)	rw-high (m)	t (days)	t(min)	Ro (m)	Ro (ft)
1.80E-03	1.56E+00	200	60.96	9.48E+01	908	277	30	43,200	456	1495
1.80E-03	1.56E+00	200	60.96	9.48E+01	908	277	90	129,600	587	1924
1.80E-03	1.56E+00	200	60.96	9.48E+01	908	277	365	525,600	901	2955
1.80E-03	1.56E+00	200	60.96	9.48E+01	908	277	1825	2,628,000	1672	5485

High K Scenario, K = 1.8 x 10-3 cm/sec, based on geometric mean for slug tests in till
Rw based on subbase grades and seasonal low water table, aquifer thickness 200 ft

K (cm/sec)	K (m/day)	B (ft)	B (m)	T (m2/day)	rw-low (ft)	rw-low (m)	t (days)	t(min)	Ro (m)	Ro (ft)
1.80E-03	1.56E+00	200	60.96	9.48E+01	720	220	30	43,200	398	1307
1.80E-03	1.56E+00	200	60.96	9.48E+01	720	220	90	129,600	529	1737
1.80E-03	1.56E+00	200	60.96	9.48E+01	720	220	365	525,600	843	2767
1.80E-03	1.56E+00	200	60.96	9.48E+01	720	220	1825	2,628,000	1615	5298

ESTIMATE UNDERDRAIN DISCHARGE

High water table scenarios, K = 1.8 x 10-3 cm/sec, Rw and s based on subbase grades and seasonal high water table

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
1.80E-03	5.10	200	6	194	908	30 days	1495	395	0.88
1.80E-03	5.10	200	6	194	908	90 days	1924	262	0.58
1.80E-03	5.10	200	6	194	908	1 year	2955	167	0.37
1.80E-03	5.10	200	6	194	908	5 years	5485	109	0.24

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-high (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
1.80E-03	5.10	50	6	44	908	30 days	1495	94	0.21
1.80E-03	5.10	50	6	44	908	90 days	1924	62	0.14
1.80E-03	5.10	50	6	44	908	1 year	2955	40	0.09
1.80E-03	5.10	50	6	44	908	5 years	5485	26	0.06

Low water table scenarios, K = 1.8 x 10-3 cm/sec, Rw and s based on subbase grades and seasonal low water table.
Assumed aquifer thickness reduced by 5 feet based on average change in water table from March to December 2023.

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
1.80E-03	5.10	195	3	192	720	30 days	1307	162	0.361
1.80E-03	5.10	195	3	192	720	90 days	1737	110	0.245
1.80E-03	5.10	195	3	192	720	1 year	2767	72	0.160
1.80E-03	5.10	195	3	192	720	5 years	5298	48	0.108

K (cm/sec)	K (ft/day)	H (ft)	s (ft)	hw (ft)	rw-low (ft)	Time from Startup	Approximate Ro (ft)	Q (gpm)	Q (cfs)
1.80E-03	5.10	45	3	42	720	30 days	1307	36	0.081
1.80E-03	5.10	45	3	42	720	90 days	1737	24.7	0.055
1.80E-03	5.10	45	3	42	720	1 year	2767	16.1	0.036
1.80E-03	5.10	45	3	42	720	5 years	5298	10.9	0.0243

Summary of Results

Using the more conservative 200-foot aquifer thickness, and the radius of influence developed after one year, the estimated long term average underdrain discharge rates are:

	Base Scenario		Low K Scenario		High K Scenario	
Long Term Average	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)
Seasonal high water table	79	0.18	59	0.13	167	0.37
Seasonal low water table	33	0.074	25	0.055	72	0.16
Average	56	0.12	42	0.094	119	0.27

Say approximately 60 gpm based on current average water table conditions, with a range from approximately 40 to 120 for high and low K scenarios and average water table conditions

The estimated underdrain discharge rates during construction and initial operation, using the 200-foot aquifer thickness and the radius of influence developed after 30 days, and assuming the entire site is constructed at the same time, are:

	Base Scenario		Low K Scenario		High K Scenario	
Peak Flow if Entire Site Constructed at One Time	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)
Seasonal high water table	207	0.46	162	0.36	395	0.88
Seasonal low water table	84	0.19	65	0.15	162	0.36
Average	145	0.32	114	0.25	278	0.62

Since the site will be constructed in phases over a period of several years, estimated peak flows accounting for the construction schedule would be significantly lower. Assuming that the final phase would include 25 percent of the underdrain and the previously constructed phases would contribute the remaining flow, the estimated maximum discharge rates are:

	Base Scenario		Low K Scenario		High K Scenario	
Peak Flow - 25% New Phase + 75% Existing Phase	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)	Discharge (gpm)	Discharge (cfs)
Seasonal high water table	111	0.25	85	0.19	224	0.50
Seasonal low water table	46	0.10	35	0.08	94	0.21
Average	78	0.17	60	0.13	159	0.35

Say approximately 50 to 110 gpm for base scenario (geometric mean K) and current seasonal low and high water table conditions, with a range up to approximately 220 gpm for high K scenario under high water table conditions

These preliminary estimates provide an approximate range of potential discharge rates for the underdrain. Actual discharge rates maybe higher or lower depending on geologic conditions, the final design, and changes in recharge conditions with the discontinuation of golf course irrigation and construction of the landfill liner.
The discharge rate is expected to decrease with time due to reduced infiltration.

Preliminary Underdrain Groundwater Mound Height Estimates

Purpose

Evaluate whether the proposed underdrain design for Dane County Landfill No. 3 will maintain the water table below the bottom of the landfill liner under gravity-drained conditions except at the leachate collection sumps.

Approach

The calculation steps are:

1. Estimate groundwater discharge to the underdrain based on aquifer properties, expected drawdown, and area of drawdown (completed in previous calculation).

2. Calculate estimated groundwater mound height between drain lines for reasonable values of hydraulic conductivity and flow using the formula developed by Hooghoudt (Smedema and Rycroft, 1983).

3. Select drain depth below subbase grades and verify that drains will maintain water table below bottom of liner.

Assumptions

Site Specific Assumptions:

1. The groundwater discharge per unit area beneath the expansion area can be estimated based on the area and expected drawdown as shown in the Underdrain Discharge calculation. The calculation provides a range of flows for high and low water table conditions and for a range of hydraulic conductivity values (base case, high K, low K).

Hooghoudt Formula Assumptions:

1. The Hooghoudt formula was developed for calculating spacing of agricultural drains based on hydraulic conductivity and recharge; however, the formula may also be used to calculate drain spacings or mound heights below an impermeable surface such as a landfill if groundwater discharge is substituted for recharge (Slane and Hoopes, 1988).

2. Discharge is distributed evenly over the area beneath the drains.

3. The influence of cut-off walls is not included; however, the maximum mound will occur between the drains if the cut-off wall is located within half the drain separation distance of the perimeter drain. [Note: No cut-off wall is proposed for Dane County LF No. 3.]

4. The water table is maintained at the specified drain flow elevations; i.e. water does not back up in pipes/drains.

5. Boundary conditions assume no mounding at the drain, maximum mounding halfway between the drains, simple geometric shape of the mound, the impermeable base is areally extensive and does not leak.

6. Converging radial flow to partially penetrating drains is assumed beneath the drain level and horizontal flow is assumed in the mound above drain invert.

References

SCS Engineers, 2024a, Feasibility Report, Dane County Landfill Site No. 3, February 2024.

SCS Engineers, 2024b, Feasibility Report Addendum No. 1, Dane County Landfill Site No. 3, July 2024.

Slane, K. O., and Hoopes, J. A., 1988, The use of groundwater models to predict groundwater mounding beneath proposed groundwater gradient control systems for sanitary landfill designs; Wisconsin Groundwater Management Practice Monitoring Project No. 7: Madison, Wisconsin, Wisconsin Department of Natural Resources, 83 p.

Smedema, L. K., and Rycroft, D. W., 1983, Land Drainage: Ithaca, New York, Cornell University Press, 376 p.

Conclusions

A drain spacing of 200 feet with a drain invert depth of 2.5 feet below the sub-base grades at the leachate line locations (not considering the trench undercut) will maintain the water table below the base of the clay component of the liner.

Under gravity-drained conditions, the water table will remain below the base of the clay at locations excluding the leachate sumps (to be designed in the Plan of Operation).

With the elimination of recharge within the Proposed Landfill footprint, the future high water table is expected to be lower than the current seasonal high water table; therefore, the assumed area of groundwater collected and assumed drawdown are conservative estimates.

Attachments: Mound Height Calculation (Step 2)
Water Table Calculation and Graph (Step 3)

Purpose: To determine the height of the groundwater mound between two underdrain pipes.

Approach: Use the Hooghoudt equation to estimate mound height.

Calculation:

The Hooghoudt equation is given by:

$$L^2 = (8k_b d_e m + 4k_a m^2)/q$$

where,

$d_e =$ $d/[(8d/\pi L)\ln(d/u)+1]$ for $d<=(L/4))$

$d_e =$ $\pi L/[8\ln(L/u)]$ for $d>(L/4)$

The Hooghoudt formula can be rewritten to solve for mound height given a drain spacing:

$$m = (-8k_b d_e + [(8k_b d_e)^2 - 4(4k_a)(-qL^2)]^{0.5})/2(4k_a)$$

where,

Variable	Description	Value	Source
L	distance between drain pipes (ft)	200	FR Plan Sheet 23
k_a	hydraulic conductivity of material above drain (ft/yr)	see below	Slug test data
k_b	hydraulic conductivity of material below drain (ft/yr)	see below	Slug test data
m	height of mound between drains (ft)	calculated	
d	distance between water level at drain and impermeable base elevation (ft)	50	Assumed base of flow to drain (see note)
d_e	equivalent (effective) depth to impermeable base (ft)	calculated	
q	recharge/groundwater discharge rate (ft/yr)	calculated	
u	wetted perimeter of drain (ft)	3	2-foot wide trench, minimum 0.5 feet below drain flow elevation

Note: The Hooghoudt formula is not sensitive to increase in the depth of the impermeable surface greater than 1/4 of the drain spacing. The depth to the "impermeable" surface is used to calculate the cross-sectional area available for groundwater movement horizontally between and radially into the drains.

Calculate the underdrain discharge rate, q, based on underdrain discharge flow and contributing area:

		Base Scenario		Low K Scenario		High K Scenario	
	Unit	Low Water Table	High Water Table	Low Water Table	High Water Table	Low Water Table	High Water Table
Area of Underdrain System	acres	37	59	37	59	37	59
Estimated Discharge	gpm	33	79	25	59	72	167
Discharge Per Acre	gpm/acre	0.89	1.32	0.66	1.00	1.92	2.81
Underdrain Discharge Rate, q	**ft/yr**	**1.4**	**2.1**	**1.1**	**1.6**	**3.1**	**4.5**

Calculate mound height using the high flow scenario:

Input Variables						Calculated values			
K above drain k_a (cm/sec)	K below drain k_b (cm/sec)	Depth to base d (ft)	Discharge q (ft/yr)	Wetted perimeter u (ft)	Drain spacing L (ft)	K above drain k_a (ft/yr)	K below drain k_b (ft/yr)	Effective depth d_e (ft)	**Mound height m (ft)**
Scenario 1: Geometric mean hydraulic conductivity from slug tests applies above and below drain.									
6.00E-04	6.00E-04	50	2.1	3	200	621	621	18	**0.92**
Scenario 2: Underdrain drainage sand conductivity applies above drain and slug test geo mean applies below drain.									
1.00E-02	6.00E-04	50	2.1	3	200	10346	621	18	**0.71**
Scenario 3: Geometric mean hydraulic conductivity from till slug tests applies above and below drain.									
3.90E-04	3.90E-04	50	1.6	3	200	404	404	18	**1.07**
Scenario 4: Geometric mean hydraulic conductivity from Sinnipee Group slug tests applies above and below drain.									
1.80E-03	1.80E-03	50	4.5	3	200	1862	1862	18	**0.66**
Scenario 5: Same as scenario 1 except drain spacing increased to 400 feet									
6.00E-04	6.00E-04	50	2.1	3	400	621	621	26	**2.45**

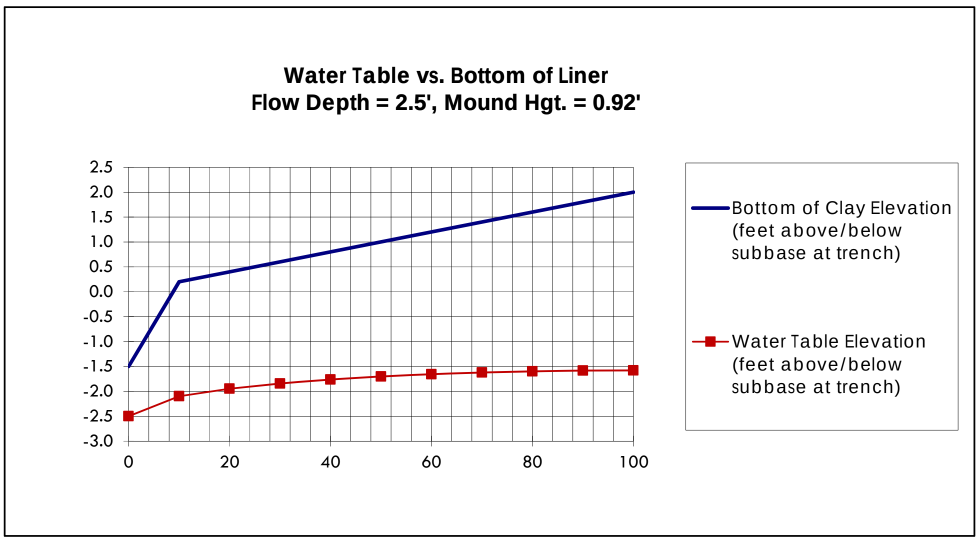
SCS ENGINEERS		Sheet No.	5 of 6
		Calc. No.	
		Rev. No.	
Job No. 25222268.00	Job: Landfill Site No. 3	By: SCC	Date: 7/14/2024
Client: Dane County	Subject: Underdrain Mound Height	Chk'd: EO	Date: 7/22/2024

Objective: Determine whether proposed drain flow depth will maintain water table below the bottom of the clay component of the liner, based on "worst case" mound height previously calculated for proposed drain spacing.

Scenario 1 - Base case, assume no sand drainage layer

Spacing	200 ft
Half-spacing	100 ft
Mound Height	0.92 ft
Drain Flow Depth	2.5 ft
Liner slope to drain	0.02 ft/ft
Undercut depth	1.5 ft
Undercut half-width	10 ft

Distance From Drain (feet)	Bottom of Clay Elevation (feet above/below subbase at trench)	Water Table Elevation (feet above/below subbase at trench)	Separation (feet)
0	-1.50	-2.50	1.00
10	0.20	-2.10	2.30
20	0.40	-1.95	2.35
30	0.60	-1.84	2.44
40	0.80	-1.76	2.56
50	1.00	-1.70	2.70
60	1.20	-1.66	2.86
70	1.40	-1.62	3.02
80	1.60	-1.60	3.20
90	1.80	-1.58	3.38
100	2.00	-1.58	3.58
Average			2.67



Notes

1) Depths in calculations and on graphs are relative to the proposed sub-base grade at the trench location, not considering the trench undercut. The actual bottom of clay will be 1.5 feet below the sub-base grade, due to the undercut for the leachate piping trench, as shown on the graph.
2) Water table elevations calculated based on formula for an ellipse with axes equal to the drain spacing and the mound height, as described in Slane and Hoopes (1988).
3) Mound heights were calculated using the Hooghoudt equation--see previous calculation for documentation.
4) Drain flow depth at 2.5 feet assumes pipe will flow half full and pipe centerline will be 2.5 feet below subbase grade without trench, or 1 foot below bottom of clay in trench.

SCS ENGINEERS

Sheet No.	6 of 6
Calc. No.	
Rev. No.	
By: SCC	Date: 7/14/2024
Chk'd: EO	Date: 7/22/2024

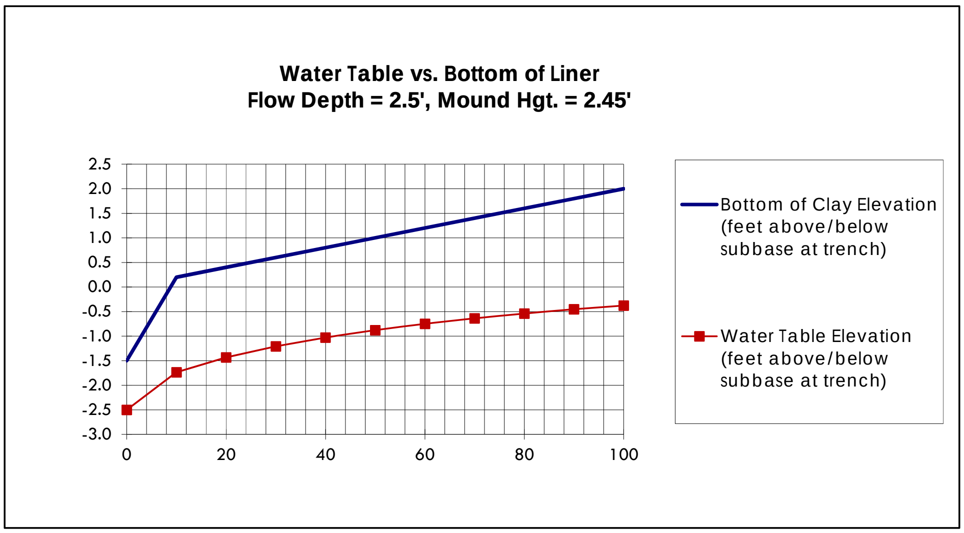
Job No. 25222268.00 — Job: Landfill Site No. 3
Client: Dane County — Subject: Underdrain Mound Height

Objective: Determine whether proposed drain flow depth will maintain water table below the bottom of the clay component of the liner, based on "worst case" mound height previously calculated for proposed drain spacing.

Scenario 2 - Alternative case when adjacent drain is at a higher elevation so the drainage divide will not be centered between the pipes. For worst case, assume double-spacing (one drain captures entire width between the 2 adjacent drains

Spacing	400 ft
Half-spacing	200 ft
Mound Height	2.45 ft
Drain Flow Depth	2.5 ft
Liner slope to drain	0.02 ft/ft
Undercut depth	1.5 ft
Undercut half-width	10 ft

Distance From Drain (feet)	Bottom of Clay Elevation (feet above/below subbase at trench)	Water Table Elevation (feet above/below subbase at trench)	Separation (feet)
0	-1.50	-2.50	1.00
10	0.20	-1.73	1.93
20	0.40	-1.43	1.83
30	0.60	-1.21	1.81
40	0.80	-1.03	1.83
50	1.00	-0.88	1.88
60	1.20	-0.75	1.95
70	1.40	-0.64	2.04
80	1.60	-0.54	2.14
90	1.80	-0.45	2.25
100	2.00	-0.38	2.38
Average			1.91



Notes

1) Depths in calculations and on graphs are relative to the proposed sub-base grade at the trench location, not considering the trench undercut. The actual bottom of clay will be 1.5 feet below the sub-base grade, due to the undercut for the leachate piping trench, as shown on the graph.
2) Water table elevations calculated based on formula for an ellipse with axes equal to the drain spacing and the mound height, as described in Slane and Hoopes (1988).
3) Mound heights were calculated using the Hooghoudt equation--see previous calculation for documentation.
4) Drain flow depth at 2.5 feet assumes pipe will flow half full and pipe centerline will be 2.5 feet below subbase grade without undercut, or 1 foot below bottom of clay in undercut.

Table 5-6. Single Well Hydraulic Conductivity Test Results - All Wells
Dane County Landfill Site No. 3 / SCS Engineers Project #25222268.00
Feasibility Report

Monitoring Well	Hydraulic Conductivity (K_h) (cm/s)	Lithology within Screen Interval	USCS Soil Type and/or Rock Unit
MW-1	4.5E-03	Loess and Outwash	ML, CL, and SP-SM
MW-2	1.7E-04	Till	SM
MW-3	1.6E-03	Till	SM
MW-4	4.4E-02	Dolomite (Prairie du Chien Group)	DOL
MW-105	5.2E-04	Loess, Outwash, and Till	CL, SP, SM
MW-105A	2.3E-04	Weathered Dolomite	GM
MW-106	5.3E-04	Loess and Till	CL and SM
MW-107	5.2E-04	Till	SM
MW-108	3.6E-04	Till	SM
MW-109	2.1E-03	Till, Weathered Dolomite, and Dolomite (Galena Fm.)	SM, SM, and DL1
MW-109A	1.4E-03	Dolomite (Galena Fm.)	DL1
MW-110	1.0E-03	Till	SM
MW-110A	1.8E-04	Sandstone (Glenwood Fm.)	SS1
MW-111	2.2E-03	Till & Outwash	SM, SP-SM
MW-112	7.5E-03	Till and Weathered Dolomite (Galena Fm.)	SM and SM
MW-113	4.5E-04	Dolomite (Galena Fm.)	DL1
MW-113A	3.9E-05	Dolomite (Platteville Fm.) & Sandstone (Glenwood Fm.)	DL2 and SS1
MW-114	2.3E-03	Loess, Till, and Sandstone (Tonti Member)	CL, SM, and SS2
MW-114A	9.6E-04	Dolomite (Prairie du Chien Gr., Shakopee Fm.)	DL3
MW-115	1.7E-02	Till, Weathered Dolomite, and Dolomite (Oneota Fm.)	SM, GM, and DL4
MW-116	4.5E-04	Sandstone (Tonti Member)	SS2
MW-116A	4.0E-03	Sandstone (Tonti Member)	SS2
MW-117	3.7E-04	Loess and Till	CH and SM
MW-117A	1.9E-04	Dolomite (Oneota Fm.)	DL4
MW-118	2.2E-03	Till and Sandstone (Tonti Member)	SM and SS2
MW-118A	8.0E-05	Variable Lithology (Readstown Member) & minor Dolomite (Prairie du Chien Gr.)	SS3 and DL5
MW-119	3.2E-03	Sandstone (Tonti Member)	SS2
MW-120	2.4E-04	Till	SM
MW-120A	1.8E-04	Dolomite (Oneota Fm.)	DL4
MW-121	4.5E-04	Till, Sandstone (Tonti Member), and Dolomite (Oneota Fm.)	SM, SS2, and DL4
MW-122	1.1E-04	Till	SM
MW-123	2.4E-04	Sandstone (Tonti Member)	SS2
MW-123A	8.0E-06	Dolomite (Shakopee Fm.)	DL3
MW-123B	5.4E-04	Variable Lithology (Readstown Member)	SS3
MW-124	1.1E-03	Dolomite (Oneota Fm.)	DL4
MW-124A	9.6E-05	Dolomite (Oneota Fm.)	DL4
MW-125	2.6E-04	Till, Variable Lithology (Readstown Member), and Dolomite (Prairie du Chien Gr.)	SM, SS3, and DL5
MW-125A	3.2E-04	Dolomite (Prairie du Chien Gr.)	DL5
Minimum	8.0E-06		
Maximum	4.4E-02		
Geometric Mean	6.0E-04		

Created by:	ACW	Date:	9/28/2023
Last revision by:	JR	Date:	1/15/2024
Checked by:	SCC	Date:	2/7/2024

I:\25222268.00\Deliverables\Feasibility Report\Tables\[5-6 Hydraulic Conductivity Test Results.xlsx]5-6 All Wells

Table 10-3b. Single Well Hydraulic Conductivity Test Results - Wells in Till
Dane County Landfill Site No. 3 / SCS Engineers Project #25222268.00
Feasibility Report Addendum No. 1

Monitoring Wells & Piezometers	Hydraulic Conductivity (Kh) (cm/s)	Lithology within Screen Interval	USCS & Rock Unit
MW-2	1.7E-04	Till	SM
MW-3	1.6E-03	Till	SM
MW-107	5.2E-04	Till	SM
MW-108	3.6E-04	Till	SM
MW-110	1.0E-03	Till	SM
MW-117	3.7E-04	Loess and Till	CH and SM
MW-120	2.4E-04	Till	SM
MW-122	1.1E-04	Till	SM
Minimum	1.1E-04		
Maximum	1.6E-03		
Geometric Mean	3.9E-04		

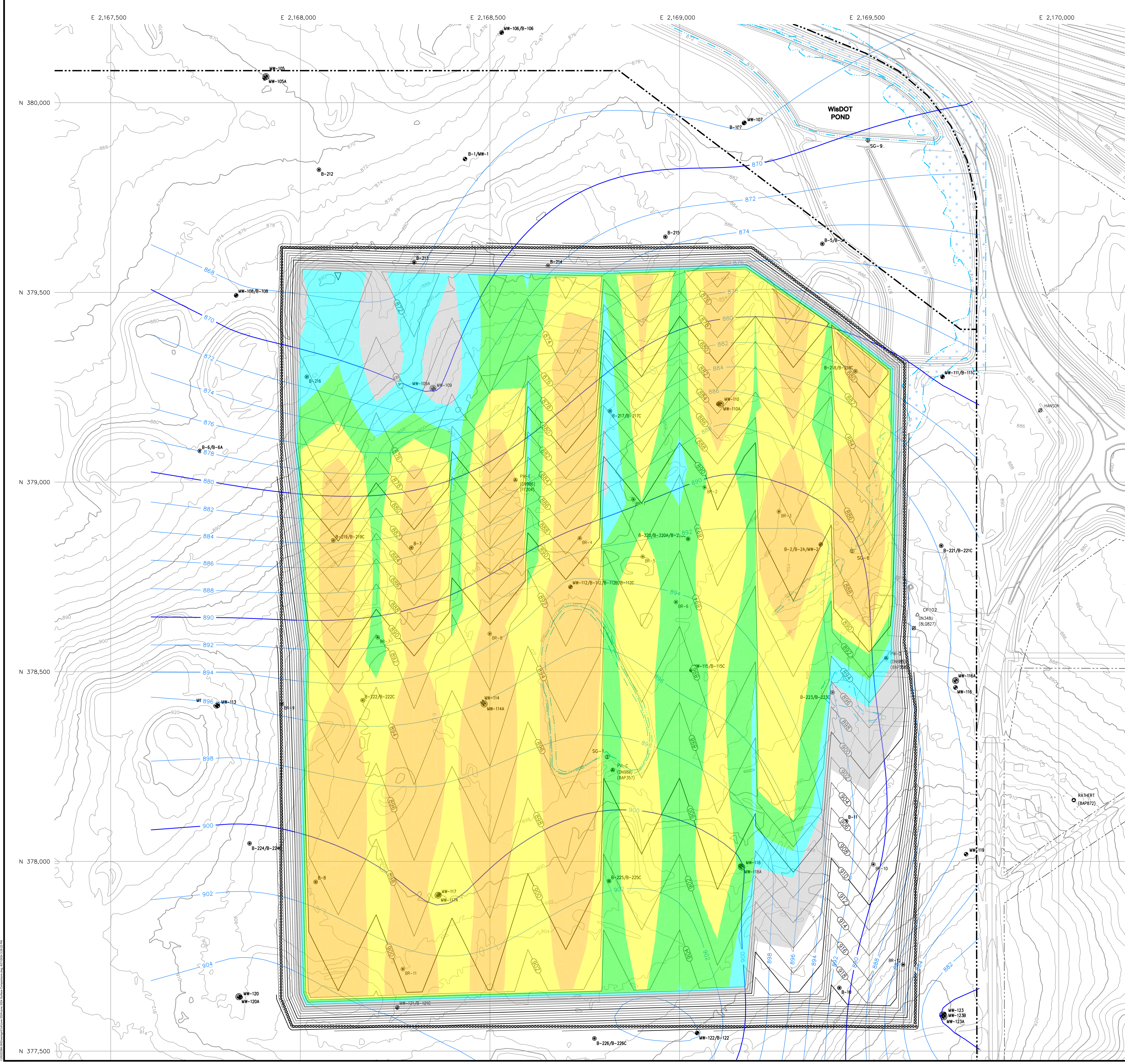
Checked by: BJS, 10/02/2023
Checked by: JR, 11/14/2023

Table 10-4. Single Well Hydraulic Conductivity Test Results - Wells in Sinnipee Group (Galena Formation)
Dane County Landfill Site No. 3 / SCS Engineers Project #25222268.00
Feasibility Report Addendum No. 1

Monitoring Well	Hydraulic Conductivity (K_h) (cm/s)	Lithology within Screen Interval	USCS Soil Type and/or Rock Unit
MW-109	2.1E-03	Till, Weathered Dolomite, and Dolomite (Galena Fm.)	SM, SM, and DL1
MW-109A	1.4E-03	Dolomite (Galena Fm.)	DL1
MW-112	7.5E-03	Till and Weathered Dolomite (Galena Fm.)	SM and SM
MW-113	4.5E-04	Dolomite (Galena Fm.)	DL1
Minimum	4.5E-04		
Maximum	7.5E-03		
Geometric Mean	1.8E-03		

Created by: ACW Date: 9/28/2023

Checked by: BJS Date: 5/17/2024



LEGEND

- PROJECT PROPERTY LINE
- PROPERTY PARCEL LINE
- PROPOSED LIMITS OF WASTE
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM/EDGE OF WATER
- EXISTING WETLAND
- EXISTING SMALL WETLAND AREA
- EXISTING SOIL BORING
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING STAFF GAUGE
- SUBBASE GRADE (2' CONTOUR)
- SUBBASE GRADE (10' CONTOUR)
- SEASONAL HIGH WATER TABLE (2' CONTOUR)
- SEASONAL HIGH WATER TABLE (10' CONTOUR)

NOTES:

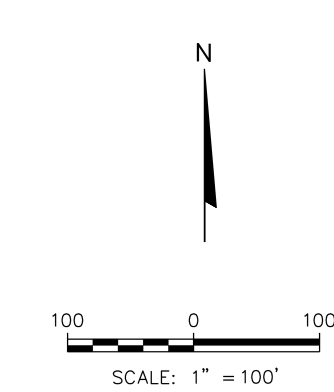
1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT BOTTOM OF CLAY LINER (SUBBASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED MARCH 29, 2023.
4. WATER TABLE SURFACE AND SUBBASE GRADES FROM FEASIBILITY REPORT ADDENDUM NO. 1, PLAN SHEETS 3 AND 23.

SEPARATION TO WATER TABLE (FEET)		
Minimum	Maximum	Color
−4.000	−2.000	
−2.000	0.000	
0.000	2.000	
2.000	4.000	
4.000	10.000	
	>10.000	

NEGATIVE VALUES (YELLOW AND ORANGE SHADING) INDICATE SEASONAL HIGH WATER TABLE ABOVE SUBBASE.

FUTURE CONTROLLED WATER TABLE WILL BE BELOW SUBBASE GRADES WITH OPERATION OF UNDERDRAIN.

AREA OF SUBBASE GRADES ABOVE SEASONAL HIGH WATER TABLE = 34.1 ACRES.



PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	06/12/2024	CHECKED BY:	MRH/BLP
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

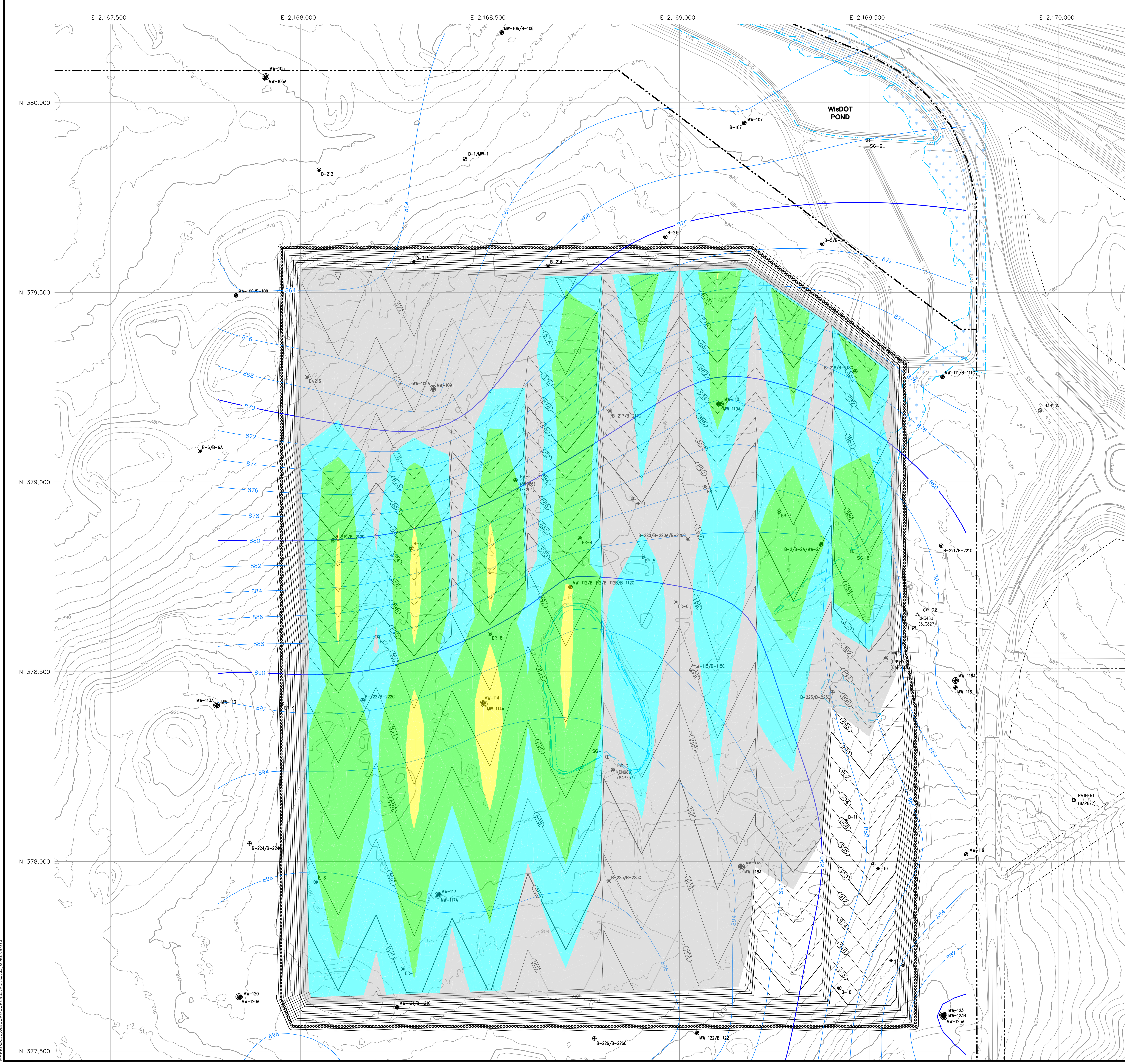
CLIENT: DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE: FEASIBILITY REPORT – ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
US HWY 12/18
MADISON, WISCONSIN

SUBBASE GRADES (JULY 2024) / SEASONAL HIGH WATER TABLE

SHEET



LEGEND

- PROJECT PROPERTY LINE
- PROPERTY PARCEL LINE
- PROPOSED LIMITS OF WASTE
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM/EDGE OF WATER
- EXISTING WETLAND
- EXISTING SMALL WETLAND AREA
- EXISTING SOIL BORING
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING STAFF GAUGE
- SUBBASE GRADE (2' CONTOUR)
- SUBBASE GRADE (10' CONTOUR)
- SEASONAL LOW WATER TABLE (2' CONTOUR)
- SEASONAL LOW WATER TABLE (10' CONTOUR)

NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT BOTTOM OF CLAY LINER (SUBBASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED DECEMBER 4, 2023.
4. WATER TABLE SURFACE AND SUBBASE GRADES FROM FEASIBILITY REPORT ADDENDUM NO. 1, PLAN SHEETS 4 AND 23.

SEPARATION TO WATER TABLE (FEET)		
Minimum	Maximum	Color
-1.000	0.000	(yellow)
0.000	2.000	(green)
2.000	4.000	(cyan)
4.000	10.000	(gray)
	>10.000	

NEGATIVE VALUES (YELLOW SHADING) INDICATE SEASONAL LOW WATER TABLE ABOVE SUBBASE.

FUTURE CONTROLLED WATER TABLE WILL BE BELOW SUBBASE GRADES WITH OPERATION OF UNDERDRAIN.

AREA OF SUBBASE GRADES ABOVE SEASONAL LOW WATER TABLE = 75.3 ACRES.

100 0 100

SCALE: 1" = 100'

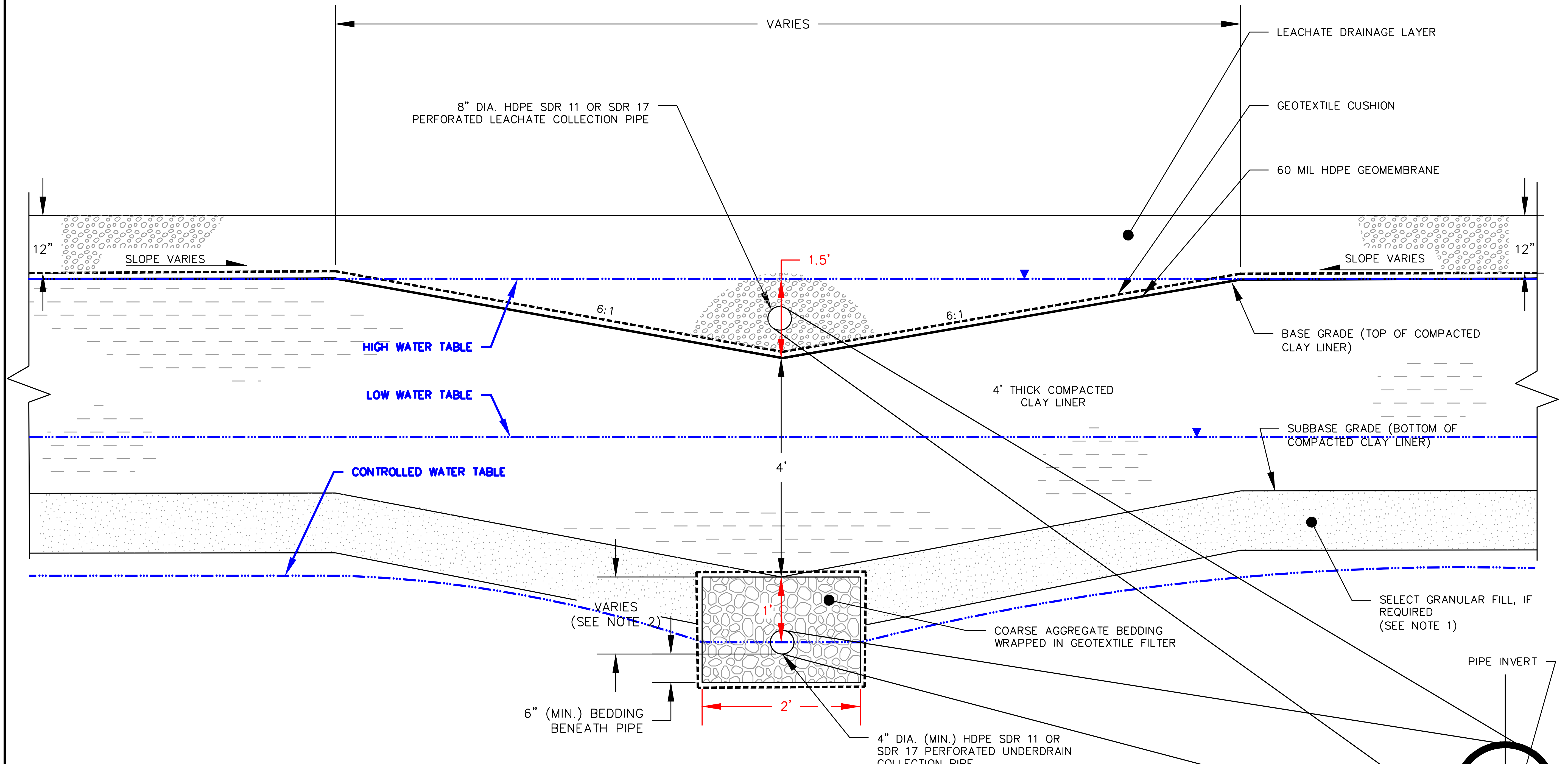
DRAWN BY:	KP
CHECKED BY:	MRH/BLP
APPROVED BY:	SCC 08/23/2024
PROJECT NO.	25222268.00
DRAWN:	06/12/2024
REVISED:	08/13/2024

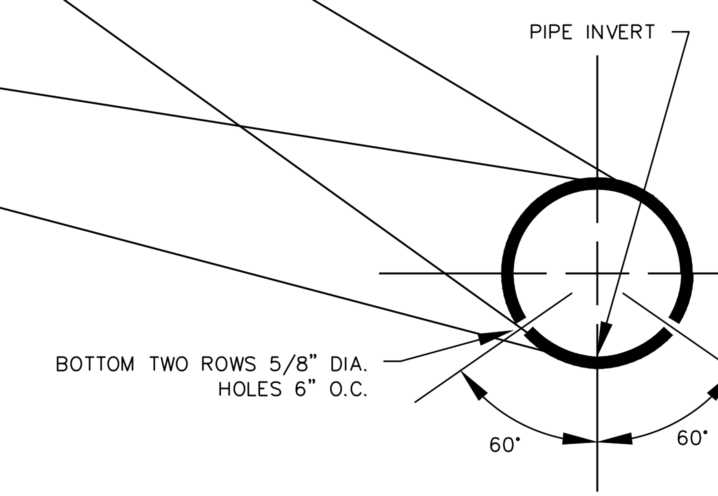
CLIENT: DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

SITE: FEASIBILITY REPORT - ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
US HWY 12/18
MADISON, WISCONSIN

SHEET: SUBBASE GRADES (JULY 2024) / SEASONAL LOW WATER TABLE





NOTES:

1. PARTIAL UNDERDRAIN DRAINAGE LAYER TO BE INCLUDED AS NECESSARY BASED ON PLAN OF OPERATION DESIGN CALCULATIONS. GEOCOMPOSITE MAY BE USED AS AN ALTERNATIVE TO GRANULAR FILL.
2. DEPTH OF COLLECTION PIPE BELOW BOTTOM OF CLAY TO BE BASED ON PLAN OF OPERATION DESIGN CALCULATIONS.
3. RED DIMENSIONS AND **BLUE WATER TABLES** ASSUMED FOR FR ADDENDUM 1 CALCULATIONS. FINAL DIMENSIONS TO BE DETERMINED FOR PLAN OF OPERATION.

ASSUMED CONDITIONS FOR
UNDERDRAIN CALCULATION

FIGURE

FEASIBILITY REPORT – ADDENDUM NO. 1
DANE COUNTY LANDFILL SITE NO. 3
4402 BRANDT ROAD
MADISON, WISCONSIN

SITE

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713

CLIENT

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	07/16/2024	CHECKED BY:	SCC
REVISED:	08/13/2024	APPROVED BY:	SCC 08/16/2024

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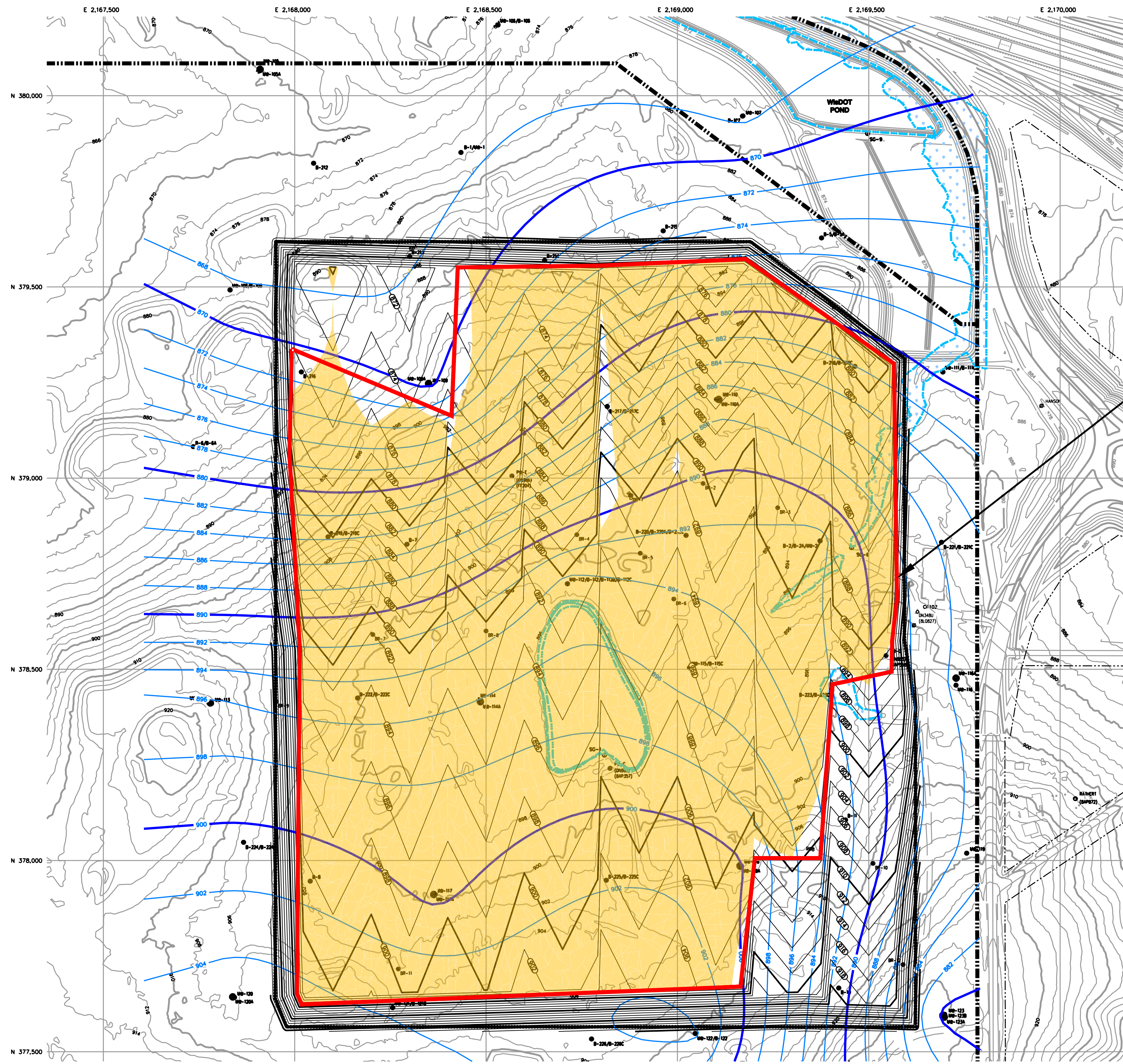

AREA AFFECTED BY UNDERDRAIN UNDER HIGH WATER TABLE CONDITIONS = 59.4 ACRES.

SHADED AREA IS AREA WHERE SUBBASE GRADES ARE WITHIN 2.5 FEET OF WATER TABLE. THE UNDERDRAIN PIPE IS ASSUMED TO BE 2.5 FEET BELOW THE SUBBASE ALONG THE CENTERLINE OF EACH CELL. AREAS WHERE THE UNDERDRAIN PIPING IS ABOVE THE WATER TABLE ARE NOT AFFECTED BY THE UNDERDRAIN.

LEGEND

- PROJECT PROPERTY LINE
- PROPERTY PARCEL LINE
- PROPOSED LIMITS OF WASTE
- EXISTING GRADE (2' CONTOUR)
- EXISTING GRADE (10' CONTOUR)
- DOT BASIN CONSTRUCTION GRADE (2' CONTOUR)
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM/EDGE OF WATER
- EXISTING WETLAND
- EXISTING SMALL WETLAND AREA
- EXISTING SOIL BORING
- EXISTING MONITORING WELL
- EXISTING PIEZOMETER
- EXISTING STAFF GAUGE
- SUBBASE GRADE (2' CONTOUR)
- SUBBASE GRADE (10' CONTOUR)
- SEASONAL HIGH WATER TABLE (2' CONTOUR)
- SEASONAL HIGH WATER TABLE (10' CONTOUR)

NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT BOTTOM OF CLAY LINER (SUBBASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED MARCH 29, 2023.

SEPARATION TO WATER TABLE (FEET)		
Minimum	Maximum	Color
-4.000	2.500	

300 0 300

SCALE: 1" = 300'

N

CLIENT

DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713

SITE

FEASIBILITY REPORT
DANE COUNTY LANDFILL SITE NO. 3
4402 BRANDT ROAD
MADISON, WISCONSIN

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	06/12/2024	CHECKED BY:	JR/MRH
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

SUBBASE GRADES (JULY 2024) / SEASONAL HIGH WATER TABLE

FIGURE

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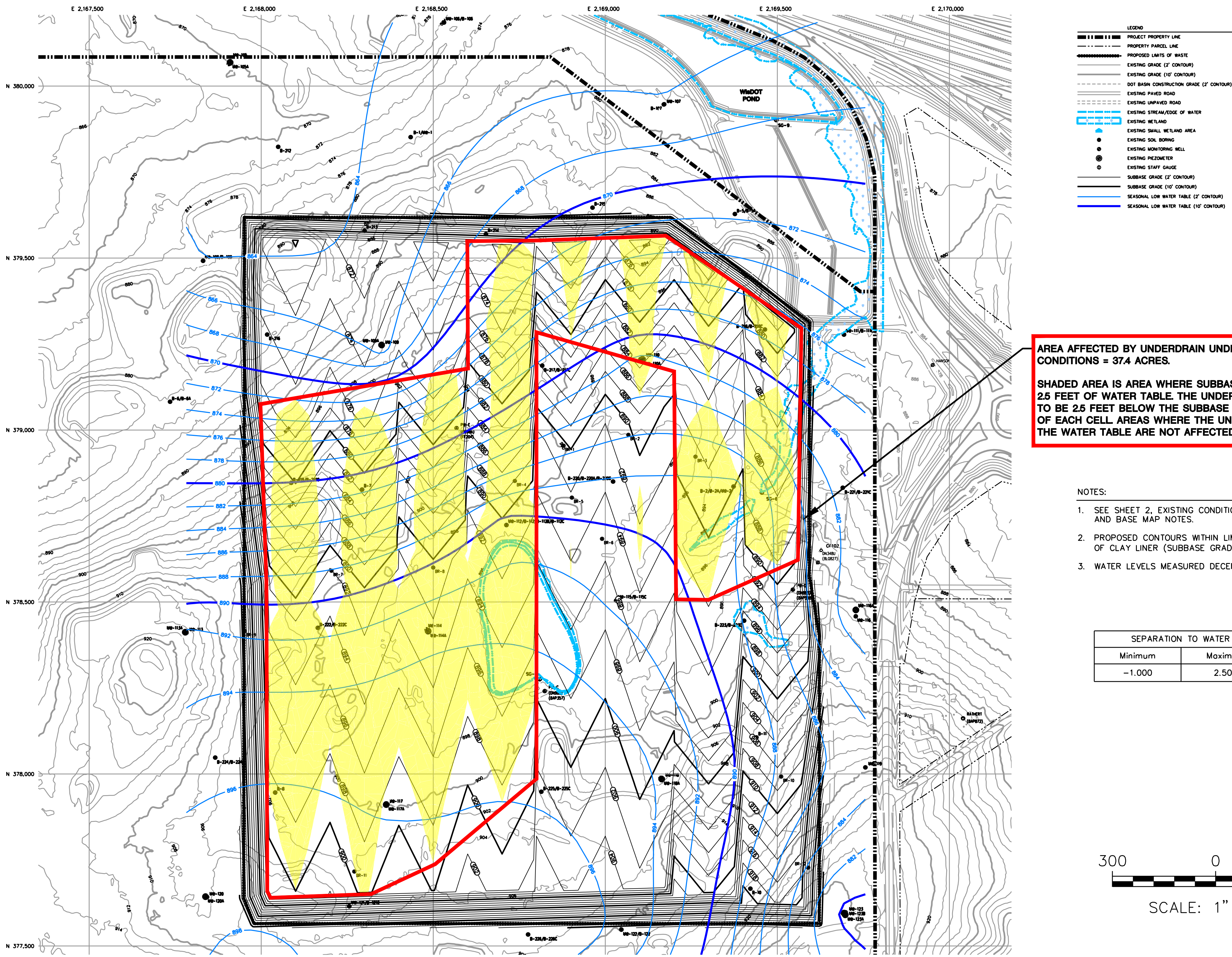

AREA AFFECTED BY UNDERDRAIN UNDER LOW WATER TABLE CONDITIONS = 37.4 ACRES.

SHADED AREA IS AREA WHERE SUBBASE GRADES ARE WITHIN 2.5 FEET OF WATER TABLE. THE UNDERDRAIN PIPE IS ASSUMED TO BE 2.5 FEET BELOW THE SUBBASE ALONG THE CENTERLINE OF EACH CELL. AREAS WHERE THE UNDERDRAIN PIPING IS ABOVE THE WATER TABLE ARE NOT AFFECTED BY THE UNDERDRAIN.

NOTES:

1. SEE SHEET 2, EXISTING CONDITIONS, FOR ADDITIONAL LEGEND ITEMS AND BASE MAP NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT BOTTOM OF CLAY LINER (SUBBASE GRADES). UNDERCUTS ARE NOT SHOWN.
3. WATER LEVELS MEASURED DECEMBER 4, 2023.

SEPARATION TO WATER TABLE (FEET)		
Minimum	Maximum	Color
-1.000	2.500	

300 0 300

SCALE: 1" = 300'

N

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CLIENT

DANE COUNTY DEPARTMENT OF WASTE AND RENEWABLES
1919 ALLIANT ENERGY CENTER WAY
MADISON, WI 53713

SITE

FEASIBILITY REPORT
DANE COUNTY LANDFILL SITE NO. 3
4402 BRANDT ROAD
MADISON, WISCONSIN

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	06/12/2024	CHECKED BY:	JR/MRH
REVISED:	08/13/2024	APPROVED BY:	SCC 08/23/2024

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

SUBBASE GRADES (JULY 2024) / SEASONAL LOW WATER TABLE

FIGURE