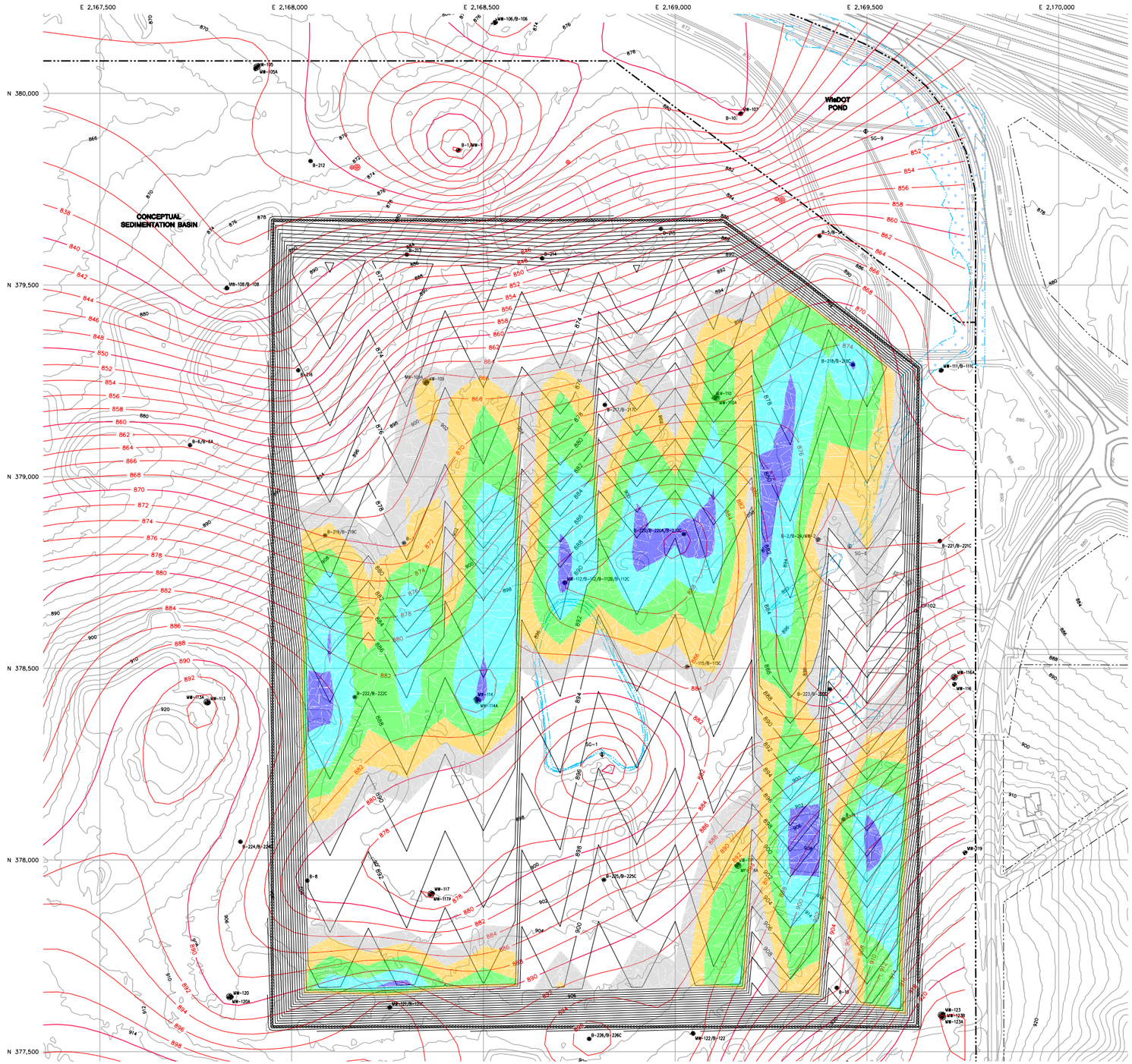
03 Subbase vs. Bedrock Figure



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 FOR LEACHATE COLLECTION LINES AND SUMPS ARE NOT SHOWN.

Separation to Bedrock			
Number	Minimum Separation	Maximum Separation	Color
1	0.0	2.0	
2	2.0	4.0	
3	4.0	6.0	
4	6.0	8.0	
5	8.0	10.0	
6	>10.0		

N

300 0 300

SCALE: 1" = 300'

TOP OF BEDROCK / SUBBASE GRADES

FIGURE

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

ENGINEER

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

SITE

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

CLIENT

PROJECT NO.	25222268.00	DRAWN BY:	KP
DRAWN:	11/16/2023	CHECKED BY:	SCC
REVISED:	02/12/2024	APPROVED BY:	SCC 02/12/2024

I:\25222268.00\Drawings\100% Subbase Surface Comparisons.dwg, 2/12/2024 2:59:23 PM

04 Average Horizontal Hydraulic Gradient and Groundwater Flow Velocity Calculation

SCS ENGINEERS

Created by: BJS, 01/30/2024
Last Rev. by: SCC, 2/13/2024
Checked by: BLP 2/13/24

Project Number:	**25222268.00**
Project Name:	**Proposed Dane County Landfill No. 3**
Client:	**Dane County**

Purpose:

To calculate the average horizontal hydraulic gradient across the site.

Approach:

Groundwater elevations were used to generate groundwater flow maps.

1 Select two groundwater elevation contour lines from the map that represent the average groundwater elevation change across the site. Select two points, one on each contour line and one point directly downgradient (perpendicular to groundwater elevation contours) from the other point.

2 Calculate the difference in head (Δh) between the points by subtracting the lower groundwater elevation of the two points from the higher groundwater elevation of the two points.

3 Measure the distance between the two points (**Δl**) by using the map scale and ruler.

4 Keep units consistent (i.e., ft/ft).

5 Calculate the horizontal gradient '(I_h) using the following equation: $I_h = \Delta h/\Delta l$

6 Calculate the average groundwater velocity (V) using the following equation: $V = KI_h/n$

Assumptions:

A contour line (representing a specific groundwater elevation) is estimated based on observed water elevations recorded from site wells. Therefore, the contour line representing a specific water elevation at a specific point is estimated and may not represent actual subsurface conditions.

Reference:

Freeze, R. A. and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, N.J., Prentice-Hall, 604 p.

SCS ENGINEERS

Created by: BJS, 01/30/2024
Last Rev. by: SCC, 2/13/2024
Checked by: BLP 2/13/24

Project Number: **25222268.00**
Project Name: **Proposed Dane County Landfill No. 3**
Client: **Dane County**

Calculations:

Title of Groundwater Flow Map (see attached)	Flow Path Segment (see flow map)	Δh (feet)	Δl (feet)	I_h Δh/Δl	K Value (ft/d)	Effective Porosity, n	V (feet/day)	V (feet/year)
Sheet 3 - High WT - Mar. 2023	Toward the E	22	600	0.037	2.81	0.30	0.34	130
	Central Area to N	8	830	0.010	2.81	0.30	0.090	33
	Toward the NW	20	830	0.024	2.81	0.30	0.23	82
Sheet 4 - Low WT - Dec. 2023	Toward the E	16	690	0.023	2.81	0.30	0.22	79
	Central Area to N	6	720	0.008	2.81	0.30	0.078	28
	Toward the NW	20	860	0.023	2.81	0.30	0.22	79
Sheet 5 - Piezo - Mar. 2023	Toward the E	26	780	0.033	0.57	0.25	0.076	28
	Central Area to N	14	790	0.018	0.57	0.25	0.040	15
	Toward the NW	16	790	0.020	0.57	0.25	0.046	17

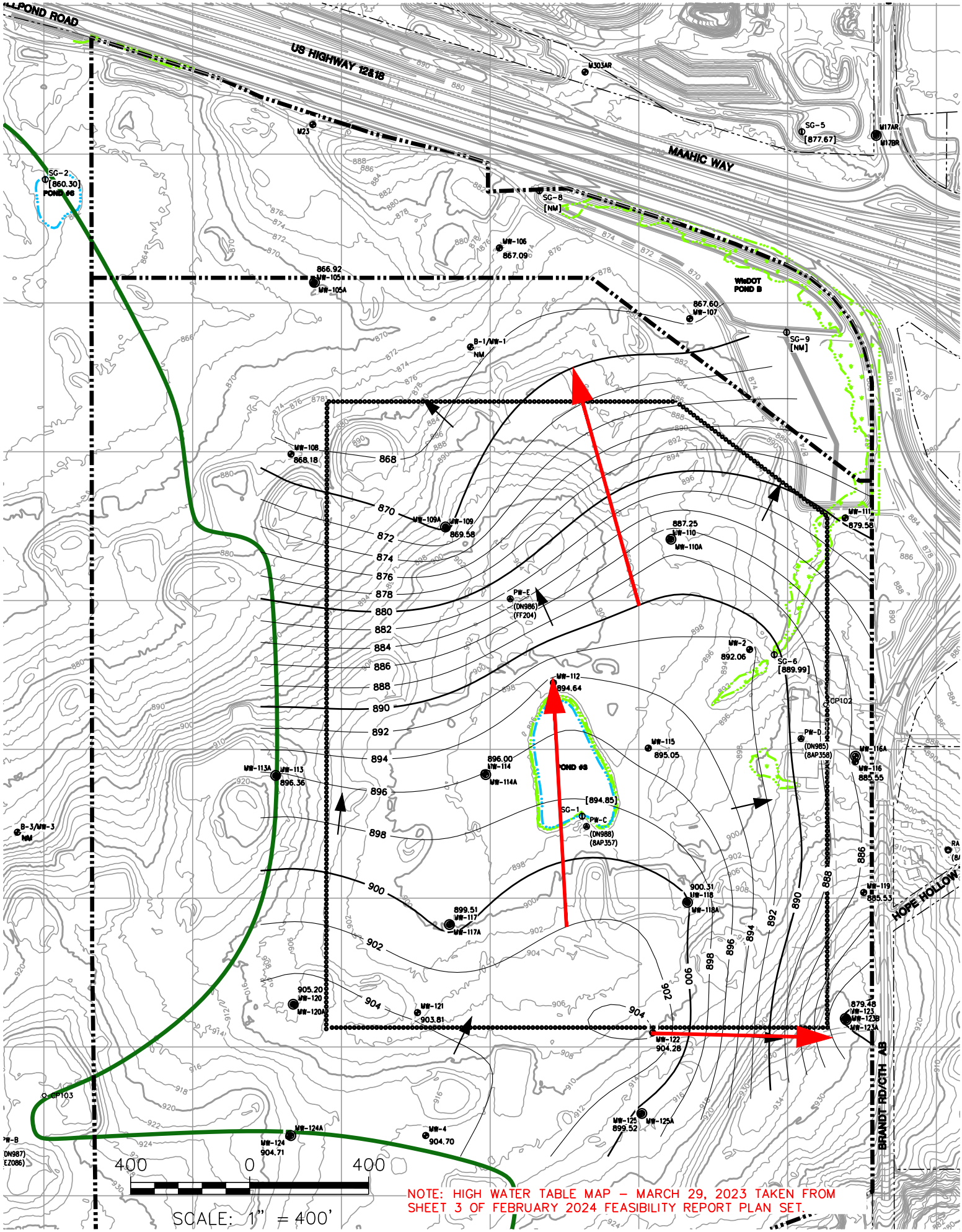
Note: Estimated groundwater velocity results in feet/day and feet/year are rounded to two significant digits.

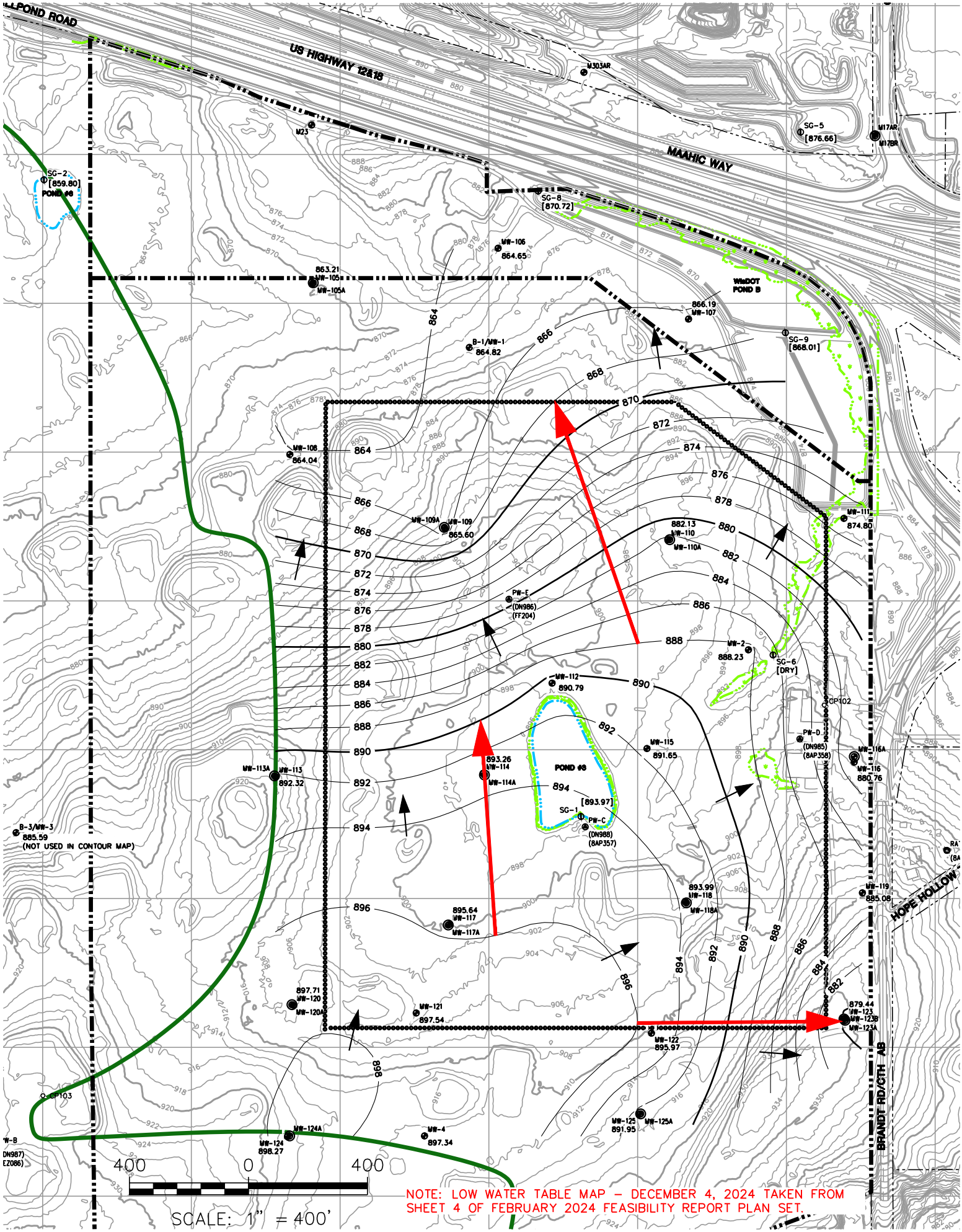
Well Type	K Value (cm/sec)	K Value (ft/d)	Effective Porosity, n
Water Table (See attached Table 5-6A for K-values)	9.9E-04	2.81	0.30
Piezometer (See attached Table 5-6B for K-values)	2.0E-04	0.57	0.25

ft = feet
ft/d = feet per day
K = hydraulic conductivity
Δl = distance between elevation points
Δh/Δl = hydraulic gradient
V = groundwater flow velocity
n = effective porosity

Attachments:

Groundwater Flow Maps (3)
Hydraulic Conductivity Test Results, Tables 5-6A and 5-6B


US HIGHWAY 12&18
MAAHIC WAY
HOPE HOLLOW
BRANDT RD/CTH AB
WisDOT POND B
POND #8
SG-2 [860.30]
SG-5 [877.67]
SG-8 [NM]
SG-9 [NM]
SG-1 [894.85]
SG-6 [889.99]
MW-303AR
M23
M17AR
M17BR
MW-106 867.09
866.92 MW-105 MW-105A
867.60 MW-107
B-1/MW-1 NM
MW-108 868.18
MW-109A MW-109 869.58
MW-111 879.58
887.25 MW-110 MW-110A
PW-E (DN986) (FF204)
MW-2 892.06
MW-112 894.64
CP102
PW-D (DN985) (8AP358)
MW-115 895.05
MW-116A MW-116 885.55
MW-113A MW-113 896.36
896.00 MW-114 MW-114A
B-3/MW-3 NM
PW-C (DN988) (8AP357)
900.31 MW-118 MW-118A
MW-119 885.53
899.51 MW-117 MW-117A
905.20 MW-120 MW-120A
MW-121 903.81
879.48 MW-123 MW-123B MW-123A
MW-122 904.28
CP103
MW-124A MW-124 904.71
MW-4 904.70
MW-125 899.52 MW-125A
868
870
872
874
876
878
880
882
884
886
888
890
892
894
896
898
900
902
904
906
400
0
400
SCALE: 1" = 400'
NOTE: HIGH WATER TABLE MAP – MARCH 29, 2023 TAKEN FROM SHEET 3 OF FEBRUARY 2024 FEASIBILITY REPORT PLAN SET.


LLPOND ROAD
US HIGHWAY 12&18
MAAHIC WAY
M303AR
M23
SG-5 [876.66]
M17AR
M17BR
SG-2 [859.80] POND #8
SG-8 [870.72]
MW-106 864.65
863.21 MW-105 MW-105A
WisDOT POND B
866.19 MW-107
SG-9 [868.01]
B-1/MW-1 864.82
MW-108 864.04
MW-109A MW-109 865.60
MW-111 874.80
882.13 MW-110 MW-110A
PW-E (DN986) (FF204)
MW-2 888.23
SG-6 [DRY]
MW-112 890.79
CP102
PW-D (DN985) (8AP358)
MW-115 891.65
MW-116A MW-116 880.76
MW-113A MW-113 892.32
893.26 MW-114 MW-114A
POND #8
[893.97]
SG-1
PW-C (DN988) (8AP357)
B-3/MW-3 885.59 (NOT USED IN CONTOUR MAP)
893.99 MW-118 MW-118A
MW-119 885.08
HOPE HOLLOW
895.64 MW-117 MW-117A
897.71 MW-120 MW-120A
MW-121 897.54
879.44 MW-123 MW-123B MW-123A
MW-122 895.97
BRANDT RD/CTH AB
CP103
MW-124A
MW-124 898.27
MW-4 897.34
MW-125 891.95
MW-125A
400 0 400
SCALE: 1" = 400'
NOTE: LOW WATER TABLE MAP – DECEMBER 4, 2024 TAKEN FROM SHEET 4 OF FEBRUARY 2024 FEASIBILITY REPORT PLAN SET.

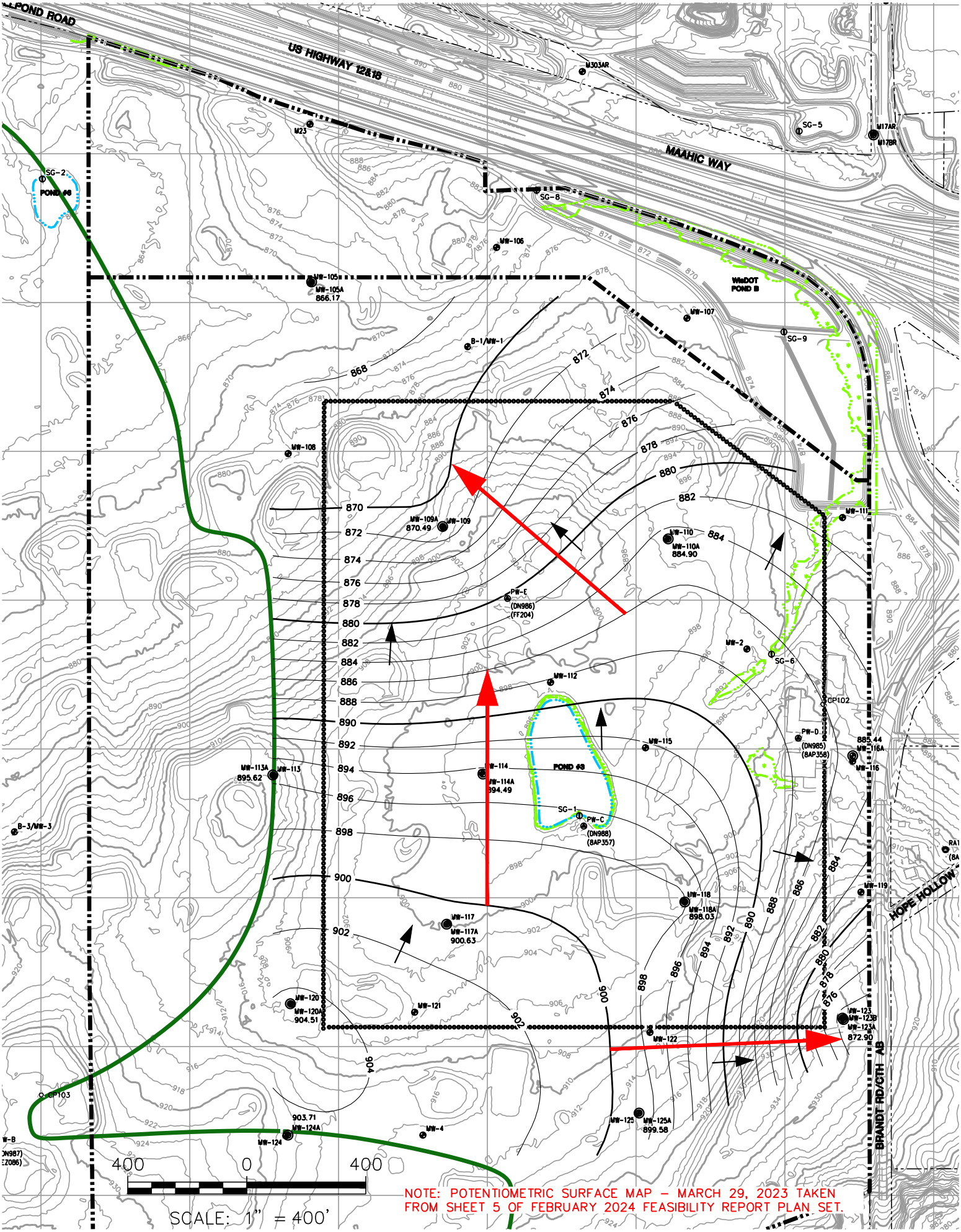

US HIGHWAY 12&18
MAAHIC WAY
HOPE HOLLOW
BRANDT RD/CTH AB
POND #3
WisDOT POND B
SG-1
SG-2
SG-5
SG-6
SG-8
SG-9
M303AR
M23
M17AR
M17BR
MW-105
MW-105A 866.17
MW-106
MW-107
MW-108
MW-109A 870.49
MW-109
MW-110
MW-110A 884.90
MW-111
MW-112
MW-113
MW-113A 895.62
MW-114
MW-114A 894.49
MW-115
MW-116
MW-116A 885.44
MW-117
MW-117A 900.63
MW-118
MW-118A 898.03
MW-119
MW-120
MW-120A 904.51
MW-121
MW-122
MW-123
MW-123A 872.90
MW-124
MW-124A 903.71
MW-125
MW-125A 899.58
MW-2
MW-4
B-1/MW-1
B-3/MW-3
PW-C (DN988) (8AP357)
PW-D (DN985) (8AP358)
PW-E (DN986) (FF204)
CP102
CP103
870
872
874
876
878
880
882
884
886
888
890
892
894
896
898
900
902
904
400
0
400
SCALE: 1" = 400'
NOTE: POTENTIOMETRIC SURFACE MAP – MARCH 29, 2023 TAKEN FROM SHEET 5 OF FEBRUARY 2024 FEASIBILITY REPORT PLAN SET.

Table 5-6A. Single Well Hydraulic Conductivity Test Results - All Water Table 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 & 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-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-110	1.0E-03	Till	SM
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-114	2.3E-03	Loess, Till, and Sandstone (Tonti Member)	CL, SM, and SS2
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-117	3.7E-04	Loess and Till	CH and SM
MW-118	2.2E-03	Till and Sandstone (Tonti Member)	SM and SS2
MW-119	3.2E-03	Sandstone (Tonti Member)	SS2
MW-120	2.4E-04	Till	SM
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-123B	5.4E-04	Variable Lithology (Readstown Member)	SS3
MW-124	1.1E-03	Dolomite (Oneota Fm.)	DL4
MW-125	2.6E-04	Till, Variable Lithology (Readstown Member), and Dolomite (Prairie du Chien Gr.)	SM, SS3, and DL5
Minimum	1.1E-04		
Maximum	4.4E-02		
Geometric Mean	9.9E-04		

Created by:	ACW	Date:	9/28/2023
Last revision by:	JR	Date:	1/15/2024
Checked by:	BJS	Date:	2/6/2024

I:\25222268.00\Data and Calculations\Hor. Grad. Calcs\[5-6 Hydraulic Conductivity Test Results.xlsx]5-6A All WT Wells

Table 5-6B
Single Well Hydraulic Conductivity Test Results - Piezometers
Dane County Landfill No. 3 / SCS Engineers Project #25222268.00

Monitoring Wells & Piezometers	Hydraulic Conductivity (Kh) (cm/s)	Lithology within Screen Interval	USCS & Rock Unit
MW-105A	2.3E-04	Weathered Dolomite	GM
MW-109A	1.4E-03	Dolomite (Galena Fm.)	DL1
MW-110A	1.8E-04	Sandstone (Glenwood Fm.)	SS1
MW-113A	3.9E-05	Dolomite (Platteville Fm.) & Sandstone (Glenwood Fm.)	DL2 and SS1
MW-114A	9.6E-04	Dolomite (Prairie du Chien Gr., Shakopee Fm.)	DL3
MW-116A	4.0E-03	Sandstone (Tonti Member)	SS2
MW-117A	1.9E-04	Dolomite (Oneota Fm.)	DL4
MW-118A	8.0E-05	Variable Lithology (Readstown Member) & minor Dolomite (Prairie du Chien Gr.)	SS3 and DL5
MW-120A	1.8E-04	Dolomite (Oneota Fm.)	DL4
MW-123A	8.0E-06	Dolomite (Shakopee Fm.)	DL3
MW-124A	9.6E-05	Dolomite (Oneota Fm.)	DL4
MW-125A	3.2E-04	Dolomite (Prairie du Chien Gr.)	DL5
Minimum	8.0E-06		
Maximum	4.0E-03		
Geometric Mean	2.0E-04		

Created by:	ACW	Date:	9/28/2023
Last revison by:	JR	Date:	1/15/2024
Checked by:	BJS	Date:	2/6/2024

I:\25222268.00\Data and Calculations\Hor. Grad. Calcs\[5-6 Hydraulic Conductivity Test Results.xlsx]5-6B Piezometers