SCS ENGINEERS Environmental Consultants & Contractors

October 31, 2024
File No. 27224420.00

Mr. Mike Smith, P.E.
Iowa Department of Natural Resources
Land Quality Bureau
6200 Park Avenue
Des Moines, Iowa 50321

Subject: Request for Permit Amendment
Revised Groundwater Underdrain System
Loess Hills Regional Sanitary Landfill
Permit No. 65-SDP-01-72
Project No. 27224420.00

Dear Mike:

On behalf of Iowa Waste Services (IWS), SCS Engineers (SCS) is requesting approval from the Iowa Department of Natural Resources (DNR) for a proposed change to the current design of the groundwater underdrain system beneath future Cells H, I, and J on the west side of the Municipal Solid Waste Landfill (MSWLF) unit at the Loess Hills Regional Sanitary Landfill (Landfill). The proposed design change is to replace the blanket-type underdrain system beneath future Cell H, I, and J with a trench system as described herein.

Background

The groundwater underdrain system design for the Cells D-Q of IWS's Municipal Solid Waste Landfill (MSWLF) unit was contained in the Request for *Permit Amendment, 2001 Horizontal Expansion Plan* dated December 28, 2001 (Doc #54247). The groundwater underdrain design presented in Doc #54247 encompassed Cells D through Q and consisted of a geonet drainage layer (10 oz/sy) that routed groundwater to 6-inch drainage pipes, whose configuration generally mirrored the leachate collection system piping. The groundwater underdrain geonet layer and piping were located 4 feet below the leachate drainage layer and piping.

The groundwater underdrain system for the permitted area at that time (Cells D through Q) was reviewed in a report entitled *Groundwater Underdrain Performance Evaluation* dated May 21, 2010 (Doc # 57838). The review commented on the adequacy of the system's capacity to manage groundwater collected from areas larger than 10 acres. The system as designed was considered adequate to manage the larger collection areas. The groundwater underdrain system was expanded to include the East Lateral and Vertical Expansion in a report entitled Comment Response – Permit Amendment Application: Lateral and Vertical Expansion dated December 22, 2022 (Doc # 105401). The lateral and vertical expansion groundwater underdrain included the same configuration as the 2001 design.

Groundwater underdrains as described in Doc # 54247 were constructed beneath Cells D East, D West, E East, E West, F East, F West, G West, G North, M, N. Construction certification documentation for the constructed portions of the groundwater underdrains are listed below.

- Construction Certification report East Half of Cell "D" and Sediment Pond Construction; June 23, 2006; Barker Lemar Engineering Consultants (Doc #54154).
- Construction Certification Report West Half of Cell "D" Construction; October 10, 2008; Barker Lemar Engineering Consultants (Doc #32821).
- Construction Observation report East Half of Cell E; December 23,2010; Barker Lemar Engineering Consultants (Doc #625551).
- Construction Observation Report West Half of Cells E and F Construction; March 23, 2016; Barker Lemar Engineering Consultants (Doc #85805).
- Construction Observation Report Cells E & F West (Phase 2) Construction; November 14, 2019; Barker Lemar Engineering Consultants (Doc #96347).
- Construction Observation report Cell G East – N; October 18, 2021; SCS Engineers (DOC #101454)
- Construction Observation Report Cell G North – M; November 15, 2022; SCS Engineers (DOC #104577)

The discharge point for the currently constructed groundwater underdrain system includes GU-1. Discharge point GU-1 can be either pumped to the sedimentation basin or the leachate lagoon. Under normal conditions the groundwater collected in the sump is pumped to the sedimentation basin, which then discharges to an unnamed tributary of Silver Creek via surface flow. If the groundwater is determined to be impacted, it is redirected to the leachate lagoon. GU-1 is sampled on a regular basis, and the groundwater is currently being treated with the leachate.

Cells H through J Groundwater Separation

The groundwater underdrain trenches proposed herein are designed to maintain a separation distance between the groundwater and the bottom of waste and would reduce construction cost and time. The proposed change to the groundwater separation system does not represent a substantial change; there are no proposed changes to the waste management boundary, leachate collection system, or other systems. The plan sheets for the proposed groundwater underdrain trenches are provided in Appendix A.

Groundwater Model

The groundwater underdrain area of the analyzed portion of the future cells (Cells H, I, and J) is approximately 33 acres. The liner and previously approved underdrain system generally sloped downward to the south at 2.00% for Cells H through J, while also draining toward a central groundwater sump GW-2. The proposed underdrain system in this report uses cell base perimeter trenches (interim and final) to intercept groundwater in the vicinity of and below the liner system. An extension of the perimeter trench would be installed with each new cell construction event, resulting in the underdrain grid shown on the Drawings in Appendix A.

Steady-state groundwater elevations and resulting flows into the underdrain system were estimated using the 3-dimensional groundwater modeling software, AnAqSim© (Analytical Aquifer Simulator) developed by Dr. Charlie Fitts. AnAqSim© utilizes the subdomain method, which is an analytic element method.

Input

The groundwater table elevations developed in the simulator used head-specified boundary conditions. The conditions were modeled to recreate the groundwater contours shown in Figure 2.1 of the 2010 Groundwater Underdrain Evaluation (PDF page 20, Doc #57838). These contours were conservatively modeled approximately 10' above the top of liner grades. One notable exception between the 2010 initial groundwater contours and the initial groundwater contours for this design as shown in Drawing A1 is that the previously installed groundwater underdrains beneath adjacent Cells D West, E & F West (Phase 2), G West, G North, and M are included as influencing components. The locations and elevations of the western edge of the groundwater underdrain layers beneath these cells were input as line sinks in the model.

The hydraulic conductivity of the aquifer input into the model was $1.7\text{x}10^{-1}$ ft/day or 6.0x10-5 cm/s (PDF page 33, Doc #57838). This value is the reported average hydraulic conductivity measured within the loess at the site. The AnAqSim© model was assumed to be isotropic.

To simulate the dewatering of the area beneath the footprints of Cells H, I and J using a trench system to lower the water table to 5' or more below the bottom of the waste, head-specified line sinks were used to model groundwater elevation contours and determine the discharge of a groundwater underdrain system below the basal portion of the cells. The line sinks were generally placed along the edges of individual cells or the inside toe of the side slope of the perimeter cell boundaries. The cells will be constructed from east to west. The line sink layout is shown on the Drawings in Appendix A. The vertices of the line sinks were placed at grade breaks, changes in flow direction, and as necessary to model the trench system. The discharge required to achieve these head-specified line sinks was considered to be the minimum hydraulic capacity of the system.

Results

The flow rate (discharge rate) of each line sink was computed by AnAqSim©. These results and the conversion to inflow per unit length of linesink are shown in Appendix C. For Cell H, The calculated total estimated flow rate required to lower and maintain the 5-foot separation of groundwater from the bottom of waste was 541.5 ft^3/day or 4050.7 gallons per day (Table C.1). For the Cells H and I, the calculated total flow rate was 833.4 ft^3/day or 6,234.3 gallons per day (Table C.2). For cells H, I, and J, the calculated total flow rate was 1144.0 ft^3/day or 8557.7 gallons per day (Table C.3). The post-model groundwater contours are shown in Appendix A for each of the three development phases. The flow calculations are shown in Appendix B.

Groundwater Underdrain Trenches

A typical cross-section detail of the proposed groundwater underdrain trench system is shown on Drawing A1 in Appendix A

The construction of the underdrain system will be in the same plan view location as the modeled line sinks. The depth of the trench below the liner is variable. The pipe invert elevations in the collection trenches will be equal to, or lower than, the line sink elevations (a lower pipe invert is more conservative). There were two phases of line sink modeling:

1. Phase One included all line sinks, regardless of whether they artificially added groundwater to the system or not. These results are shown in Appendix C. This created a conservative condition for the required flow from the aggregate and the pipes incorporated into the system.
2. Phase Two eliminated the line sinks that artificially added water to the system. These results are the groundwater contours shown in Appendix A, and are understood to be more representative of actual groundwater contours. The trench portions represented by the removed line sinks will still be installed to provide groundwater collection capability at an elevation nominally 5 feet below the bottom of waste in the event that groundwater elevations in these areas become higher than the modeled conditions.

For Cell H

The collection trenches generally flow from west to east and north to south at a 1.0% slope. The flow trenches terminate at a sump that is outside of the limits of Cell H, but will be below the south end of future Cell I. This was done to allow for one sump/pump to dewater the full build-out of Cells H, I, and J.

The Addition of Cell I

The north line sinks (14-17) split flow directions at the low point of the cell (the leachate collection trench) to minimize the drop needed to flow to the north-south line sinks that flow south. The new westernmost line sinks (19-23) flow to line sink 24 at the south edge of the cell, which then flows to the sump installed as part of Cell H construction.

The Addition of Cell J

Similar to Cell I, the north line sinks (25-28) split flow directions at the low point of the cell (the leachate collection trench) to minimize the drop needed to flow to the north-south line sinks that flow south. The new westernmost line sinks (29-34) flow to line sink 35 at the south edge of the cell, which then flows to line sink 36 and subsequently to line sink 24 installed as part of Cell I construction.

Pipe Sizing

A 4-inch perforated pipe is proposed for the underdrain collection system. The minimum slope of the collection system is 1.0% (except line sink 13 at 0.5%, which negligibly contributes to the system). The maximum modeled flow volume for the system 1,144.0 ft^3/day. The maximum capacity of a 4-inch pipe at 1.0% slope is 16,487 ft^3/day. This indicates that the underdrain system has over 14 times the necessary capacity managed the modeled flow volumes. Calculations are shown in Appendix B.

The previous pipe stability calculations (see Doc # 105401) assumed 235 feet of waste with 5.5 feet of cover soil above the pipe. The conditions of the cells analyzed herein show a maximum loading of approximately 140 feet of waste and 5.5 feet of cover soil. The additional loading of the pipes of the proposed underdrain system would be a maximum of 8 feet of additional soil to account for the depth of trenches. The previous calculations determined that using 6-inch SDR 17 would be adequate. The proposed underdrain system will use 4-inch SDR 11 pipe which has significantly improved stability characteristics.

<u>Aggregate</u>

The required permeability of the granular media in the trench is calculated using Darcy's Law for gravity flow shown below:

$$Q = k\ i\ A$$

Where:
Q = Groundwater inflow to the collection trench
k = Permeability of the trench drainage media
i = Gradient of the groundwater on the upgradient side of the trench
A = Cross-sectional area of the flow into the trench

As the flow rate is variable depending on the line sink, the flow for each sink was divided by the length of the sink to generate a flow per linear foot. As shown in Tables C1, C2, and C3 in Appendix C, the groundwater inflow (Q) into line sink 29 was the worst-case scenario at 1.26 ft^3/day/ft. The flow into the trench was assumed to happen only on the vertical side of the trench, so the area (A) is equal to 2 ft^2. The hydraulic gradient (i) was conservatively assumed to be 0.01 ft/ft. A gradient of approximately 0.07 ft/ft was indicated by the modeled contours. The required permeability of the drainage media was calculated to be 2.22×10^{-2} cm/sec. Therefore, an aggregate with a permeability of at least 5.0×10^{-2} cm/sec is proposed for the trench aggregate. Calculations are shown in Appendix B.

If you have any questions or need further information or clarification, please contact Tim Buelow at 515-681-5455.

Sincerely,

Matt Kuhlenengel, E.I.
Staff Professional
SCS Engineers

Timothy C. Buelow, P.E.
Senior Project Advisor
SCS Engineers

MRK/TCB

copies: Rachel Hanigan, Chaz Roberts, Bret Stephens, Kelly Danielson, Loess Hills Sanitary Landfill

Certification

Timothy C.
Buelow
14445

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Date: 10/31/2024

Timothy C. Buelow, P.E.

License No. 14445

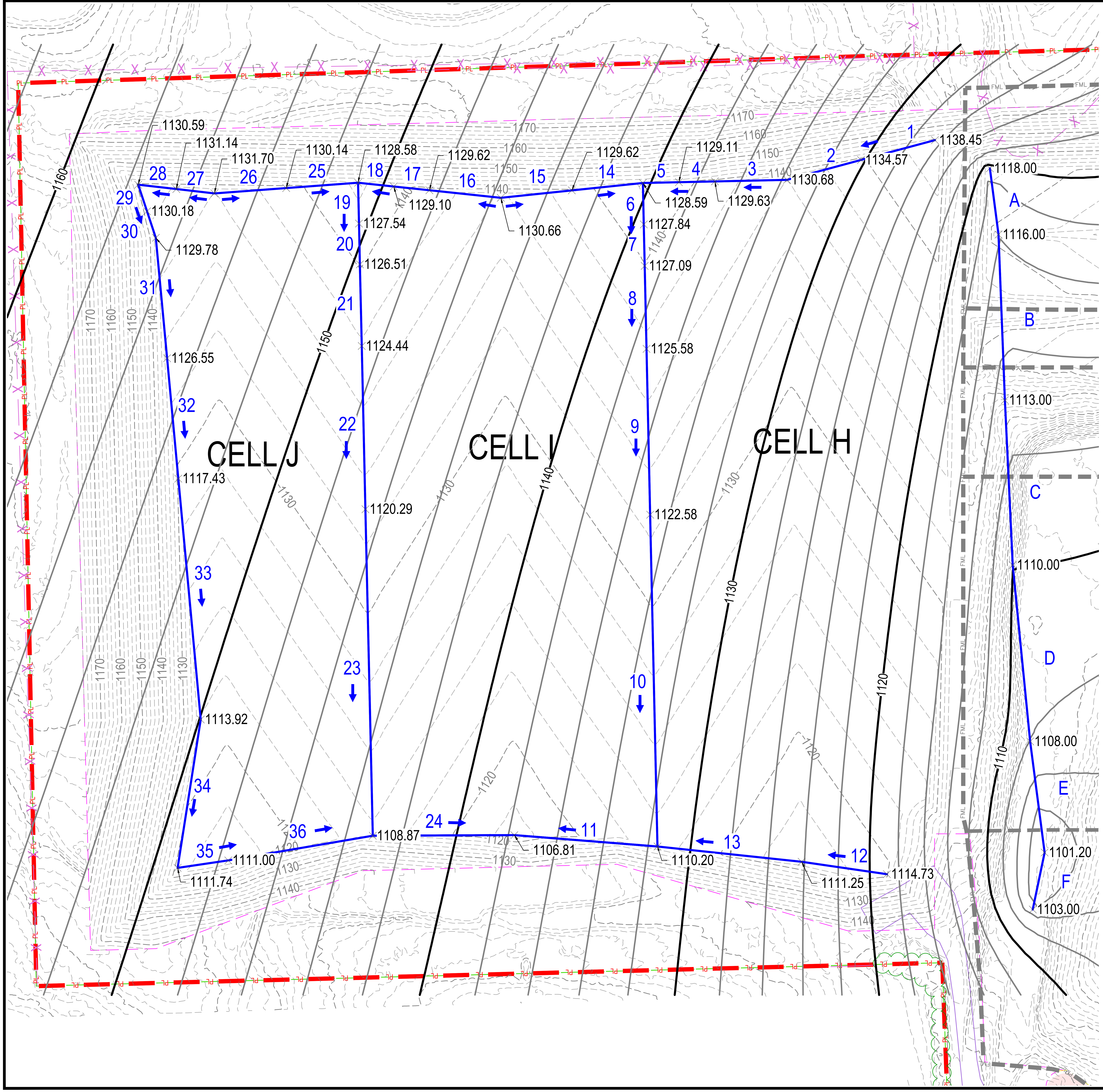
My license renewal date is December 31, 2025

Pages or sheets covered by this seal:

Loess Hills Groundwater Underdrain Re-Design Letter Report and Appendices A, B, and C.

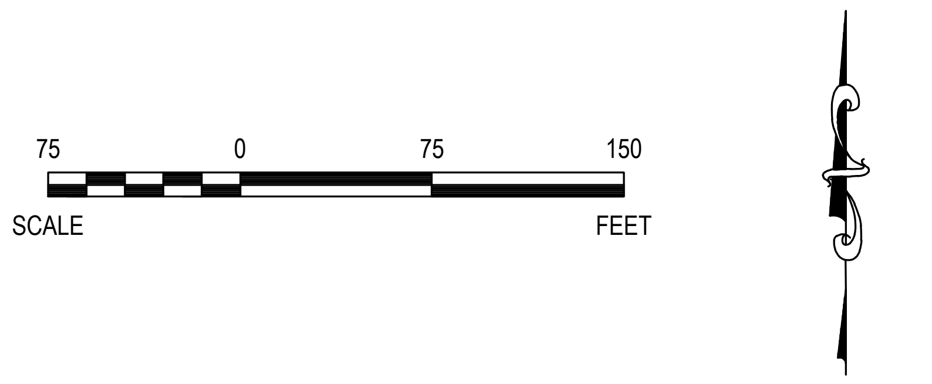
Appendix A

Plan Sheets



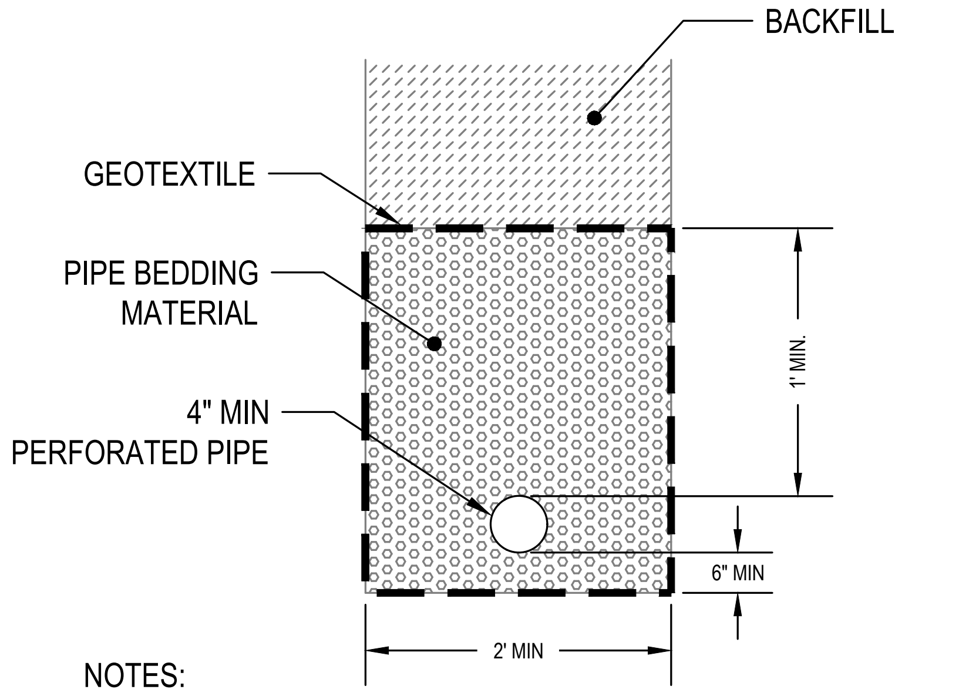
LEGEND:

- - - 1160 - - -	10' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
- - - - - - -	2' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
—— 1160 ——	10' CONTOUR, PROPOSED GROUNDWATER ELEVATION
————	2' CONTOUR, PROPOSED GROUNDWATER ELEVATION
—— 1/A ——	HEAD-SPECIFIED LINE SINK MODEL CONDITION (PROPOSED/EXISTING, RESPECTIVELY)
→	FLOW DIRECTION



NOTES:

1. EXISTING / PROPOSED TOP OF LINER IS THE SURFACE: "BOTTOM OF EXCAVATION" PROVIDED BY WEAVER CONSULTING GROUP, RAISED 3 FEET TO ACCOUNT FOR THE GRADING LAYER AND 2 FEET OF CLAY LINER.



NOTES:

1. GEOTEXTILE AND PIPE BEDDING PERMEABILITY EQUAL TO OR GREATER THAN $5.0x10^{-2}$ CM / SEC

① UNDERDRAIN PIPE TRENCH DETAIL

NOT TO SCALE

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SHEET TITLE
EXISTING GROUNDWATER CONTOURS

PROJECT TITLE
LOESS HILLS REGIONAL LANDFILL
GROUNDWATER UNDERDRAIN

CLIENT
IOWA WASTE SERVICES, LLC
59722 290TH STREET
MALVERN, IOWA 51551

SCS ENGINEERS
14755 GROVER STREET
OMAHA, NE 68144
PH. (402) 884-6202 FAX. (913) 681-0012

PROJ. NO. 27224420.00
DWN. BY: MRK
PROJ. MGR TCB
DSN. BY: MRK
CHK. BY: TCB

CADD FILE:
LOESS HILL PROPOSED GWUD LINESINK MODEL.DWG

DATE: 10/23/24

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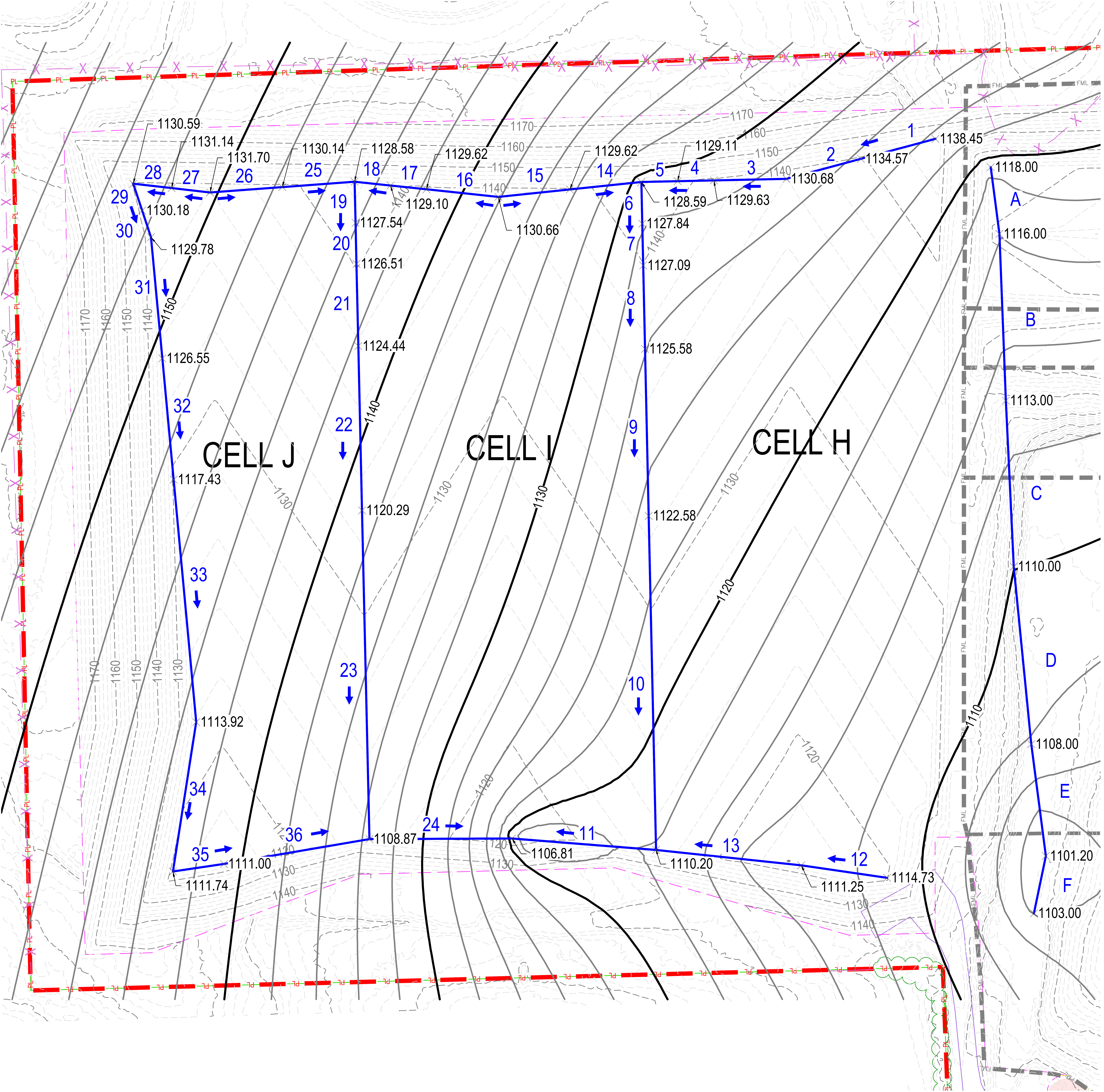
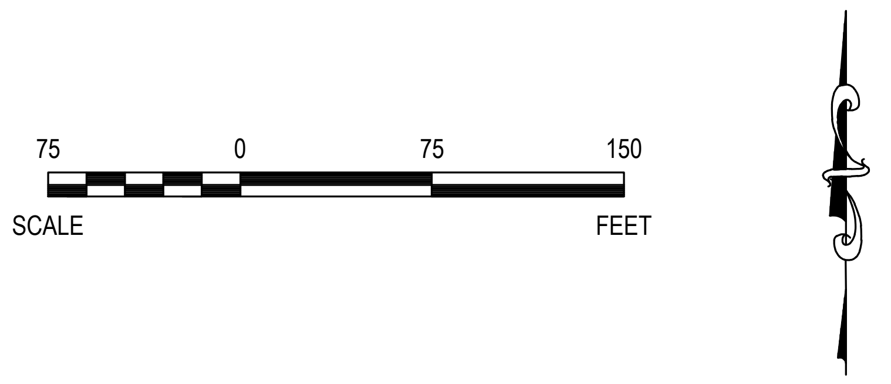


LEGEND:

- - - - 1160 - - - -	10' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
- - - - - - - -	2' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
—— 1160 ——	10' CONTOUR, PROPOSED GROUNDWATER ELEVATION
————	2' CONTOUR, PROPOSED GROUNDWATER ELEVATION
———— 1/A	HEAD-SPECIFIED LINE SINK MODEL CONDITION (PROPOSED/EXISTING, RESPECTIVELY)
➡	FLOW DIRECTION



NOTES:

1. EXISTING / PROPOSED TOP OF LINER IS THE SURFACE: "BOTTOM OF EXCAVATION" PROVIDED BY WEAVER CONSULTING GROUP, RAISED 3 FEET TO ACCOUNT FOR THE GRADING LAYER AND 2 FEET OF CLAY LINER.

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SHEET TITLE
RESULTING GROUNDWATER CONTOURS (CELL H)

PROJECT TITLE
LOESS HILLS REGIONAL LANDFILL GROUNDWATER UNDERDRAIN

CLIENT
IOWA WASTE SERVICES, LLC
59722 290TH STREET
MALVERN, IOWA 51551

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14755 GROVER STREET
OMAHA, NE 68144
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PROJ. NO. 27224420.00
DWN. BY: MRK
PROJ. MGR TCB
DSN. BY: MRK
CHK. BY: TCB

CADD FILE:
LOESS HILL PROPOSED GWUD LINESINK MODEL.DWG

DATE: 10/23/24

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A2

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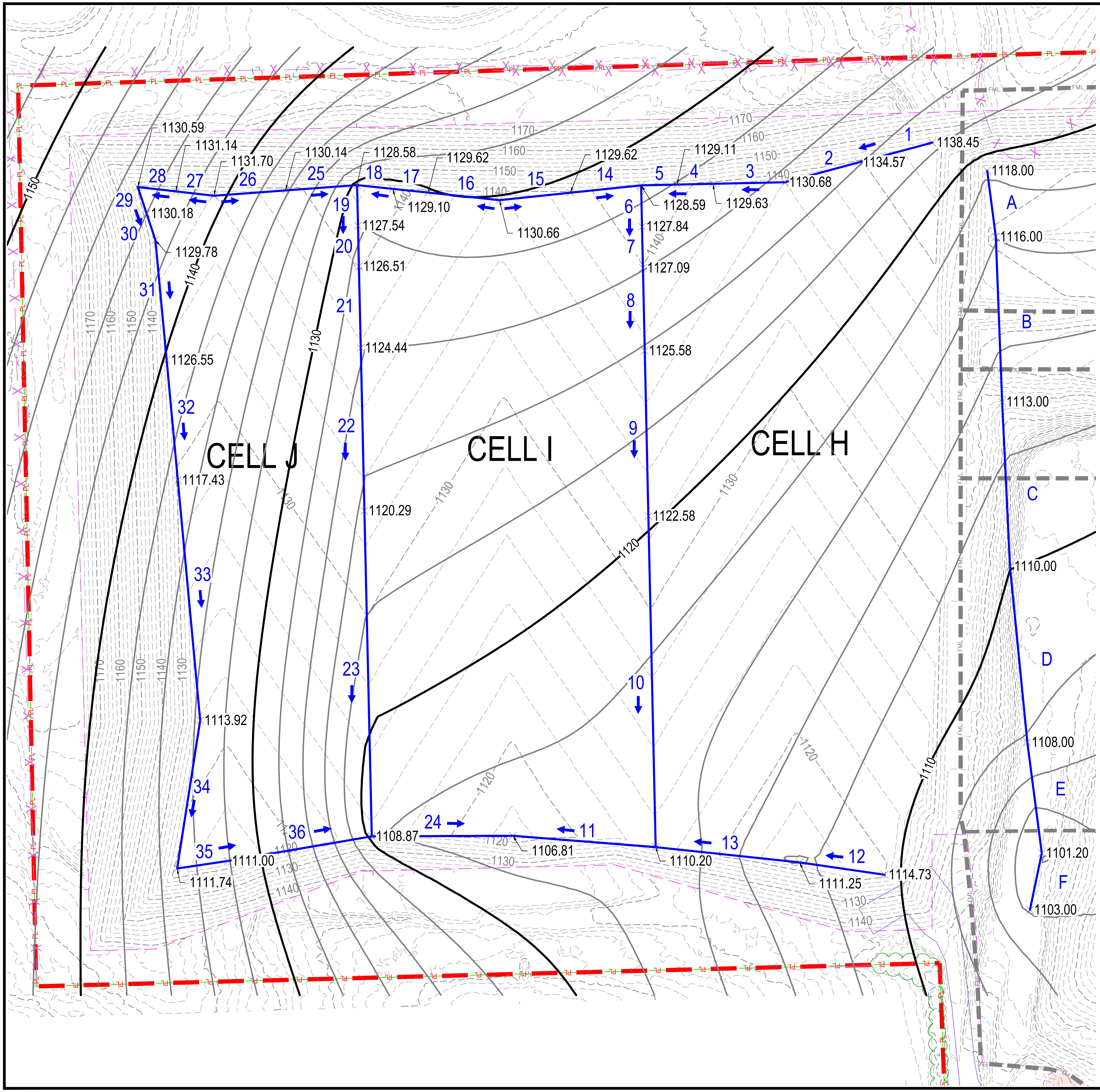

LEGEND:

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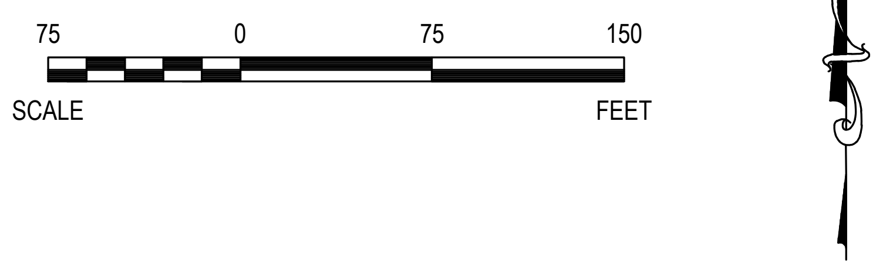
	2' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
1160	10' CONTOUR, PROPOSED GROUNDWATER ELEVATION
	2' CONTOUR, PROPOSED GROUNDWATER ELEVATION
1/A	HEAD-SPECIFIED LINE SINK MODEL CONDITION (PROPOSED/EXISTING, RESPECTIVELY)
➡	FLOW DIRECTION



NOTES:

1. EXISTING / PROPOSED TOP OF LINER IS THE SURFACE: "BOTTOM OF EXCAVATION" PROVIDED BY WEAVER CONSULTING GROUP, RAISED 3 FEET TO ACCOUNT FOR THE GRADING LAYER AND 2 FEET OF CLAY LINER.

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SHEET TITLE
RESULTING GROUNDWATER CONTOURS (CELL H)

PROJECT TITLE
LOESS HILLS REGIONAL LANDFILL GROUNDWATER UNDERDRAIN

CLIENT
IOWA WASTE SERVICES, LLC
59722 290TH STREET
MALVERN, IOWA 51551

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PROJ. NO. 27224420.00	DWN. BY: MRK	
DSN. BY: MRK	CHK. BY: TCB	PROJ. MGR TCB

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LOESS HILL PROPOSED GWUD LINESINK MODEL.DWG

DATE:
10/23/24

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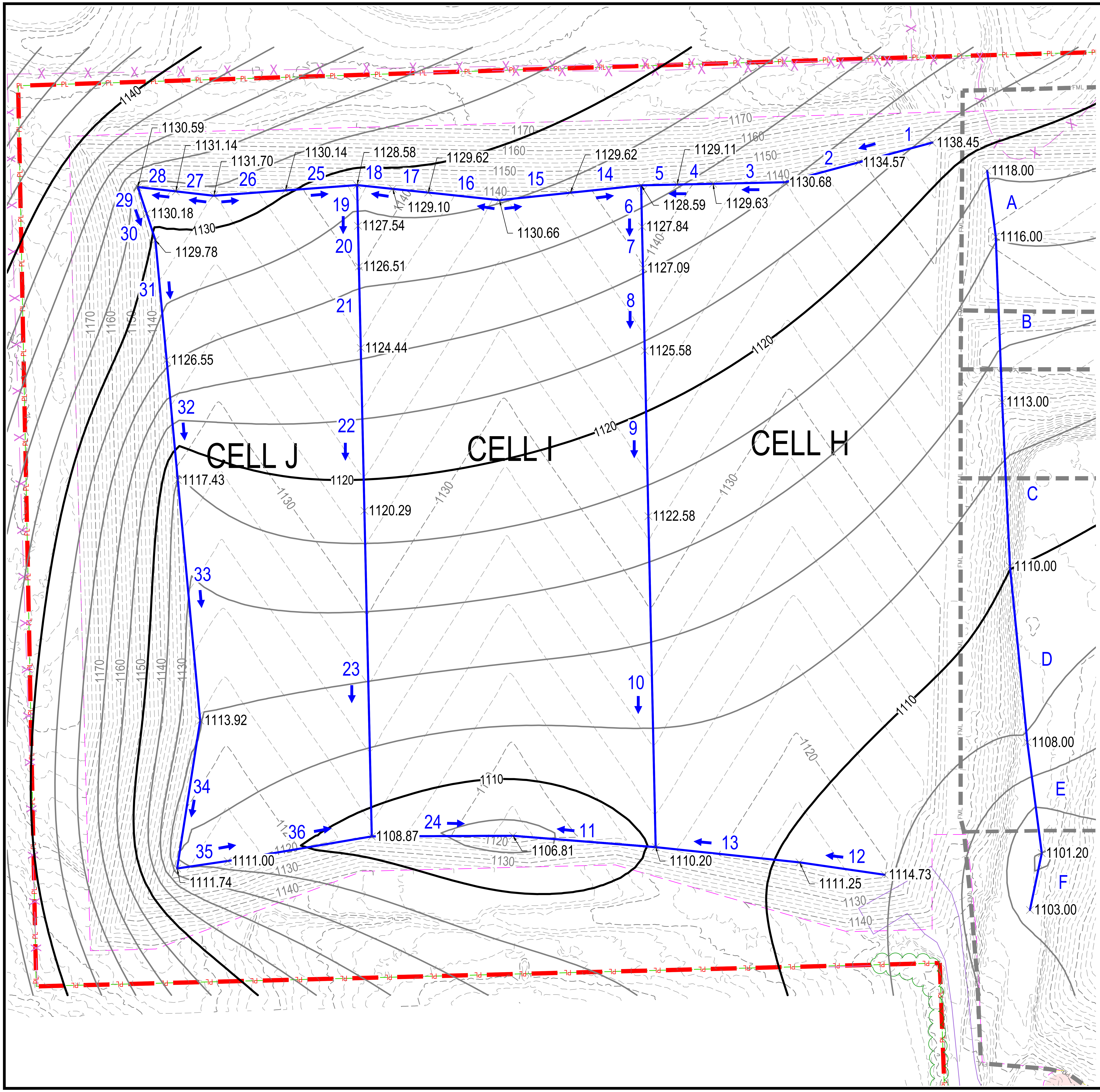
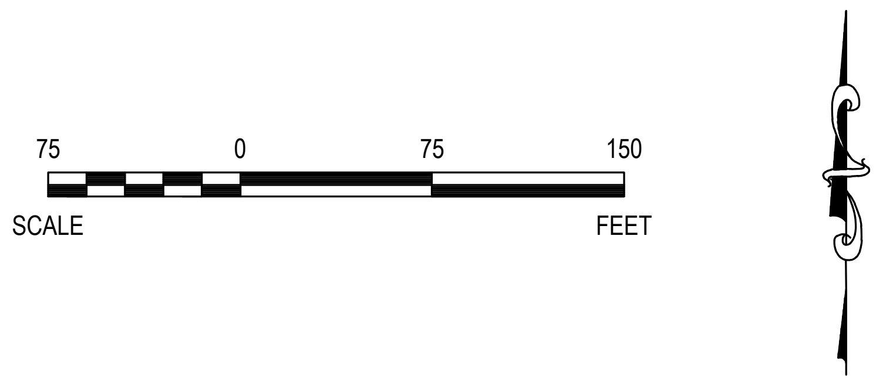


LEGEND:

- - - - 1160 - - - -	10' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
- - - - - - - -	2' CONTOUR, EXISTING OR PROPOSED TOP OF LINER
—— 1160 ——	10' CONTOUR, PROPOSED GROUNDWATER ELEVATION
————	2' CONTOUR, PROPOSED GROUNDWATER ELEVATION
—— 1/A ——	HEAD-SPECIFIED LINE SINK MODEL CONDITION (PROPOSED/EXISTING, RESPECTIVELY)
➡	FLOW DIRECTION



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SHEET TITLE
RESULTING GROUNDWATER CONTOURS (CELL H-J)

PROJECT TITLE
LOESS HILLS REGIONAL LANDFILL
GROUNDWATER UNDERDRAIN

CLIENT
IOWA WASTE SERVICES, LLC
59722 290TH STREET
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PROJ. NO. 27224420.00
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DWN. BY: MRK
CHK. BY: TCB
PROJ. MGR TCB

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LOESS HILL PROPOSED GWUD LINESINK MODEL.DWG

DATE: 10/23/24

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Appendix B

Groundwater Underdrain System Calculations

Appendix B
NW Iowa Area Landfill Groundwater Underdrain Calculations

Capacity of Proposed Collection Trench Aggregate

$$k = \left(\frac{Q}{iA}\right)$$

Where:

$Q/L = Q_{in}/L$ = 1.46E-05 ft^3/sec/ft

Maximum Line Sink Inflow/linear foot = 1.26 ft^3/day/ft (Table C3)

i = 1.00%

Length = 1 ft

Height = 2.00 ft

A = 2.00 ft^2

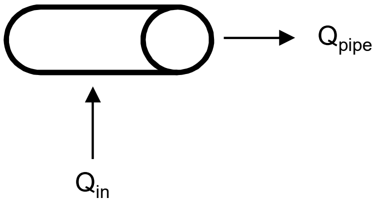
$k = k_{req}$ = 7.29E-04 ft/sec

2.22E-02 cm/sec

Capacity of Proposed Collection Trench Piping (4" @ 1.0%)

$$Q = \left(\frac{1.49}{n}\right)AR^{2/3}\sqrt{S}$$

Where:



Pipe Diameter = 4 in

n = 0.013

A = 0.087 ft^2

P = 1.047 ft

R = 0.083333333 ft

S = 1.00%

Q_{pipe} = 1.91E-01 ft^3/sec

= **16,487 ft^3/day**

85.65 gpm

Q_{in} = 1,144.0 ft^3/day

(Table B3, 1144.0 ft^3/day)

Q_{pipe}/Q_{in} = **14.41**

Sufficient capacity in pipe? Yes

Appendix C

Groundwater Model Results

Some of the line sinks in the model specified a higher elevation than the surrounding groundwater. These line sinks artificially added additional groundwater to the modeled water table that does not exist (raising the groundwater contours to match the line sink). These line sinks were excluded from analysis. However, this additional groundwater was not eliminated from the total flow, making the model more conservative.

Table C1. Groundwater Model Results – Cell H

Linesink	Inflow, ft^3/day	Length, ft	Inflow per unit length, ft^3/day/ft
1	N/A	-	-
2	N/A	-	-
3	18.0	104.5	0.2
4	16.6	52.3	0.3
5	38.3	52.3	0.7
6	49.9	60.1	0.8
7	30.4	60.1	0.5
8	45.6	120.3	0.4
9	61.9	240.5	0.3
10	32.0	481.0	0.1
11	191.9	208.2	0.9
12	N/A	-	-
13	56.7	210.2	0.3
TOTAL	**541.5**	-	-

Table C2. Groundwater Model Results – Cells H-I

Linesink	Inflow, ft^3/day	Length, ft	Inflow per unit length, ft^3/day/ft
1	N/A	-	-
2	N/A	-	-
3	6.1	104.5	0.1
4	6.5	52.3	0.1
5	13.2	52.3	0.3
6	8.7	60.1	0.1
7	5.0	60.1	0.1
8	0.7	120.3	0.0
9	N/A	-	-
10	N/A	-	-
11	43.2	208.2	0.2
12	N/A	-	-
13	42.2	210.2	0.2
15	22.3	103.5	0.2
16	1.4	104.1	0.0
17	8.5	52.0	0.2
18	20.4	52.0	0.4
19	47.8	59.2	0.8
20	63.0	59.2	1.1
21	39.5	118.4	0.3
22	65.0	236.7	0.3
23	109.9	473.4	0.2
24	225.5	205.2	1.1
25	104.6	104.4	1.0
TOTAL	**833.4**	-	-

Table C3. Groundwater Model Results – Cells H-I-J

Linesink	Inflow, ft³/day	Length, ft	Inflow per unit length, ft³/day/ft
1	N/A	-	-
2	N/A	-	-
3	1.4	104.5	0.0
4	3.7	52.3	0.1
5	10.1	52.3	0.2
6	8.7	60.1	0.1
7	4.6	60.1	0.1
8	N/A	-	-
9	N/A	-	-
10	N/A	-	-
11	85.1	208.2	0.4
12	N/A	-	-
13	30.6	210.2	0.1
14	14.6	103.5	0.1
15	N/A	-	-
16	N/A	-	-
17	7.6	52.0	0.1
18	16.4	52.0	0.3
19	13.2	59.2	0.2
20	11.4	59.2	0.2
21	14.0	118.4	0.1
22	13.9	236.7	0.1
23	N/A	-	-
24	70.5	205.2	0.3
25	30.3	104.4	0.3
26	8.0	104.4	0.1
27	6.0	55.6	0.1
28	48.6	55.6	0.9
29	51.0	40.5	1.3
30	22.4	40.5	0.6
31	56.6	175.3	0.3
32	104.0	175.3	0.6
33	231.5	350.6	0.7
34	148.9	217.7	0.7
35	76.8	74.3	1.0
36	54.2	212.5	0.3
TOTAL	**1,144.0**	-	-