APPENDIX III-3D-1

Groundwater Level Data

HISTORICAL GROUNDWATER ELEVATIONS

Well ID	TOC	GROUNDWATER ELEVATIONS (ft-msl)															
		12/9/2004	12/19-20/2005	12/13-14/2006	12/17-18/2007	12/29/2008	12/21/2009	12/9/2010	12/1/2011	12/10-11/2012	12/9-10/2013	12/8-9/2014	12/7-8/2015	12/19/2016	12/11-12/2017	12/17-18/2018	12/12-13/2019
MW-6	107.8	95.7	91.6	93.3	97.6	93.3	96.0	92.4	89.9	89.5	89.6	86.0	93.2	94.1	95.2	97.1	95.8
MW-7	105.3	93.1	89.7	92.1	96.3	90.0	94.5	91.3	88.2	87.4	86.2	79.5	90.0	92.9	94.0	97.2	95.9
MW-8	105.3	92.5	89.3	91.6	95.3	89.5	93.7	90.8	87.8	87.1	85.9	78.9	89.3	92.4	93.4	96.5	95.2
MW-9	108.5	90.2	87.7	89.9	94.5	86.9	88.5	87.3	77.5	78.7	84.2	81.6	88.0	92.8	93.4	95.5	94.3
MW-10	105.2	92.9	90.3	90.8	94.4	90.2	92.9	90.0	88.7	86.6	87.4	83.5	90.4	92.5	93.1	95.2	93.8
MW-11	105.5	93.5	89.0	88.1	94.3	91.1	90.7	88.7	86.2	87.5	89.3	88.5	92.6	92.7	93.1	94.6	93.2
MW-12	105.1	93.2	86.8	89.3	96.4	89.6	84.3	87.1	85.1	87.7	88.3	91.5	94.8	93.5	94.0	95.2	94.2
MW-13	105.1	91.2	87.0	87.9	95.4	88.0	88.4	86.8	85.6	87.1	87.9	88.7	95.0	93.2	93.6	95.7	94.2
MW-14	106.4	86.9	84.3	88.9	95.4	83.0	79.1	81.4	82.1	83.8	87.4	88.1	95.2	94.6	95.5	100.0	95.6
MW-15	106.8	87.9	86.0	88.9	95.4	85.5	84.1	84.3	84.8	86.4	87.8	88.6	95.1	94.0	94.8	96.2	94.9
MW-16	106.3	88.9	86.4	89.3	95.8	86.1	84.8	84.9	85.0	87.1	88.2	88.9	95.5	92.4	95.3	96.7	95.3
MW-17	105.8	87.4	85.2	87.9	95.6	82.3	79.8	80.7	83.4	85.1	87.3	88.0	95.3	95.3	96.7	98.0	96.3
MW-18	106.3	90.4	87.0	89.8	95.9	86.7	83.5	83.6	84.7	86.2	88.3	88.4	95.8	96.2	97.3	98.8	97.0
MW-19	109.1	91.8	88.3	90.8	97.4	88.8	86.9	86.4	86.5	87.8	89.6	89.2	96.4	96.2	97.6	98.9	97.0
MW-20	110.7	93.9	89.9	91.7	98.2	92.3	92.1	89.8	88.7	90.0	91.8	90.7	97.4	96.6	97.7	99.0	97.2
MW-21	107.9	95.2	90.8	92.7	97.4	93.5	95.0	91.9	89.6	89.6	90.0	87.2	93.7	94.4	95.6	96.9	95.9

APPENDIX III-3D-2

Short Term Depressurization Calculations

HAWTHORN PARK RECYCLING AND DISPOSAL FACILITY
APPENDIX III-3D-2: SHORT-TERM DEPRESSURIZATION CALCULATIONS
SHORT TERM STABILITY USING DEPRESSURIZATION WELLS

Date: 8/6/2020
Prepared: PKP
Checked: JBF
Reviewed: CGD

I. To provide depressurization, wells will be distributed as needed along the boundary of the proposed landfill expansion cells.

The drawdown in the potentiometric surface of Layer II groundwater was determined using the Theis Well Solution for each reference point (Freeze & Cherry, 1979, pg. 317). The Theis Well Solution defines drawdown as:

$$h_o - h_{(r,\,t)} = \frac{Q}{4\Pi T}\int_U^{\infty}\frac{e^{-udu}}{u}$$

Where: h_o-$h_{(r,t)}$ = drawdown at a distance, r in feet (ft), after time t in minutes (min)
Q = pumping rate of the well (ft^3/min)
T = transmissivity of the aquifer (ft^2/min)

And "u" is defined as:

$$u = \frac{r^2 S}{4Tt}$$

Where: r = distance from the well to the point of observation (ft)
S = storage constant (storativity) (unitless)
t = time after initiation of pumping (min)

The solution to the exponential integral can be estimated by the following equation:

$$W(u) = \int_u^{\infty}\frac{e^{-udu}}{u} = (-0.577216) - \ln(u) + u - \frac{u^2}{(2\cdot 2!)} + \frac{u^3}{(3\cdot 3!)} - \frac{u^4}{(4\cdot 4!)} + \cdots$$

The worst case condition occurs were the excavation depth is greatest and where Layer I is the thinnest. Based on a review of the site information, the northernmost cell in the Center Block expansion area appears to represent worst-case conditions.

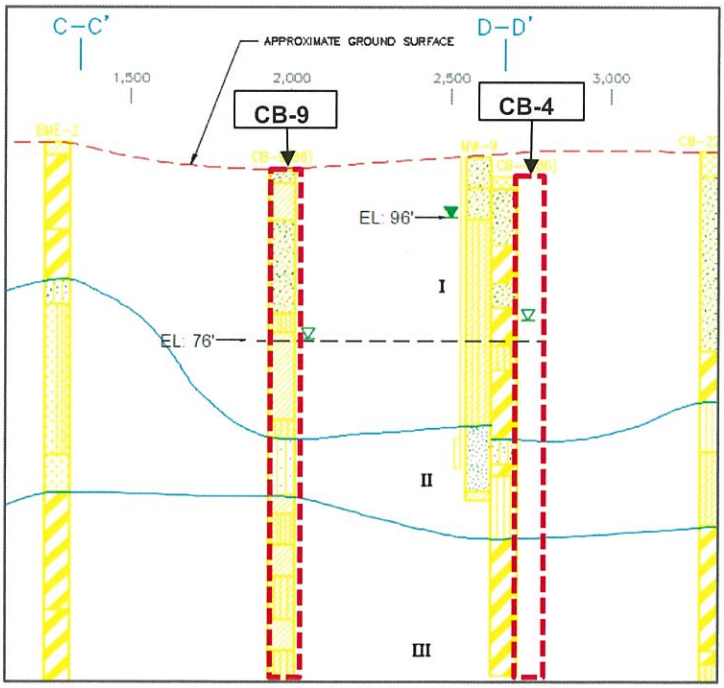

Figure 1: Subsurface Profile

STATE OF TEXAS
4/12/21
CHARLES G. DOMINGUEZ
83247
LICENSED
PROFESSIONAL ENGINEER

For Sheets 1 through 3

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The required drawdown calculation is based on the subsurface conditions and the highest groundwater measured in MW-8 through MW-10 in December 2019. Out of these three wells, the highest recorded groundwater elevation recorded was 95.2 ft. The subsurface conditions indicate the layer of concern for uplift during liner construction and initial waste placement is the Layer I clay / Layer II sand interface at an approximate elevation of 60 ft-msl. The excavation elevation will be 76 ft-msl.

Layer I/II Interface elevation =	60	ft-msl	
Max. Ground Water Elev. =	96.0	ft-msl	(conservative)
Pressure Head =	36.0	ft	
Hydrostatic Pressure =	2246	psf	
Base of excavation elevation =	76	ft-msl	
Thickness of Layer I =	16		
Layer I Unit wt. =	130	pcf	
Soil Ballast Pressure =	2080	psf	
Factor of Safety =	0.93		

A dewatering system will be installed to reduce the hydrostatic pressure on the liner to increase the factor of safety to 1.2.

Factor of Safety =	1.2	= 2080/Hydrostatic Pressure
Allowable Hydrostatic Press. =	1733	psf
Corresponding Head =	28	ft
GW Elevation =	88	ft-msl
Required Drawdown =	8.2	ft

As shown on the figure below, a series of depressurization wells will be installed around the perimeter of the cell prior to excavation to lower the groundwater level at the center of the cell to 88 ft-msl or lower. The calculation for drawdown at the center of the cell from the depressurization well pumping is as follows:

$u = r^2S/4Tt$

r = distance from the well to the center of the cell (ft)

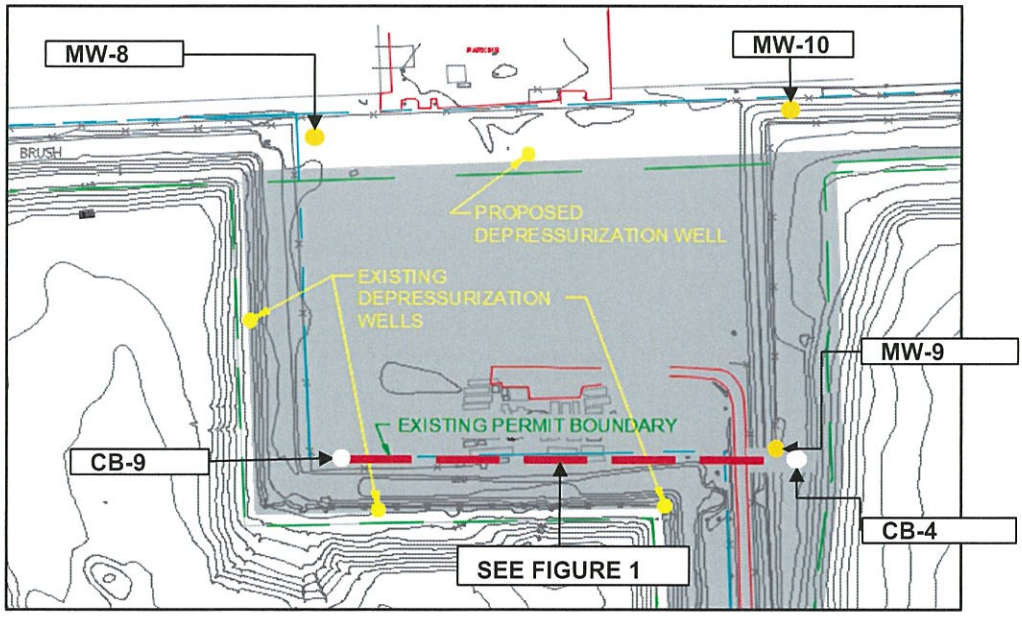

Figure 2: Proposed And Existing Depressurization Well Locations Plan

From pumping tests performed at the site by McBride-Ratcliff as part of the Permit Application, the average storativity was found to be 2.86 x 10^{-4}, and the average transmissivity was 1.35 ft^2/min.

Calculations below, assess the drawdown from each depressurization well at a point near the center of the expansion cell given the following conditions:

Q = 30 gpm
t = 60 days
r= distance to center of expansion cell

Well	Well Location	r (ft)	S	T (ft^2/min)	t (min)	u	W(u)
New	North	270	0.00029	1.35	86400	4.5E-05	9.4
Existing	West	470	0.00029	1.35	86400	1.4E-04	8.3
Existing	Southeast	375	0.00029	1.35	86400	8.6E-05	8.8
Existing	Southwest	420	0.00029	1.35	86400	1.1E-04	8.6

The drawdown (Δh) from each depressurization well is then calculated using the following equation:

$$\Delta h = Q \times W(u) / (4 \times \Pi \times T)$$

Well	Well Location	Q (ft^3/min)	W(u)	T (ft^2/min)	Δh (ft)
New	North	4.0	9.44	1.35	**2.2**
Existing	West	4.0	8.33	1.35	**2.0**
Existing	Southeast	4.0	8.78	1.35	**2.1**
Existing	Southwest	4.0	8.56	1.35	**2.0**
				TOTAL =	**8.3**

The drawdown influences from all wells at a single point are summed, according to the principal of superposition (Freeze and Cherry, 1979) to acquire the total drawdown of the reference location.

The one proposed well placed and three existing wells in-place as indicated on the figure above will provide approximately 8.3 feet of drawdown; therefore, providing an adequate factor of safety against hydrostatic uplift. As the soil liner is constructed and waste is placed, the resisting overburden will increase and the drawdown

The drawdown can be monitored using the depressurization wells and monitor wells. If necessary to maintain the appropriate drawdown in the excavation area, adjustments to the system can be made including changing the pumping rates or installing additional depressurization wells.

APPENDIX III-3D-3

Example Ballast Calculations

EXAMPLE BALLAST CALCULATIONS

Date: 9/18/2020
Made By: PKP
Checked By: JBF
Reviewed By: CGD

1.0 OBJECTIVE

Determine the factor of safety against uplift for various points along the liner system.

2.0 CALCULATIONS

The factor of safety against uplift will be calculated using the following procedures:

1. Determine the hydrostatic pressure, P, acting on the base of the bottom of the liner system and the sidewall liner system from the assumed seasonal high groundwater table, and the resistance provided by the ballast.

   A. Bottom of Soil Liner

   Determine the maximum hydrostatic uplift pressure, P, acting on the bottom of the liner system using the unit weight of water, γ_w , times the vertical distance from the base of the liner system to the seasonal high water table, H_{wt}.

   $$P = \gamma_w H_{wt}$$

   The resisting pressure, R, provided by the ballast is equal to the sum of the unit weights of each ballast

   $$R = \sum(\gamma_i T_i)$$

   B. Sidewall Soil Liner

   Determine the maximum normal uplift pressure, P_N, acting at a location on the base of the sidewall liner system using the unit weight of water times the vertical distance from the location on the sidewall to the seasonal high piezometric level.

   $$P_N = \gamma_w H_{wt}$$

   The resisting pressure, R_N, provided by the ballast is equal to the normal component of the sum of the unit weights of each ballast component, γ_i, times their respective vertical thickness, T_i, as shown in the following equation:

   $$R_N = \sum(\gamma_i T_i) \cos^2\beta$$

   where β is the angle between the sidewall liner and horizontal.

2. The equations for R and P are solved for equilibrium to find the thickness of ballast required to counteract the calculated water pressure.

   The safety factors indicated in the regulations, either 1.2 or 1.5 depending on the type and configuration of ballast used, are incorporated into the above referenced equations by multiplying by the appropriate factor. If only soil ballast is used, a factor of 1.2 is used in the equation, and if some combination of soil layers and waste is used as ballast, a factor of 1.5 is used.

2.1 BALLAST CALCULATIONS

The following calculation sheets document example ballast calculations referencing Figures III-3D-3 and III-3D-4 for calculation points.

3.0 CONCLUSION

The factor of safety against uplift exceeds 1.5 for each point analyzed.

For sheets 1 through 11

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BALLAST CALCULATION **POINT 1 FINAL-FILLED CONFIGURATION**
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	31.0	123.0	44.4	1377.8
2	Protective Cover	1.0	92.0	110.0	110.0
3	Clay Liner	3.0	91.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				1847.8
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.7		88.0			605.3
HYDROSTATIC OFF-SET FACTOR				**3.1**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	31.00	123.0	44.4	1240.0
2	Protective Cover	1.0	92.0	110.0	99.0
3	Clay Liner	3.0	91.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				1663.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.7		88.0			605.3
HYDROSTATIC OFF-SET FACTOR				**2.7**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION **POINT 1 REQUIRED WASTE THICKNESS**
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	9.9	101.9	44.4	437.9
2	Protective Cover	1.0	92.0	110.0	110.0
3	Clay Liner	3.0	91.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				907.9
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)	Top of Subgrade ELEV. (FT.)				HYDROSTATIC FORCE (lb)****
97.7	88.0				605.3
HYDROSTATIC OFF-SET FACTOR				**1.5**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	12.1	104.1	44.4	484.9
2	Protective Cover	1.0	92.0	110.0	99.0
3	Clay Liner	3.0	91.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				907.9
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)	Top of Subgrade ELEV. (FT.)				HYDROSTATIC FORCE (lb)****
97.7	88.0				605.3
HYDROSTATIC OFF-SET FACTOR				**1.5**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION **POINT 2 FINAL-FILLED CONFIGURATION**
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	52.0	132.0	44.4	2311.1
2	Protective Cover	1.0	80.0	110.0	110.0
3	Clay Liner	3.0	79.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				2781.1
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.4		76.0			1273.0
HYDROSTATIC OFF-SET FACTOR				**2.2**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	52.00	132.0	44.4	2080.0
2	Protective Cover	1.0	80.0	110.0	99.0
3	Clay Liner	3.0	79.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				2503.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.4		76.0			1273.0
HYDROSTATIC OFF-SET FACTOR				**2.0**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION POINT 2 REQUIRED WASTE THICKNESS
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	32.4	112.4	44.4	1440.7
2	Protective Cover	1.0	80.0	110.0	110.0
3	Clay Liner	3.0	79.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				1910.7
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.4		76.0			1273.0
HYDROSTATIC OFF-SET FACTOR				1.5	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	37.2	117.2	44.4	1486.4
2	Protective Cover	1.0	80.0	110.0	99.0
3	Clay Liner	3.0	79.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				1909.4
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.4		76.0			1273.0
HYDROSTATIC OFF-SET FACTOR				1.5	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION POINT 3 FINAL-FILLED CONFIGURATION
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	52.0	132.0	44.4	2311.1
2	Protective Cover	1.0	80.0	110.0	110.0
3	Clay Liner	3.0	79.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				2781.1
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.9		76.0			1366.6
HYDROSTATIC OFF-SET FACTOR				2.0	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	52.00	132.0	44.4	2080.0
2	Protective Cover	1.0	80.0	110.0	99.0
3	Clay Liner	3.0	79.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				2503.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.9		76.0			1366.6
HYDROSTATIC OFF-SET FACTOR				1.8	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION POINT 3 REQUIRED WASTE THICKNESS
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	35.5	115.5	44.4	1579.8
2	Protective Cover	1.0	80.0	110.0	110.0
3	Clay Liner	3.0	79.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				2049.8
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.9		76.0			1366.6
HYDROSTATIC OFF-SET FACTOR				1.5	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	40.7	120.7	44.4	1626.8
2	Protective Cover	1.0	80.0	110.0	99.0
3	Clay Liner	3.0	79.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				2049.8
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
97.9		76.0			1366.6
HYDROSTATIC OFF-SET FACTOR				1.5	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION HAWTHORN PARK

POINT 4 FINAL-FILLED CONFIGURATION

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	17.0	117.0	44.4	755.6
2	Protective Cover	1.0	100.0	110.0	110.0
3	Clay Liner	3.0	99.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				1225.6
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.9		96.0			56.2
HYDROSTATIC OFF-SET FACTOR				**21.8**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	17.00	117.0	44.4	680.0
2	Protective Cover	1.0	100.0	110.0	99.0
3	Clay Liner	3.0	99.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				1103.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.9		96.0			56.2
HYDROSTATIC OFF-SET FACTOR				**19.6**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION POINT 4 REQUIRED WASTE THICKNESS
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	0.0	100.0	44.4	0.0
2	Protective Cover	1.0	100.0	110.0	110.0
3	Clay Liner	3.0	99.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				470.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.9		96.0			56.2
HYDROSTATIC OFF-SET FACTOR				8.4	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	0.0	100.0	44.4	0.0
2	Protective Cover	1.0	100.0	110.0	99.0
3	Clay Liner	3.0	99.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				423.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
96.9		96.0			56.2
HYDROSTATIC OFF-SET FACTOR				7.5	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION **POINT 5** **FINAL-FILLED CONFIGURATION**
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	17.0	117.0	44.4	755.6
2	Protective Cover	1.0	100.0	110.0	110.0
3	Clay Liner	3.0	99.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				1225.6
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
98.8		96.0			174.7
HYDROSTATIC OFF-SET FACTOR				**7.0**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	17.00	117.0	44.4	680.0
2	Protective Cover	1.0	100.0	110.0	99.0
3	Clay Liner	3.0	99.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				1103.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
98.8		96.0			174.7
HYDROSTATIC OFF-SET FACTOR				**6.3**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.

BALLAST CALCULATION **POINT 5 REQUIRED WASTE THICKNESS**
HAWTHORN PARK

BOTTOM LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	0.0	100.0	44.4	0.0
2	Protective Cover	1.0	100.0	110.0	110.0
3	Clay Liner	3.0	99.0	120.0	360.0
	TOTAL OFF-SETTING BALLAST (lb)				470.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
98.8		96.0			174.7
HYDROSTATIC OFF-SET FACTOR				**2.7**	

SIDEWALL LINER

BALLAST CALCULATIONS - WASTE & SOIL AS BALLAST					
LAYER NO.	BALLAST MATERIAL	T_i LAYER THICKNESS (FT.)	ELEV. @ TOP OF LAYER	γ_i WET UNIT WEIGHT (PCF)	R_N OFF-SETTING BALLAST[2] (lb)
1	Waste	0.00	100.0	44.4	0.0
2	Protective Cover	1.0	100.0	110.0	99.0
3	Clay Liner	3.0	99.0	120.0	324.0
	TOTAL OFF-SETTING BALLAST (lb)				423.0
HYDROSTATIC FORCE CALCULATION					
G.W. ELEV.[1] (FT.)		Top of Subgrade ELEV. (FT.)			HYDROSTATIC FORCE (lb)****
98.8		96.0			174.7
HYDROSTATIC OFF-SET FACTOR				**2.4**	

[1] Based on site Historical Groundwater Elevations table data, Appendix III-3D-1.

[2] Normal uplift force equals weight of water multiplied by the vertical distance from the location on the sidewall to the seasonal high water level multiplied by a unit area, A, of 1 ft^2 measured along the liner. On the Sidewall Liner the angle β is between the horizontal liner and 3H:1V sideslope.

[3] A minimum safety factor of 1.50 is required since the ballast includes waste.