THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

Volume 5 of 6

CITY OF KINGSVILLE, TEXAS

September 2018
Revision 0

STATE OF TEXAS
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09/12/18

Prepared by

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Engineering | Planning | Allied Services

HANSON PROJECT NO. 16L0438-0003

APPENDIX 6B.13

HYDROCAD MODEL 100 YEAR POST DEVELOPMENT CHUTES

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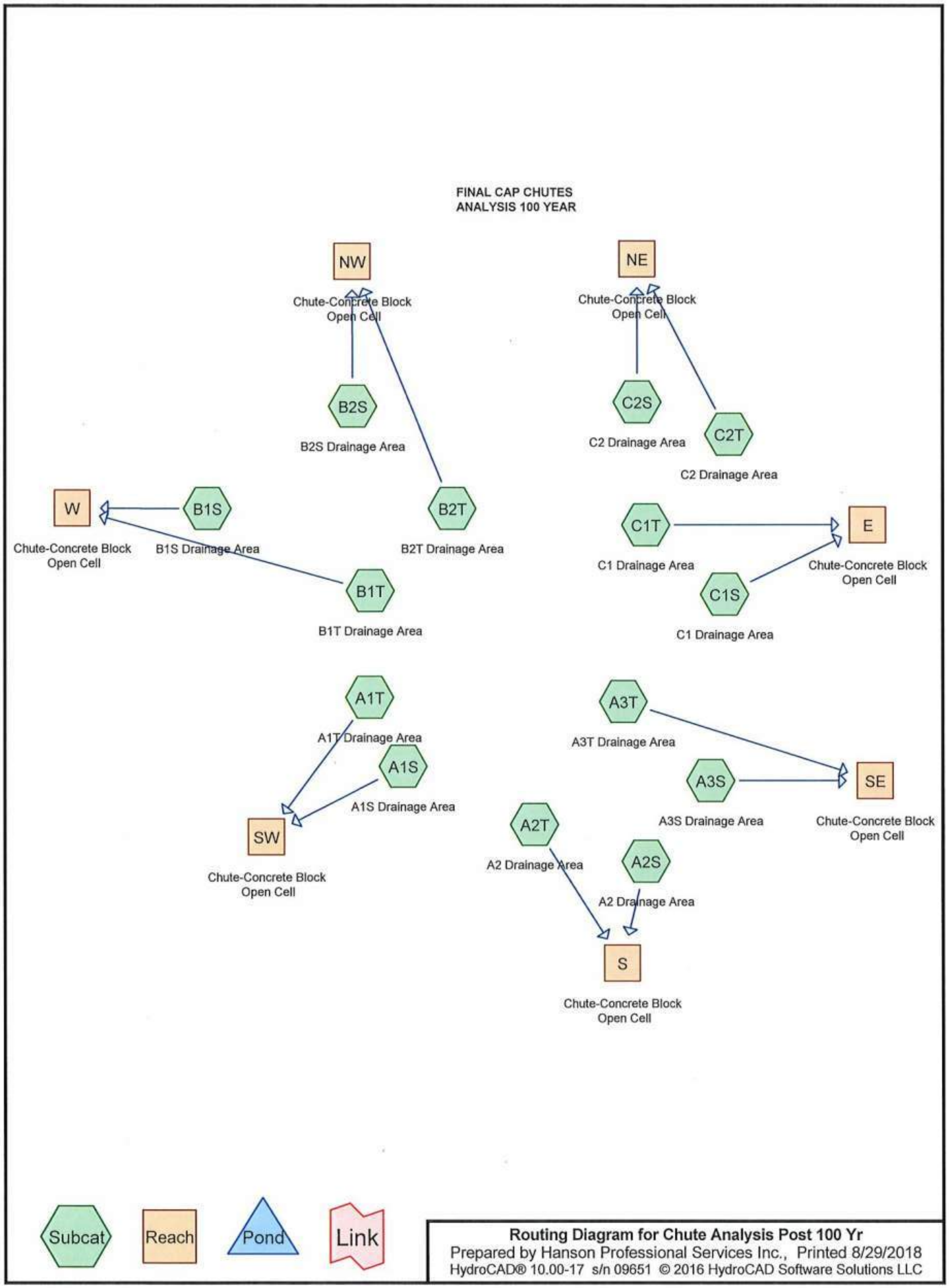
FINAL CAP CHUTES
ANALYSIS 100 YEAR
NW
Chute-Concrete Block
Open Cell
B2S
B2S Drainage Area
B2T
B2T Drainage Area
NE
Chute-Concrete Block
Open Cell
C2S
C2 Drainage Area
C2T
C2 Drainage Area
W
Chute-Concrete Block
Open Cell
B1S
B1S Drainage Area
B1T
B1T Drainage Area
C1T
C1 Drainage Area
E
Chute-Concrete Block
Open Cell
C1S
C1 Drainage Area
A1T
A1T Drainage Area
A1S
A1S Drainage Area
SW
Chute-Concrete Block
Open Cell
A3T
A3T Drainage Area
A3S
A3S Drainage Area
SE
Chute-Concrete Block
Open Cell
A2T
A2 Drainage Area
A2S
A2 Drainage Area
S
Chute-Concrete Block
Open Cell
Subcat
Reach
Pond
Link
Routing Diagram for Chute Analysis Post 100 Yr
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
119.627	79	50-75% Grass cover, Fair, HSG C (A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T)
119.627	**79**	**TOTAL AREA**

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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
119.627	HSG C	A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T
0.000	HSG D	
0.000	Other	
119.627		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	119.627	0.000	0.000	119.627	50-75% Grass cover, Fair	A1S, A1T, A2S, A2T, A3S, A3T, B1S, B1T, B2S, B2T, C1S, C1T, C2S, C2T
0.000	**0.000**	**119.627**	**0.000**	**0.000**	**119.627**	**TOTAL AREA**	

Chute Analysis Post 100 Yr *Type III 24-hr 100-Year Rainfall=11.50"*
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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A1S: A1S Drainage Area Runoff Area=8.009 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=70.23 cfs 5.892 af

Subcatchment A1T: A1T Drainage Area Runoff Area=7.425 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=65.11 cfs 5.463 af

Subcatchment A2S: A2 Drainage Area Runoff Area=12.241 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=107.35 cfs 9.006 af

Subcatchment A2T: A2 Drainage Area Runoff Area=5.120 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=44.90 cfs 3.767 af

Subcatchment A3S: A3S Drainage Area Runoff Area=10.760 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=94.36 cfs 7.916 af

Subcatchment A3T: A3T Drainage Area Runoff Area=7.489 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=1,050' Tc=16.7 min CN=79 Runoff=54.75 cfs 5.510 af

Subcatchment B1S: B1S Drainage Area Runoff Area=14.884 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=130.52 cfs 10.951 af

Subcatchment B1T: B1T Drainage Area Runoff Area=7.499 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=950' Tc=16.0 min CN=79 Runoff=55.80 cfs 5.517 af

Subcatchment B2S: B2S Drainage Area Runoff Area=8.806 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=77.22 cfs 6.479 af

Subcatchment B2T: B2T Drainage Area Runoff Area=4.309 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=850' Tc=13.7 min CN=79 Runoff=33.95 cfs 3.170 af

Subcatchment C1S: C1 Drainage Area Runoff Area=11.506 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=100.90 cfs 8.465 af

Subcatchment C1T: C1 Drainage Area Runoff Area=6.292 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=800' Tc=12.5 min CN=79 Runoff=51.20 cfs 4.629 af

Subcatchment C2S: C2 Drainage Area Runoff Area=10.038 ac 0.00% Impervious Runoff Depth=8.83"
Tc=10.0 min CN=79 Runoff=88.03 cfs 7.385 af

Subcatchment C2T: C2 Drainage Area Runoff Area=5.249 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=800' Tc=12.5 min CN=79 Runoff=42.72 cfs 3.862 af

Reach E: Chute-Concrete Block Avg. Flow Depth=0.85' Max Vel=21.04 fps Inflow=150.87 cfs 13.094 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=150.59 cfs 13.094 af

Reach NE: Chute-Concrete Block Avg. Flow Depth=0.79' Max Vel=20.16 fps Inflow=129.70 cfs 11.247 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=129.45 cfs 11.247 af

Chute Analysis Post 100 Yr *Type III 24-hr 100-Year Rainfall=11.50"*
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Reach NW: Chute-Concrete Block Avg. Flow Depth=0.72' Max Vel=19.21 fps Inflow=109.40 cfs 9.649 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=109.22 cfs 9.649 af

Reach S: Chute-Concrete Block Avg. Flow Depth=0.86' Max Vel=21.09 fps Inflow=152.24 cfs 12.773 af
n=0.025 L=451.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=151.94 cfs 12.773 af

Reach SE: Chute-Concrete Block Avg. Flow Depth=0.83' Max Vel=20.70 fps Inflow=142.28 cfs 13.426 af
n=0.025 L=441.7' S=0.2500 '/' Capacity=877.36 cfs Outflow=142.08 cfs 13.426 af

Reach SW: Chute-Concrete Block Avg. Flow Depth=0.81' Max Vel=20.41 fps Inflow=135.35 cfs 11.355 af
n=0.025 L=406.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=135.08 cfs 11.355 af

Reach W: Chute-Concrete Block Avg. Flow Depth=0.93' Max Vel=22.10 fps Inflow=179.96 cfs 16.468 af
n=0.025 L=456.0' S=0.2500 '/' Capacity=877.30 cfs Outflow=179.71 cfs 16.468 af

Total Runoff Area = 119.627 ac Runoff Volume = 88.012 af Average Runoff Depth = 8.83"
100.00% Pervious = 119.627 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment A1S: A1S Drainage Area

Use Conservative Value of Tc=10 min.

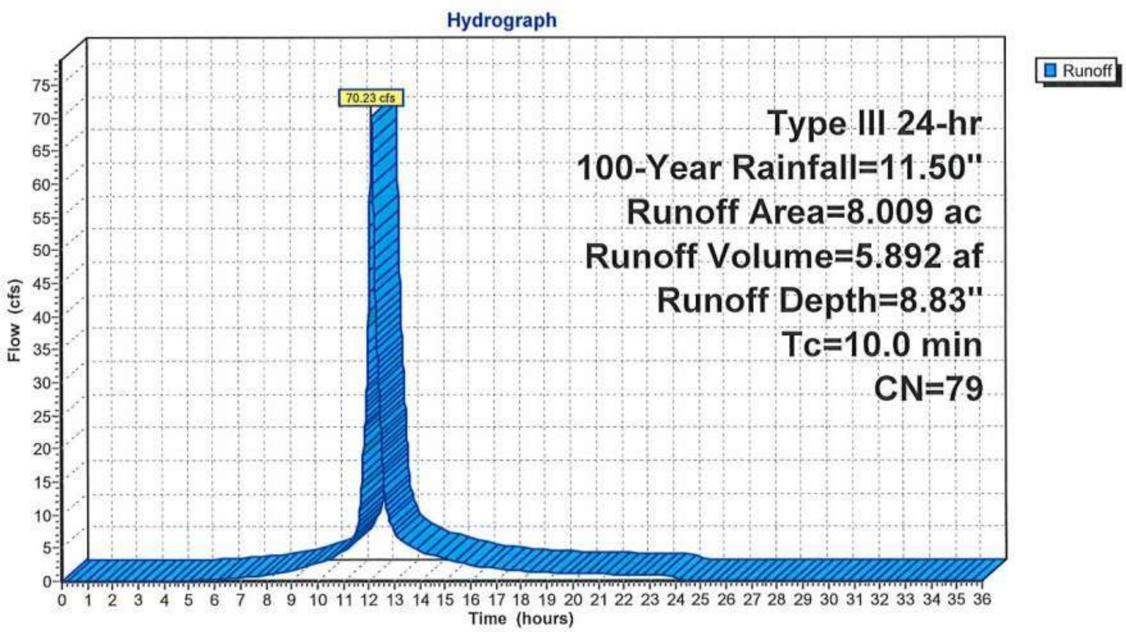
Runoff = 70.23 cfs @ 12.14 hrs, Volume= 5.892 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.009	79	50-75% Grass cover, Fair, HSG C
8.009		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1S-Chute Flow Evaluation**

Subcatchment A1S: A1S Drainage Area



Summary for Subcatchment A1T: A1T Drainage Area

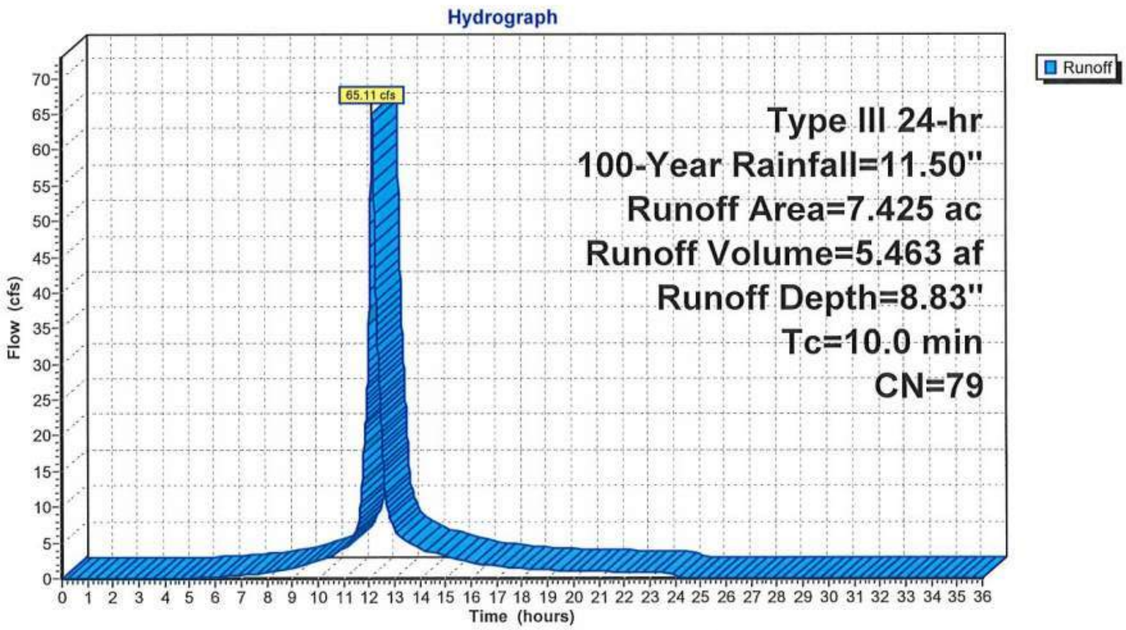
Runoff = 65.11 cfs @ 12.14 hrs, Volume= 5.463 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.425	79	50-75% Grass cover, Fair, HSG C
7.425		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A1T-Chute Flow Evaluation**

Subcatchment A1T: A1T Drainage Area



Summary for Subcatchment A2S: A2 Drainage Area

Use Conservative Value of Tc=10 min.

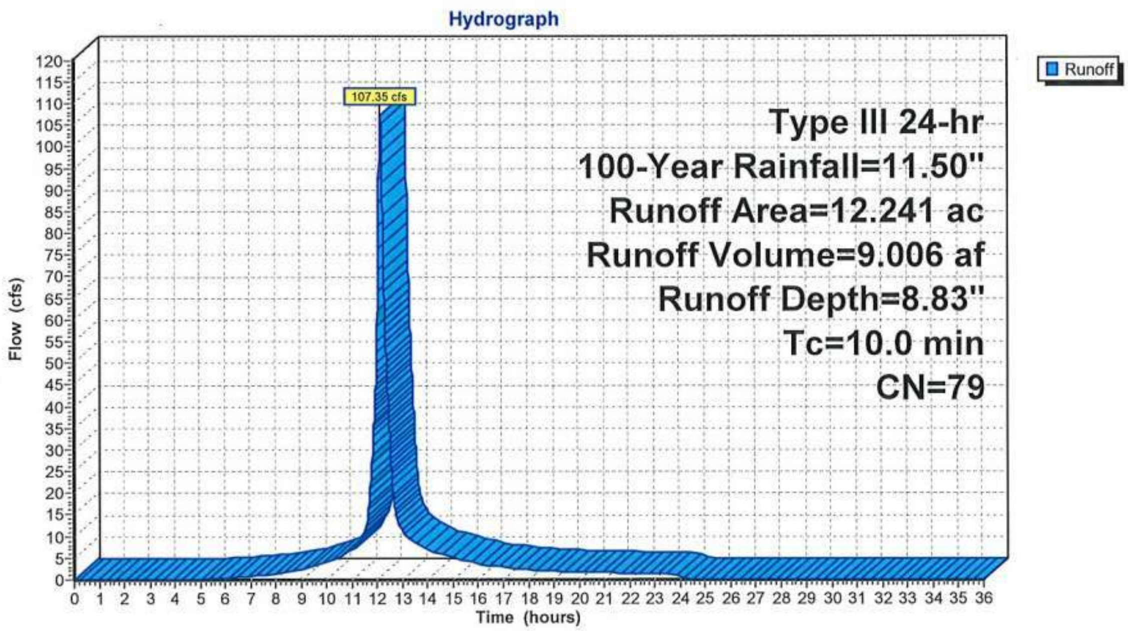
Runoff = 107.35 cfs @ 12.14 hrs, Volume= 9.006 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
12.241	79	50-75% Grass cover, Fair, HSG C
12.241		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2S: A2 Drainage Area



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Summary for Subcatchment A2T: A2 Drainage Area

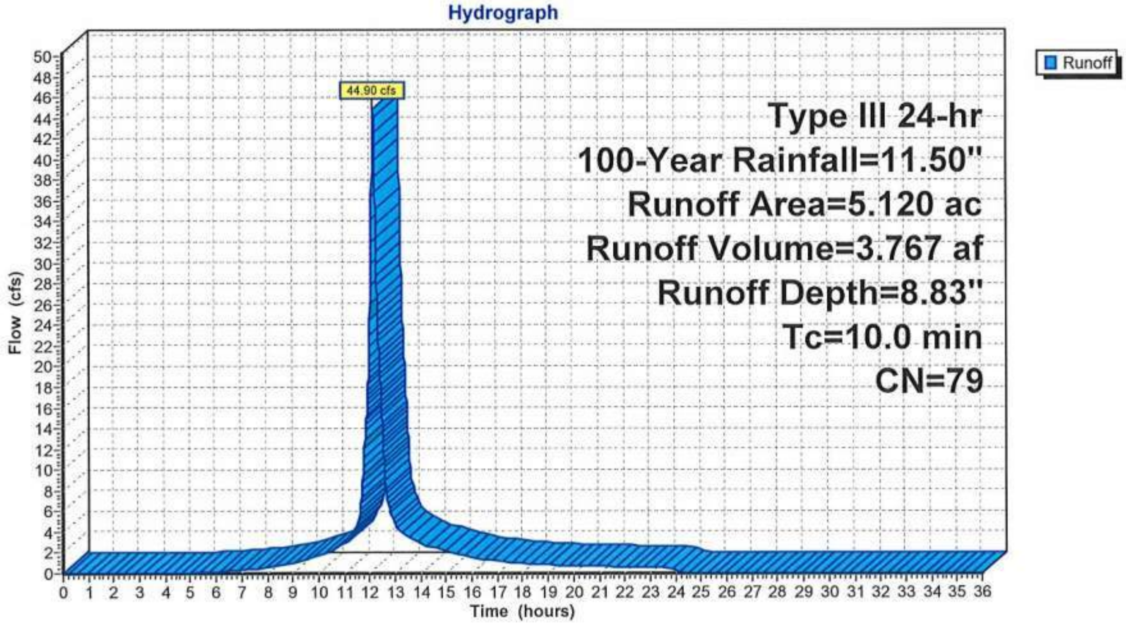
Runoff = 44.90 cfs @ 12.14 hrs, Volume= 3.767 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
5.120	79	50-75% Grass cover, Fair, HSG C
5.120		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A2 Drainage Area**

Subcatchment A2T: A2 Drainage Area



Summary for Subcatchment A3S: A3S Drainage Area

Use Conservative Value of Tc=10 min.

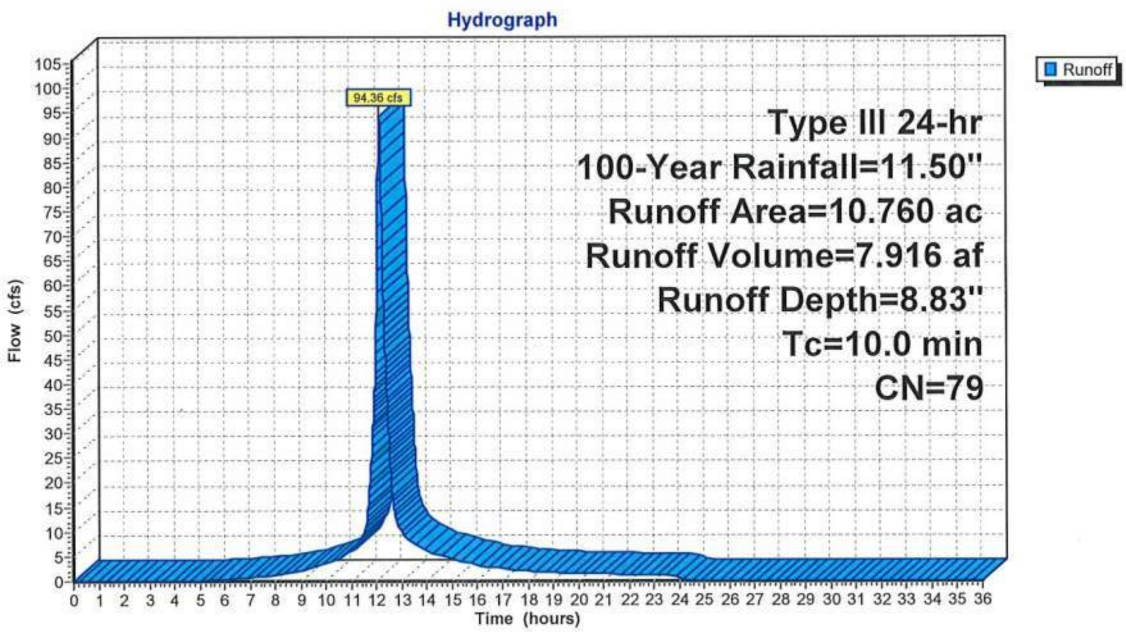
Runoff = 94.36 cfs @ 12.14 hrs, Volume= 7.916 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
10.760	79	50-75% Grass cover, Fair, HSG C
10.760		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, A3S-Chute Flow Evaluation**

Subcatchment A3S: A3S Drainage Area



Summary for Subcatchment A3T: A3T Drainage Area

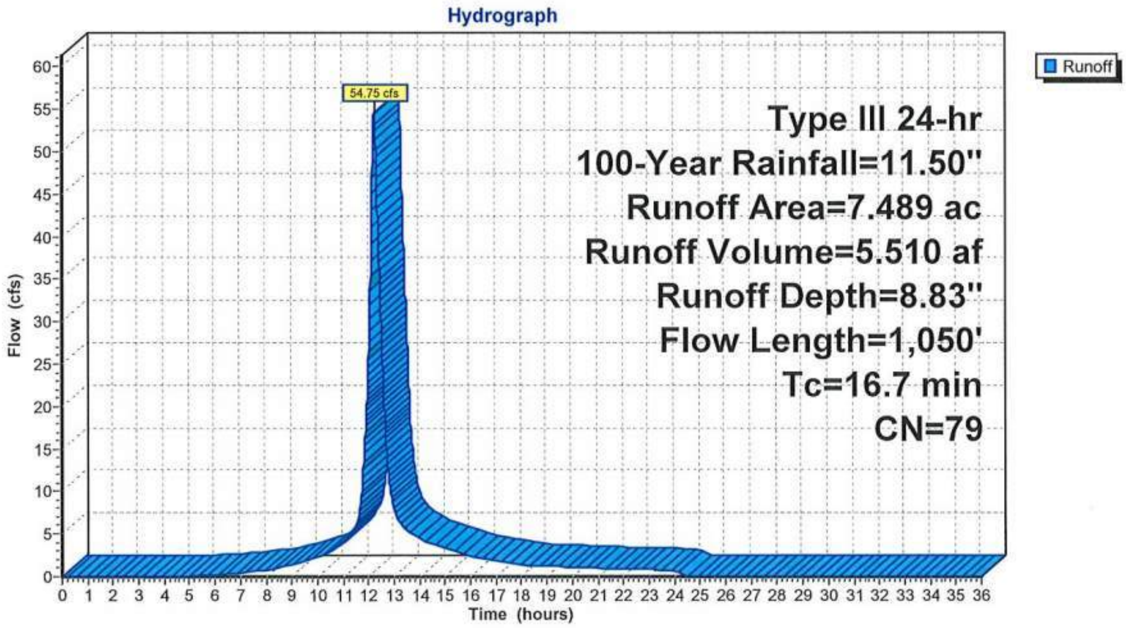
Runoff = 54.75 cfs @ 12.22 hrs, Volume= 5.510 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.489	79	50-75% Grass cover, Fair, HSG C
7.489		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	750		1.30		**Direct Entry, A3T-Chute Flow Evaluation**
7.1	300		0.70		**Direct Entry,**
16.7	1,050	Total			

Subcatchment A3T: A3T Drainage Area



Summary for Subcatchment B1S: B1S Drainage Area

Use Conservative Value of Tc=10 min.

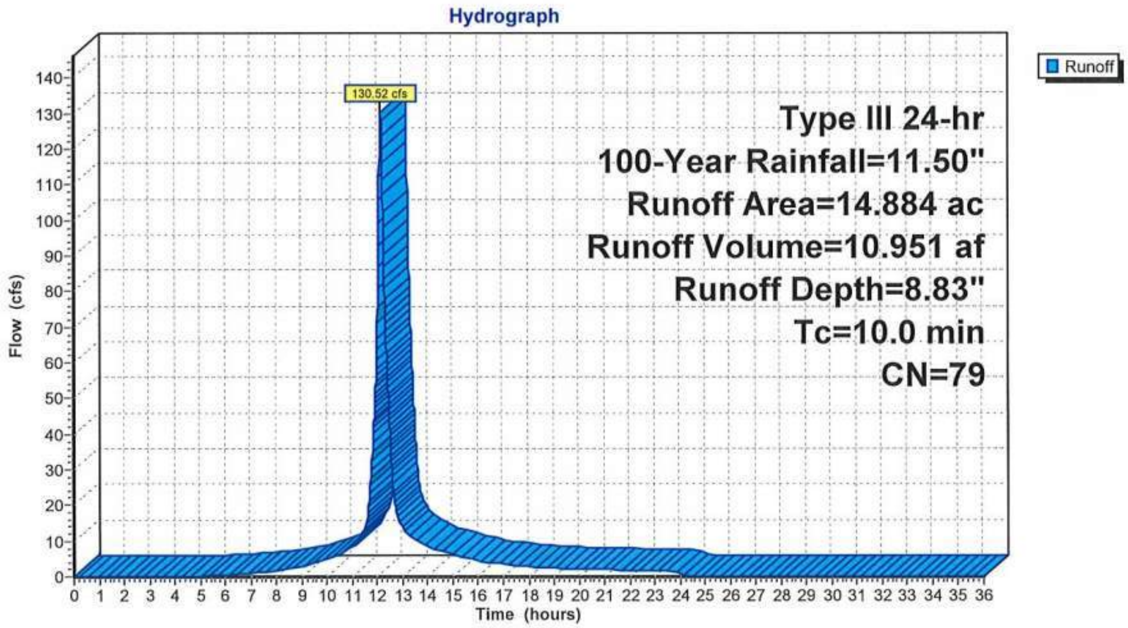
Runoff = 130.52 cfs @ 12.14 hrs, Volume= 10.951 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
14.884	79	50-75% Grass cover, Fair, HSG C
14.884		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S-Chute Flow Evaluation**

Subcatchment B1S: B1S Drainage Area



Summary for Subcatchment B1T: B1T Drainage Area

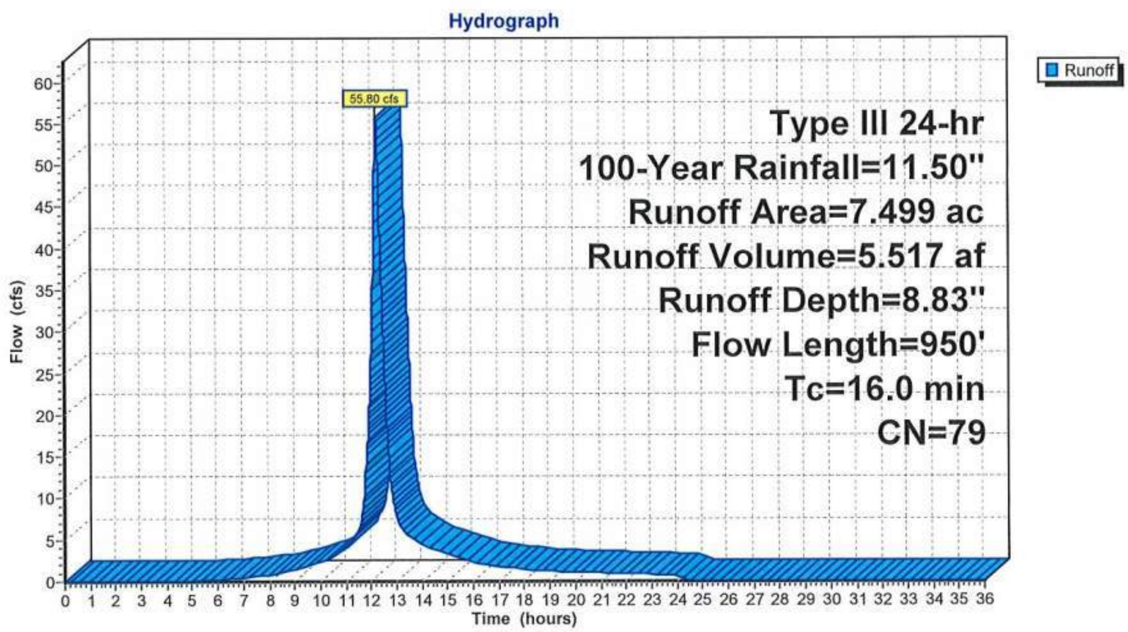
Runoff = 55.80 cfs @ 12.21 hrs, Volume= 5.517 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
7.499	79	50-75% Grass cover, Fair, HSG C
7.499		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T-Chute Flow Evaluation**
8.3	350		0.70		**Direct Entry,**
16.0	950	Total			

Subcatchment B1T: B1T Drainage Area



Summary for Subcatchment B2S: B2S Drainage Area

Use Conservative Value of Tc=10 min.

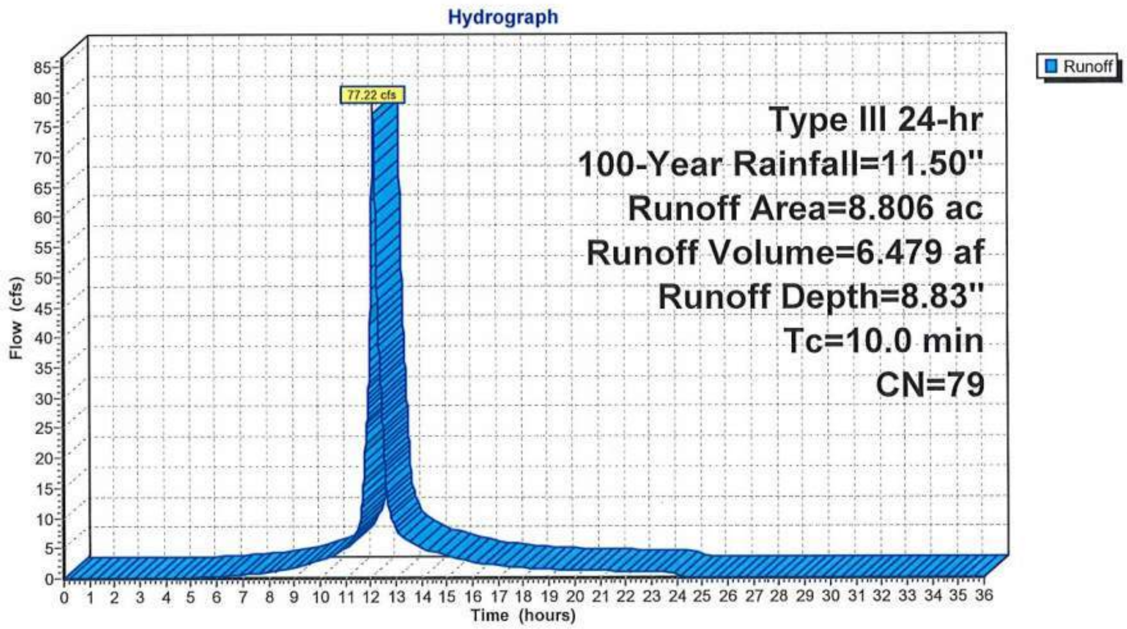
Runoff = 77.22 cfs @ 12.14 hrs, Volume= 6.479 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.806	79	50-75% Grass cover, Fair, HSG C
8.806		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B2S-Chute Flow Evaluation**

Subcatchment B2S: B2S Drainage Area



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Summary for Subcatchment B2T: B2T Drainage Area

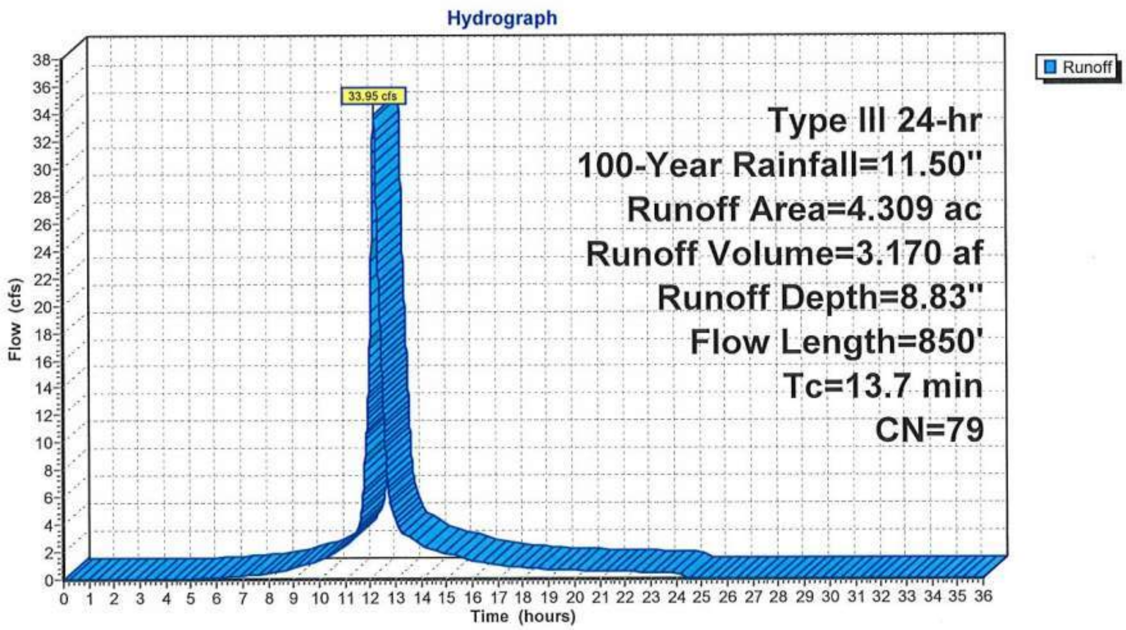
Runoff = 33.95 cfs @ 12.18 hrs, Volume= 3.170 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
4.309	79	50-75% Grass cover, Fair, HSG C
4.309		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B2T-Chute Flow Evaluation**
6.0	250		0.70		**Direct Entry,**
13.7	850	Total			

Subcatchment B2T: B2T Drainage Area



Summary for Subcatchment C1S: C1 Drainage Area

Use Conservative Value of Tc=10 min.

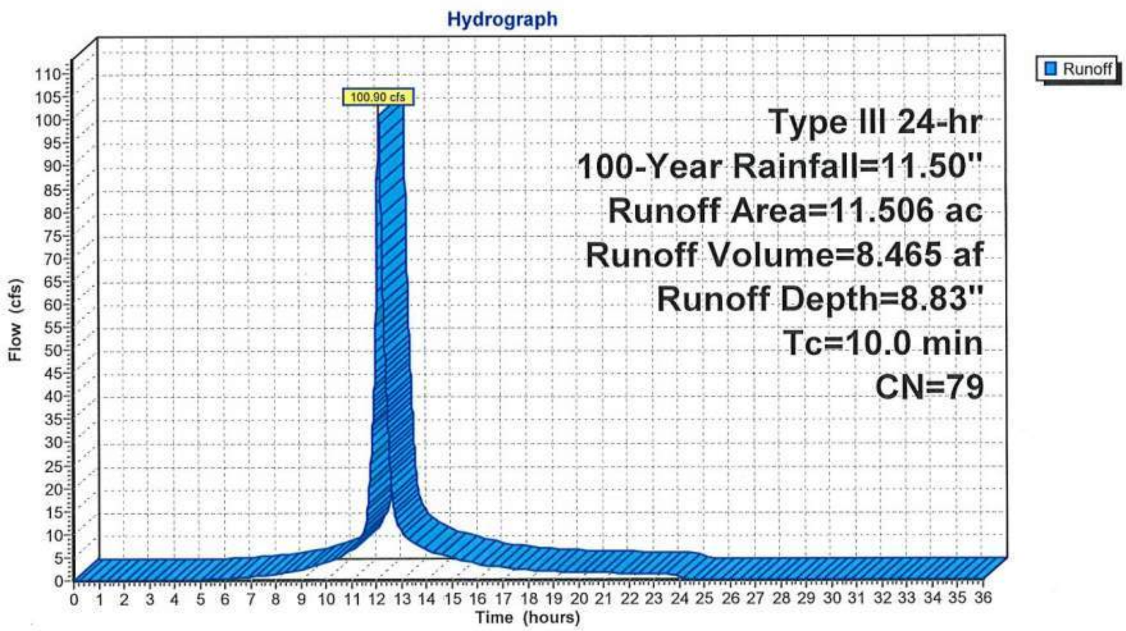
Runoff = 100.90 cfs @ 12.14 hrs, Volume= 8.465 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
11.506	79	50-75% Grass cover, Fair, HSG C
11.506		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C1 Drainage Area**

Subcatchment C1S: C1 Drainage Area



Summary for Subcatchment C1T: C1 Drainage Area

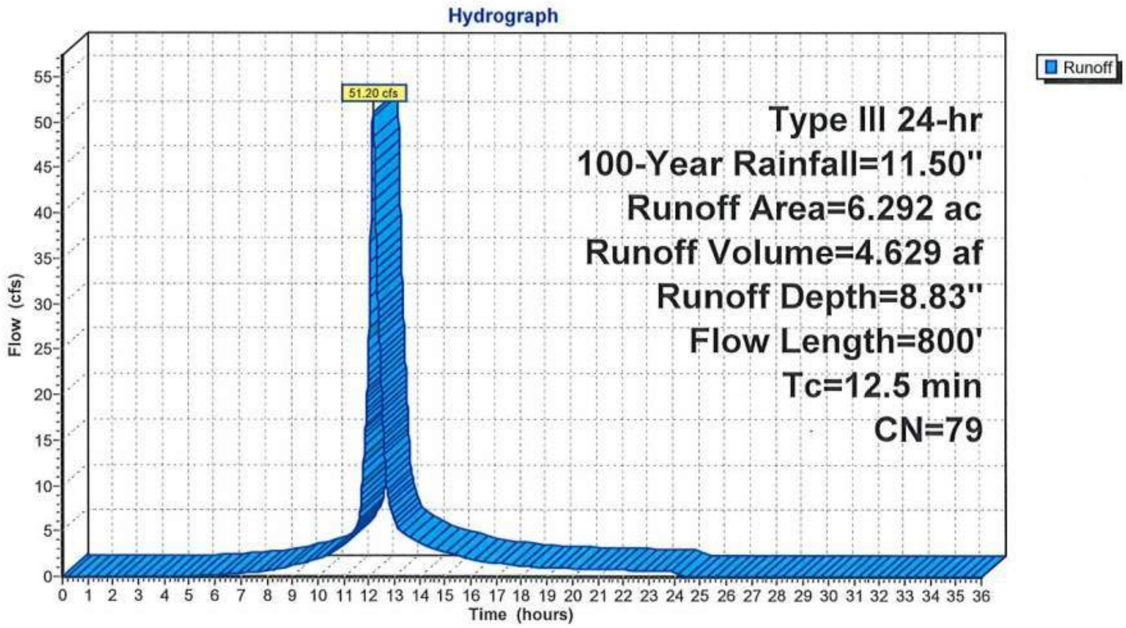
Runoff = 51.20 cfs @ 12.17 hrs, Volume= 4.629 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
6.292	79	50-75% Grass cover, Fair, HSG C
6.292		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C1 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C1T: C1 Drainage Area



Summary for Subcatchment C2S: C2 Drainage Area

Use Conservative Value of Tc=10 min.

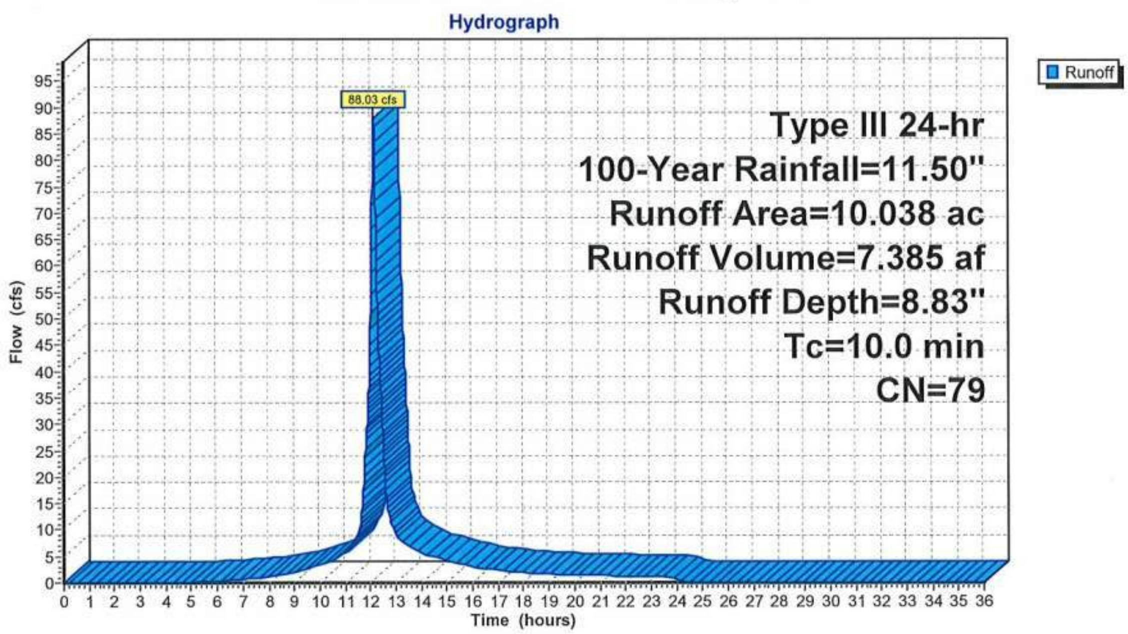
Runoff = 88.03 cfs @ 12.14 hrs, Volume= 7.385 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
10.038	79	50-75% Grass cover, Fair, HSG C
10.038		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, C2 Drainage Area**

Subcatchment C2S: C2 Drainage Area



Summary for Subcatchment C2T: C2 Drainage Area

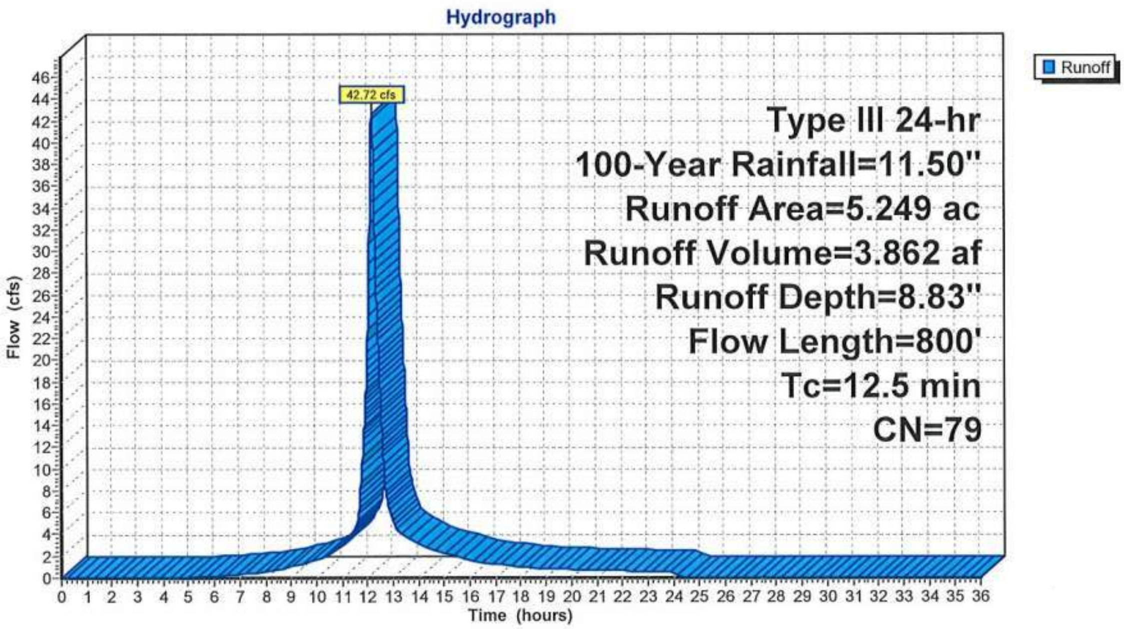
Runoff = 42.72 cfs @ 12.17 hrs, Volume= 3.862 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
5.249	79	50-75% Grass cover, Fair, HSG C
5.249		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, C2 Drainage Area**
4.8	200		0.70		**Direct Entry,**
12.5	800	Total			

Subcatchment C2T: C2 Drainage Area



Chute Analysis Post 100 Yr *Type III 24-hr 100-Year Rainfall=11.50"*
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Summary for Reach E: Chute-Concrete Block Open Cell

Inflow Area = 17.798 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 150.87 cfs @ 12.14 hrs, Volume= 13.094 af
Outflow = 150.59 cfs @ 12.16 hrs, Volume= 13.094 af, Atten= 0%, Lag= 0.6 min

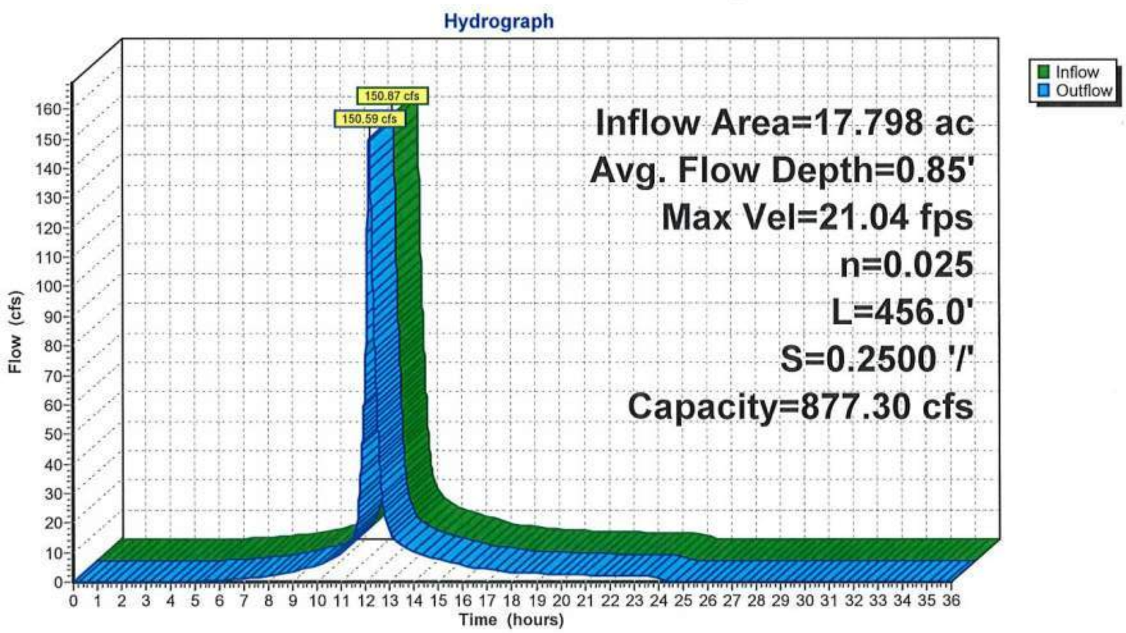
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.04 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.59 fps, Avg. Travel Time= 1.2 min

Peak Storage= 3,267 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach E: Chute-Concrete Block Open Cell



Summary for Reach NE: Chute-Concrete Block Open Cell

Inflow Area = 15.287 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 129.70 cfs @ 12.14 hrs, Volume= 11.247 af
Outflow = 129.45 cfs @ 12.16 hrs, Volume= 11.247 af, Atten= 0%, Lag= 0.6 min

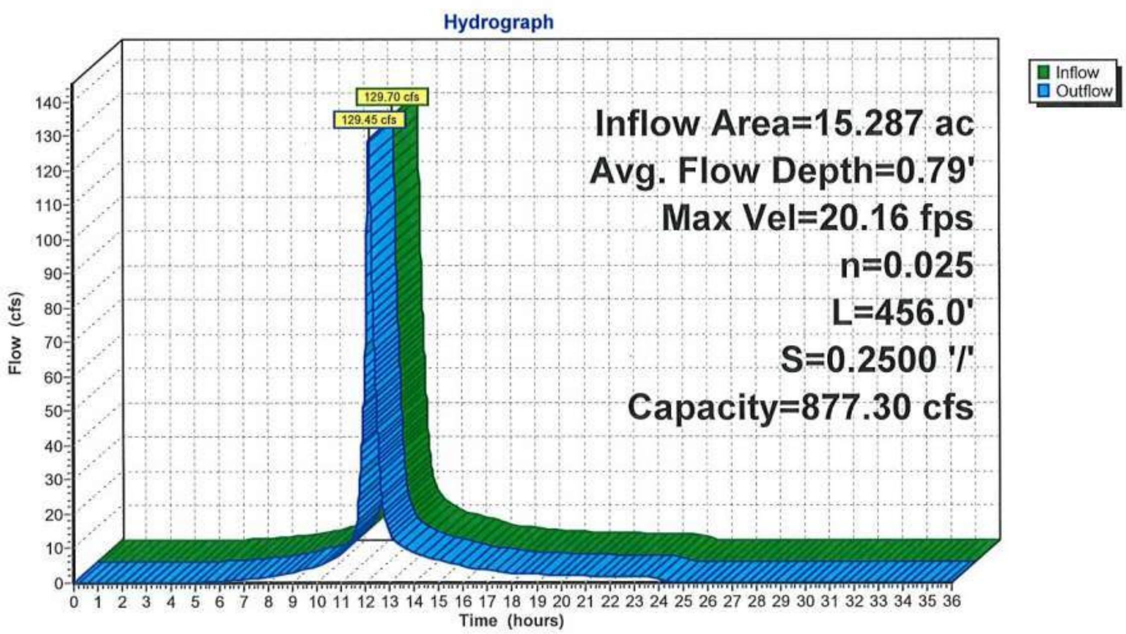
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.16 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.26 fps, Avg. Travel Time= 1.2 min

Peak Storage= 2,930 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach NE: Chute-Concrete Block Open Cell



Summary for Reach NW: Chute-Concrete Block Open Cell

Inflow Area = 13.115 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 109.40 cfs @ 12.15 hrs, Volume= 9.649 af
Outflow = 109.22 cfs @ 12.16 hrs, Volume= 9.649 af, Atten= 0%, Lag= 0.7 min

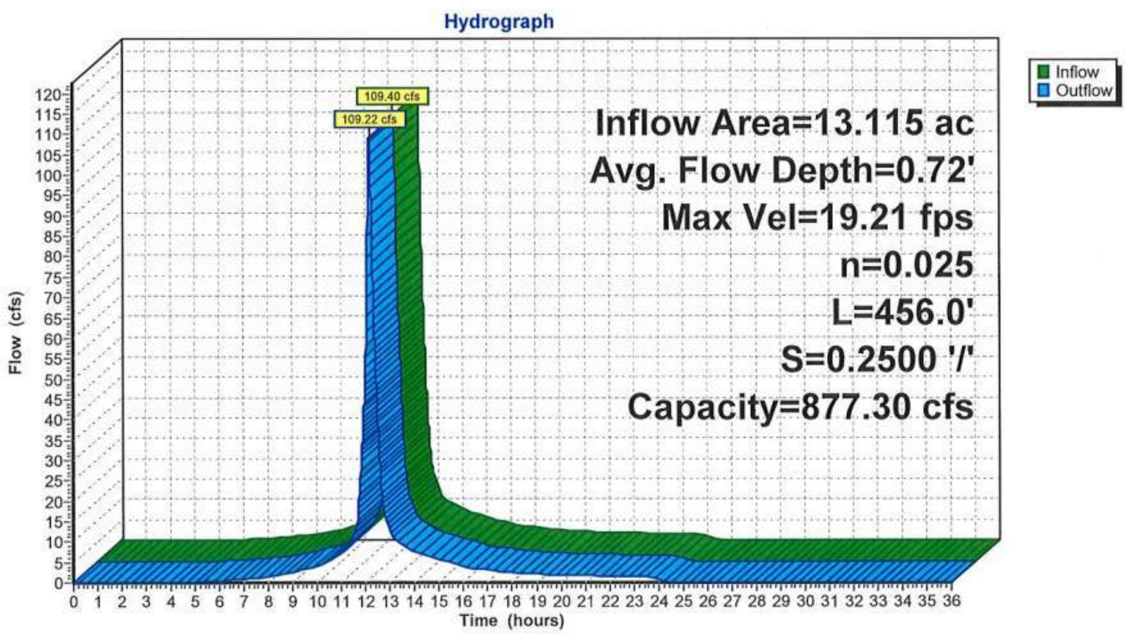
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.21 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 5.93 fps, Avg. Travel Time= 1.3 min

Peak Storage= 2,595 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach NW: Chute-Concrete Block Open Cell



Summary for Reach S: Chute-Concrete Block Open Cell

Inflow Area = 17.361 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 152.24 cfs @ 12.14 hrs, Volume= 12.773 af
Outflow = 151.94 cfs @ 12.15 hrs, Volume= 12.773 af, Atten= 0%, Lag= 0.6 min

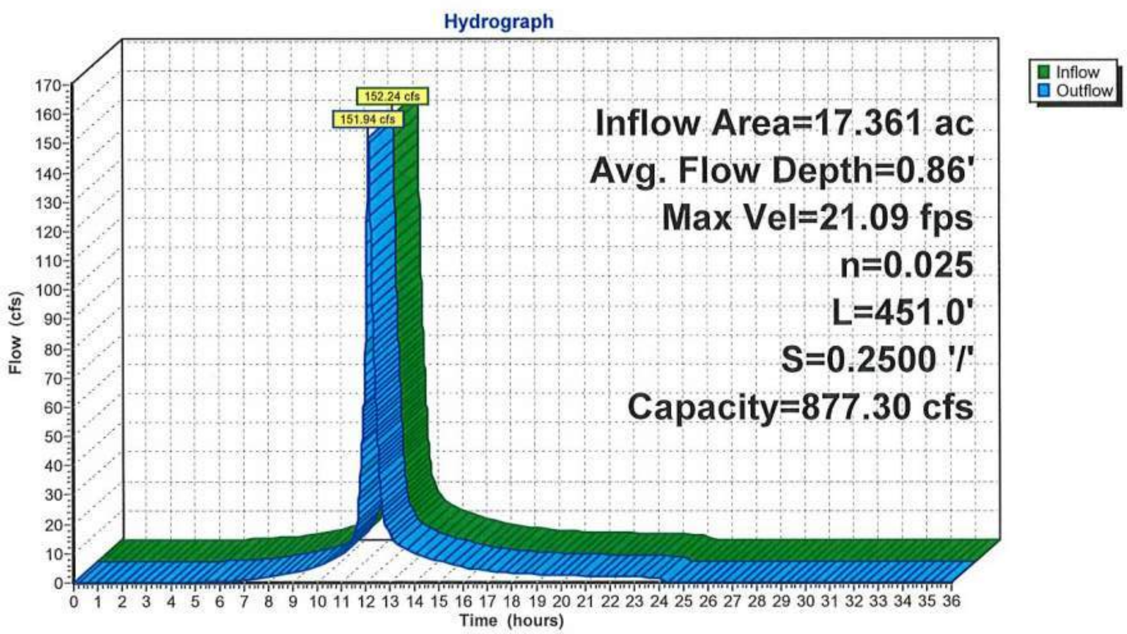
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 21.09 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.55 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,252 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.86'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 451.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 59.25'

‡

Reach S: Chute-Concrete Block Open Cell



Summary for Reach SE: Chute-Concrete Block Open Cell

Inflow Area =	18.249 ac,	0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow =	142.28 cfs @	12.15 hrs, Volume= 13.426 af
Outflow =	142.08 cfs @	12.16 hrs, Volume= 13.426 af, Atten= 0%, Lag= 0.6 min

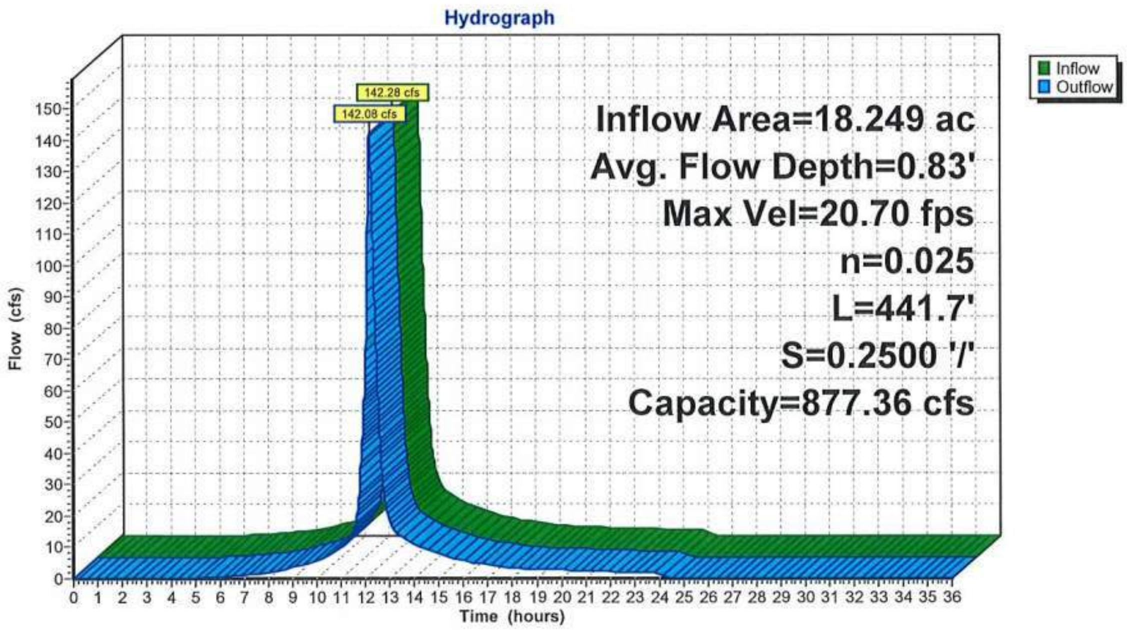
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.70 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.61 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,034 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.83'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.36 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 441.7' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 61.56'

‡

Reach SE: Chute-Concrete Block Open Cell



Summary for Reach SW: Chute-Concrete Block Open Cell

Inflow Area = 15.434 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 135.35 cfs @ 12.14 hrs, Volume= 11.355 af
Outflow = 135.08 cfs @ 12.15 hrs, Volume= 11.355 af, Atten= 0%, Lag= 0.5 min

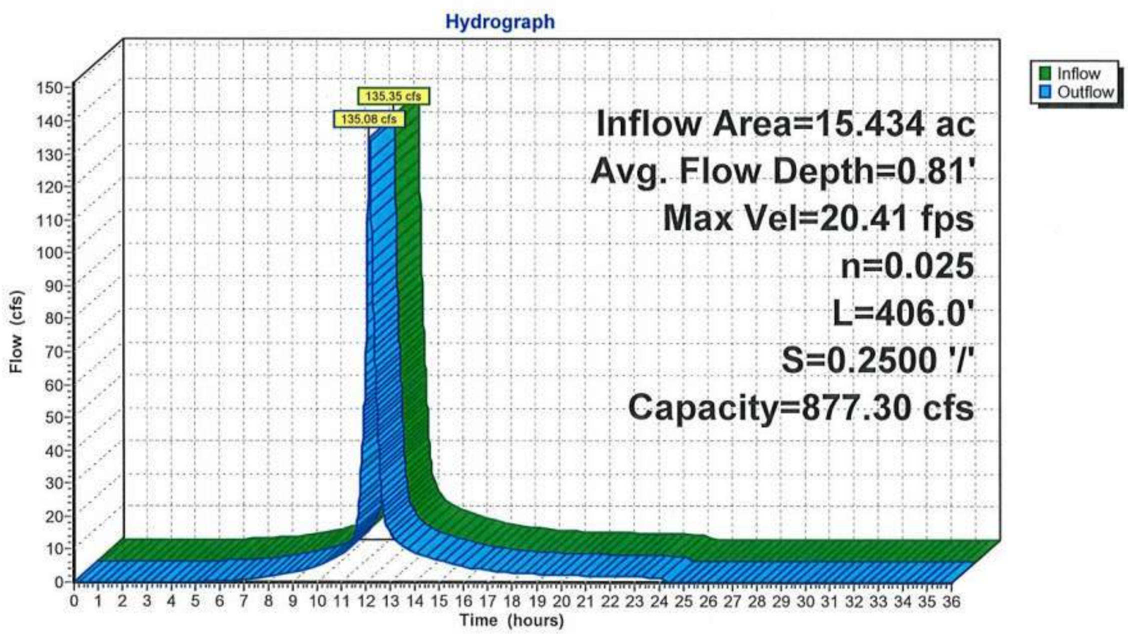
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 20.41 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 6.30 fps, Avg. Travel Time= 1.1 min

Peak Storage= 2,690 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 406.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 70.50'

‡

Reach SW: Chute-Concrete Block Open Cell



Summary for Reach W: Chute-Concrete Block Open Cell

Inflow Area = 22.383 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 179.96 cfs @ 12.15 hrs, Volume= 16.468 af
Outflow = 179.71 cfs @ 12.16 hrs, Volume= 16.468 af, Atten= 0%, Lag= 0.6 min

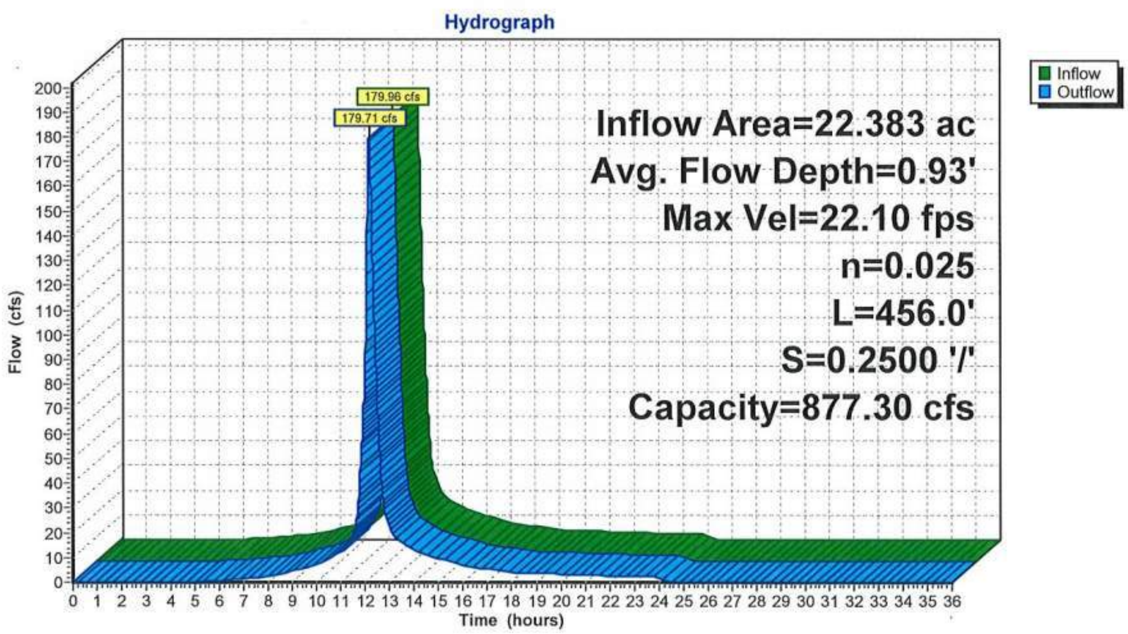
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 22.10 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 7.09 fps, Avg. Travel Time= 1.1 min

Peak Storage= 3,711 cf @ 12.15 hrs
Average Depth at Peak Storage= 0.93'
Bank-Full Depth= 2.00' Flow Area= 26.0 sf, Capacity= 877.30 cfs

5.00' x 2.00' deep channel, n= 0.025 Rubble masonry, cemented
Side Slope Z-value= 4.0 '/' Top Width= 21.00'
Length= 456.0' Slope= 0.2500 '/'
Inlet Invert= 172.00', Outlet Invert= 58.00'

‡

Reach W: Chute-Concrete Block Open Cell



APPENDIX 6B.14

ENGINEERING HANDBOOK CHUTE SPILLWAYS-CHUTE SPILLWAY DESIGN

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

ENGINEERING
HANDBOOK

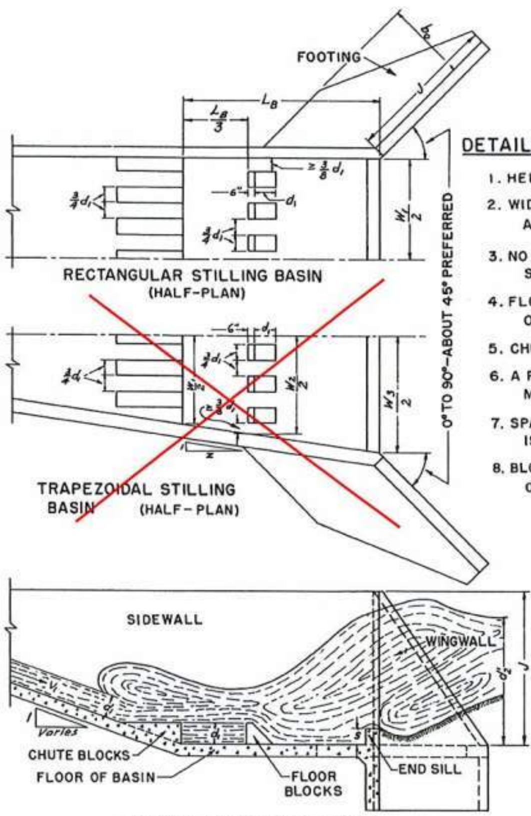
chute spillways

section 14

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

2.193

HYDRAULIC DESIGN CRITERIA AND CHARTS FOR SAF STILLING BASIN



SECTION ALONG CENTER LINE

DETAILS OF LAYOUT FOR FLOOR AND CHUTE BLOCKS

1. HEIGHT OF FLOOR AND CHUTE BLOCKS IS d_1
2. WIDTH AND SPACING OF FLOOR AND CHUTE BLOCKS APPROXIMATELY $\frac{3d_1}{4}$
3. NO FLOOR BLOCK SHOULD BE PLACED CLOSER TO SIDEWALL THAN $\frac{3d_1}{8}$
4. FLOOR BLOCKS OCCUPY BETWEEN 40 AND 55 PERCENT OF STILLING BASIN WIDTH AT BLOCKS
5. CHUTE BLOCKS TO BE STAGGERED WITH FLOOR BLOCKS
6. A PORTION OF A CHUTE BLOCK OR A WHOLE CHUTE BLOCK MAY BE ADJACENT TO A SIDEWALL
7. SPACE BETWEEN SIDEWALL AND FIRST CHUTE BLOCK IS NOT TO BE GREATER THAN APPROXIMATELY $\frac{3d_1}{4}$
8. BLOCKS ARE TO BE SYMMETRICAL ABOUT STILLING BASIN CENTER LINE

From Tables:
Lb = 8 ft
J = 6 ft
d'2 = 5 ft
s = 4 in

DESIGN FORMULAS

$3 \leq F_1 \leq 300$

1. $F_1 = \frac{v_1^2}{g d_1}$
2. $d_2 = \frac{d_1}{2}\left(-1 + \sqrt{8F_1 + 1}\right)$
3. $d_2' = 1.4\, d_1 F_1^{0.45}$
4. $L_B = \frac{4.5\, d_2}{F_1^{0.38}}$
5. $J = \frac{d_2}{3} + d_2'$
6. $s = 0.07\, d_2$
7. $z \geq 3\sqrt{F_1}$

DEFINITION OF SYMBOLS

F_1 = FROUDE'S NUMBER $\equiv \frac{v_1^2}{g d_1}$ (DIMENSIONLESS NUMBER)
v_1 = ENTRANCE VELOCITY OF WATER TO SAF STILLING BASIN — FT./SEC.
d_1 = ENTRANCE DEPTH OF WATER TO SAF STILLING BASIN — FEET
L_B = LENGTH OF SAF STILLING BASIN — FEET
J = HEIGHT OF SIDEWALLS OF SAF STILLING BASIN — FEET
s = HEIGHT OF TRANSVERSE END SILL OF SAF STILLING BASIN — FEET
d_2' = REQUIRED HEIGHT OF TAILWATER OVER SAF STILLING BASIN — FEET
d_2 = SEQUENT DEPTH OF FLOW TO DEPTH d_1 — FEET
g = ACCELERATION DUE TO GRAVITY — 32.16 FT./SEC.^{2}
W_1 = WIDTH OF SAF STILLING BASIN AT DOWNSTREAM END OF CHUTE BLOCKS-FEET
W_2 = WIDTH OF SAF STILLING BASIN AT UPSTREAM END OF FLOOR BLOCKS-FEET
W_3 = WIDTH OF SAF STILLING BASIN AT DOWNSTREAM END — FEET
Z = DIVERGENCE OF SIDEWALL (RATIO)

REFERENCE		STANDARD DRAWING NO.
Blaisdell, F.W. "Development and Hydraulic Design, Saint Anthony Falls Stilling Basin." (SAF Stilling Basin) Trans. A S C E 113 P. 483-561; 1948	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE ENGINEERING DIVISION-DESIGN SECTION	ES-73 SHEET 1 OF 3 DATE: 3-23-53 Revised 4-10-54

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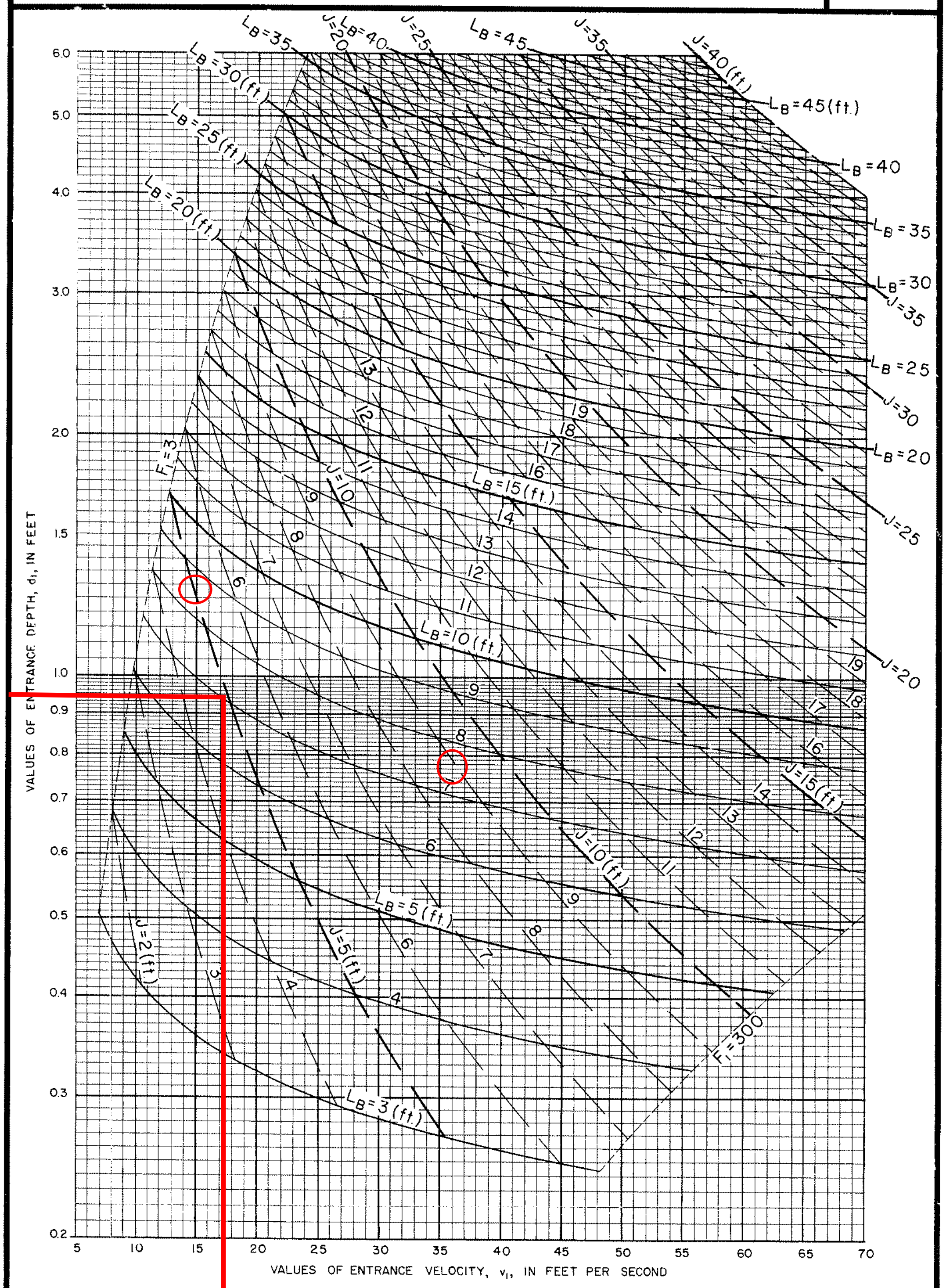
HYDRAULIC DESIGN CRITERIA AND CHARTS
FOR SAF STILLING BASIN

L_B - Feet
J - Feet



REFERENCE
Blaisdell, F. W. "Development And Hydraulic Design, Saint Anthony Falls Stilling Basin." (SAF Stilling Basin)
Trans. A S C E 113 P. 483-561, 1948
This diagram was developed by Paul D. Doubt, Engineering Design Section.

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ENGINEERING DIVISION-DESIGN SECTION

STANDARD DRAWING NO.
ES-73
SHEET 2 OF 3
DATE: 3-23-53
Revised 4-10-54

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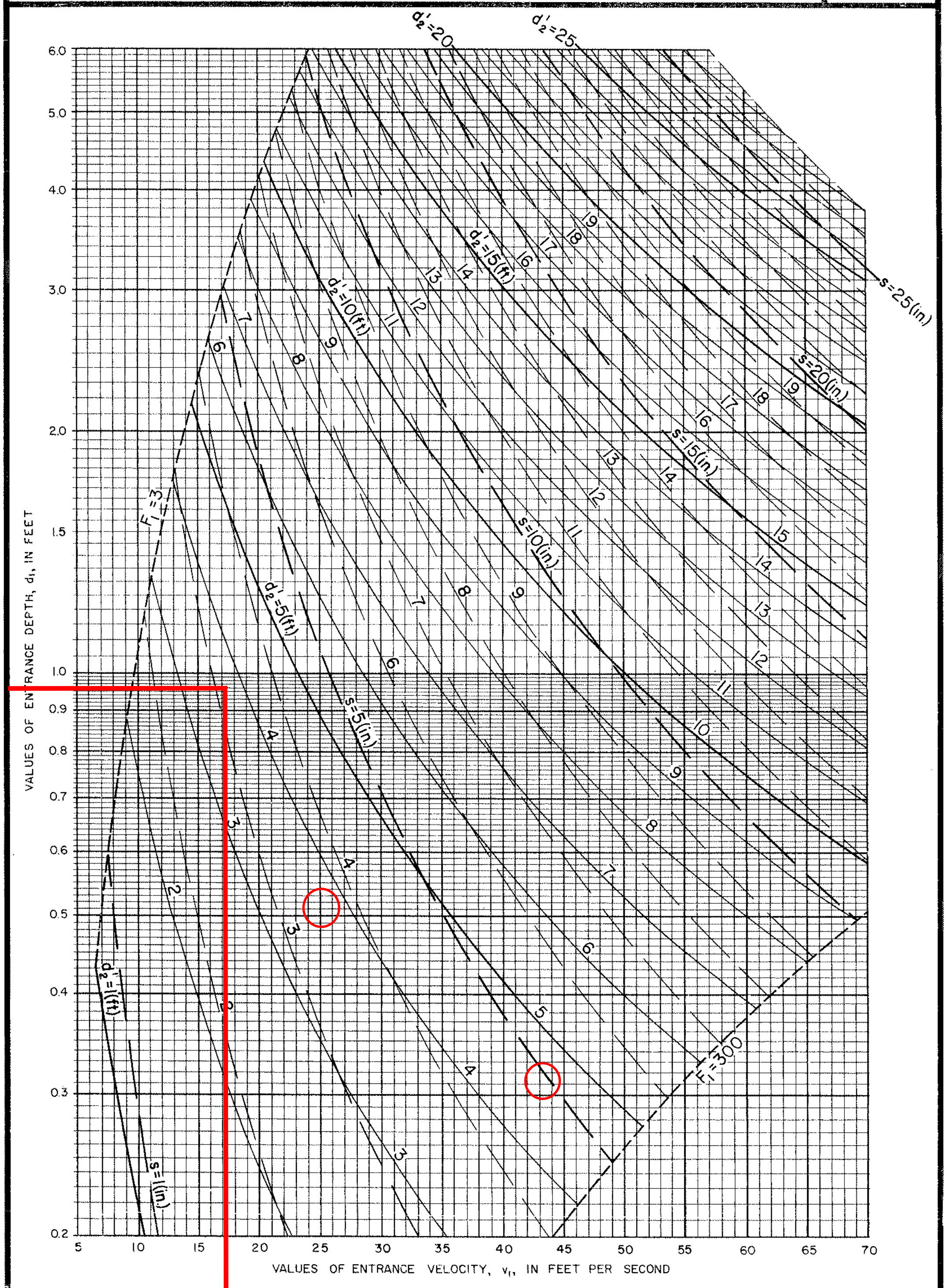
HYDRAULIC DESIGN CRITERIA AND CHARTS FOR SAF STILLING BASIN

s - Inches
d_2' - Feet



REFERENCE
Blaisdell, F. W. "Development And Hydraulic Design, Saint Anthony Falls Stilling Basin." (SAF Stilling Basin)
Trans. A S C E 113 P. 483-561 1948
This diagram was developed by Paul D. Doubt, Engineering Design Section.

Highest Chute Velocity 20.10 ft/sec

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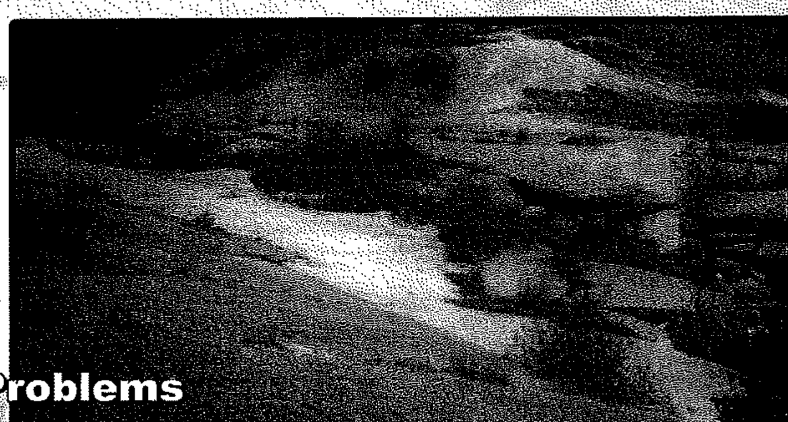
ENGINEERING DIVISION-DESIGN SECTION

STANDARD DRAWING NO.
ES-73
SHEET 3 OF 3
DATE: 3-23-53
Revised 4-10-54

YOUR EROSION CONTROL SOLUTION

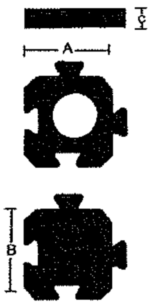
EPP
EROSION PREVENTION PRODUCTS

New Solutions...



...to Old Problems

CHANNEL LOCK®



BLOCK SPECIFICATIONS

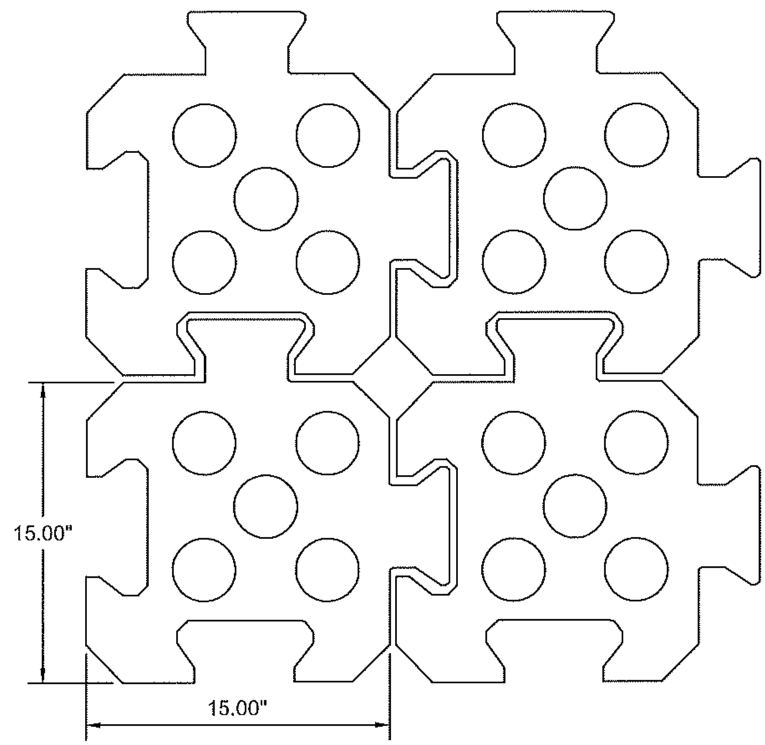
Dimensions A	Dimensions B	Dimensions C	Specific Weight Lbs/Ft3	Compressive Strength/PSI	Max Absorption Avg. of 3 Units	Coverage Area Per Block	Weight Lbs/Ft2	Weight Per Block	Open Area 0%
15"	15"	4 1/2	130-150	4,000	10%	1.56 S.F.	36 Lbs.	56 Lbs.	18-23%
15"	15"	5 1/2	130-150	4,000	10%	1.56 S.F.	43 Lbs.	66 Lbs	18-23%
15"	15"	8"	130-150	4,000	10%	1.56 S.F.	75 Lbs.	118 Lbs.	18-23%
A	B	C							
15"	15"	4 1/2	130-150	4,000	10%	1.56 S.F.	42 Lbs.	65 Lbs.	5%-7%
15"	15"	5 1/2	130-150	4,000	10%	1.56 S.F.	50 Lbs.	78 Lbs.	5%-7%
15"	15"	8"	130-150	4,000	10%	1.56 S.F.	83 Lbs.	130 Lbs.	5%-7%

As Approved & Utilized By:

- U.S. Army Corps of Engineers
- Texas Department of Transportation
- Harris County Flood Control District
- CAL-TRANS (California Transportation)
- City of Houston, TX
- City of Corpus Christi, TX
- City of San Diego, CA
- City of Henderson, NV
- U.S. Parks & Wildlife
- FEMA (Federal Emergency Management Assistance)

EPP
EROSION PREVENTION PRODUCTS

P.O. Box 891586 Houston, TX 77289-1586
PH: 281-286-2120 FAX: 281.286.2133 eppchannellock@aol.com
www.eppchannellock.com



NOTES:

1. GEOTEXTILE TYPE VARIES DEPENDING ON SOIL CONDITIONS.
2. BLOCKS TO BE BACKFILLED WITH NATIVE BACKFILL AND SEEDED FOR VEGETATION.
3. EACH UNIT COVERS 1.5625 SQ.FT.

Channel-Lock II
Flexible Revetment System

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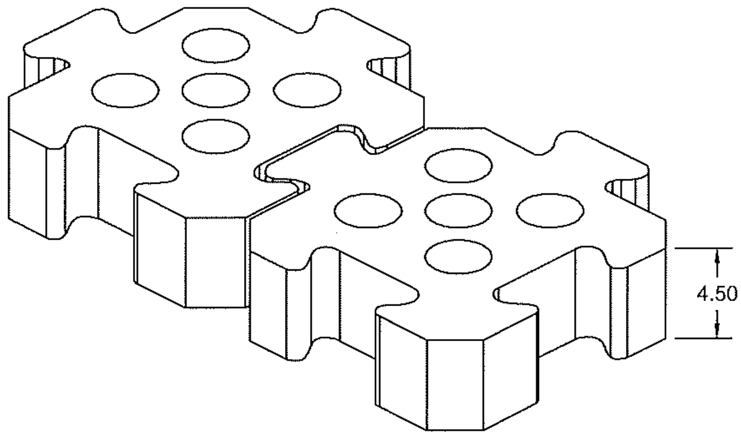
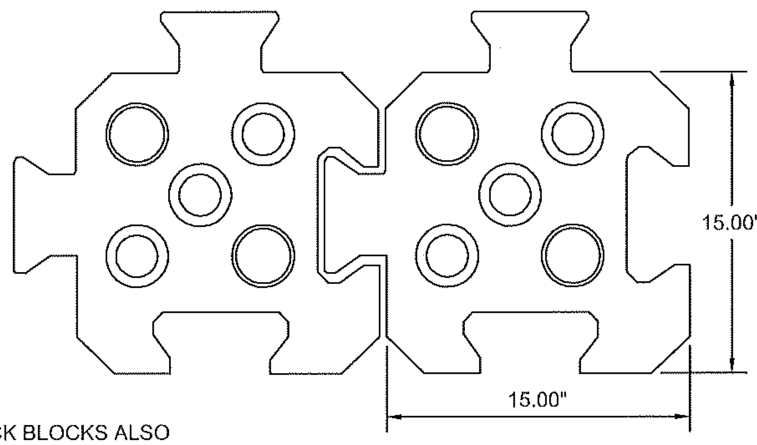
CHANNEL LOCK II BLOCK DETAILS

CAD File Name:	BLOCK
SCALE: N/A	SHEET 1 OF 1





NOTES:
1. 6" AND 8" THICK BLOCKS ALSO AVAILABLE

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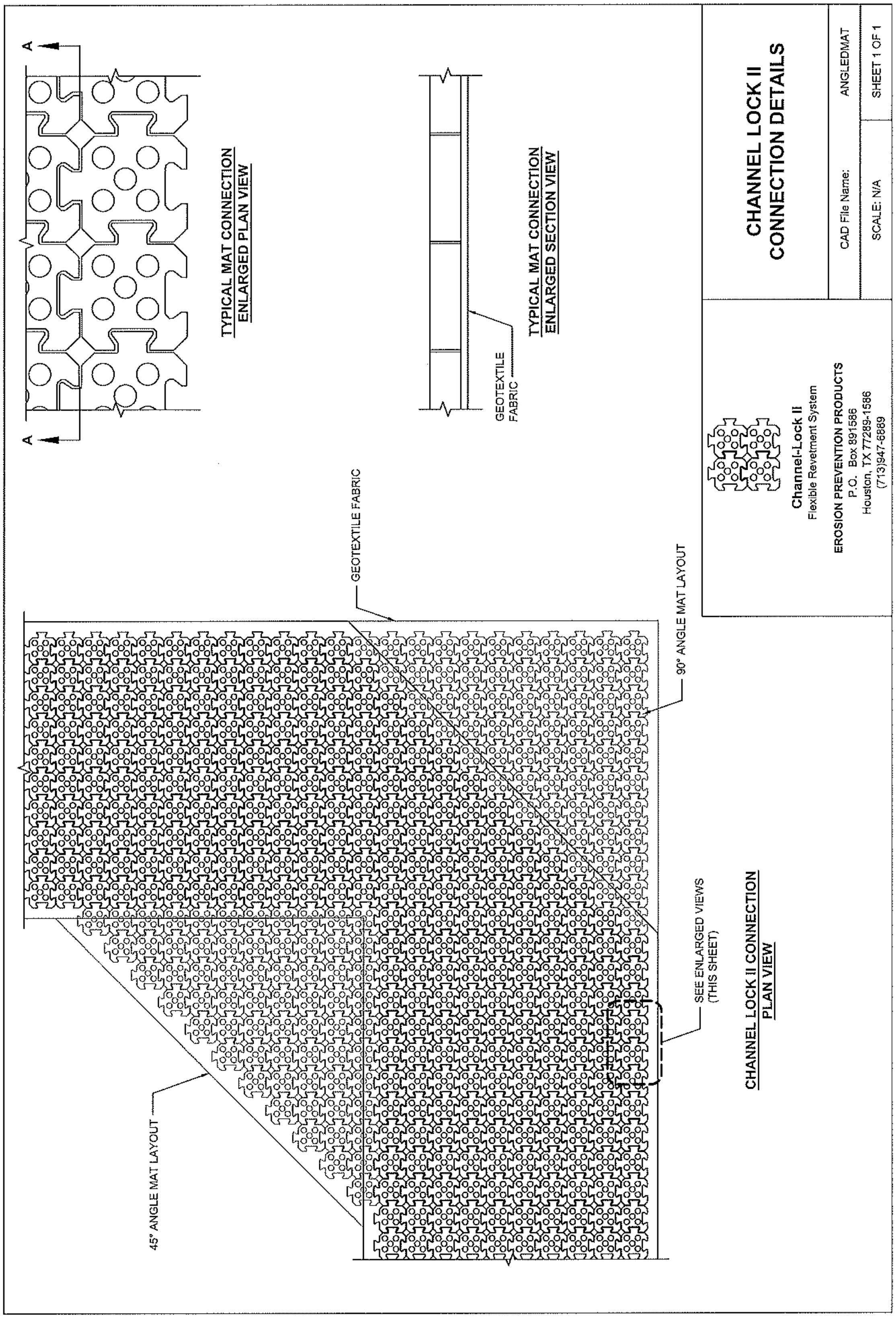
CHANNEL LOCK II
4.5" THICK

CAD File Name:	BLOCK
SCALE: N/A	SHEET 1 OF 1


TYPICAL MAT CONNECTION
ENLARGED PLAN VIEW
A
A
TYPICAL MAT CONNECTION
ENLARGED SECTION VIEW
GEOTEXTILE FABRIC
GEOTEXTILE FABRIC
90° ANGLE MAT LAYOUT
45° ANGLE MAT LAYOUT
SEE ENLARGED VIEWS (THIS SHEET)
CHANNEL LOCK II CONNECTION
PLAN VIEW
CHANNEL LOCK II
CONNECTION DETAILS
CAD File Name: ANGLEDMAT
SCALE: N/A
SHEET 1 OF 1
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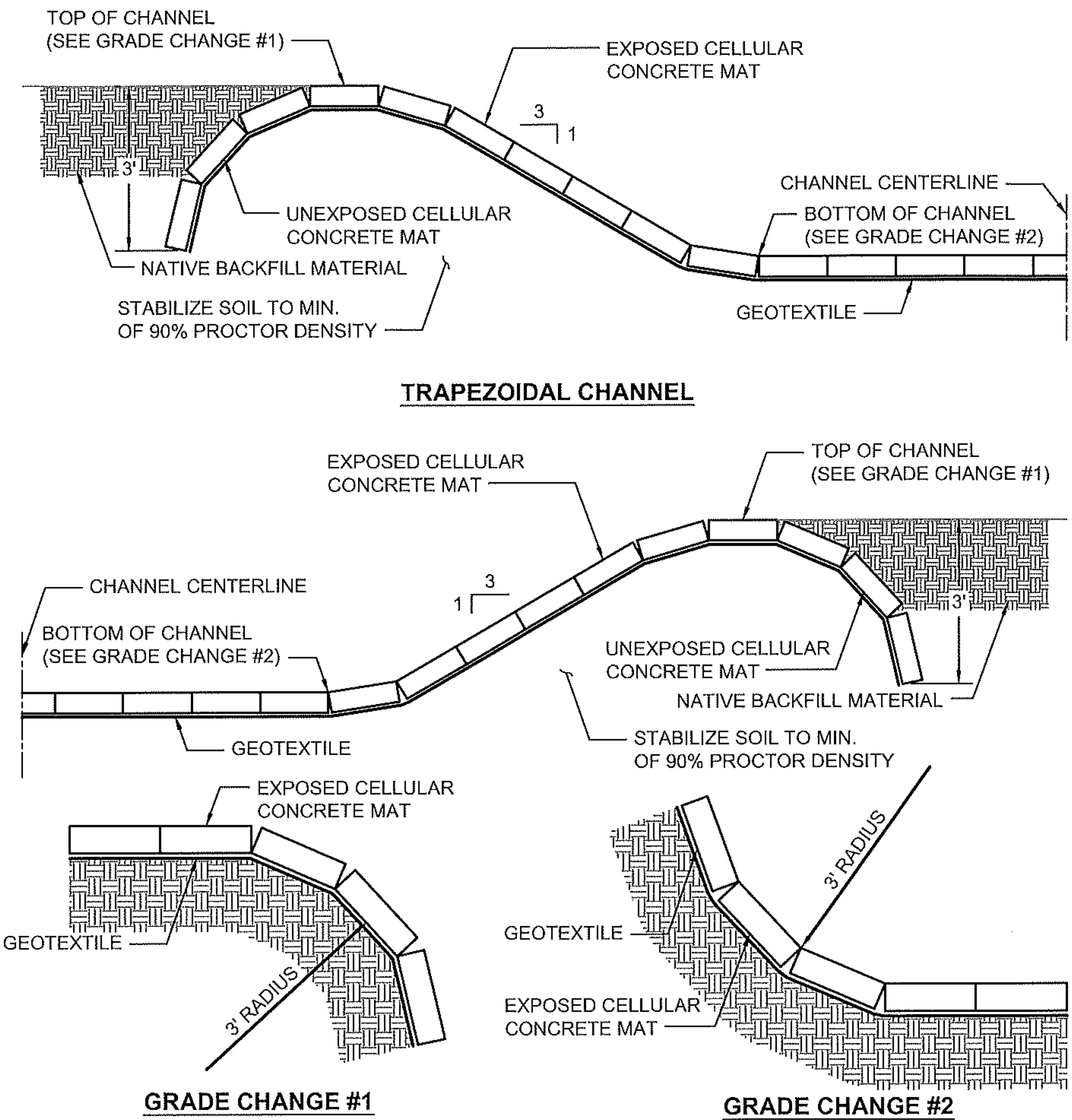

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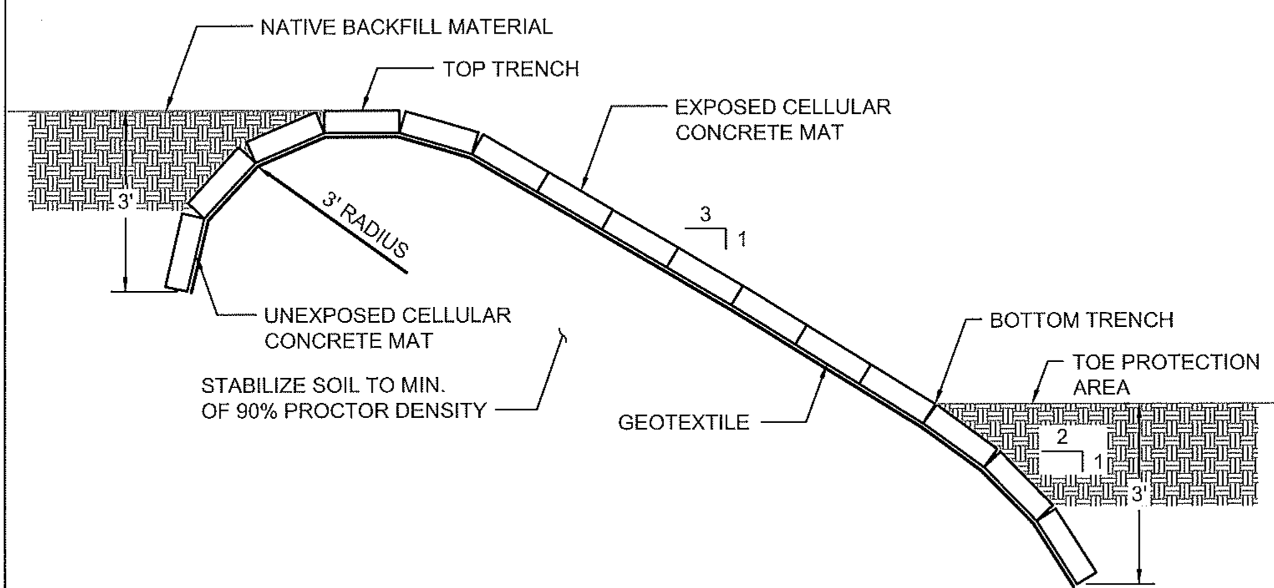
TRAPEZOIDAL CHANNEL DETAIL

CAD File Name:	TRAP-CHA
SCALE: N/A	SHEET 1 OF 1



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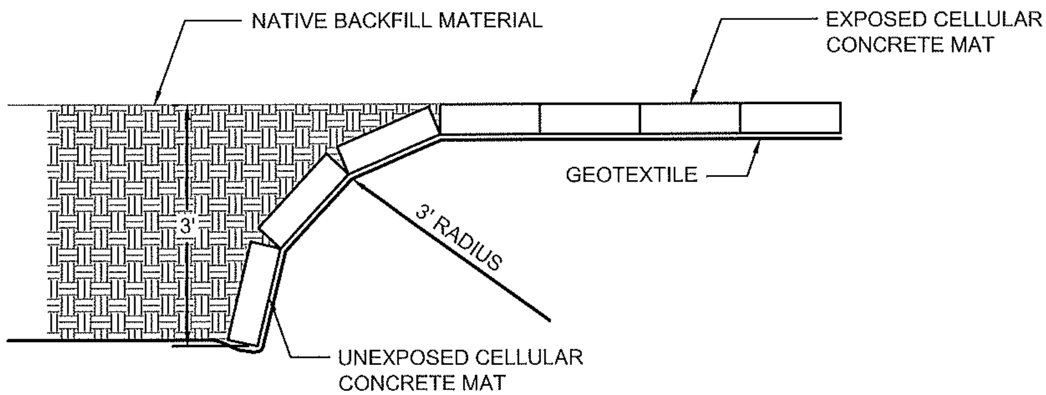
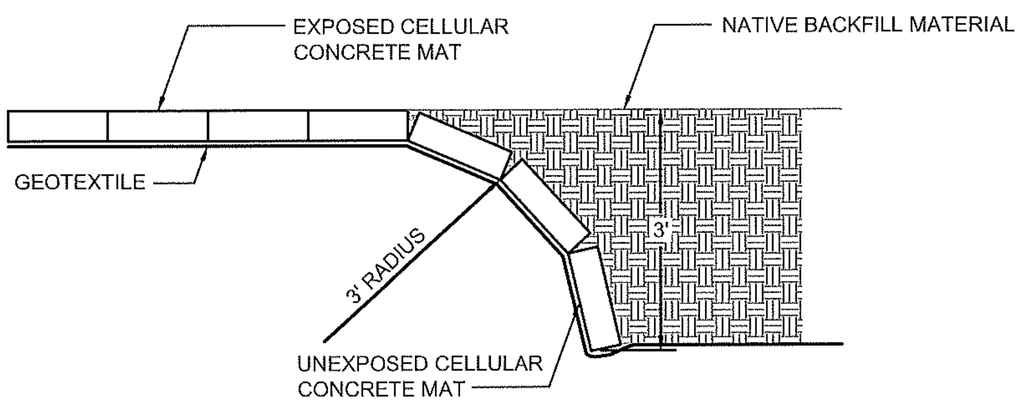
STANDARD SLOPE DETAIL

CAD File Name:	SLOPE 3 1
SCALE: N/A	SHEET 1 OF 1



UPSTREAM FLANK



DOWNSTREAM FLANK

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Flexible Revetment System

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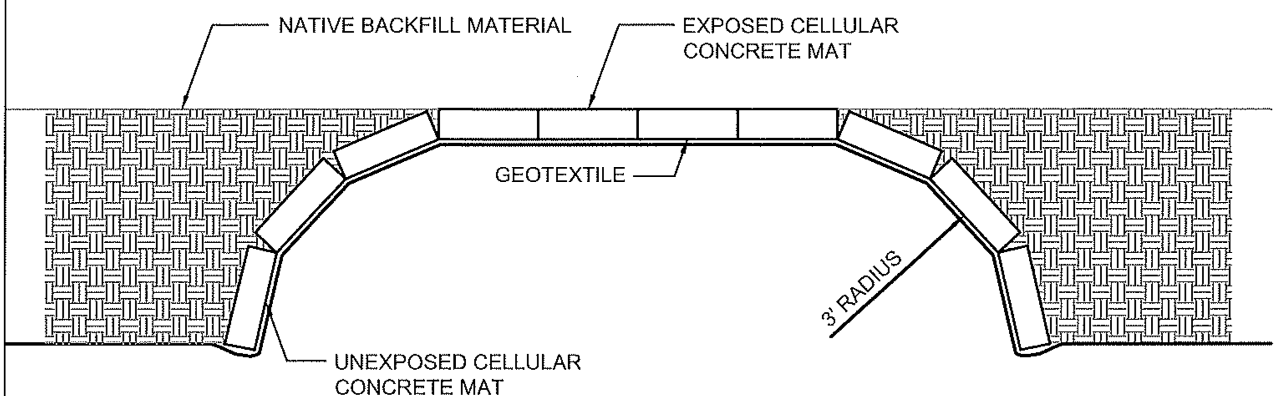
UPSTREAM AND DOWNSTREAM FLANK DETAILS

CAD File Name:	FLANKS
SCALE: N/A	SHEET 1 OF 1



Channel-Lock II
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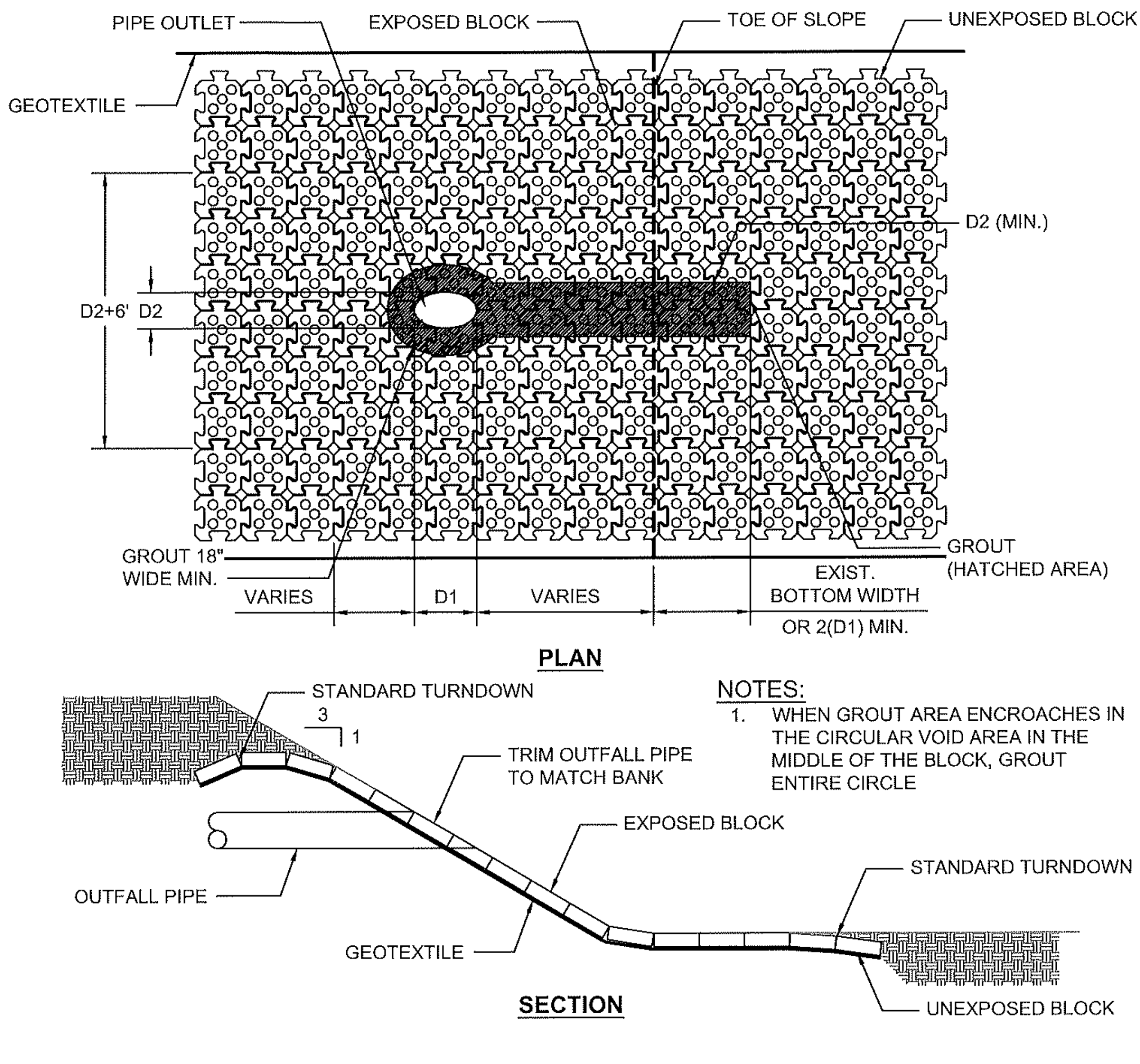
SIDE FLANK DETAILS

CAD File Name:	SIADE-FLK
SCALE: N/A	SHEET 1 OF 1



NOTES:

1. WHEN GROUT AREA ENCROACHES IN THE CIRCULAR VOID AREA IN THE MIDDLE OF THE BLOCK, GROUT ENTIRE CIRCLE

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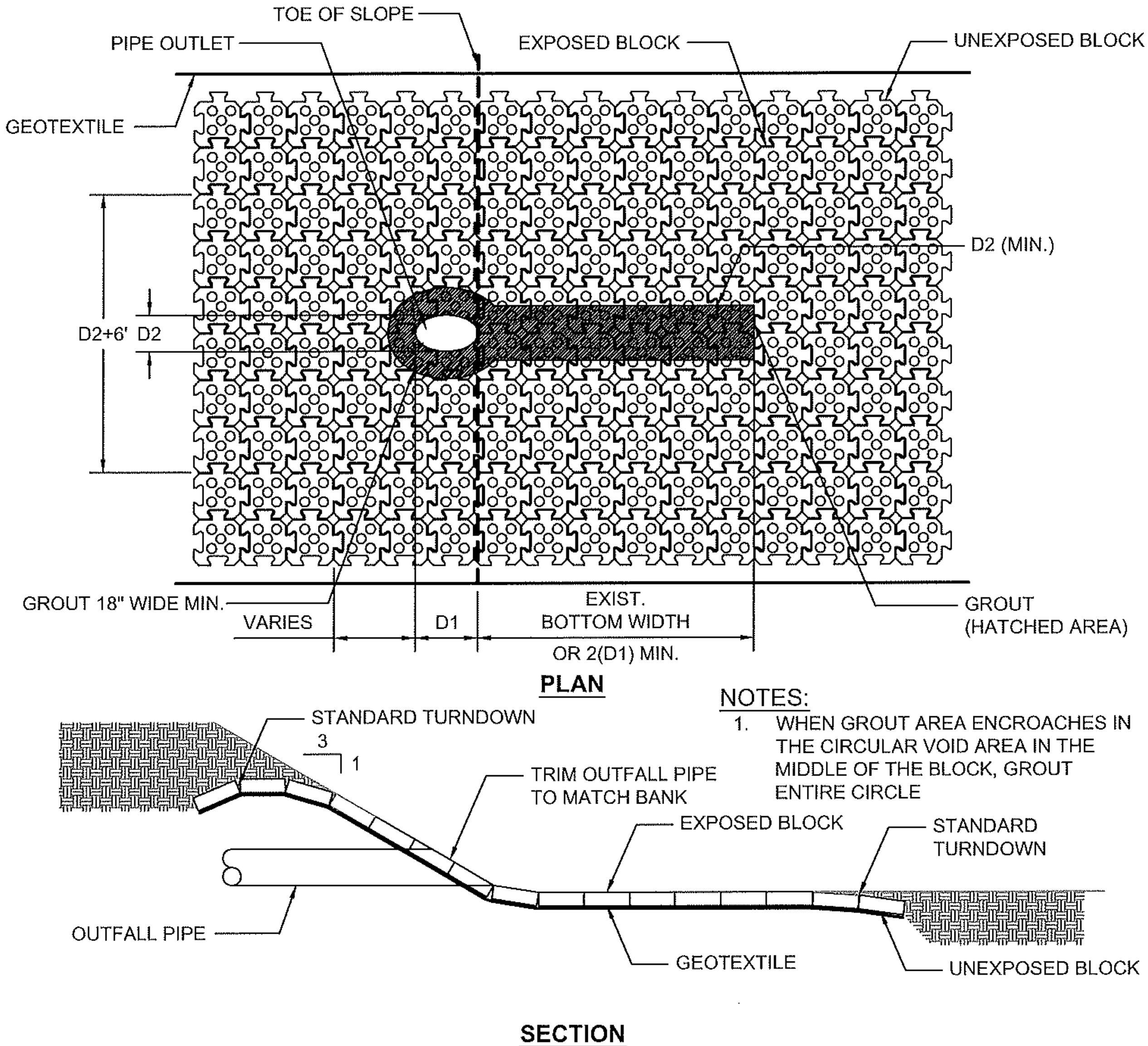
PIPE OUTLET DETAIL NO. 1

CAD File Name:	OUTFALL1
SCALE: N/A	SHEET 1 OF 1



NOTES:

1. WHEN GROUT AREA ENCROACHES IN THE CIRCULAR VOID AREA IN THE MIDDLE OF THE BLOCK, GROUT ENTIRE CIRCLE

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PIPE OUTLET DETAIL NO. 2

CAD File Name:	OUTFALL2
SCALE: N/A	SHEET 1 OF 1

SPECIFICATIONS
FOR

CHANNEL LOCK II®

CLASS 450
FLEXIBLE REVETMENT SYSTEM

**TABLE OF CONTENTS
FOR
EROSION CONTROL**

PART 1 - GENERAL

1.1 SCOPE OF WORK:

This item consists of furnishing and installing an interlocking flexible revetment system (cellular concrete blocks) in accordance with the lines, grades, design and dimensions shown on the plan and drawings and specified herein.

1.2 REFERENCES:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designations only.

American Society for Testing and Materials (ASTM) Publications.

ASTM C 33-97	Concrete Aggregates
ASTM C 140-91	Sampling and Testing Concrete Masonry Units
ASTM D-7277	Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow
ASTM D-7276	Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow.

US Federal Highway Administration (FHWA) and US Bureau of Reclamation (USBR)

FHWA RD-89-199	Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow

1.3 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

Materials delivered to the site shall be inspected for damage, unloaded and stored with the minimum of handling. Contractor may designate a storage site at the project for materials to be delivered and stored prior to placement if needed. Storage site to be approved by the Contracting Officer. Materials shall not be stored directly on the ground and shall be kept free of dirt and debris. Materials shall be so handled as to ensure delivery to the site in sound undamaged condition. Synthetic geotextiles that are not to be installed immediately shall be protected from the direct sunlight and in accordance with the applicable portions of the SECTION entitled GEOTEXTILES.

1.4 MEASUREMENT:

Unit of measurement for the cellular concrete blocks shall be by the square feet of surface area satisfactorily covered with the cellular concrete blocks.

1.5 PAYMENT:

Unit of payment for acceptable cellular concrete blocks placed will be made at the contract unit price per square foot for "cellular concrete blocks", which price shall include costs of furnishing, hauling and placing the cellular concrete blocks.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA:

The interlocking flexible revetment system shall be as described herein known as Channel Lock II, or an approved equal design by the engineer. Hydraulic test data and block performance according to FHWA-RD-89-199 will be required to be submitted for approval by the Contracting Officer. The 4.5" concrete blocks shall be a minimum of 38 lbs. PSF (per square foot), shall withstand water velocity of 26.1 FPS and have a critical shear stress value of 31.8 lbs. PSF (at 0 Horizontal). The ACB System shall have been tested on a 2H:1V slope, direction of flow, according to ASTM D-7277 and shall have the following minimum properties:.

Surface Void Ratio	20%
Drainage Correction Factor	22.0%
Critical Velocity – FPS	26.1 ft/sec
Critical Shear Stress – Lbs/Ft^2	31.8 Lbs.
Weight per Block, Minimum	60 Lbs
Curvature Radius	3 feet
Block Thickness:	4.50"

2.2 CELLULAR CONCRETE BLOCKS:

The cellular concrete blocks shall be octagonal shaped with interlocking components four directional within a 15" module. Each component shall resist horizontal movement when interlocked into adjacent blocks. (Interlock is hereby defined as the inability to pull apart or separate when one component is placed in conjunction with another component). The assembled blocks shall be the open-cell type to allow for re-vegetation.

2.21 Concrete Materials:

The compressive strength of the concrete shall be a minimum of 4000 PSI at 28 days. The core compressive strength shall not be less than the minimum and test cores shall be tested at the engineer's option. Test procedures shall be in accordance with ASTM C 140-91. Cores failing to meet the minimum compressive strength requirements shall be cause for rejection of the represented lot by the engineer.

2.22 Aggregate:

The aggregate shall meet the requirements of ASTM C 33-97, except for grading. Aggregate grading shall be reasonably consistent and shall be well-graded from the maximum size which can be conveniently handled with available equipment

2.3 FILTER FABRIC:

The filter fabric used for cellular concrete blocks shall be in accordance with the SECTION entitled GEOTEXTILES.

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION:

Areas on which filter fabric and cellular concrete blocks are to be placed shall be constructed to the lines and grades shown. The subgrade for the cellular concrete blocks shall be free of voids, pits and depressions. Voids, pits and depressions shall be brought to grade by backfilling in accordance with the applicable portions of the SECTION entitled STRIPPING, EXCAVATION, FILLING and BACKFILLING. Obstructions, such as roots and projecting stones larger than 1 inch remaining on the surface, shall be removed and the soft or low density pockets of material removed shall be filled with selected material and compacted to a minimum of 90% proctor density.

3.12 Perimeter:

Excavation and preparation for anchor trenches, side trenches, toe trenches and aprons shall be done in accordance to the lines, grades and dimensions shown on the plans.

2.41 Inspection:

Immediately prior to placing the filter fabric and cellular concrete blocks, the prepared area shall be inspected by the Contractor and approved before the fabric or blocks are placed thereon.

3.2 INSTALLATION OF CELLULAR CONCRETE BLOCKS:

3.21 Filter Fabric:

Placement of filter fabric shall be installed in accordance with the SECTION entitled GEOTEXTILES and as stated herein.

3.22 Placement of Cellular Concrete Blocks:

Cellular Concrete Blocks shall be installed in accordance with ASTM D-6884. Block installer must have a minimum of five (5) years experience installing ACB Systems and have installed at least 1Million square feet within the past five (5) years for the block system being submitted for approval. In addition Cellular concrete blocks shall be placed within the limits shown. The blocks shall be interlocked in a manner which discourages any vertical displacement or horizontal movement. The cellular concrete blocks shall be placed on the filter fabric in such a manner as to produce a level surface. No more than 200 linear feet of filter fabric shall be laid before covered with concrete blocks. Fabric installed more than two (2) days not covered by blocks shall be lifted and the surface of the slope inspected for slope defects. The Contracting Officer will require uncovered fabric to be lifted after heavy rainfall to inspect for slope damage. The manufacturer, Contractor and Client shall discuss subgrade preparation, geotextile and cellular block placement at the pre-construction meeting to ensure that all parties are aware of the issues regarding installation. The manufacturer of the cellular concrete blocks shall be present during the first week of block placement to assist the Contractor. The Contractor shall furnish a certificate from the manufacturer or an authorized representative thereof stating that the blocks were installed correctly. Final acceptance and approval of the installation will be made by the Contracting Officer.

3.23 Quality Control:

Equipment shall not be allowed on the installed concrete blocks until topsoil is placed over the revetment system to refrain from breaking or damaging any blocks.

3.3 FINISHING:

3.41 The voids of the cellular concrete blocks for the limits shown shall be filled with topsoil, seed and fertilizer in accordance with the SECTION entitled TURF. At no time shall more than 200 lineal feet of blocks be exposed unturfed. Prior to turf placement, the blocks surface shall be inspected for damage. Individual blocks which are cracked and reduce the individual block weight to 1/3 shall be replaced prior to the placement of turf.

3.4 CONTRACTOR QUALITY CONTROL:

The Contractor shall inspect for compliance with contract requirements and record the inspection of operations including but not limited to the following as applicable:

(1) Preparation of surface to receive cellular concrete blocks or mattresses
(2) Individual concrete blocks and filter fabric soundness and free of defects
(3) Assembly of cellular concrete blocks and filter fabric on the prepared subgrade

SPECIFICATIONS
FOR

CHANNEL LOCK II™
FLEXIBLE REVETMENT SYSTEM

WITH
POLYESTER REVETMENT CABLES

**TABLE OF CONTENTS
FOR
EROSION CONTROL**

PART 1 - GENERAL

1.1 SCOPE OF WORK:

This item consists of furnishing and installing an interlocking flexible revetment system (cellular concrete blocks) in accordance with the lines, grades, design and dimensions shown on the plan and drawings and specified herein.

1.2 REFERENCES:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designations only.

American Society for Testing and Materials (ASTM) Publications.

ASTM C 33-97	Concrete Aggregates
ASTM C 140-91	Sampling and Testing Concrete Masonry Units
ASTM D 4268-93	Testing Fiber ropes

US Federal Highway Administration (FHWA) and US Bureau of Reclamation (USBR)

FHWA RD-89-199	Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow.

1.3 DELIVERY, STORAGE AND HANDLING OF MATERIALS:

Materials delivered to the site shall be inspected for damage, unloaded and stored with the minimum of handling. Contractor may designate a storage site at the project for materials to be delivered and stored prior to placement if needed. Storage site to be approved by the Contracting Officer, if necessary. Materials shall not be stored directly on the ground and shall be kept free of dirt and debris. Materials shall be so handled as to ensure delivery to the site in sound undamaged condition. Synthetic geotextiles that are not to be installed immediately shall be protected from the direct sunlight and in accordance with the applicable portions of the SECTION entitled GEOTEXTILES.

1.4 MEASUREMENT:

Unit of measurement for the cellular concrete blocks shall be by the square foot of surface area satisfactorily covered with the cellular concrete blocks.

1.5 PAYMENT:

Unit of payment for acceptable cellular concrete blocks placed will be made at the contract unit price per square foot for "cellular concrete blocks", which price shall include costs of furnishing, hauling and placing the cellular concrete blocks with cables.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA:

The interlocking flexible revetment system shall be as described herein known as Channel Lock II or an approved equal. Hydraulic test data and block performance according to FHWA-RD-89-199 will be required to be submitted for approval by the Contracting Officer. The concrete blocks shall be a minimum of 4.50" Thick, have a Net Weight/Area of 36 lbs. PSF for the open cell blocks and shall withstand water flow velocities of 26.1 FPS and critical shear stress (at horizontal) of 31.8 lbs. PSF on a 1V:2H slope in direction of flow.

2.2 CELLULAR CONCRETE BLOCKS:

The cellular concrete blocks shall be octagonal shaped with interlocking components four directional within a 15" module. Each component shall resist horizontal movement when interlocked into adjacent blocks. (Interlock is hereby defined as the inability to pull apart or separate when one component is placed in conjunction with another component). The assembled blocks shall be the open-cell type and have a void space of approximately 24% to allow for re-vegetation. Maximum water absorption shall be 7%.

2.21 Concrete Materials:

The compressive strength of the concrete shall be a minimum of 4000 PSI at 28 days. The core compressive strength shall not be less than the minimum and test cores shall be tested at the engineer's option. Test procedures shall be in accordance with ASTM C 140-91. Cores failing to meet the minimum compressive strength requirements shall be cause for rejection of the represented lot by the engineer.

2.22 Aggregate:

The aggregate shall meet the requirements of ASTM C 33-97, except for grading. Aggregate grading shall be reasonably consistent and shall be well-graded from the maximum size which can be conveniently handled with available equipment

2.3 CELLULAR CONCRETE BLOCKS WITH CABLES:

The cellular concrete blocks shall have cables and shall be installed as an assembly of concrete blocks connected by the use of revetment cables. The cables will extend through 2 or more tunnels within the blocks to bind the mattresses in both the longitudinal and lateral directions. Cable shall conform to ASTM D 4268-93.

2.4 CABLE REQUIREMENTS:

Cable shall be constructed of high tenacity, low elongation and continuous filament polyester fibers. Cables shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65 to 70 percent of the total weight of the cable. The revetment cable shall have the following minimum physical properties:

Nominal Cable Diameter:	20 mm
Approximate Strength Lbs.	3,700
Weight	Yield – 41.3 ft/lb.

2.41 The revetment cable shall exhibit good to excellent resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction shall not be affected by continuous immersion in fresh or salt water.

2.42 Selection of cable and fittings shall ensure a safe design factor for mattresses being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the result splice shall provide a minimum of 75 percent of the minimum rated cable strength. Fittings such as sleeves, stops and washers shall be in accordance with manufacturer's recommendations unless otherwise shown.

2.43 Elongation Requirements:

Requirements listed below are based upon stabilized new and dry cable. The tolerance of these values is plus or minus 5 percent.

	% Breaking Strength		
	10%	20%	30%
Permanent Elongation (While Working)	0.7	1.8	2.6
Elastic Elongation	0.6	1.4	2.2
Total Stretch	1.3	3.2	4.8

2.5 FILTER FABRIC:

The filter fabric used for cellular concrete blocks shall be in accordance with the SECTION entitled GEOTEXTILES.

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION:

Areas on which filter fabric and cellular concrete blocks are to be placed shall be constructed to the lines and grades shown. The subgrade for the cellular concrete blocks shall be free of voids, pits and depressions. Voids, pits and depressions shall be brought to grade by backfilling in accordance with the applicable portions of the SECTION entitled STRIPPING, EXCAVATION, FILLING AND BACKFILLING. Obstructions, such as roots and projecting stones larger than 1 inch remaining on the surface, shall be removed and the soft or low density pockets of material removed shall be filled with selected material and compacted to a minimum of 90% proctor density.

3.12 Perimeter:

Excavation and preparation for anchor trenches, side trenches, toe trenches and aprons shall be done in accordance to the lines, grades and dimensions shown on the plans.

3.13 Inspection:

Immediately prior to placing the filter fabric and cellular concrete blocks, the prepared area shall be inspected by the Contractor and approved before the fabric or blocks are placed thereon.

3.2 INSTALLATION OF CELLULAR CONCRETE MATTRESSES:

3.21 Filter Fabric:

Placement of filter fabric shall be installed in accordance with the SECTION entitled GEOTEXTILES USED AS FILTERS and as stated herein.

3.22 Placement of Cellular Concrete Mats:

Cellular concrete mats shall be placed within the limits shown. The blocks shall be interlocked in a manner which discourages any vertical displacement or horizontal movement. The cellular concrete mats shall be placed on the filter fabric in such a manner as to produce a level surface. Individual blocks which are hand installed and hand threaded cables shall be installed according to manufacturer's recommendations. No more than 200 linear feet of filter fabric shall be laid before covered with concrete blocks. Fabric installed more than two (2) days not covered by blocks shall be lifted and the surface of the slope inspected for slope defects. The Contracting Officer will require uncovered fabric to be lifted after heavy rainfall to inspect for slope damage. The manufacturer, Contractor and Client shall discuss subgrade preparation, geotextile and cellular block placement at the pre-construction meeting to ensure that all parties are aware of the issues regarding installation. The manufacturer of the cellular concrete mats shall be present during the first week of block placement to assist the Contractor. The Contractor shall furnish a certificate from the manufacturer or an authorized representative thereof stating that the blocks were installed correctly. Final acceptance and approval of the installation will be made by the Contracting officer.

3.23 Quality Control:

Equipment shall be minimized on the installed concrete blocks until backfill or topsoil is placed over the revetment system to refrain from breaking or damaging any blocks. Any blocks broken or damaged shall be repaired prior to final inspections.

3.24 Grouting:

Any areas where there are partial blocks (to avoid small blocks with reduced hydraulic stability) shall be grouted. Joints where block interlock is discontinuous shall be grouted. Field placed grout shall be non-shrink and have a compressive strength of 4,000 psi, the durability properties of the ACBM concrete, and shall meet the ACBM manufacturer's requirements. All cable ties and anchoring shall be completed prior to placing the grout.

3.3 FINISHING:

3.41 The voids of the cellular concrete blocks for the limits shown shall be filled with gravel or topsoil per the specifications. At no time shall more than 500 lineal feet of blocks be exposed not backfilled. Prior to backfill, the blocks surface shall be inspected for damage. Individual blocks which are cracked and reduce the individual block weight to 1/3 shall be replaced prior to the placement of backfill.

3.4 CONTRACTOR QUALITY CONTROL:

The Contractor shall inspect for compliance with contract requirements and record the inspection of operations including but not limited to the following as applicable:

(1) Preparation of surface to receive cellular concrete blocks or mattresses
(2) Individual concrete blocks and filter fabric soundness and free of defects
(3) Cables and fittings - breaking strength
(4) Assembly of cellular concrete blocks bound by cables to form cellular concrete mattresses
(5) Placement of blocks or mattresses and filter fabric on the prepared subgrade

TENCATE

Mirafi

Drainage Separation

Mirafi® 180N

Mirafi® 180N is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that the fibers retain their relative position. Mirafi® 180N geotextile is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D 4632	N (lbs)	912 (205)	912 (205)
Grab Tensile Elongation	ASTM D 4632	%	50	50
Trapezoid Tear Strength	ASTM D 4533	N (lbs)	356 (80)	356 (80)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2411 (350)	
Puncture Strength[1]	ASTM D 4833	N (lbs)	490 (110)	
CBR Puncture Strength	ASTM D 6241	N (lbs)	2225 (500)	
Apparent Opening Size (AOS)[2]	ASTM D 4751	mm (U.S. Sieve)	0.18 (80)	
Permittivity	ASTM D 4491	sec^{-1}	1.1	
Flow Rate	ASTM D 4491	$l/min/m^2$ ($gal/min/ft^2$)	3870 (95)	
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70	

[1] ASTM D 4833 has been replaced with ASTM D 6241
[2] ASTM D 4751: AOS is a Maximum Opening Diameter Value

Physical Properties	Test Method	Unit	Typical Value	
Weight	ASTM D 5261	g/m^2 (oz/yd^2)	271 (8.0)	
Thickness	ASTM D 5199	mm (mils)	1.8 (72)	
Roll Dimensions (width x length)	--	m (ft)	3.8 x 110 (12.5 x 360)	4.5 x 91 (15 x 300)
Roll Area	--	m^2 (yd^2)	418 (500)	
Estimated Roll Weight	--	kg (lb)	120 (265)	

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TENCATE
materials that make a difference

FGS000351
ETQR26

APPENDIX 6B.14.1

CHUTE DETAILS

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JOSE C. GARZA
91790
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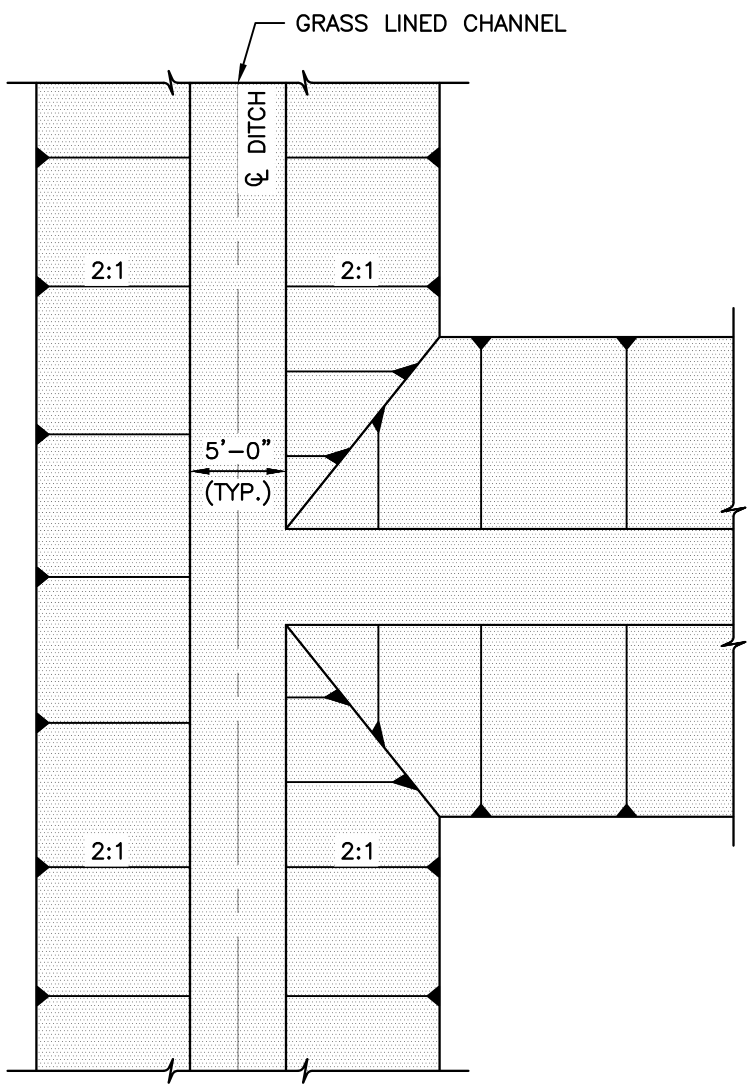
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.



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DETAIL – DRAINAGE CHUTE/OUTLET
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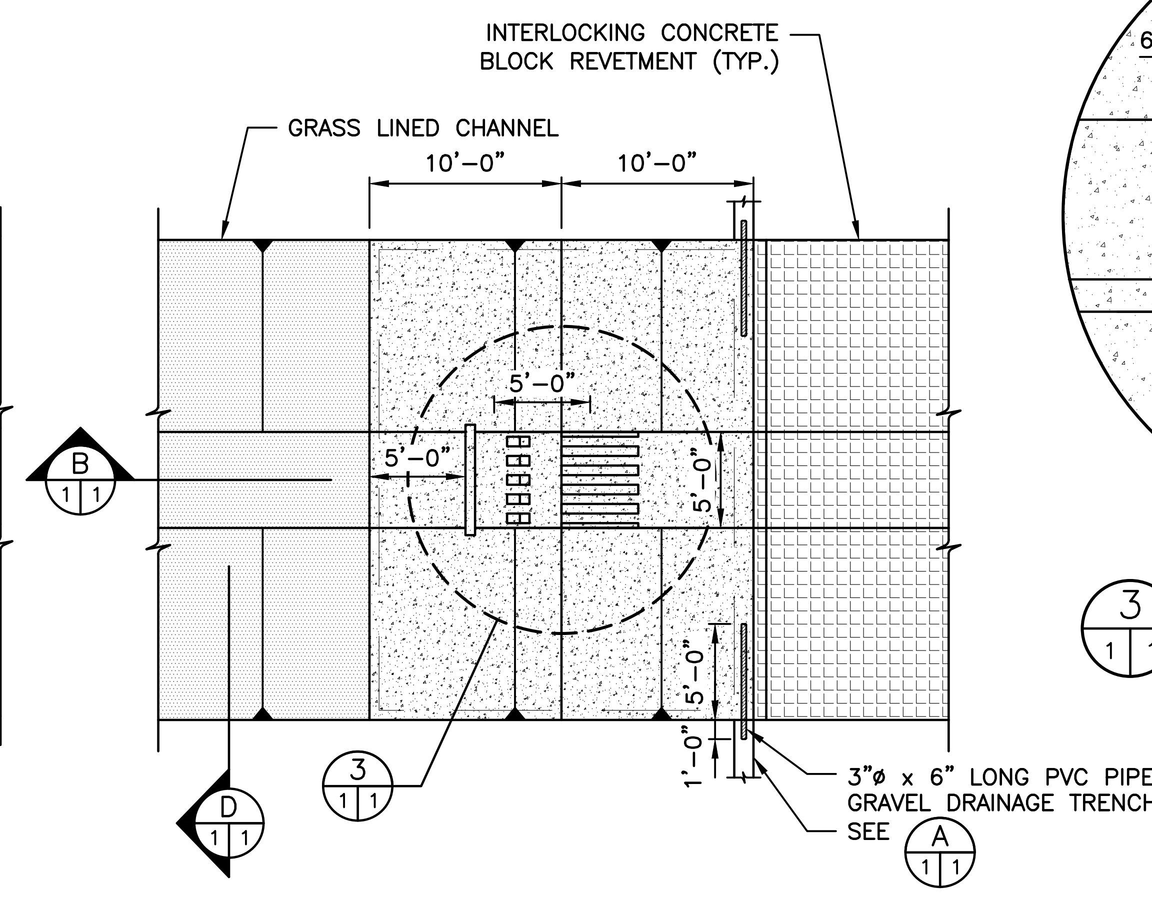

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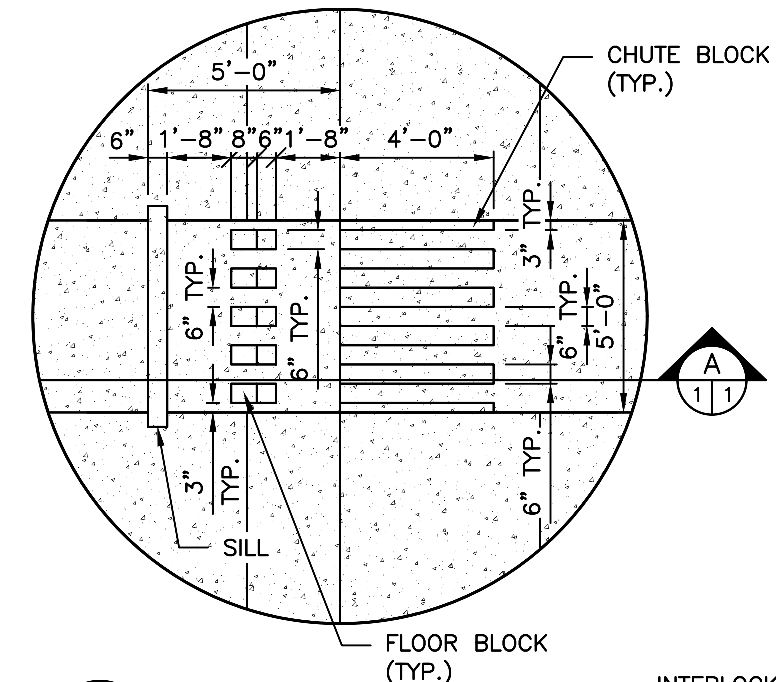

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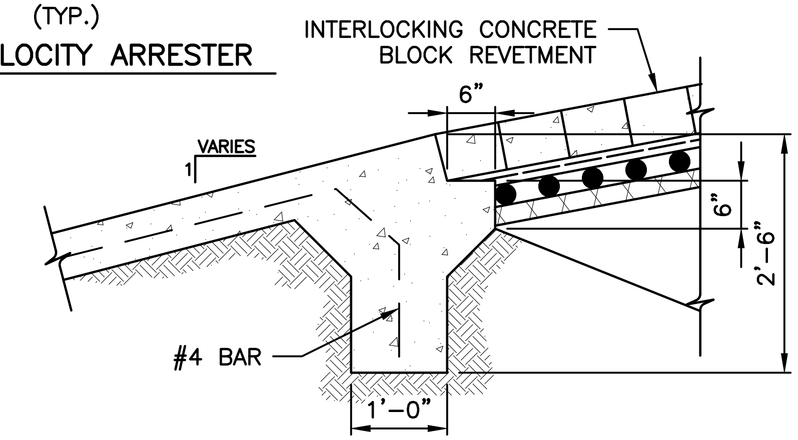

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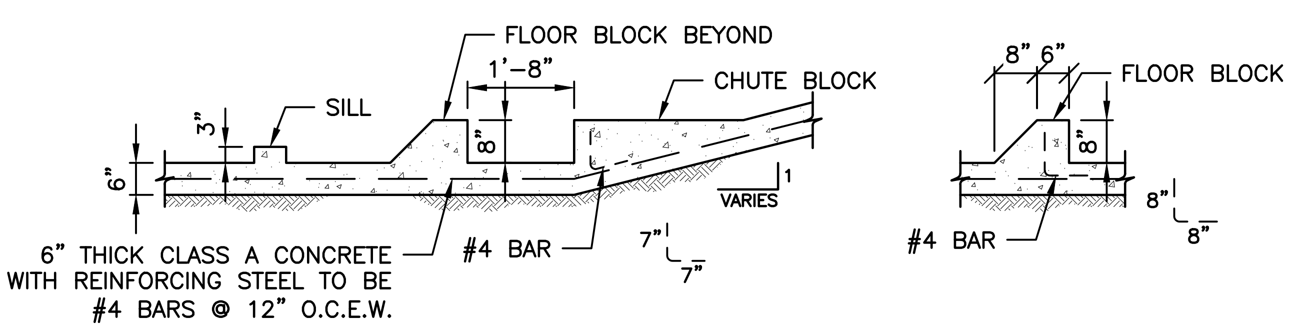

A | 1 | 1
SECTION – VELOCITY ARRESTER
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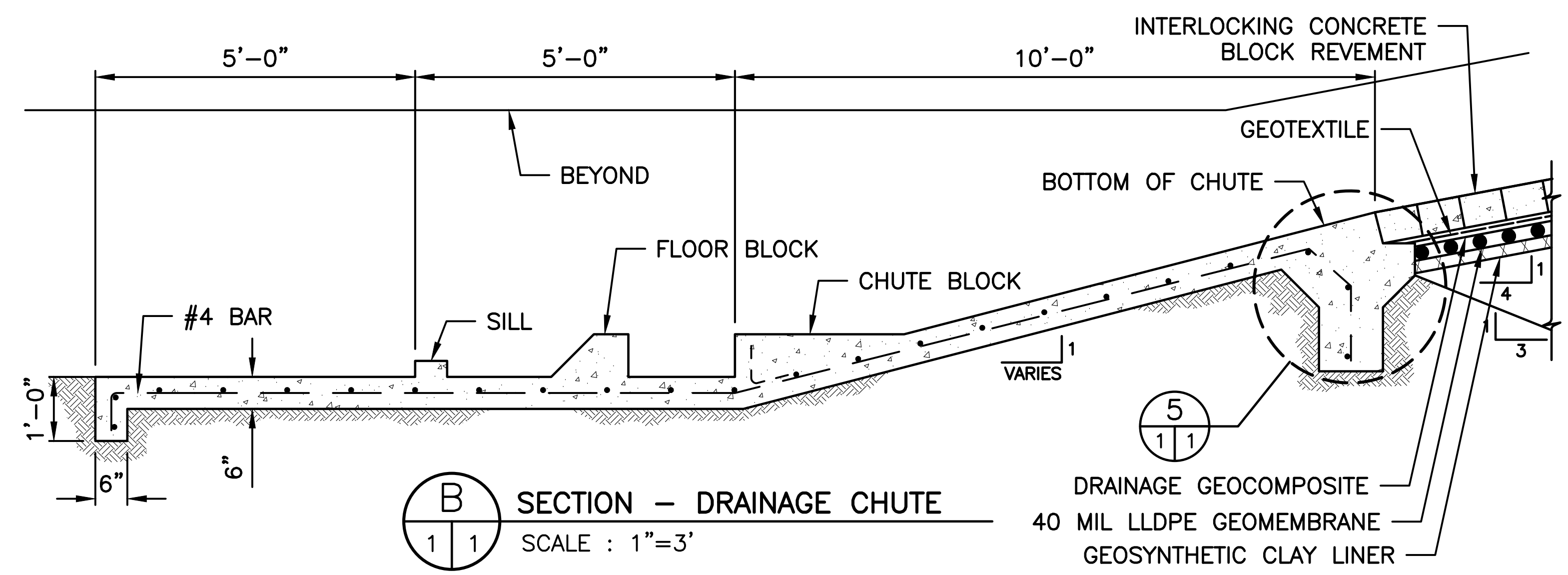

B | 1 | 1
SECTION – DRAINAGE CHUTE
SCALE : 1"=3'

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NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

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Hanson No.	16L0438
Filename	8514-03-PERMIT DETAILS
Scale	AS SHOWN
Date	09/12/2018

LAYOUT	DT	09/12/2018
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REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 6, APPENDIX 6B.14.1
CHUTE DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.14.1

APPENDIX 6B.14.2

CHUTE DETAILS

STATE OF TEXAS
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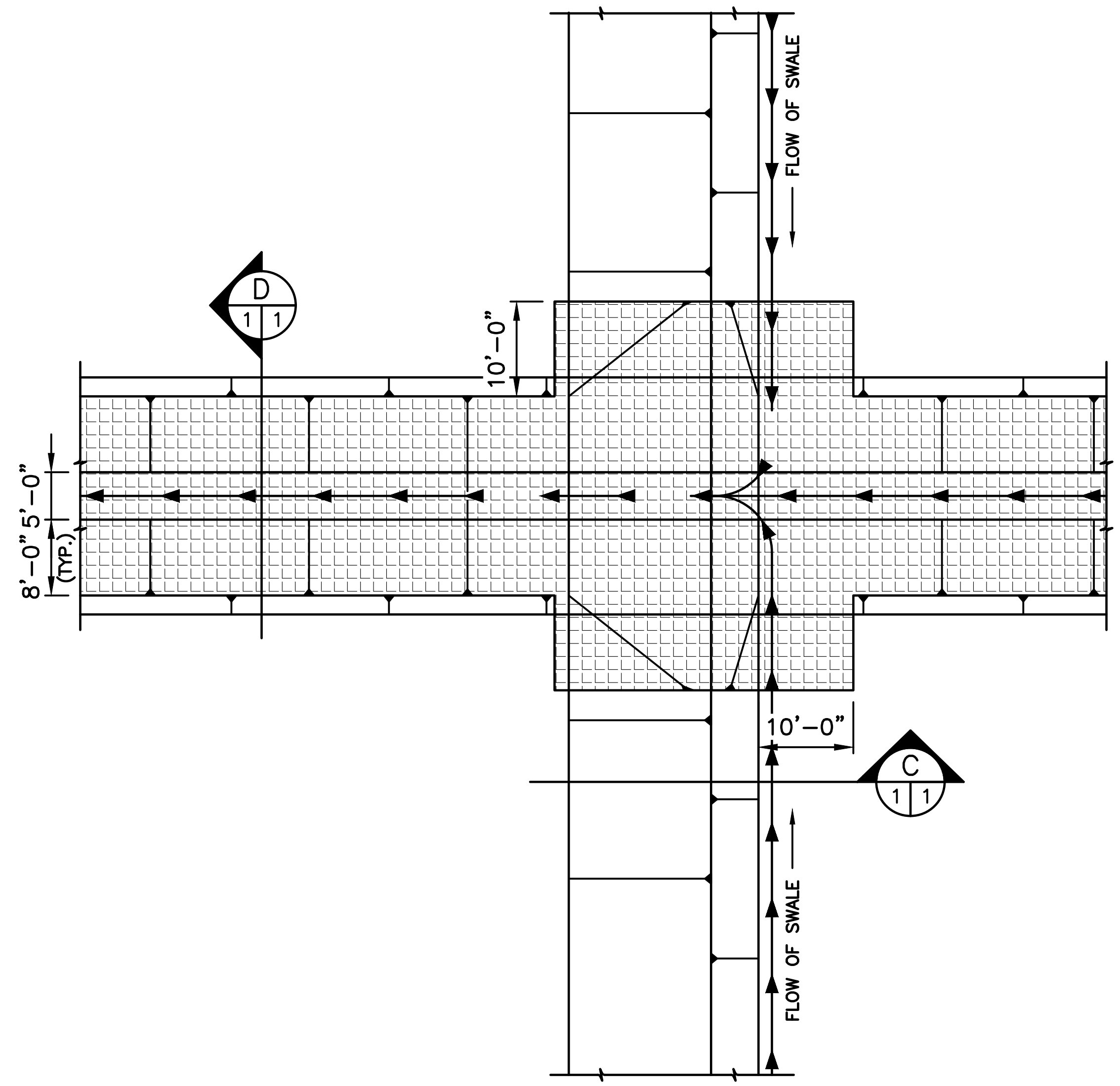

6 1 1 DETAIL – MID SIDE SLOPE DRAINAGE CHUTE CONFLUENCE
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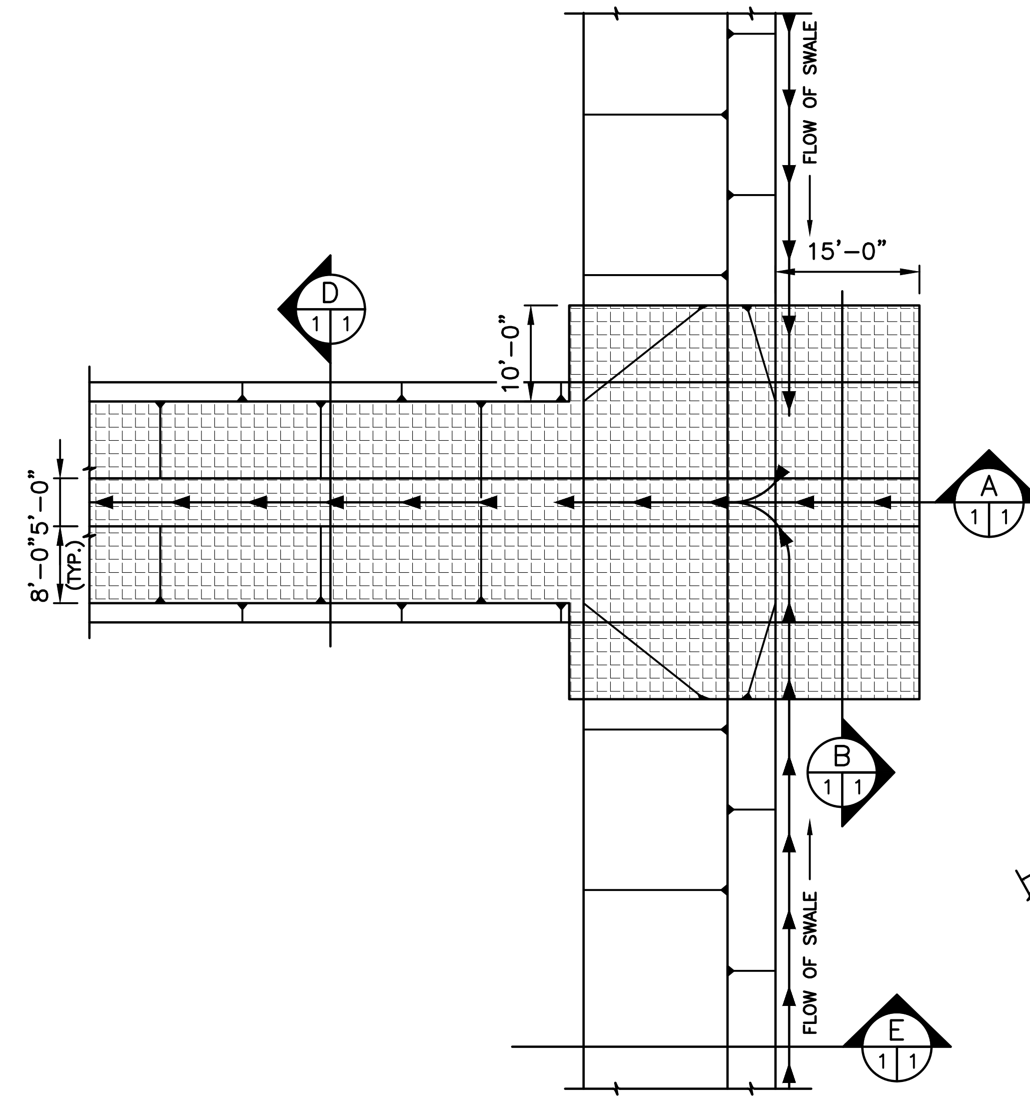

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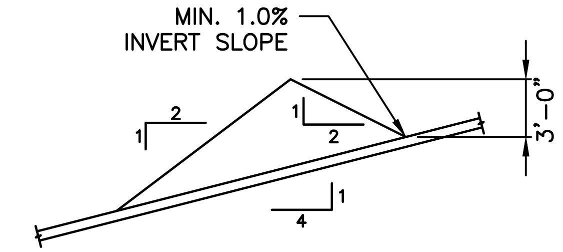
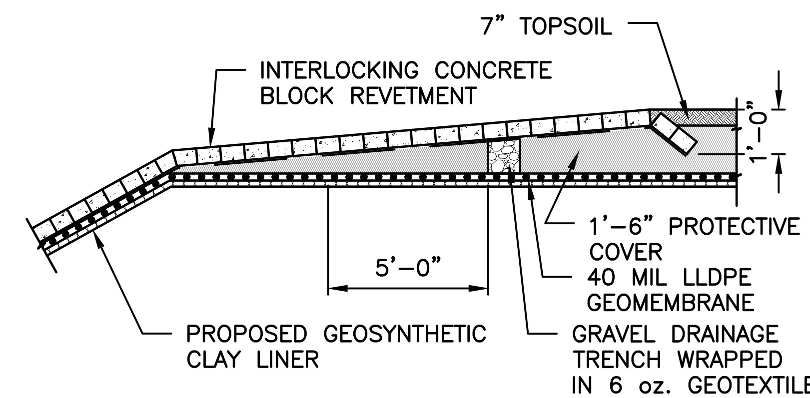
SCALE : 1"=20'



NOTE: CONSRTUCT BERM WITH SOIL FROM BORROW AREA. PLACE IN 8" LOOSE LIFTS AND COMPACT TO 90% MODIFIED PROCTOR DENSITY.

C 1 1 SECTION – SIDE SLOPE BERM ON 4:1 SLOPE AREA
SCALE : 1"=10'



A 1 1 SECTION – DRAINAGE CHUTE
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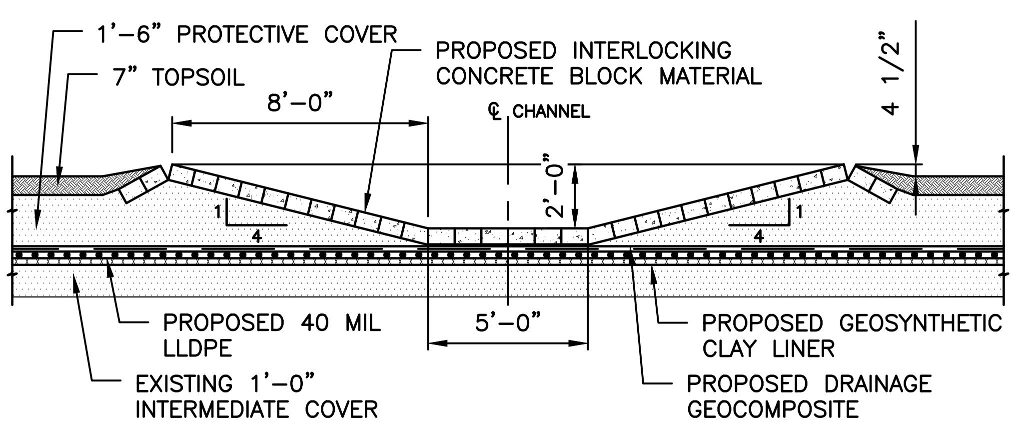
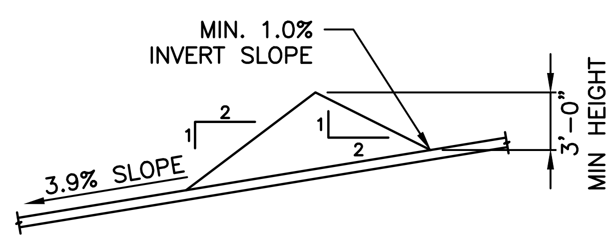


D 1 1 SECTION – DRAINAGE CHUTE STRUCTURE
SCALE : 1"=6'



NOTE: CONSRTUCT BERM WITH SOIL FROM BORROW AREA. PLACE IN 8" LOOSE LIFTS AND COMPACT TO 90% MODIFIED PROCTOR DENSITY.

E 1 1 SECTION – SIDE SLOPE BERM ON 3.9% SLOPE AREA
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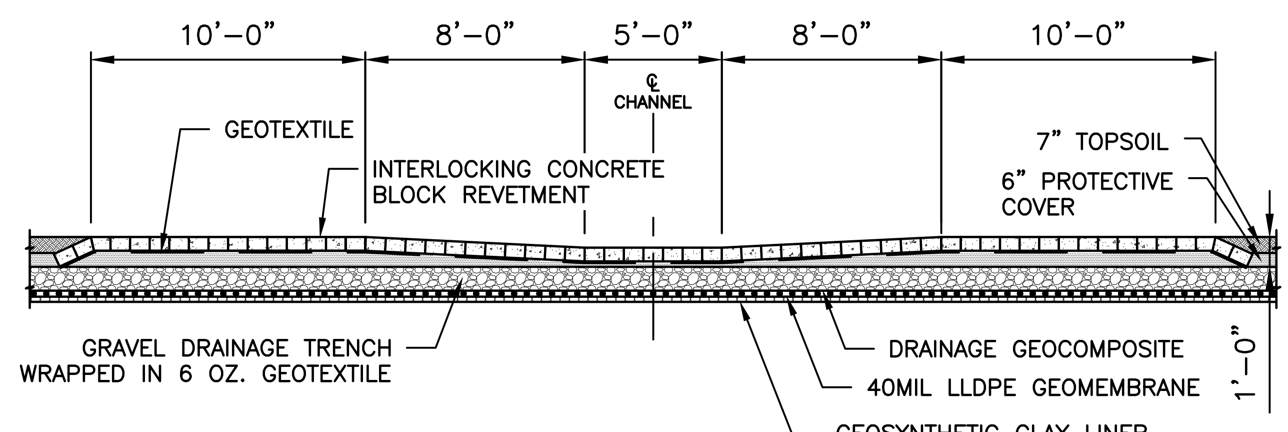

B 1 1 SECTION – DRAINAGE CHUTE
SCALE : N.T.S.

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Filename 8514-03-PERMIT DETAILS
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PART III, ATTACHMENT 6, APPENDIX 6B.14.2
CHUTE DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.14.2

APPENDIX 6B.15

HYDROCAD MODEL POST DEVELOPMENT DIVERSION BERMS (SWALES) NRCS & RATIONAL METHODS

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APPENDIX 6B.15.1

POST DEVELOPMENT TYPICAL DIVERSION BERM DRAINAGE PLAN

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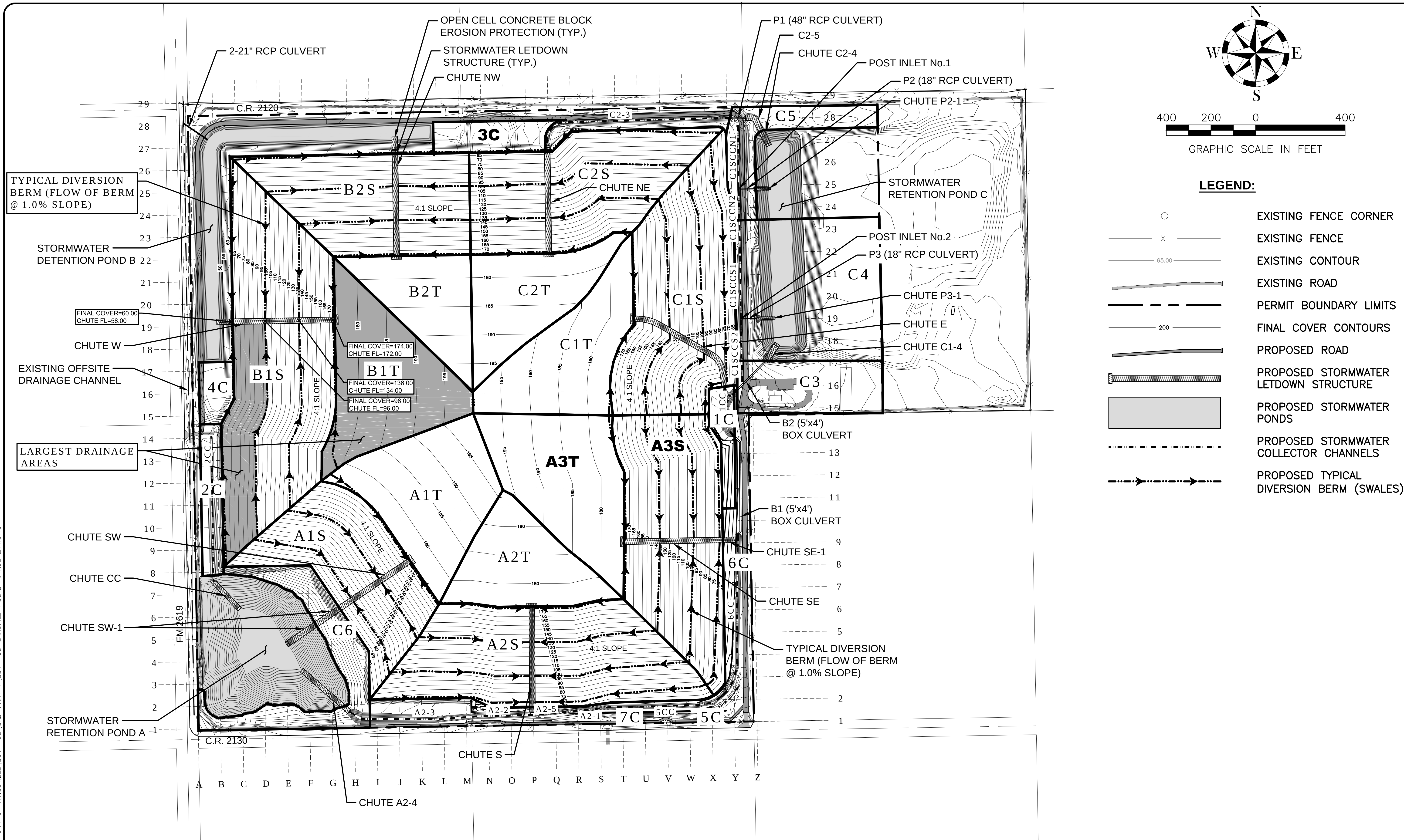

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PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
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Date 09/12/2018

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DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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Offices Nationwide

PART III, ATTACHMENT 6, APPENDIX 6B.15.1
POST DEVELOPMENT TYPICAL DIVERSION BERM DRAINAGE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.15.1

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I:\16JOBS\16L0438\8514-CITY OF KINGSVILLE\8514-03\CAD-PART-II\8514-03-LANDFILL-POSTDRAINAGEPLAN.DWG

APPENDIX 6B.15.2

NATIONAL ENGINEERING HANDBOOK (NEH) FIGURE 15-4 VELOCITY VERSUS SLOPE FOR SHALLOW CONCENTRATED FLOW [ANNOTATED]

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09/12/18
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Figure 15–4 Velocity versus slope for shallow concentrated flow

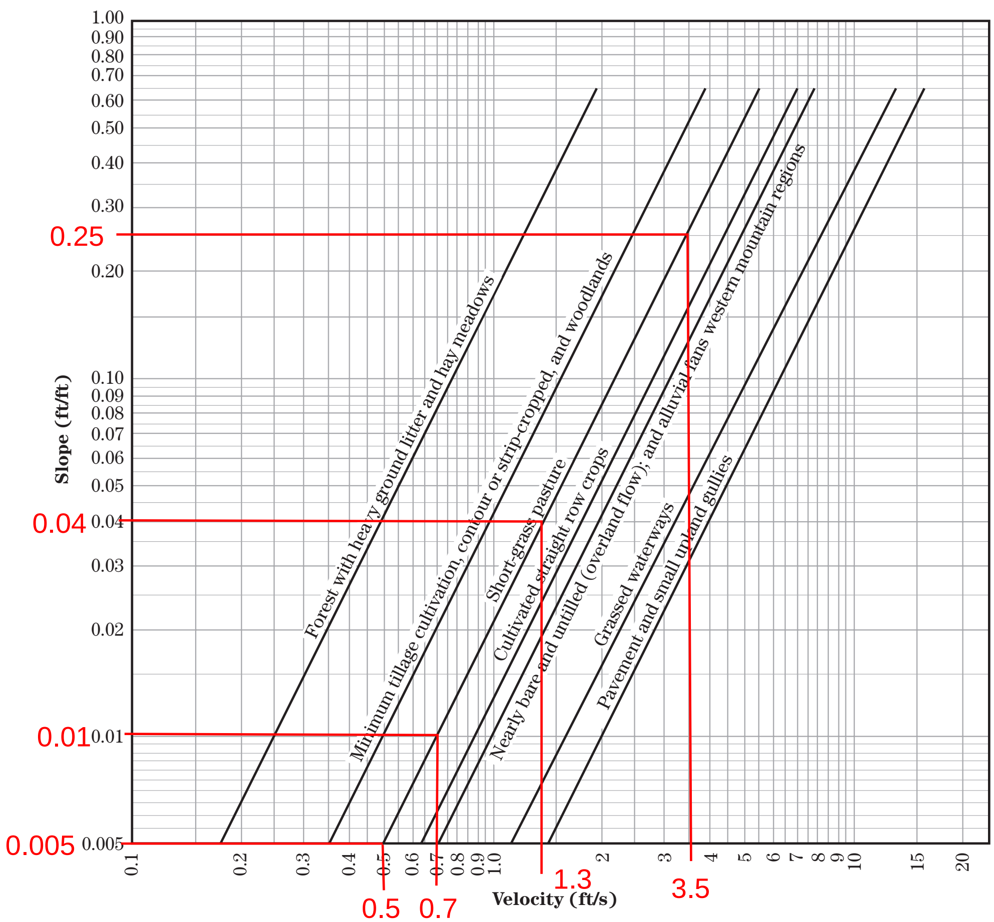

Table 15–3 Equations and assumptions developed from figure 15–4

Flow type	Depth (ft)	Manning's *n*	Velocity equation (ft/s)
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V = 16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V = 9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V = 8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V = 6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V = 5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V = 2.516(s)^{0.5}$

APPENDIX 6B.15.3

HYDROCAD-SWALES INPUT DATA (SWALE B1S-0.5% SLOPE)

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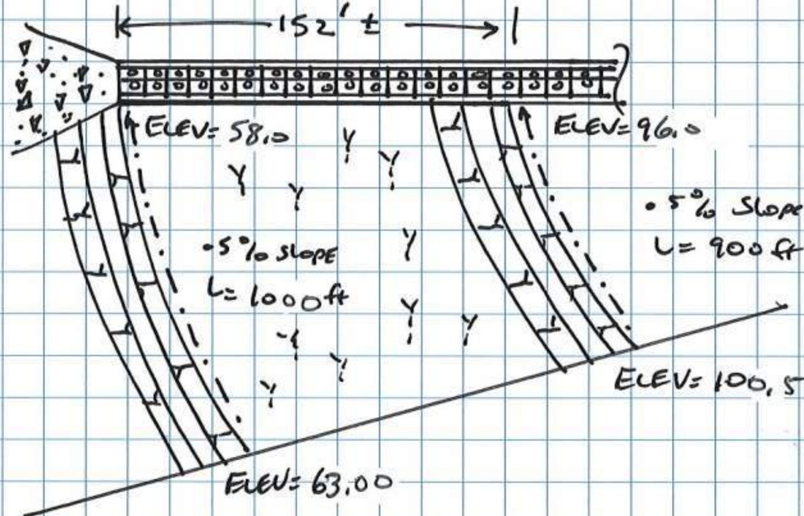
HANSON		
	JOB NO. 8514-03 City of Kingsville Landfill	SHEET NO.
	DESCRIPTION Permit Amendment - Post Development - Swales	DATE 8/29/18
	HydroCAD - Swales Input DATA	BY JCG

Swale B15

.5% slope



- Short Grass
- (.5%) Slope for swale
- L= 1000 ft
- V= .5 ft/sec (For (.005) ft/ft → graph / Figure ⇒ 0.5 ft/sec Velocity; Short grass)
  For (.25 ft/ft) → graph → 3.5 ft/sec
- Area = $(1000\text{ft})(152\text{ ft})\left(\frac{1\text{ Ac}}{43560\text{ ft}^2}\right) \Rightarrow 3.5\text{ Ac} \pm$
- $S = \frac{5.0\text{ ft}}{1000\text{ ft}} \Rightarrow .005\text{ ft/ft}, .5\%$
- $t_c = \frac{1000\text{ ft}}{.5\text{ ft/sec}} + \frac{152\text{ ft}}{3.5\text{ ft/sec}} \Rightarrow \frac{2000\text{ sec} + 43.43\text{ sec}}{60\text{ sec/min}} \Rightarrow 34.05\text{ min}$

APPENDIX 6B.15.4

HYDROCAD-SWALES INPUT DATA (SWALE B1S-1.0% SLOPE)

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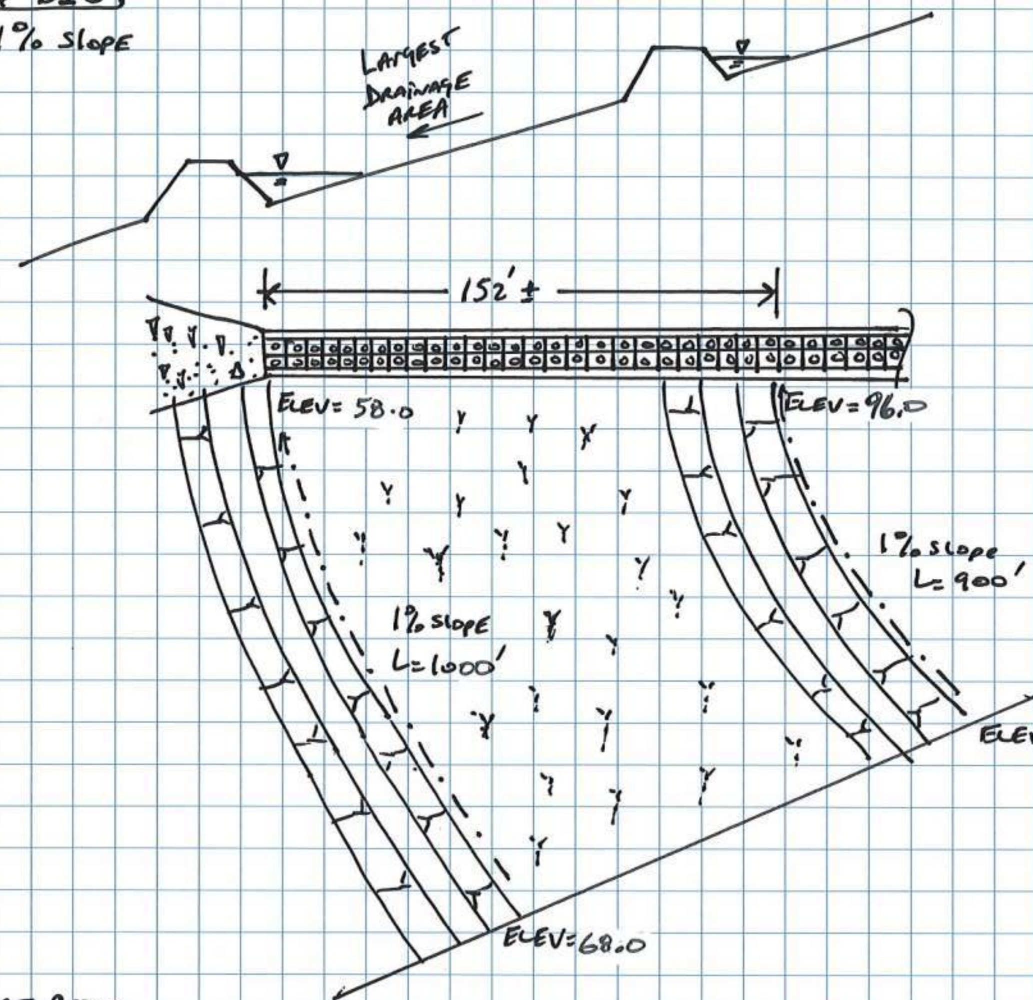
JOB NO. 8514-03 City of Kingsville Landfill	SHEET NO.
DESCRIPTION Permit Amendment - Post Development - Swales	DATE 8/29/18
HydroCAD - Swales Input Data	BY JCG

Swale B1S

1% slope



- SHORT GRASS
- (1%) slope for swale
- L= 1000 ft
- V= 0.7 ft/sec (For (.01) ft/ft → graph / Figure ⇒ 0.7 ft/sec velocity ; short grass)
- AREA = (1000 ft)(152 ft)($\frac{1\ Ac}{43560\ ft^2}$) ⇒ 3.5 Ac ± For (.25 ft/ft) → graph → 3.5 ft/sec
- $S = \frac{10\ ft}{1000\ ft}$ ⇒ .01 ft/ft, 1%

- $t_c = \dfrac{\frac{1000\ ft}{.7\ ft/sec} + \frac{152\ ft}{3.5\ ft/sec}}{60\ sec/min} \Rightarrow \dfrac{1428.6\ sec + 43.43\ sec}{60\ sec/min} \Rightarrow 24.53\ min$

APPENDIX 6B.15.5

HYDROCAD-SWALES INPUT DATA (SWALE B1T-0.5 % & 1.0% SLOPE)

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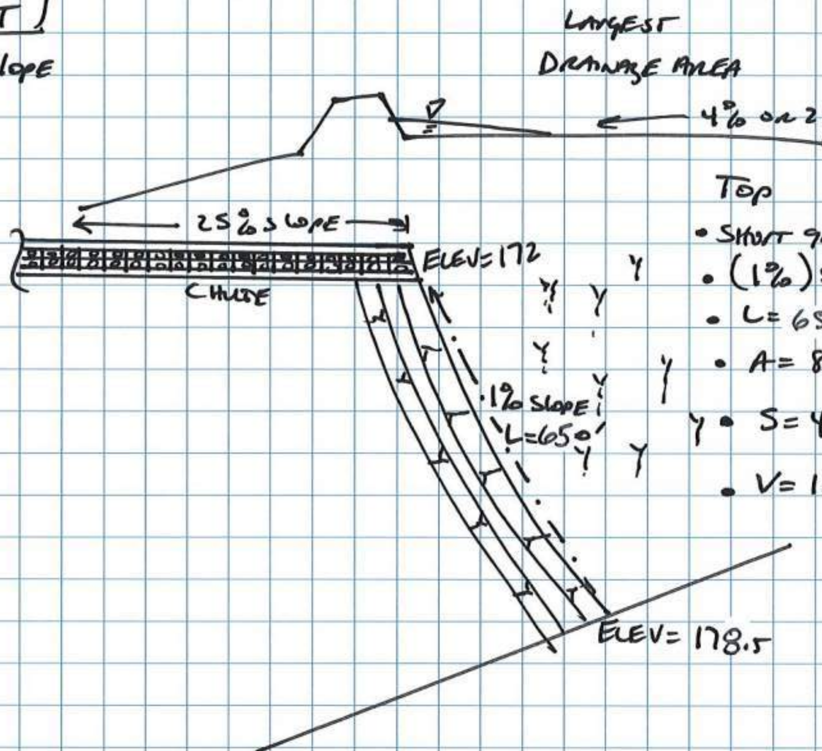
HANSON Engineering | Planning | Allied Services		
JOB NO. 8514-03 City of Kingsville Landfill		SHEET NO.
DESCRIPTION Permit Amendment – Post Development – Swales		DATE 8/29/18
Hydrocad – Swales Input Data		BY JCG

Swale BIT

1% slope

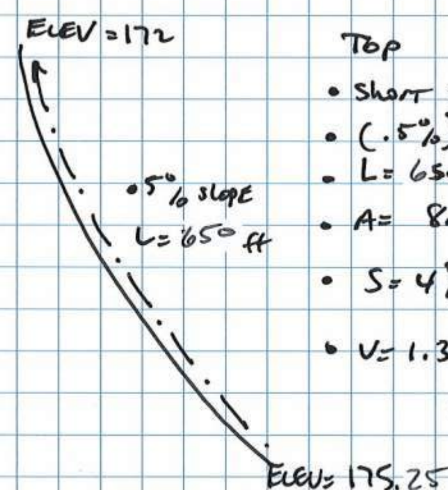


Top

- Short grass
- (1%) Slope for swale
- L= 650 ft
- A= 8.75 Ac ±(Conservative)
- S= 4% or .04 ft/ft (Top)
- V= 1.3 ft/sec (For .04 ft/ft → graph/Fig. Short grass)

Swale BIT

.5% slope



Top

- Short grass
- (.5%) Slope for swale
- L= 650 ft
- A= 8.74 Ac (Conservative)
- S= 4% or .04 ft/ft (Top)
- V= 1.3 ft/sec (For .04 ft/ft → graph/Fig. short grass).

APPENDIX 6B.15.6

HYDROCAD-SWALES INPUT DATA (DRAINAGE AREA B1S)

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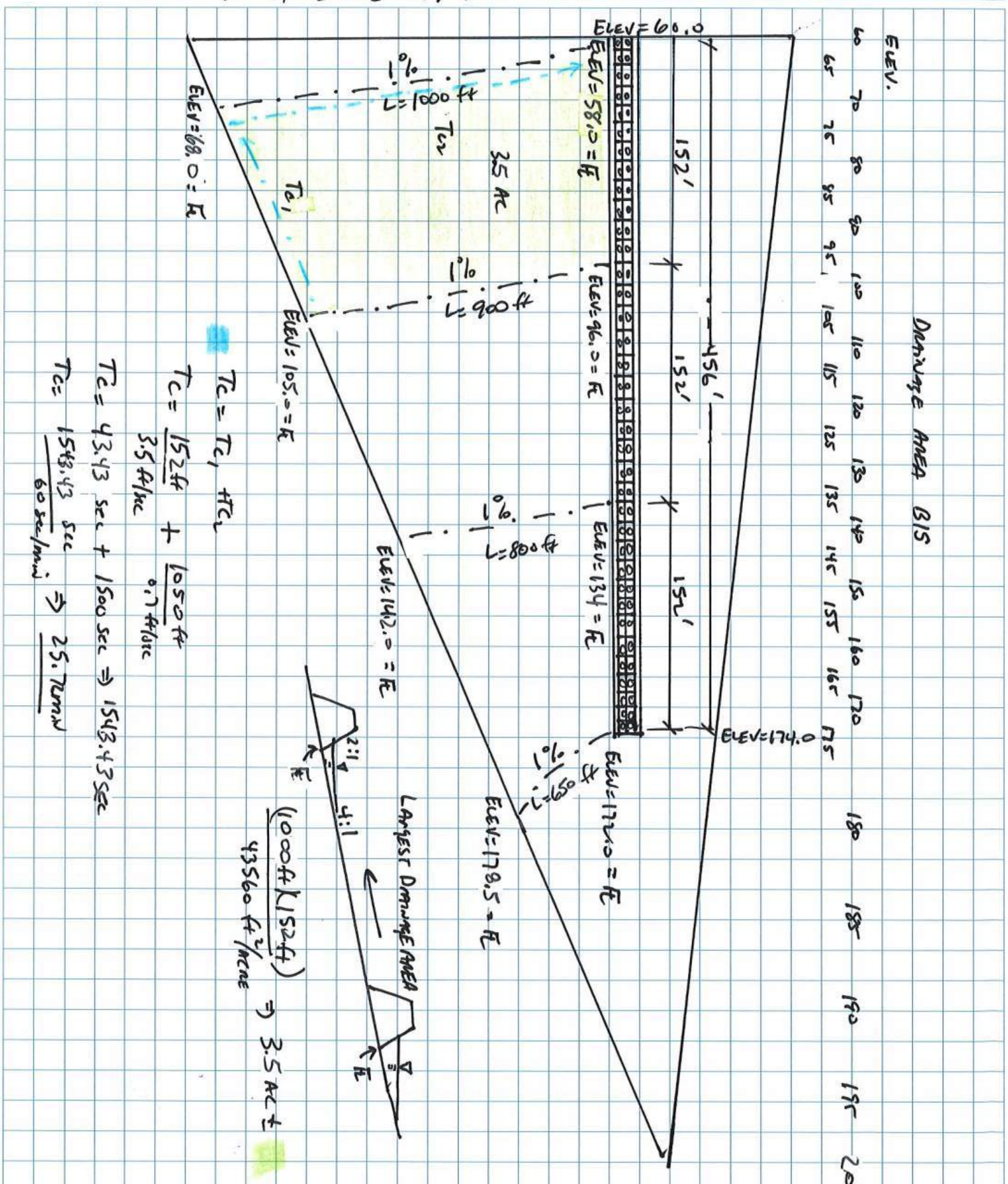
HANSON

JOB NO. 8514-03 City of Kingsville Landfill	SHEET NO.
DESCRIPTION Permit Amendment – Post Development – Swales	DATE 8/29/18
HydroCad – Swales Input Data	BY JCG



APPENDIX 6B.15.7

HYDROCAD-SWALES INPUT DATA (DRAINAGE AREA B1T)

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HANSON

JOB NO. 8514-03 City of Kingsville Landfill

SHEET NO.

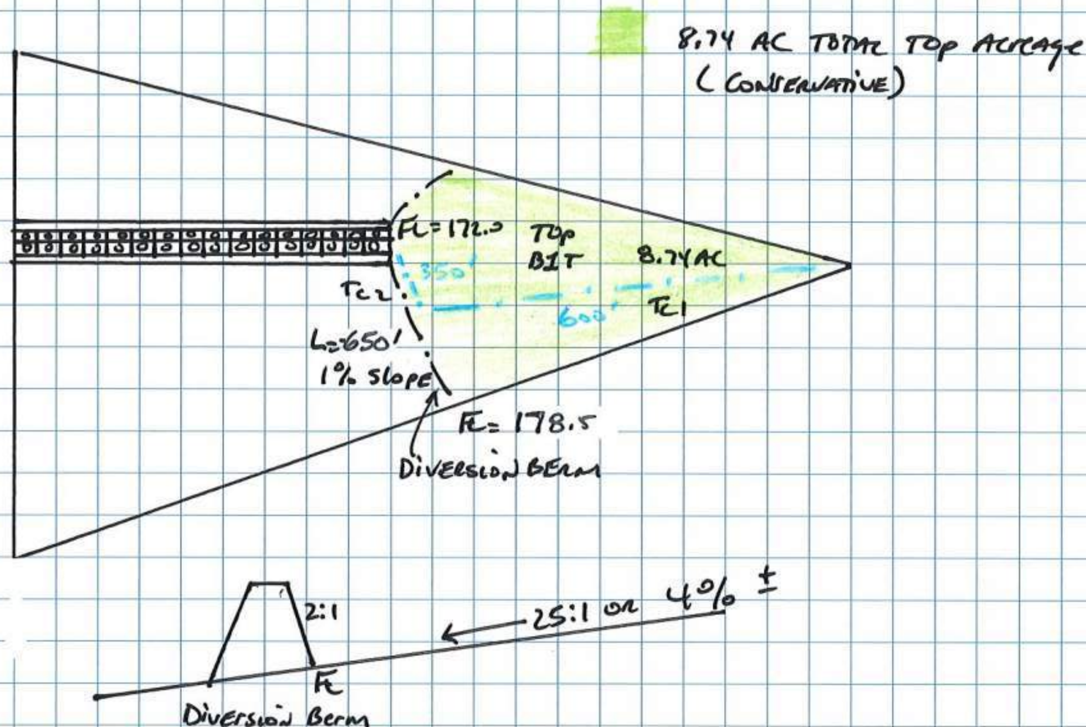
DESCRIPTION Permit Amendment Post Development – Diversion Berm

DATE 8/29/18

Hydrocad – Diversion Berms Input Data

BY JLG

Drainage Area B1T Not to Scale



$$T_c = T_{c_1} + T_{c_2}$$

$$T_c = \frac{600\ ft}{1.3\ ft/sec} + \frac{350\ ft}{0.7\ ft/sec}$$

$$T_c = 461.54\ sec + 500\ sec \Rightarrow 961.54\ sec$$

$$T_c = \frac{961.54\ sec}{60\ sec/min} \Rightarrow 16\ min$$

APPENDIX 6B.15.8

HYDROCAD-MODEL 25 YEAR POST DEVELOPMENT DIVERSION BERMS (NRCS METHOD)

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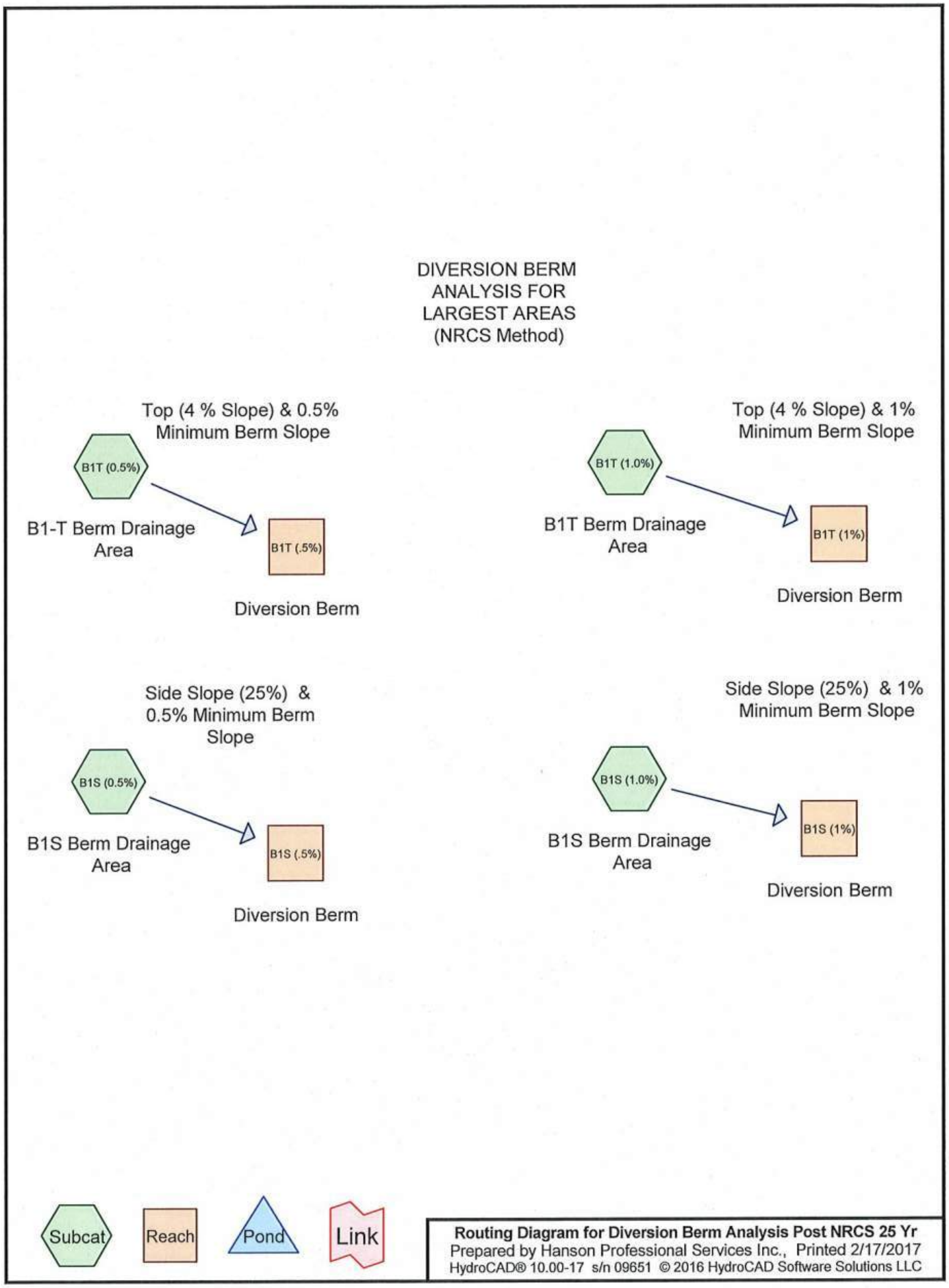
DIVERSION BERM
ANALYSIS FOR
LARGEST AREAS
(NRCS Method)
Top (4 % Slope) & 0.5%
Minimum Berm Slope
B1T (0.5%)
B1-T Berm Drainage
Area
B1T (.5%)
Diversion Berm
Top (4 % Slope) & 1%
Minimum Berm Slope
B1T (1.0%)
B1T Berm Drainage
Area
B1T (1%)
Diversion Berm
Side Slope (25%) &
0.5% Minimum Berm
Slope
B1S (0.5%)
B1S Berm Drainage
Area
B1S (.5%)
Diversion Berm
Side Slope (25%) & 1%
Minimum Berm Slope
B1S (1.0%)
B1S Berm Drainage
Area
B1S (1%)
Diversion Berm
Subcat
Reach
Pond
Link
Routing Diagram for Diversion Berm Analysis Post NRCS 25 Yr
Prepared by Hanson Professional Services Inc., Printed 2/17/2017
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
24.480	79	50-75% Grass cover, Fair, HSG C (B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%))
24.480	**79**	**TOTAL AREA**

Diversion Berm Analysis Post NRCS 25 Yr
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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
24.480	HSG C	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	HSG D	
0.000	Other	
24.480		**TOTAL AREA**

Diversion Berm Analysis Post NRCS 25 Yr
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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	24.480	0.000	0.000	24.480	50-75% Grass cover, Fair	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	**0.000**	**24.480**	**0.000**	**0.000**	**24.480**	**TOTAL AREA**	

Diversion Berm Analysis Post NRCS 25 Yr *Type III 24-hr 25-Year Rainfall=8.70"*
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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment B1S (0.5%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=1,152' Tc=34.0 min CN=79 Runoff=13.31 cfs 1.797 af

Subcatchment B1S (1.0%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=1,152' Tc=24.5 min CN=79 Runoff=15.48 cfs 1.797 af

Subcatchment B1T (0.5%): B1-T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=950' Tc=19.4 min CN=79 Runoff=42.61 cfs 4.489 af

Subcatchment B1T (1.0%): B1T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=6.16"
Flow Length=950' Tc=16.0 min CN=79 Runoff=46.06 cfs 4.489 af

Reach B1S (.5%): Diversion Berm Avg. Flow Depth=1.30' Max Vel=2.53 fps Inflow=13.31 cfs 1.797 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=119.21 cfs Outflow=12.80 cfs 1.797 af

Reach B1S (1%): Diversion Berm Avg. Flow Depth=1.21' Max Vel=3.40 fps Inflow=15.48 cfs 1.797 af
n=0.030 L=1,000.0' S=0.0100 '/' Capacity=168.59 cfs Outflow=14.89 cfs 1.797 af

Reach B1T (.5%): Diversion Berm Avg. Flow Depth=1.13' Max Vel=2.37 fps Inflow=42.61 cfs 4.489 af
n=0.030 L=650.0' S=0.0050 '/' Capacity=554.14 cfs Outflow=40.60 cfs 4.489 af

Reach B1T (1%): Diversion Berm Avg. Flow Depth=1.02' Max Vel=3.14 fps Inflow=46.06 cfs 4.489 af
n=0.030 L=650.0' S=0.0100 '/' Capacity=783.67 cfs Outflow=44.24 cfs 4.489 af

Total Runoff Area = 24.480 ac Runoff Volume = 12.572 af Average Runoff Depth = 6.16"
100.00% Pervious = 24.480 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment B1S (0.5%): B1S Berm Drainage Area

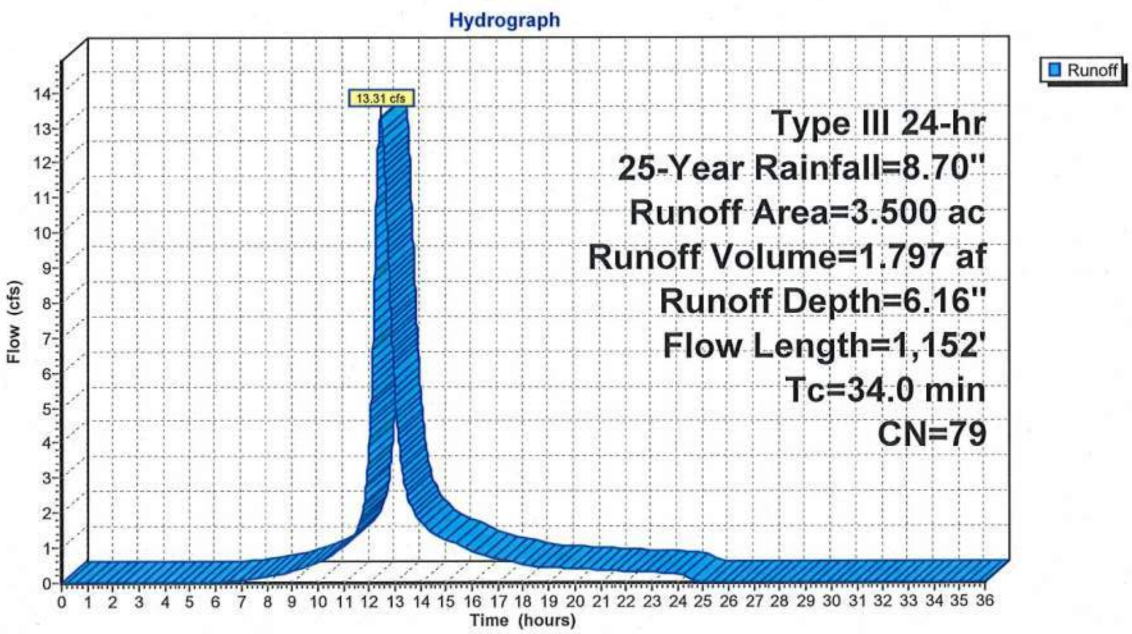
Runoff = 13.31 cfs @ 12.46 hrs, Volume= 1.797 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
3.500	79	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.3	1,000		0.50		**Direct Entry, B1S Swale Drainage Area**
0.7	152		3.50		**Direct Entry, Direct**
34.0	1,152	Total			

Subcatchment B1S (0.5%): B1S Berm Drainage Area



Summary for Subcatchment B1S (1.0%): B1S Berm Drainage Area

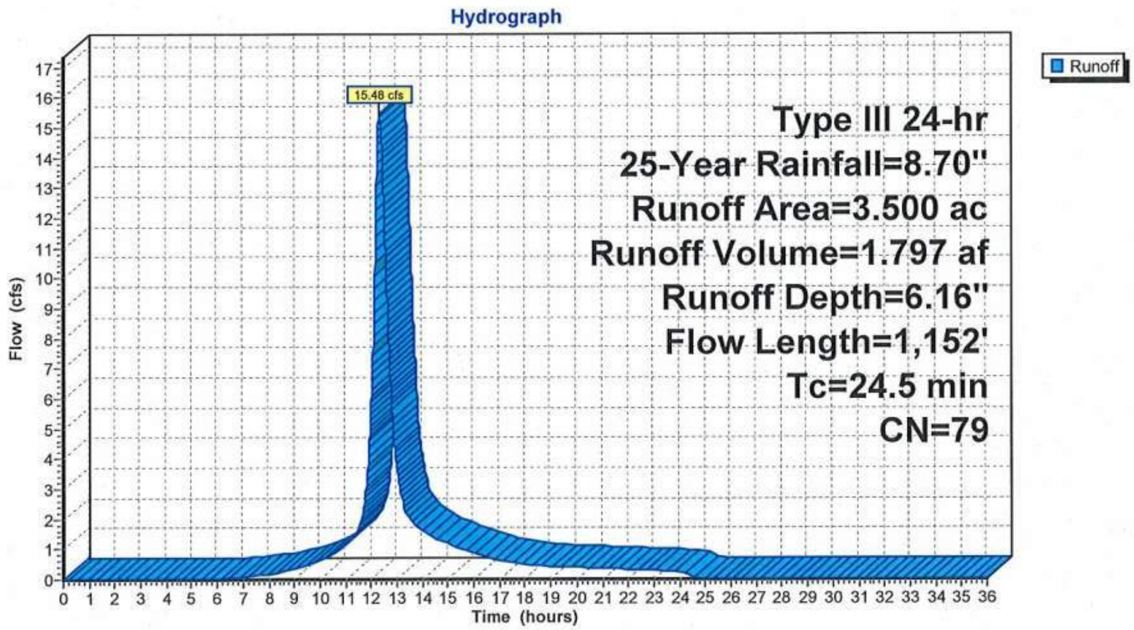
Runoff = 15.48 cfs @ 12.33 hrs, Volume= 1.797 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
3.500	79	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	1,000		0.70		**Direct Entry, B1S Drainage Area**
0.7	152		3.50		**Direct Entry, Direct**
24.5	1,152	Total			

Subcatchment B1S (1.0%): B1S Berm Drainage Area



Summary for Subcatchment B1T (0.5%): B1-T Berm Drainage Area

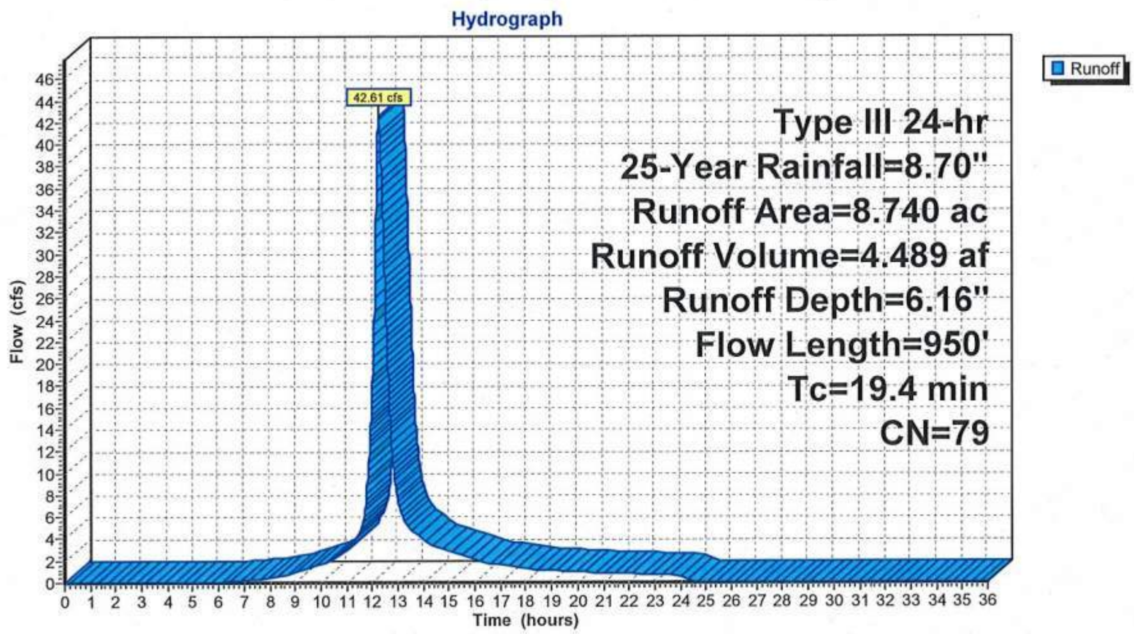
Runoff = 42.61 cfs @ 12.26 hrs, Volume= 4.489 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.740	79	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T Swale Drainage Area**
11.7	350		0.50		**Direct Entry, Direct**
19.4	950	Total			

Subcatchment B1T (0.5%): B1-T Berm Drainage Area



Summary for Subcatchment B1T (1.0%): B1T Berm Drainage Area

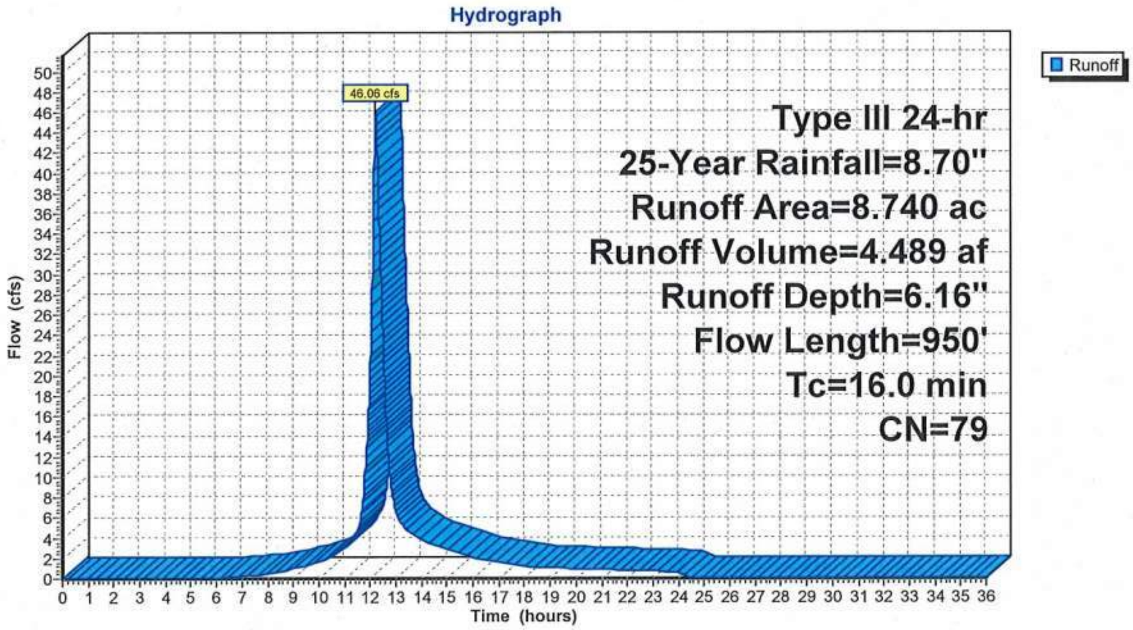
Runoff = 46.06 cfs @ 12.21 hrs, Volume= 4.489 af, Depth= 6.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=8.70"

Area (ac)	CN	Description
8.740	79	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T Swale Drainage Area**
8.3	350		0.70		**Direct Entry, Direct**
16.0	950	Total			

Subcatchment B1T (1.0%): B1T Berm Drainage Area



Diversion Berm Analysis Post NRCS 25 Yr *Type III 24-hr 25-Year Rainfall=8.70"*
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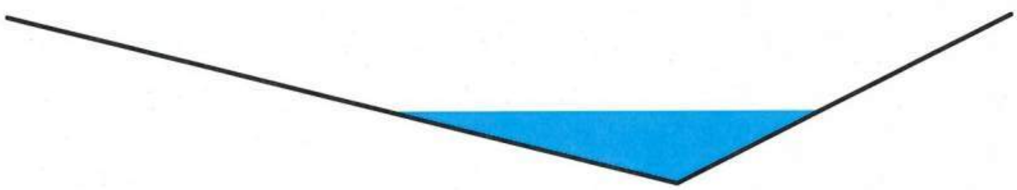
Summary for Reach B1S (.5%): Diversion Berm

Inflow Area =	3.500 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	13.31 cfs @	12.46 hrs, Volume=	1.797 af
Outflow =	12.80 cfs @	12.66 hrs, Volume=	1.797 af, Atten= 4%, Lag= 11.8 min

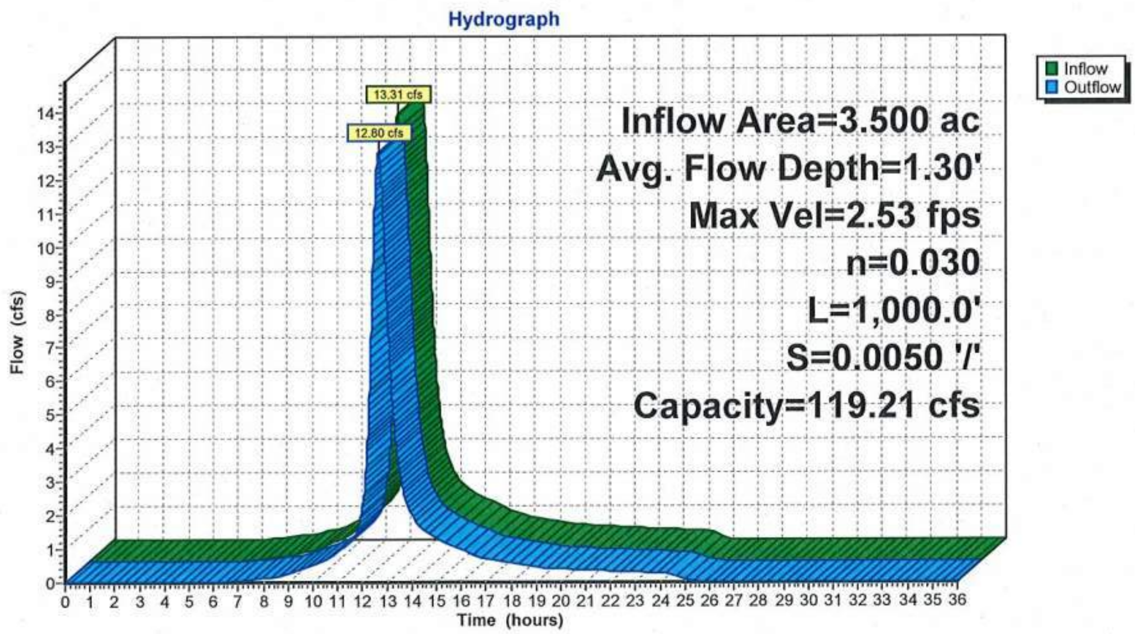
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.53 fps, Min. Travel Time= 6.6 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 18.2 min

Peak Storage= 5,064 cf @ 12.55 hrs
Average Depth at Peak Storage= 1.30'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 119.21 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 63.00', Outlet Invert= 58.00'



Reach B1S (.5%): Diversion Berm



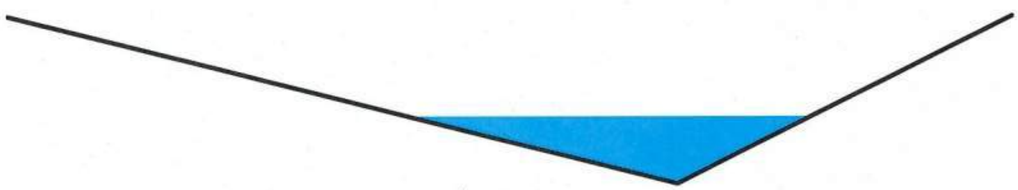
Summary for Reach B1S (1%): Diversion Berm

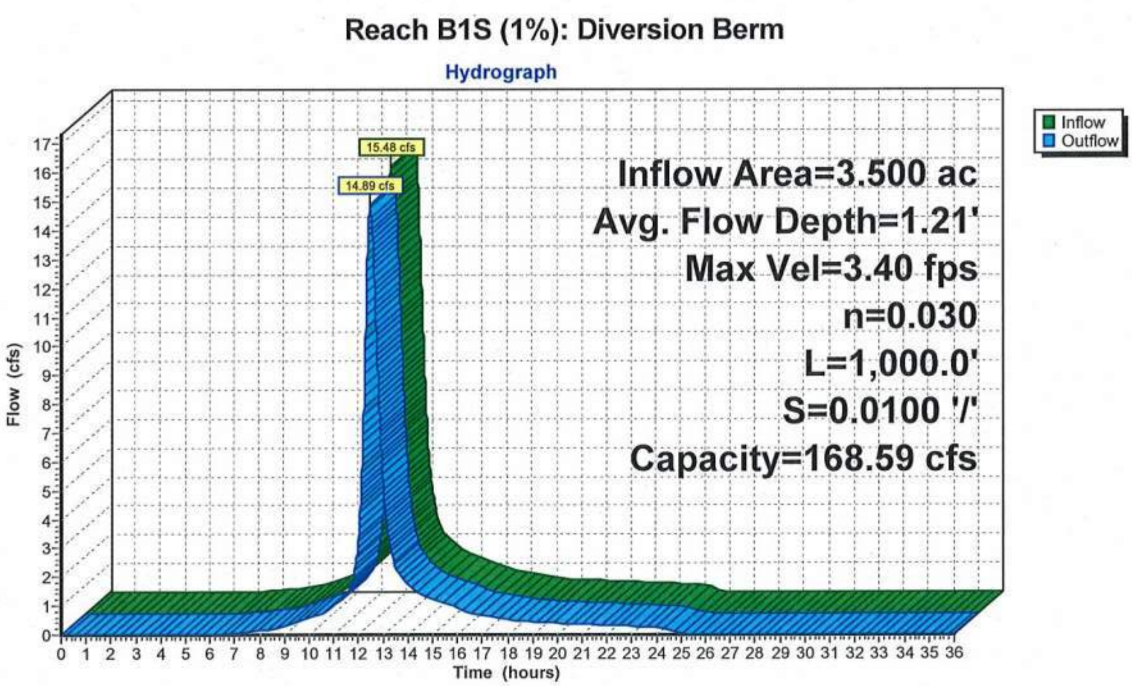
Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 6.16" for 25-Year event
Inflow = 15.48 cfs @ 12.33 hrs, Volume= 1.797 af
Outflow = 14.89 cfs @ 12.48 hrs, Volume= 1.797 af, Atten= 4%, Lag= 8.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.40 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 13.1 min

Peak Storage= 4,374 cf @ 12.39 hrs
Average Depth at Peak Storage= 1.21'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 168.59 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0100 '/'
Inlet Invert= 68.00', Outlet Invert= 58.00'





Summary for Reach B1T (.5%): Diversion Berm

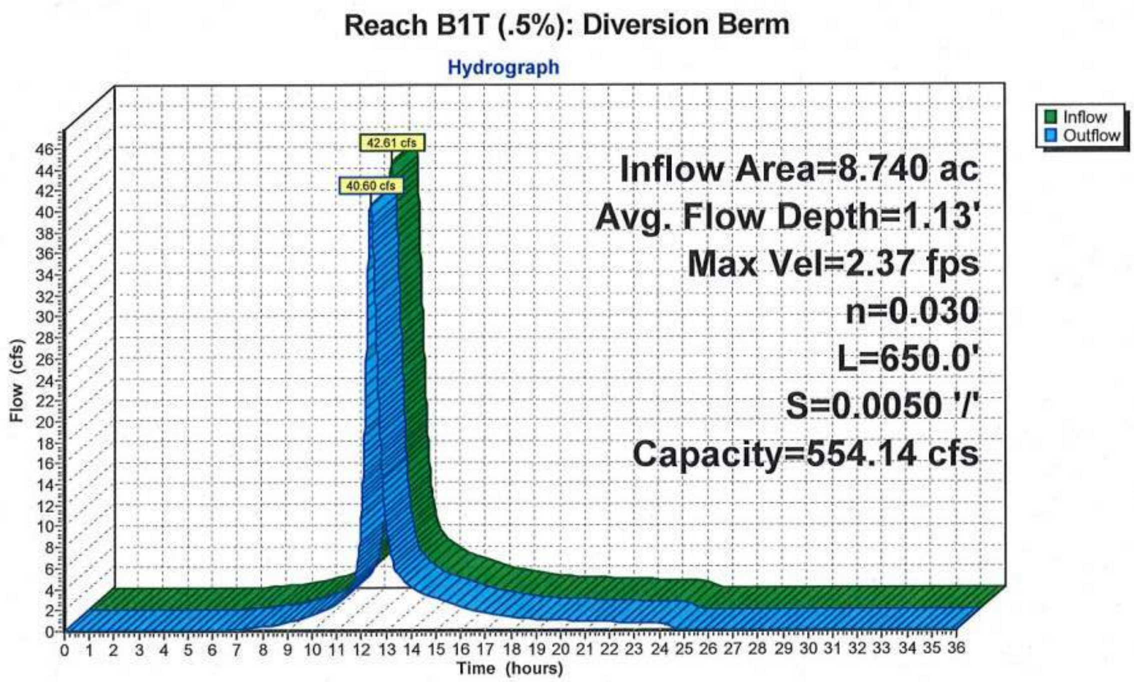
Inflow Area =	8.740 ac,	0.00% Impervious,	Inflow Depth = 6.16"	for 25-Year event
Inflow =	42.61 cfs @	12.26 hrs, Volume=	4.489 af	
Outflow =	40.60 cfs @	12.40 hrs, Volume=	4.489 af, Atten= 5%, Lag= 8.0 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.37 fps, Min. Travel Time= 4.6 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 12.8 min

Peak Storage= 11,123 cf @ 12.32 hrs
Average Depth at Peak Storage= 1.13'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 554.14 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0050 '/'
Inlet Invert= 175.25', Outlet Invert= 172.00'

‡



Summary for Reach B1T (1%): Diversion Berm

Inflow Area =	8.740 ac,	0.00% Impervious, Inflow Depth = 6.16"	for 25-Year event
Inflow =	46.06 cfs @	12.21 hrs, Volume=	4.489 af
Outflow =	44.24 cfs @	12.32 hrs, Volume=	4.489 af, Atten= 4%, Lag= 6.2 min

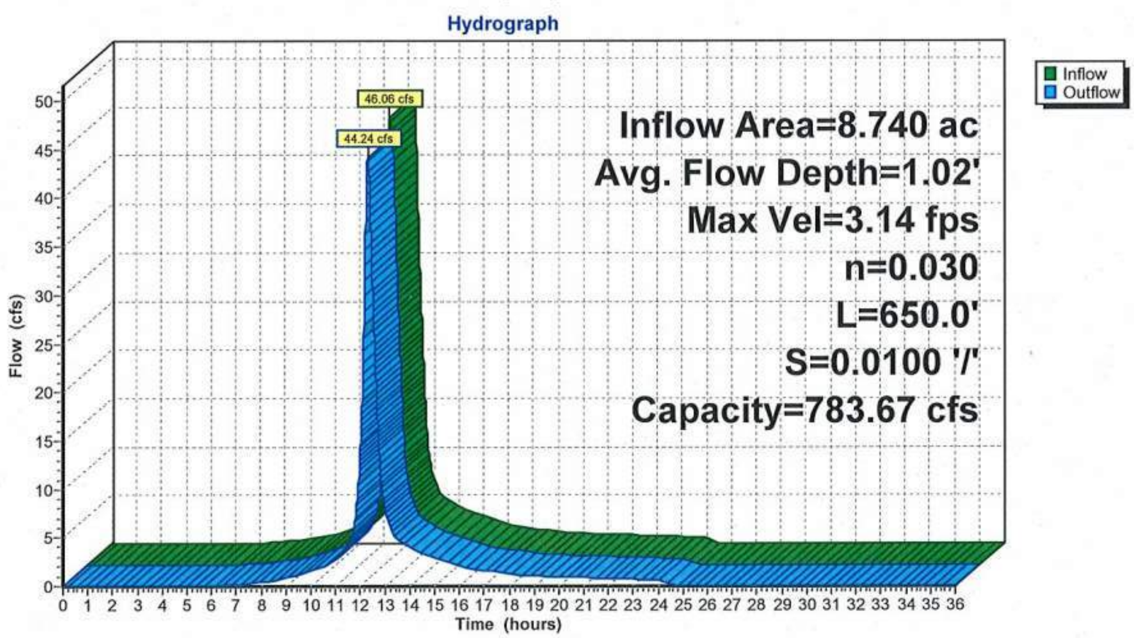
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.14 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.17 fps, Avg. Travel Time= 9.3 min

Peak Storage= 9,148 cf @ 12.26 hrs
Average Depth at Peak Storage= 1.02'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 783.67 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0100 '/'
Inlet Invert= 178.50', Outlet Invert= 172.00'

‡

Reach B1T (1%): Diversion Berm



APPENDIX 6B.15.9

HYDROCAD-MODEL 25 YEAR POST DEVELOPMENT DIVERSION BERMS (RATIONAL METHOD)

STATE OF TEXAS
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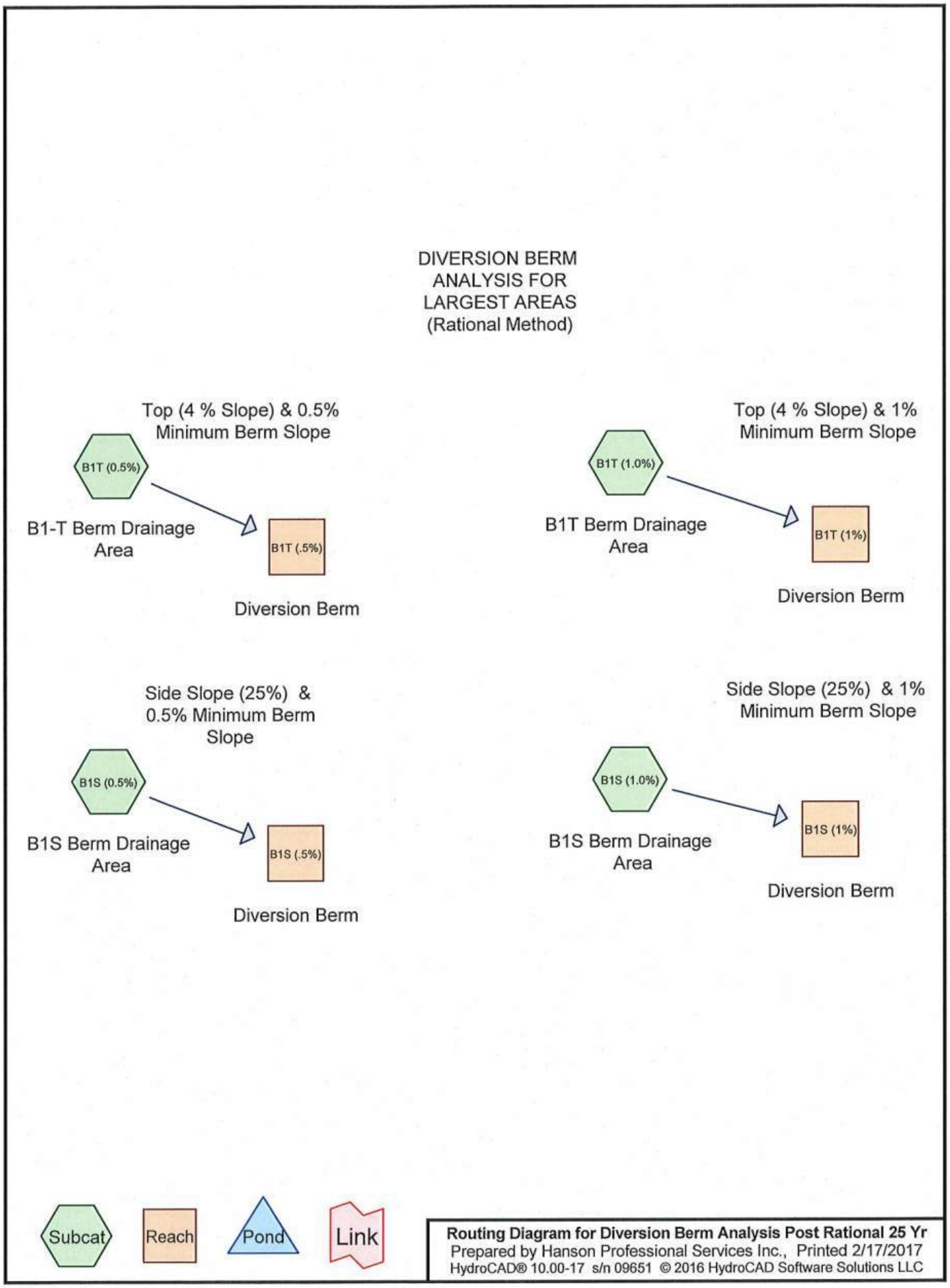
Jose C. Garza, P.E.


DIVERSION BERM
ANALYSIS FOR
LARGEST AREAS
(Rational Method)
Top (4 % Slope) & 0.5%
Minimum Berm Slope
B1T (0.5%)
B1-T Berm Drainage
Area
B1T (.5%)
Diversion Berm
Top (4 % Slope) & 1%
Minimum Berm Slope
B1T (1.0%)
B1T Berm Drainage
Area
B1T (1%)
Diversion Berm
Side Slope (25%) &
0.5% Minimum Berm
Slope
B1S (0.5%)
B1S Berm Drainage
Area
B1S (.5%)
Diversion Berm
Side Slope (25%) & 1%
Minimum Berm Slope
B1S (1.0%)
B1S Berm Drainage
Area
B1S (1%)
Diversion Berm
Subcat
Reach
Pond
Link
Routing Diagram for Diversion Berm Analysis Post Rational 25 Yr
Prepared by Hanson Professional Services Inc., Printed 2/17/2017
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Diversion Berm Analysis Post Rational 25 Yr
Prepared by Hanson Professional Services Inc.
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Printed 2/17/2017

Area Listing (all nodes)

Area (acres)	C	Description (subcatchment-numbers)
24.480	0.70	50-75% Grass cover, Fair, HSG C (B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%))
24.480	**0.70**	**TOTAL AREA**

Diversion Berm Analysis Post Rational 25 Yr
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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
24.480	HSG C	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	HSG D	
0.000	Other	
24.480		**TOTAL AREA**

Diversion Berm Analysis Post Rational 25 Yr
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Page 4

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	24.480	0.000	0.000	24.480	50-75% Grass cover, Fair	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	**0.000**	**24.480**	**0.000**	**0.000**	**24.480**	**TOTAL AREA**	

Time span=0.00-2.00 hrs, dt=0.01 hrs, 201 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment B1S (0.5%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=1.17"
Tc=10.0 min C=0.70 Runoff=24.27 cfs 0.340 af

Subcatchment B1S (1.0%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=1.17"
Tc=10.0 min C=0.70 Runoff=24.27 cfs 0.340 af

Subcatchment B1T (0.5%): B1-T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=1.17"
Tc=10.0 min C=0.70 Runoff=60.61 cfs 0.849 af

Subcatchment B1T (1.0%): B1T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=1.17"
Tc=10.0 min C=0.70 Runoff=60.61 cfs 0.849 af

Reach B1S (.5%): Diversion Berm Avg. Flow Depth=1.42' Max Vel=2.69 fps Inflow=24.27 cfs 0.340 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=119.21 cfs Outflow=16.33 cfs 0.340 af

Reach B1S (1%): Diversion Berm Avg. Flow Depth=1.30' Max Vel=3.58 fps Inflow=24.27 cfs 0.340 af
n=0.030 L=1,000.0' S=0.0100 '/' Capacity=168.59 cfs Outflow=18.14 cfs 0.340 af

Reach B1T (.5%): Diversion Berm Avg. Flow Depth=1.18' Max Vel=2.45 fps Inflow=60.61 cfs 0.849 af
n=0.030 L=650.0' S=0.0050 '/' Capacity=554.14 cfs Outflow=46.04 cfs 0.849 af

Reach B1T (1%): Diversion Berm Avg. Flow Depth=1.07' Max Vel=3.24 fps Inflow=60.61 cfs 0.849 af
n=0.030 L=650.0' S=0.0100 '/' Capacity=783.67 cfs Outflow=49.71 cfs 0.849 af

Total Runoff Area = 24.480 ac Runoff Volume = 2.379 af Average Runoff Depth = 1.17"
100.00% Pervious = 24.480 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment B1S (0.5%): B1S Berm Drainage Area

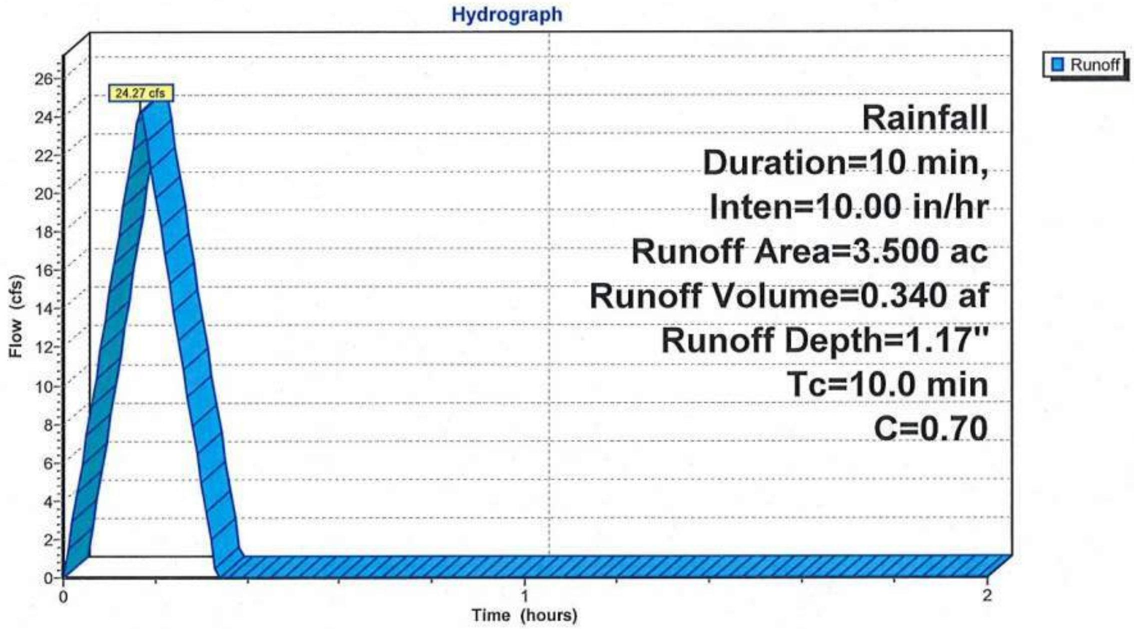
Runoff = 24.27 cfs @ 0.17 hrs, Volume= 0.340 af, Depth= 1.17"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=10.00 in/hr

Area (ac)	C	Description
3.500	0.70	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S Swale Drainage Area**

Subcatchment B1S (0.5%): B1S Berm Drainage Area



Summary for Subcatchment B1S (1.0%): B1S Berm Drainage Area

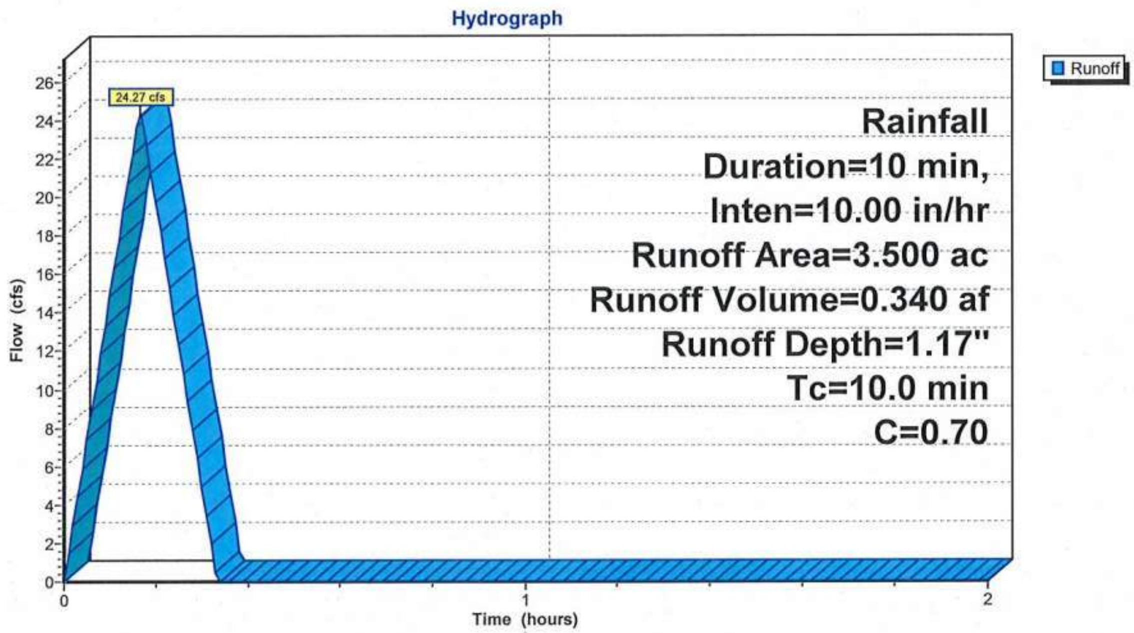
Runoff = 24.27 cfs @ 0.17 hrs, Volume= 0.340 af, Depth= 1.17"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=10.00 in/hr

Area (ac)	C	Description
3.500	0.70	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S Drainage Area**

Subcatchment B1S (1.0%): B1S Berm Drainage Area



Summary for Subcatchment B1T (0.5%): B1-T Berm Drainage Area

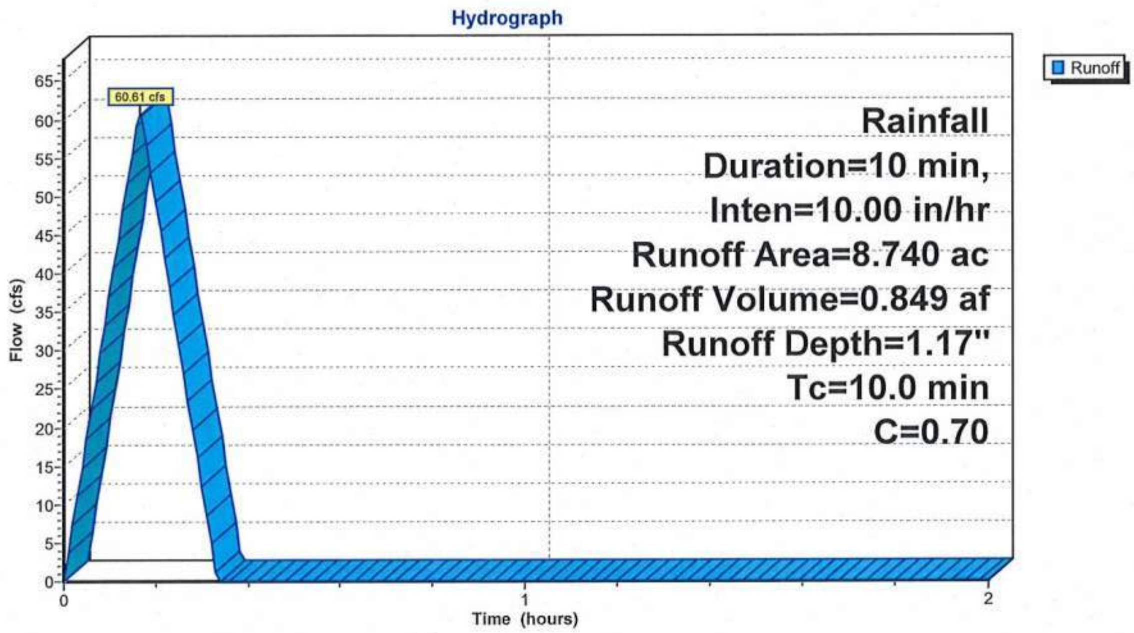
Runoff = 60.61 cfs @ 0.17 hrs, Volume= 0.849 af, Depth= 1.17"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=10.00 in/hr

Area (ac)	C	Description
8.740	0.70	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1T Swale Drainage Area**

Subcatchment B1T (0.5%): B1-T Berm Drainage Area



Summary for Subcatchment B1T (1.0%): B1T Berm Drainage Area

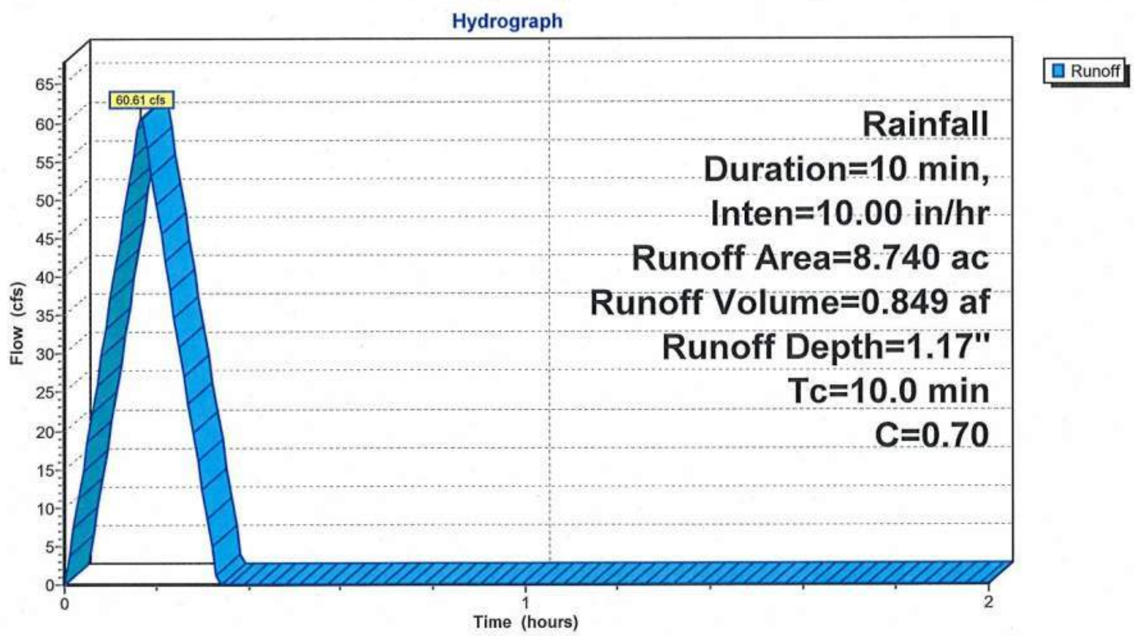
Runoff = 60.61 cfs @ 0.17 hrs, Volume= 0.849 af, Depth= 1.17"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=10.00 in/hr

Area (ac)	C	Description
8.740	0.70	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1T Swale Drainage Area**

Subcatchment B1T (1.0%): B1T Berm Drainage Area



Summary for Reach B1S (.5%): Diversion Berm

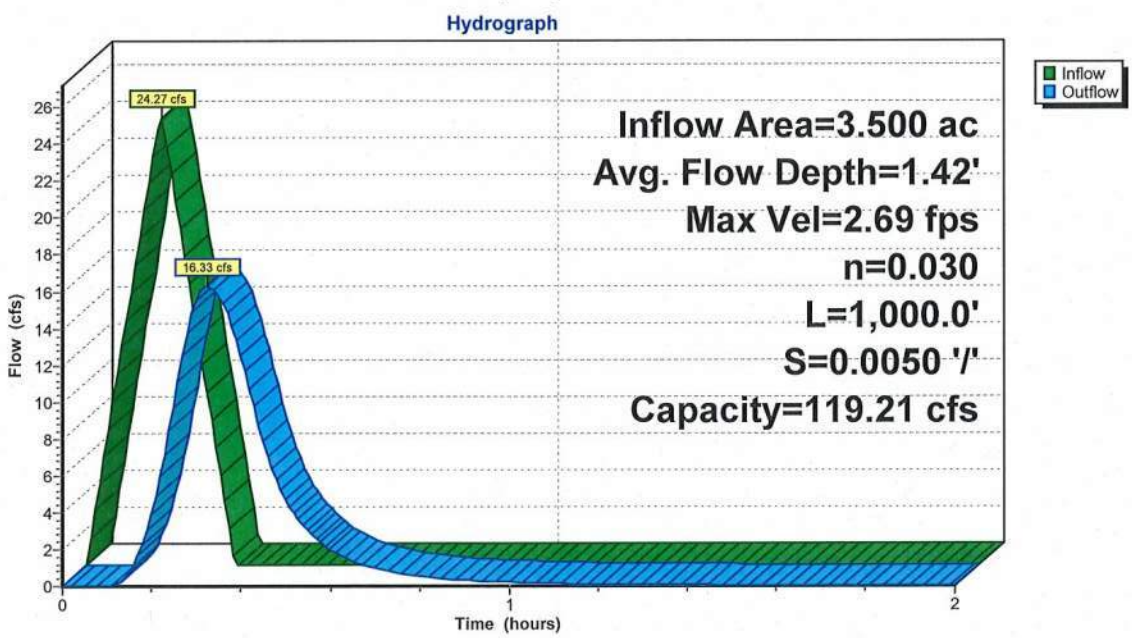
Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 1.17"
Inflow = 24.27 cfs @ 0.17 hrs, Volume= 0.340 af
Outflow = 16.33 cfs @ 0.33 hrs, Volume= 0.340 af, Atten= 33%, Lag= 9.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.69 fps, Min. Travel Time= 6.2 min
Avg. Velocity = 1.07 fps, Avg. Travel Time= 15.5 min

Peak Storage= 6,086 cf @ 0.22 hrs
Average Depth at Peak Storage= 1.42'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 119.21 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 63.00', Outlet Invert= 58.00'

Reach B1S (.5%): Diversion Berm



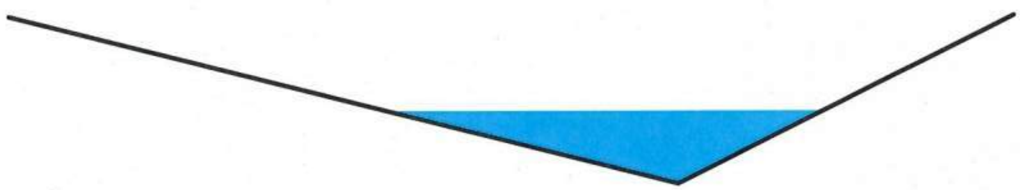
Summary for Reach B1S (1%): Diversion Berm

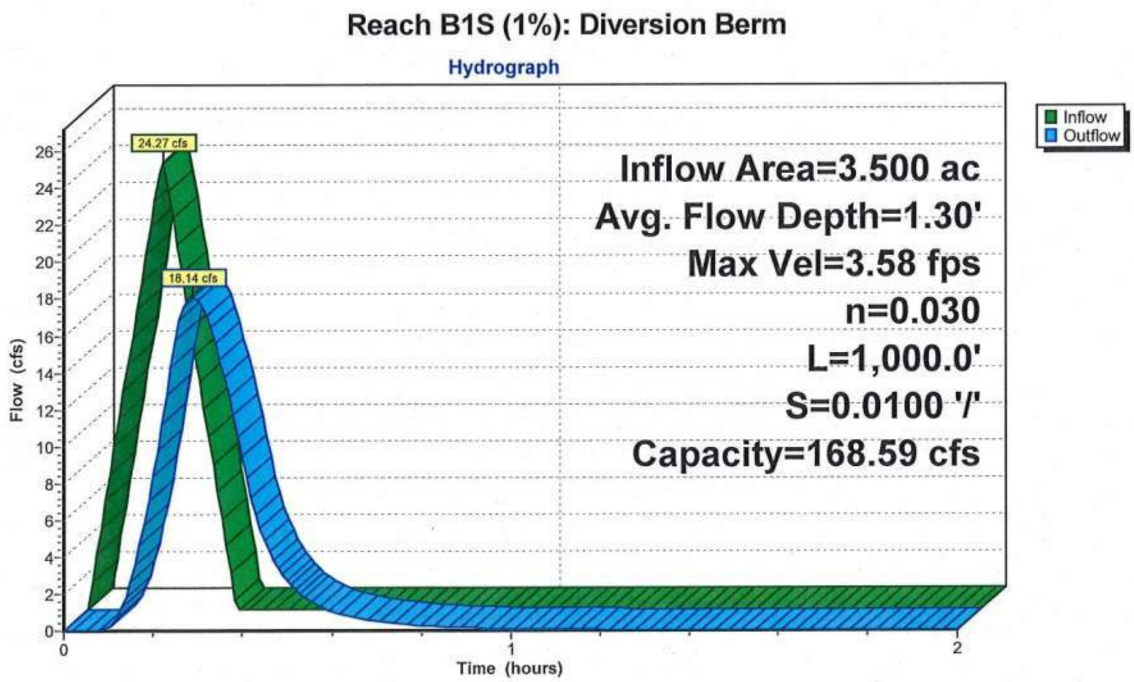
Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 1.17"
Inflow = 24.27 cfs @ 0.17 hrs, Volume= 0.340 af
Outflow = 18.14 cfs @ 0.29 hrs, Volume= 0.340 af, Atten= 25%, Lag= 7.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.58 fps, Min. Travel Time= 4.7 min
Avg. Velocity = 1.28 fps, Avg. Travel Time= 13.1 min

Peak Storage= 5,076 cf @ 0.21 hrs
Average Depth at Peak Storage= 1.30'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 168.59 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0100 '/'
Inlet Invert= 68.00', Outlet Invert= 58.00'





Summary for Reach B1T (.5%): Diversion Berm

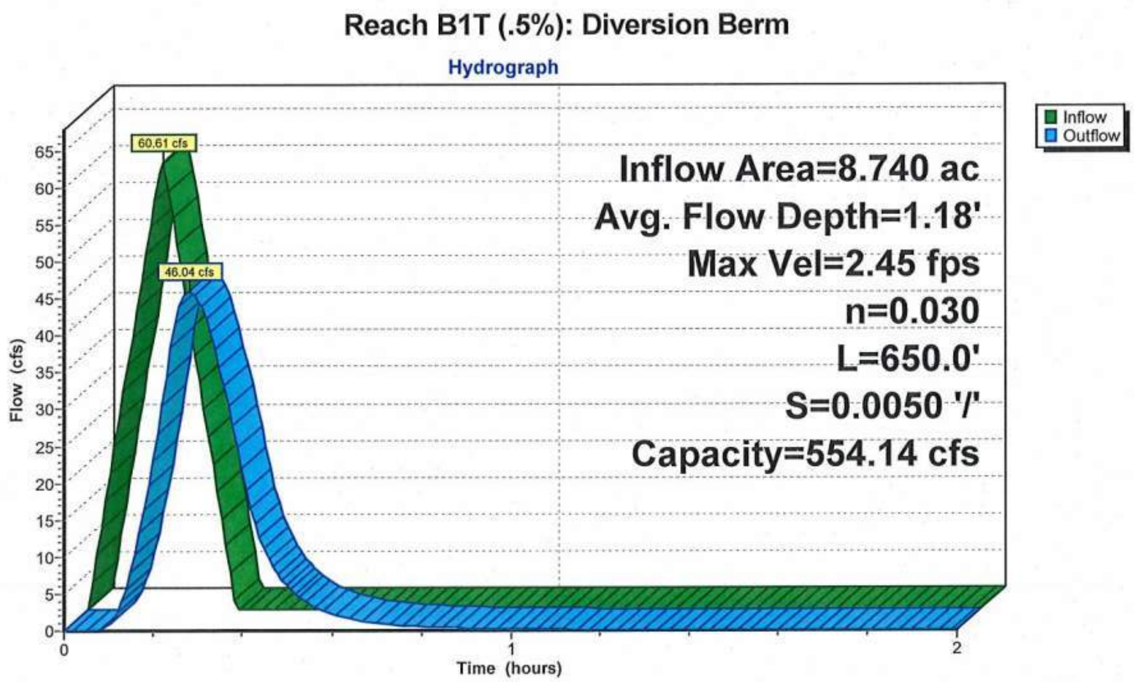
Inflow Area = 8.740 ac, 0.00% Impervious, Inflow Depth = 1.17"
Inflow = 60.61 cfs @ 0.17 hrs, Volume= 0.849 af
Outflow = 46.04 cfs @ 0.28 hrs, Volume= 0.849 af, Atten= 24%, Lag= 6.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.45 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 12.6 min

Peak Storage= 12,234 cf @ 0.21 hrs
Average Depth at Peak Storage= 1.18'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 554.14 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0050 '/'
Inlet Invert= 175.25', Outlet Invert= 172.00'

‡



Summary for Reach B1T (1%): Diversion Berm

Inflow Area = 8.740 ac, 0.00% Impervious, Inflow Depth = 1.17"
Inflow = 60.61 cfs @ 0.17 hrs, Volume= 0.849 af
Outflow = 49.71 cfs @ 0.26 hrs, Volume= 0.849 af, Atten= 18%, Lag= 5.3 min

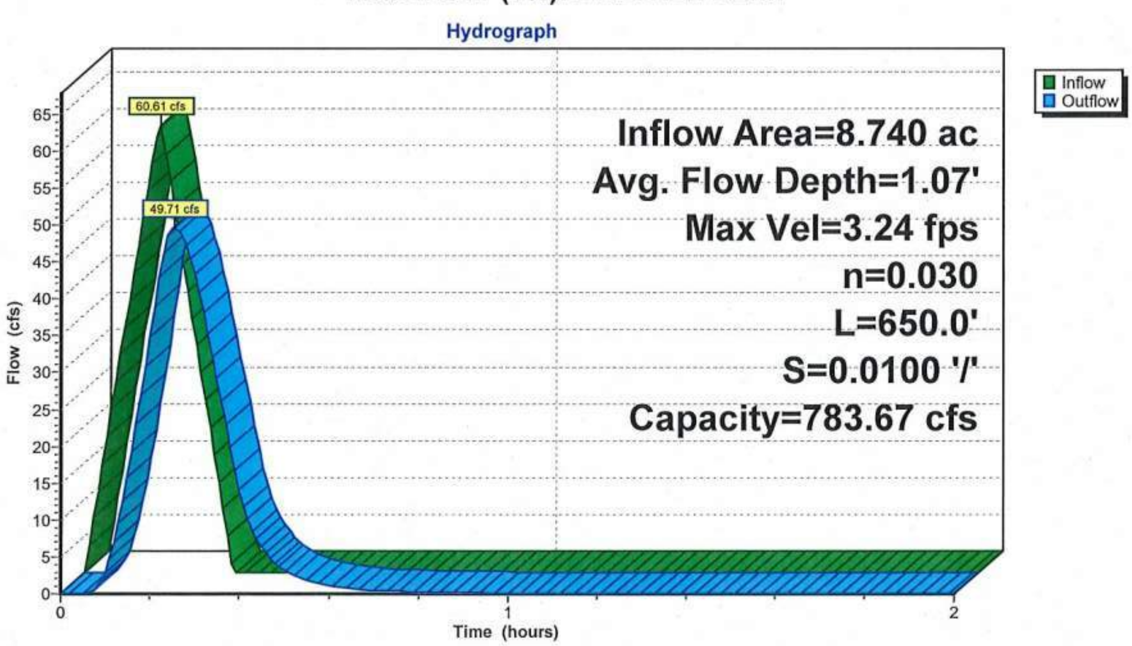
Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.24 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 10.6 min

Peak Storage= 9,999 cf @ 0.20 hrs
Average Depth at Peak Storage= 1.07'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 783.67 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0100 '/'
Inlet Invert= 178.50', Outlet Invert= 172.00'

‡

Reach B1T (1%): Diversion Berm



APPENDIX 6B.15.10

SUMMARY OF 25 YEAR INTENSITY FLOW RATES BY RATIONAL METHOD AND NRCS METHOD FOR SWALE DESIGN

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Required: Determine the 25-year intensity flow rates by Rational Method and NRCS Method
Use the calcuclated flow rates for swale design

Assumptions: Largest Drainage Area for Swale on 25:1 (4% slope) is B1T
Largest Drainage Area for Swale on 4:1 (25% slope) is B1S
Tc = 10 minutes (minimum allowed, TxDOT Hydraulic Design Manual)
CN = 79 (50-75% Grass Cover, Fair, HSG C)
Minimum swale slope = 1 %
Manning's n= **0.03** (earth, grassed & winding)

Rational Method

Q = CIA

Where; C = Runoff Coefficient = **0.7** (Use Conservative Runoff Coefficient Value of 0.7)
I = Rainfall intensity, in/hr
A = Drainage Area, Ac

$$I = \frac{b}{(Tc + d)^e}$$

Where; b= 93 — TxDOT Hydraulic Design Manual (12-85)
d= 8.7 — Values for Kleberg County, 25-year storm event
e= 0.761
Tc= 10
I = 10.0 in/hr

Conclusion:

Max Calculated Swale Depth***	**1.30**	ft
Proposed Swale Depth	**3**	ft
Calculated Depth < Proposed Depth	**TRUE**	
Max CalculatedFlow Velocity	**3.59**	ft
Max Design Velocity	5	fps
Calculated Velocity < Design Velocity	**TRUE**	

SUMMARY OF 25-YEAR INTENSITY FLOW RATES BY RATIONAL AND NRCS METHOD FOR SWALE DESIGN

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth *	Flow Velocity
			Rational Method *	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	60.6	25	2	50.3	**1.07**	3.25
B1S	1.20	0.0019	24.3	4	2	18.2	**1.30**	3.59

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth **	Flow Velocity
			NRCS Method **	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	46.1	25	2	44.2	**1.02**	3.15
B1S	1.20	0.0019	15.5	4	2	15.0	**1.21**	3.42

*** Rational method values as determined by HydroCad comparable to NRCS Method but slightly higher .**

**** NRCS Method as determined by HydroCad swale design.**

***** Check Max Calculated Swale Depth for 100-year storm event**

APPENDIX 6B.15.11

HYDROCAD MODEL 100 YEAR POST DEVELOPMENT DIVERSION BERMS (NRCS METHOD)

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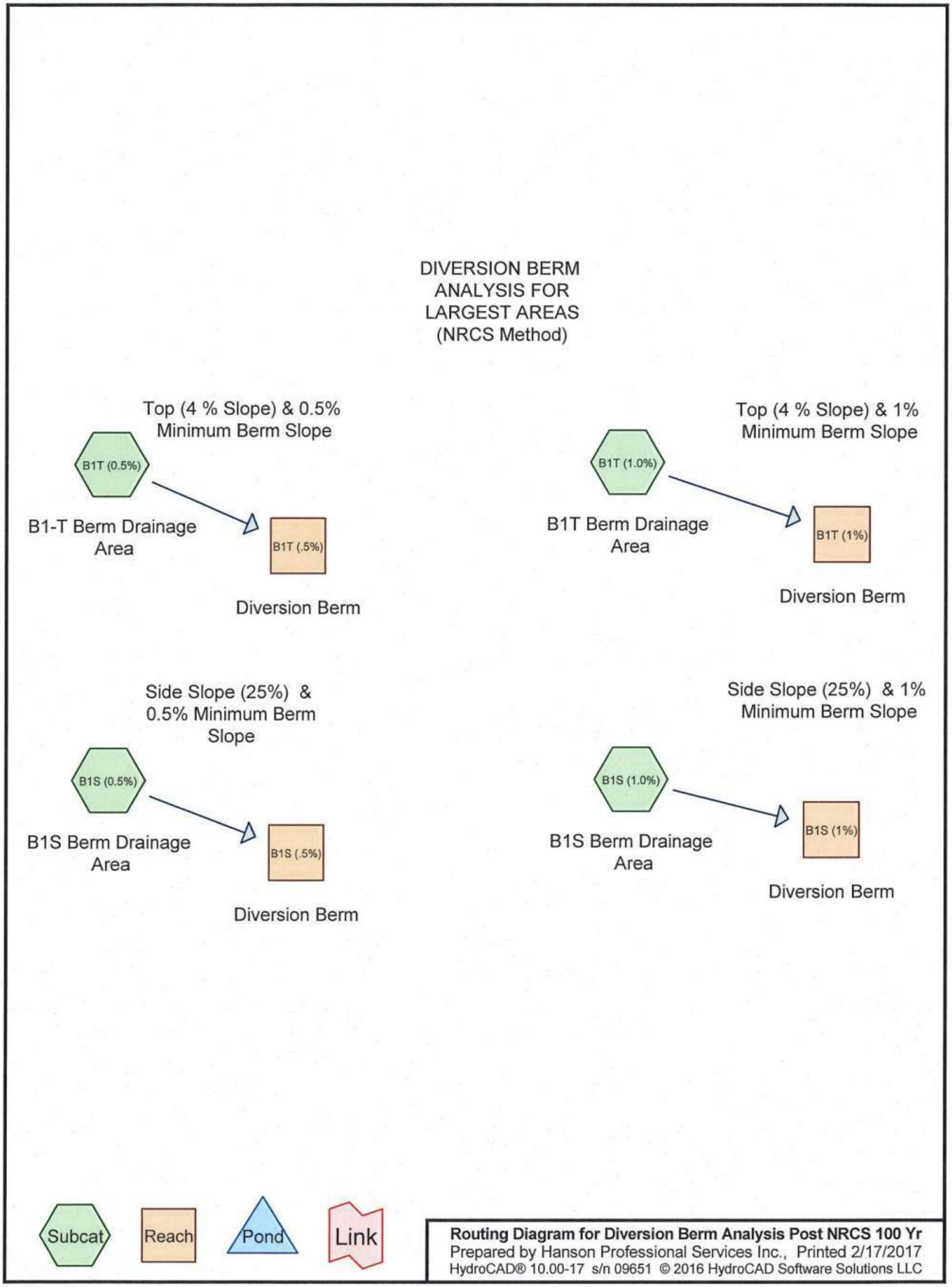
DIVERSION BERM
ANALYSIS FOR
LARGEST AREAS
(NRCS Method)
Top (4 % Slope) & 0.5%
Minimum Berm Slope
B1T (0.5%)
B1-T Berm Drainage
Area
B1T (.5%)
Diversion Berm
Top (4 % Slope) & 1%
Minimum Berm Slope
B1T (1.0%)
B1T Berm Drainage
Area
B1T (1%)
Diversion Berm
Side Slope (25%) &
0.5% Minimum Berm
Slope
B1S (0.5%)
B1S Berm Drainage
Area
B1S (.5%)
Diversion Berm
Side Slope (25%) & 1%
Minimum Berm Slope
B1S (1.0%)
B1S Berm Drainage
Area
B1S (1%)
Diversion Berm
Subcat
Reach
Pond
Link
Routing Diagram for Diversion Berm Analysis Post NRCS 100 Yr
Prepared by Hanson Professional Services Inc., Printed 2/17/2017
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Diversion Berm Analysis Post NRCS 100 Yr
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
24.480	79	50-75% Grass cover, Fair, HSG C (B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%))
24.480	**79**	**TOTAL AREA**

Diversion Berm Analysis Post NRCS 100 Yr
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Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
24.480	HSG C	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	HSG D	
0.000	Other	
24.480		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	24.480	0.000	0.000	24.480	50-75% Grass cover, Fair	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	**0.000**	**24.480**	**0.000**	**0.000**	**24.480**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment B1S (0.5%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=1,152' Tc=34.0 min CN=79 Runoff=18.81 cfs 2.575 af

Subcatchment B1S (1.0%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=1,152' Tc=24.5 min CN=79 Runoff=21.87 cfs 2.575 af

Subcatchment B1T (0.5%): B1-T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=950' Tc=19.4 min CN=79 Runoff=60.17 cfs 6.430 af

Subcatchment B1T (1.0%): B1T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=8.83"
Flow Length=950' Tc=16.0 min CN=79 Runoff=65.04 cfs 6.430 af

Reach B1S (.5%): Diversion Berm Avg. Flow Depth=1.48' Max Vel=2.76 fps Inflow=18.81 cfs 2.575 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=119.21 cfs Outflow=18.20 cfs 2.575 af

Reach B1S (1%): Diversion Berm Avg. Flow Depth=1.38' Max Vel=3.72 fps Inflow=21.87 cfs 2.575 af
n=0.030 L=1,000.0' S=0.0100 '/' Capacity=168.59 cfs Outflow=21.14 cfs 2.575 af

Reach B1T (.5%): Diversion Berm Avg. Flow Depth=1.28' Max Vel=2.59 fps Inflow=60.17 cfs 6.430 af
n=0.030 L=650.0' S=0.0050 '/' Capacity=554.14 cfs Outflow=57.74 cfs 6.430 af

Reach B1T (1%): Diversion Berm Avg. Flow Depth=1.16' Max Vel=3.43 fps Inflow=65.04 cfs 6.430 af
n=0.030 L=650.0' S=0.0100 '/' Capacity=783.67 cfs Outflow=62.81 cfs 6.430 af

Total Runoff Area = 24.480 ac Runoff Volume = 18.011 af Average Runoff Depth = 8.83"
100.00% Pervious = 24.480 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment B1S (0.5%): B1S Berm Drainage Area

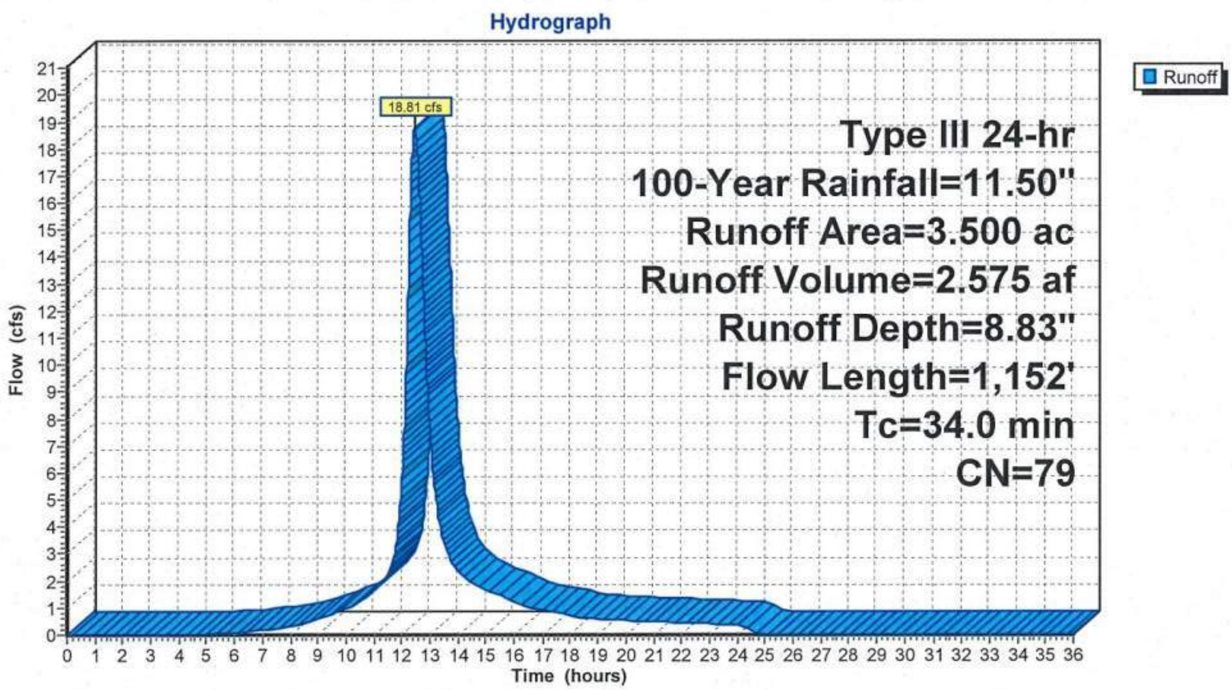
Runoff = 18.81 cfs @ 12.44 hrs, Volume= 2.575 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
3.500	79	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
33.3	1,000		0.50		**Direct Entry, B1S Swale Drainage Area**
0.7	152		3.50		**Direct Entry, Direct**
34.0	1,152	Total			

Subcatchment B1S (0.5%): B1S Berm Drainage Area



Summary for Subcatchment B1S (1.0%): B1S Berm Drainage Area

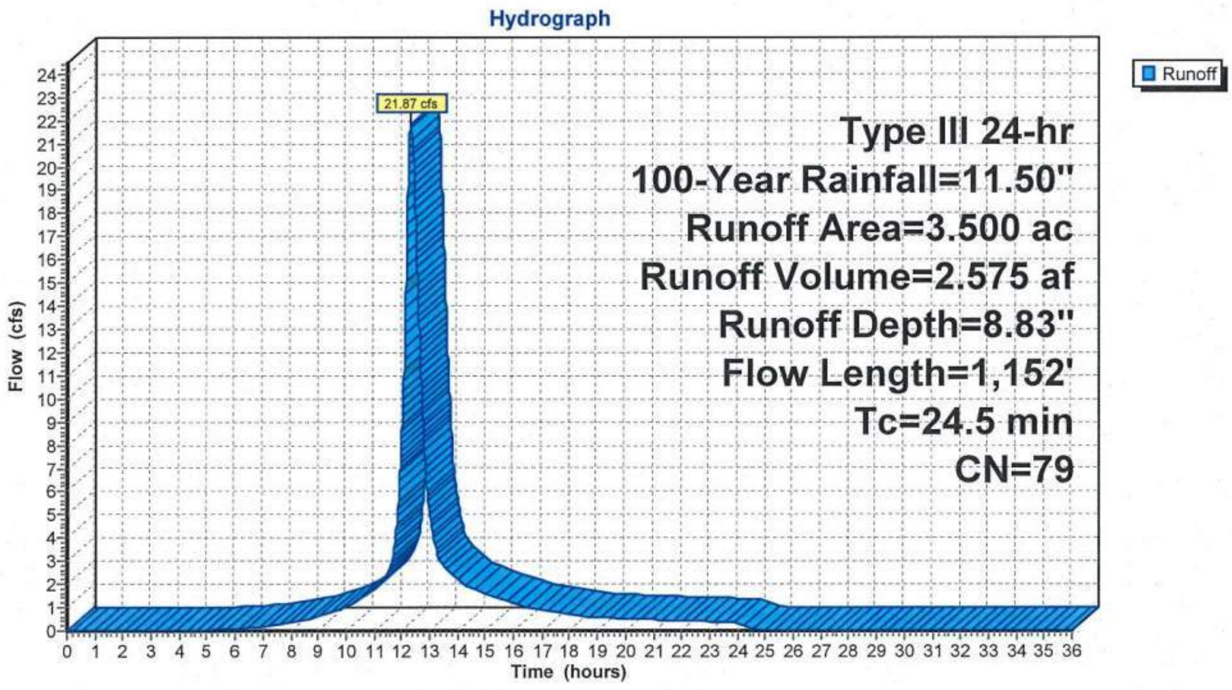
Runoff = 21.87 cfs @ 12.33 hrs, Volume= 2.575 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
3.500	79	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.8	1,000		0.70		**Direct Entry, B1S Drainage Area**
0.7	152		3.50		**Direct Entry, Direct**
24.5	1,152	Total			

Subcatchment B1S (1.0%): B1S Berm Drainage Area



Summary for Subcatchment B1T (0.5%): B1-T Berm Drainage Area

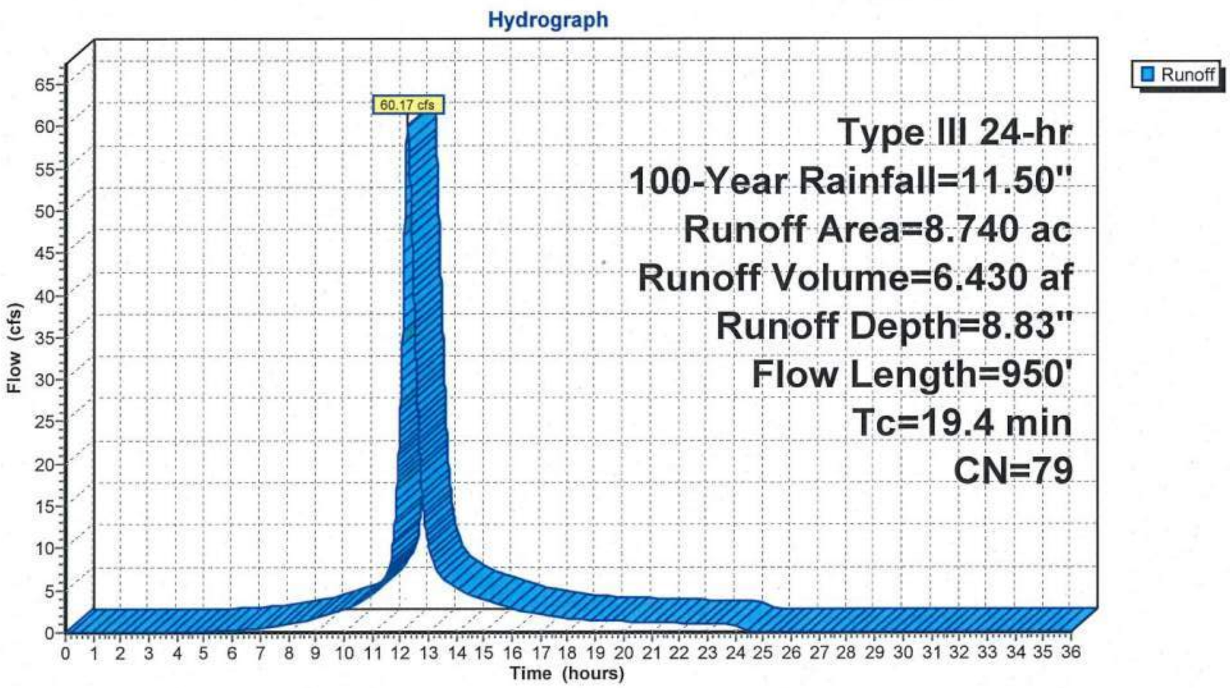
Runoff = 60.17 cfs @ 12.26 hrs, Volume= 6.430 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.740	79	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T Swale Drainage Area**
11.7	350		0.50		**Direct Entry, Direct**
19.4	950	Total			

Subcatchment B1T (0.5%): B1-T Berm Drainage Area



Summary for Subcatchment B1T (1.0%): B1T Berm Drainage Area

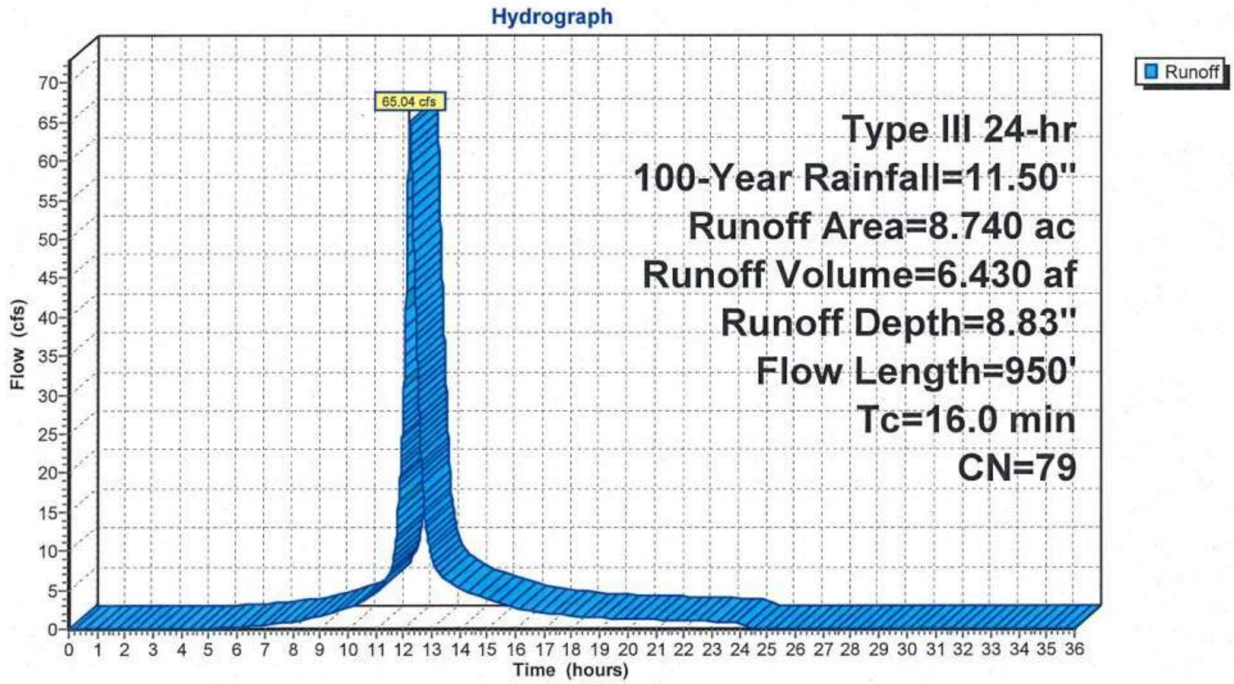
Runoff = 65.04 cfs @ 12.21 hrs, Volume= 6.430 af, Depth= 8.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=11.50"

Area (ac)	CN	Description
8.740	79	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	600		1.30		**Direct Entry, B1T Swale Drainage Area**
8.3	350		0.70		**Direct Entry, Direct**
16.0	950	Total			

Subcatchment B1T (1.0%): B1T Berm Drainage Area



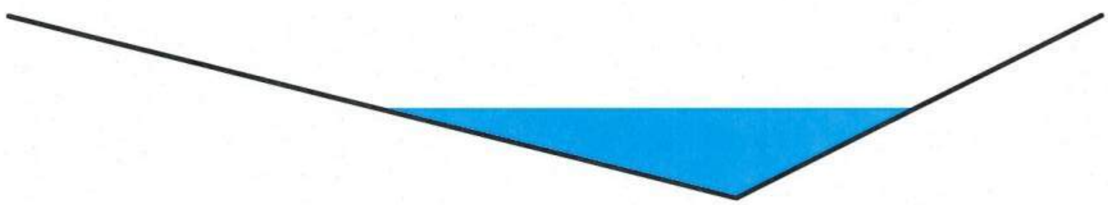
Summary for Reach B1S (.5%): Diversion Berm

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 18.81 cfs @ 12.44 hrs, Volume= 2.575 af
Outflow = 18.20 cfs @ 12.63 hrs, Volume= 2.575 af, Atten= 3%, Lag= 11.7 min

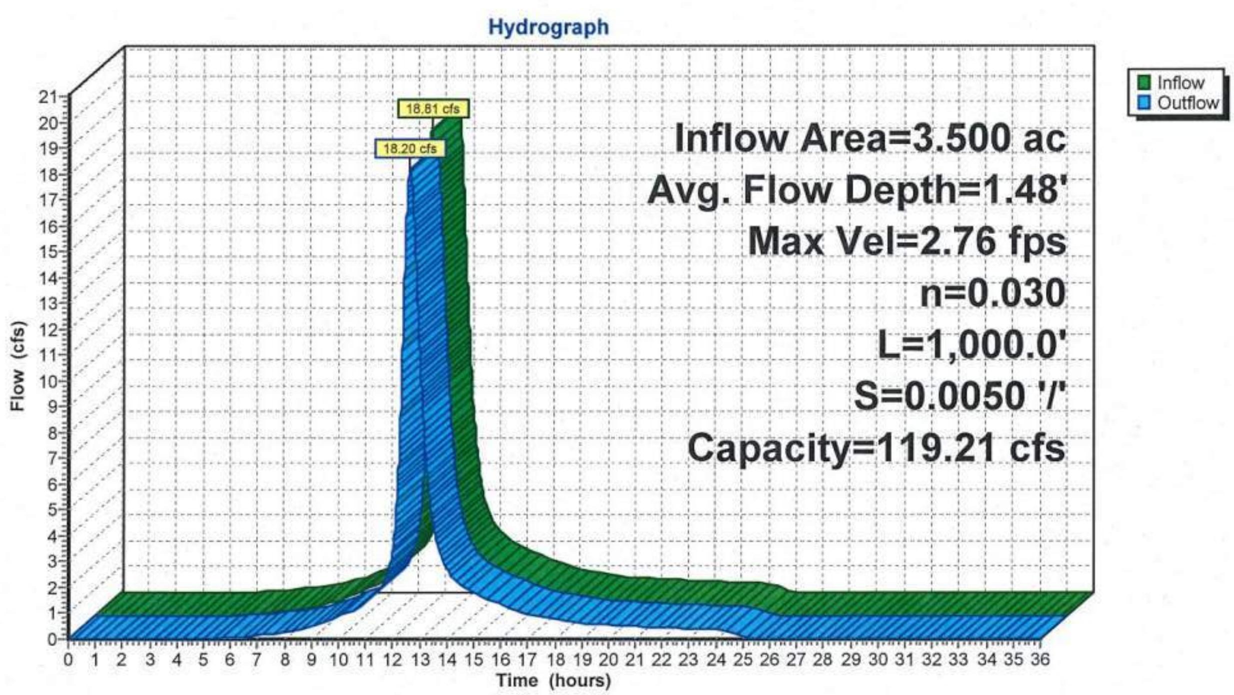
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.76 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 16.9 min

Peak Storage= 6,594 cf @ 12.53 hrs
Average Depth at Peak Storage= 1.48'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 119.21 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 63.00', Outlet Invert= 58.00'



Reach B1S (.5%): Diversion Berm



Diversion Berm Analysis Post NRCS 100 Yr *Type III 24-hr 100-Year Rainfall=11.50"*
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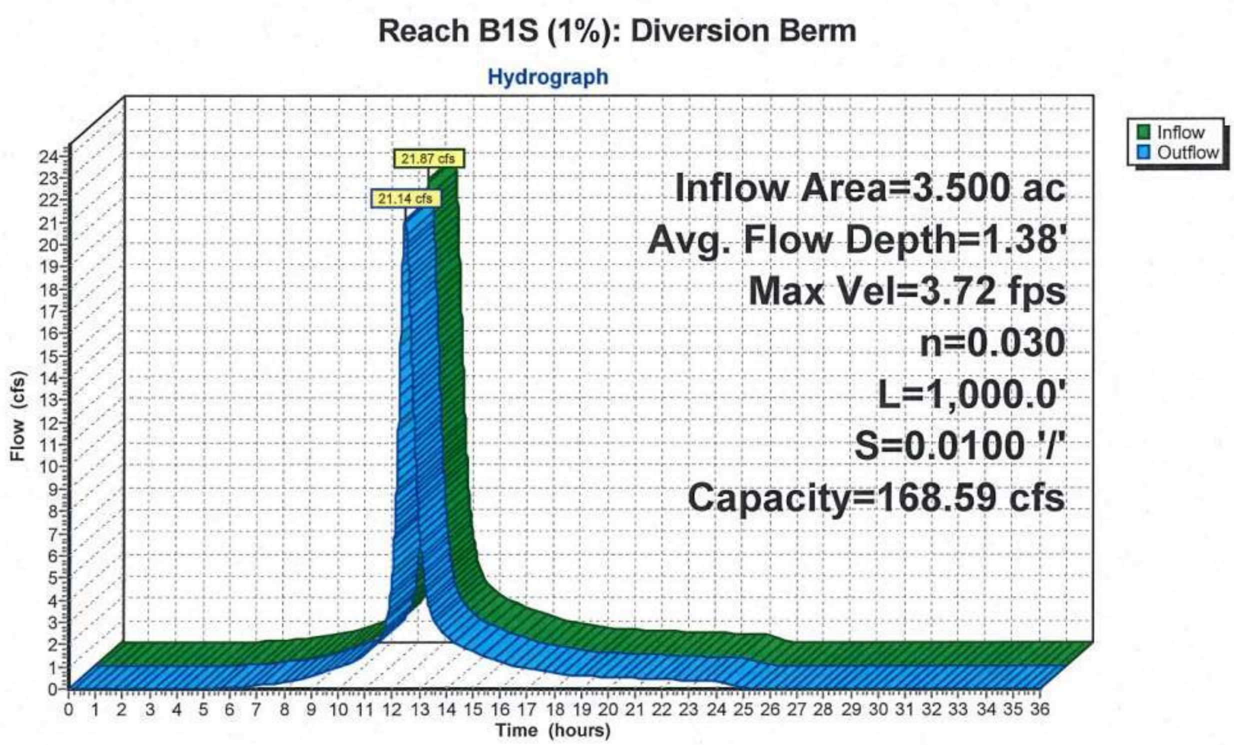
Summary for Reach B1S (1%): Diversion Berm

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 21.87 cfs @ 12.33 hrs, Volume= 2.575 af
Outflow = 21.14 cfs @ 12.46 hrs, Volume= 2.575 af, Atten= 3%, Lag= 7.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.72 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 12.2 min

Peak Storage= 5,691 cf @ 12.39 hrs
Average Depth at Peak Storage= 1.38'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 168.59 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0100 '/'
Inlet Invert= 68.00', Outlet Invert= 58.00'



Summary for Reach B1T (.5%): Diversion Berm

Inflow Area = 8.740 ac, 0.00% Impervious, Inflow Depth = 8.83" for 100-Year event
Inflow = 60.17 cfs @ 12.26 hrs, Volume= 6.430 af
Outflow = 57.74 cfs @ 12.38 hrs, Volume= 6.430 af, Atten= 4%, Lag= 7.3 min

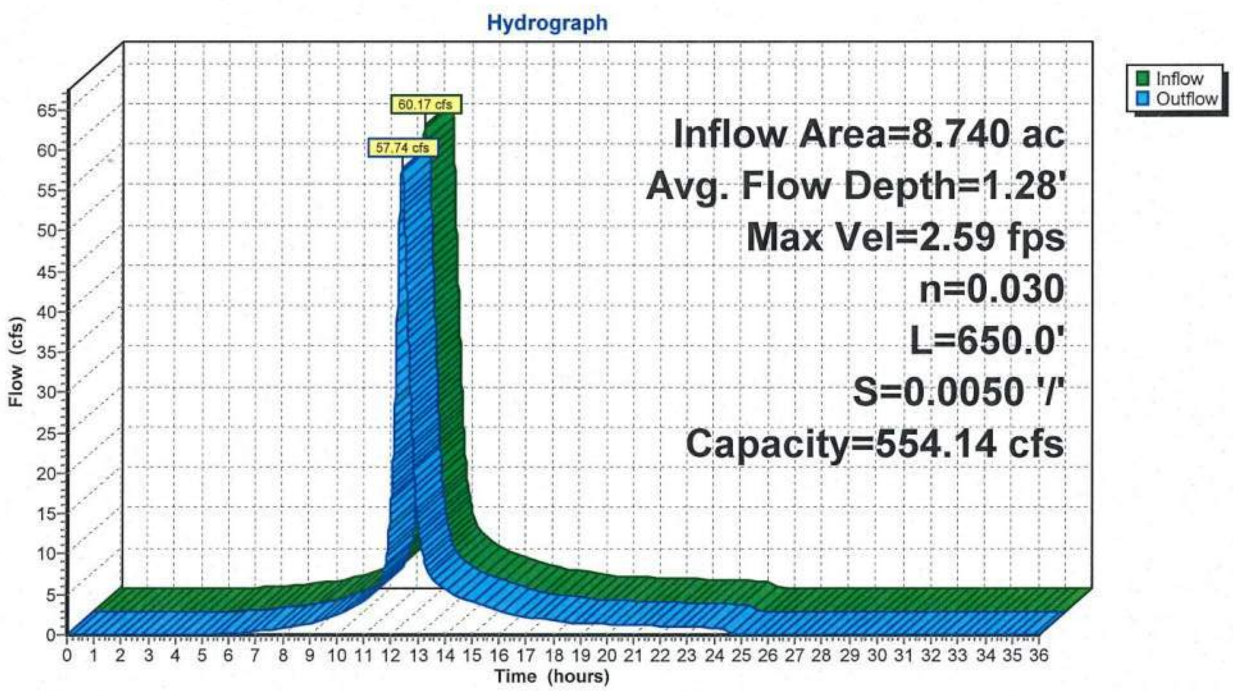
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.59 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 11.8 min

Peak Storage= 14,484 cf @ 12.31 hrs
Average Depth at Peak Storage= 1.28'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 554.14 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0050 '/'
Inlet Invert= 175.25', Outlet Invert= 172.00'

‡

Reach B1T (.5%): Diversion Berm



Diversion Berm Analysis Post NRCS 100 Yr *Type III 24-hr 100-Year Rainfall=11.50"*
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Summary for Reach B1T (1%): Diversion Berm

Inflow Area =	8.740 ac,	0.00% Impervious, Inflow Depth = 8.83"		for 100-Year event
Inflow =	65.04 cfs @	12.21 hrs, Volume=	6.430 af	
Outflow =	62.81 cfs @	12.31 hrs, Volume=	6.430 af, Atten= 3%, Lag= 5.6 min	

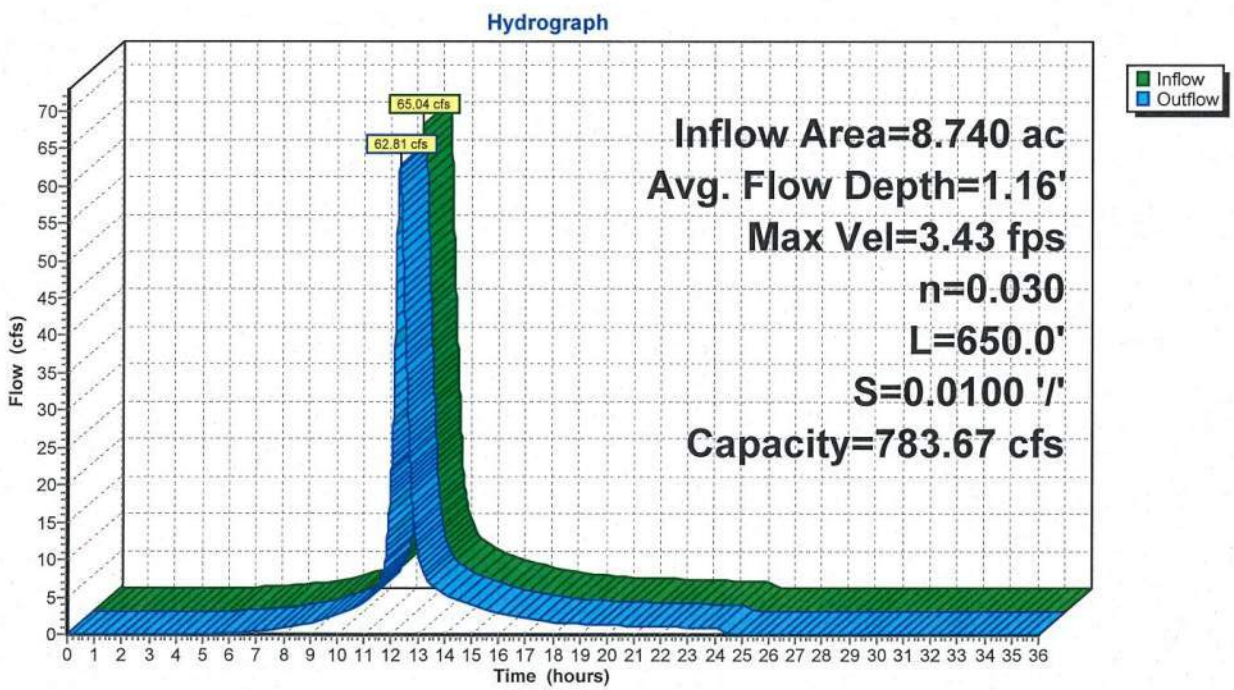
Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.43 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 8.6 min

Peak Storage= 11,899 cf @ 12.25 hrs
Average Depth at Peak Storage= 1.16'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 783.67 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0100 '/'
Inlet Invert= 178.50', Outlet Invert= 172.00'

‡

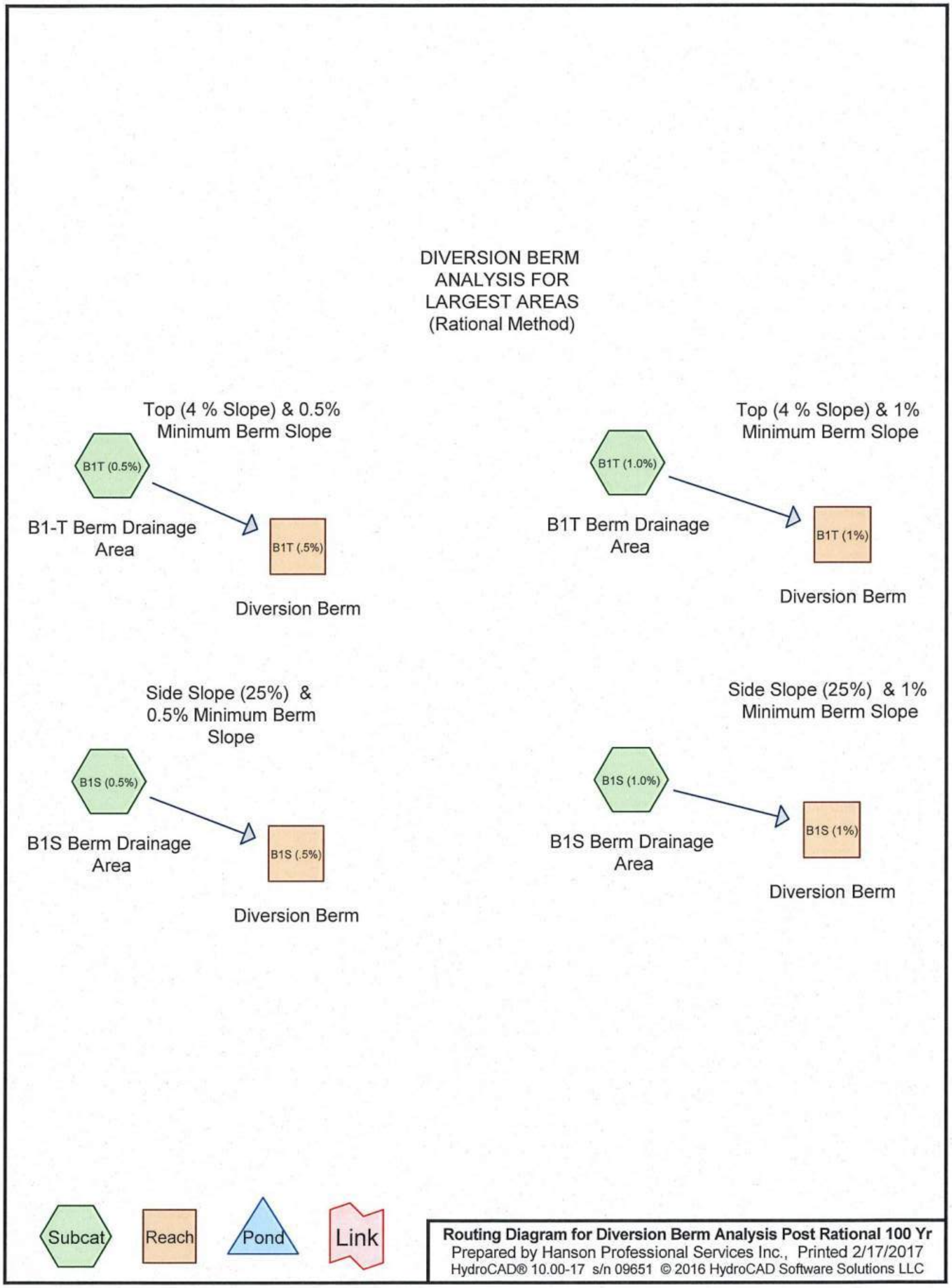
Reach B1T (1%): Diversion Berm



APPENDIX 6B.15.12

HYDROCAD MODEL 100 YEAR POST DEVELOPMENT DIVERSION BERMS (RATIONAL METHOD)

STATE OF TEXAS
JOSE C. GARZA
91790
LICENSED
PROFESSIONAL ENGINEER
09/12/18
Jose C. Garza, P.E.


DIVERSION BERM
ANALYSIS FOR
LARGEST AREAS
(Rational Method)
Top (4 % Slope) & 0.5%
Minimum Berm Slope
B1T (0.5%)
B1-T Berm Drainage
Area
B1T (.5%)
Diversion Berm
Top (4 % Slope) & 1%
Minimum Berm Slope
B1T (1.0%)
B1T Berm Drainage
Area
B1T (1%)
Diversion Berm
Side Slope (25%) &
0.5% Minimum Berm
Slope
B1S (0.5%)
B1S Berm Drainage
Area
B1S (.5%)
Diversion Berm
Side Slope (25%) & 1%
Minimum Berm Slope
B1S (1.0%)
B1S Berm Drainage
Area
B1S (1%)
Diversion Berm
Subcat
Reach
Pond
Link
Routing Diagram for Diversion Berm Analysis Post Rational 100 Yr
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Diversion Berm Analysis Post Rational 100 Yr
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Area Listing (all nodes)

Area (acres)	C	Description (subcatchment-numbers)
24.480	0.70	50-75% Grass cover, Fair, HSG C (B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%))
24.480	**0.70**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
24.480	HSG C	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	HSG D	
0.000	Other	
24.480		**TOTAL AREA**

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	24.480	0.000	0.000	24.480	50-75% Grass cover, Fair	B1S (0.5%), B1S (1.0%), B1T (0.5%), B1T (1.0%)
0.000	**0.000**	**24.480**	**0.000**	**0.000**	**24.480**	**TOTAL AREA**	

Diversion Berm Analysis Post Rational 100 Yr *Rainfall Duration=10 min, Inten=11.30 in/hr*
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Time span=0.00-2.00 hrs, dt=0.01 hrs, 201 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment B1S (0.5%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=1.32"
Tc=10.0 min C=0.70 Runoff=27.43 cfs 0.384 af

Subcatchment B1S (1.0%): B1S Berm Runoff Area=3.500 ac 0.00% Impervious Runoff Depth=1.32"
Tc=10.0 min C=0.70 Runoff=27.43 cfs 0.384 af

Subcatchment B1T (0.5%): B1-T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=1.32"
Tc=10.0 min C=0.70 Runoff=68.49 cfs 0.960 af

Subcatchment B1T (1.0%): B1T Berm Runoff Area=8.740 ac 0.00% Impervious Runoff Depth=1.32"
Tc=10.0 min C=0.70 Runoff=68.49 cfs 0.960 af

Reach B1S (.5%): Diversion Berm Avg. Flow Depth=1.50' Max Vel=2.78 fps Inflow=27.43 cfs 0.384 af
n=0.030 L=1,000.0' S=0.0050 '/' Capacity=119.21 cfs Outflow=18.73 cfs 0.384 af

Reach B1S (1%): Diversion Berm Avg. Flow Depth=1.37' Max Vel=3.70 fps Inflow=27.43 cfs 0.384 af
n=0.030 L=1,000.0' S=0.0100 '/' Capacity=168.59 cfs Outflow=20.70 cfs 0.384 af

Reach B1T (.5%): Diversion Berm Avg. Flow Depth=1.24' Max Vel=2.53 fps Inflow=68.49 cfs 0.960 af
n=0.030 L=650.0' S=0.0050 '/' Capacity=554.14 cfs Outflow=52.59 cfs 0.959 af

Reach B1T (1%): Diversion Berm Avg. Flow Depth=1.12' Max Vel=3.35 fps Inflow=68.49 cfs 0.960 af
n=0.030 L=650.0' S=0.0100 '/' Capacity=783.67 cfs Outflow=56.63 cfs 0.960 af

Total Runoff Area = 24.480 ac Runoff Volume = 2.688 af Average Runoff Depth = 1.32"
100.00% Pervious = 24.480 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment B1S (0.5%): B1S Berm Drainage Area

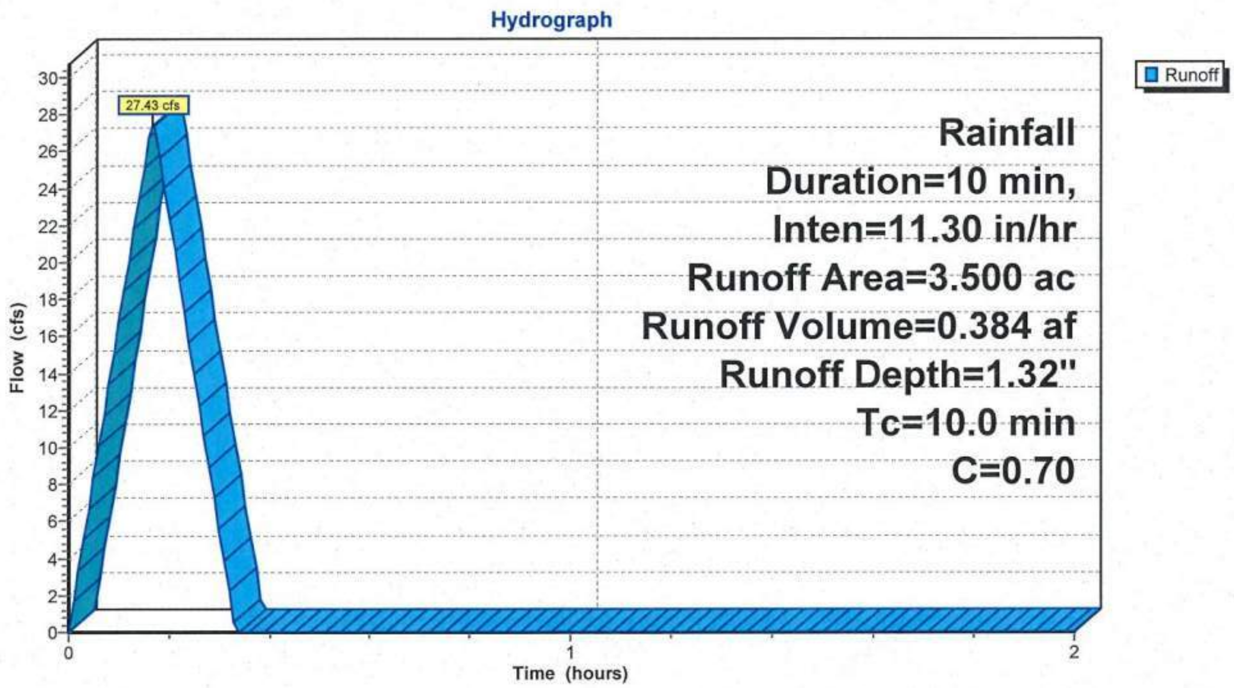
Runoff = 27.43 cfs @ 0.17 hrs, Volume= 0.384 af, Depth= 1.32"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=11.30 in/hr

Area (ac)	C	Description
3.500	0.70	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S Swale Drainage Area**

Subcatchment B1S (0.5%): B1S Berm Drainage Area



Summary for Subcatchment B1S (1.0%): B1S Berm Drainage Area

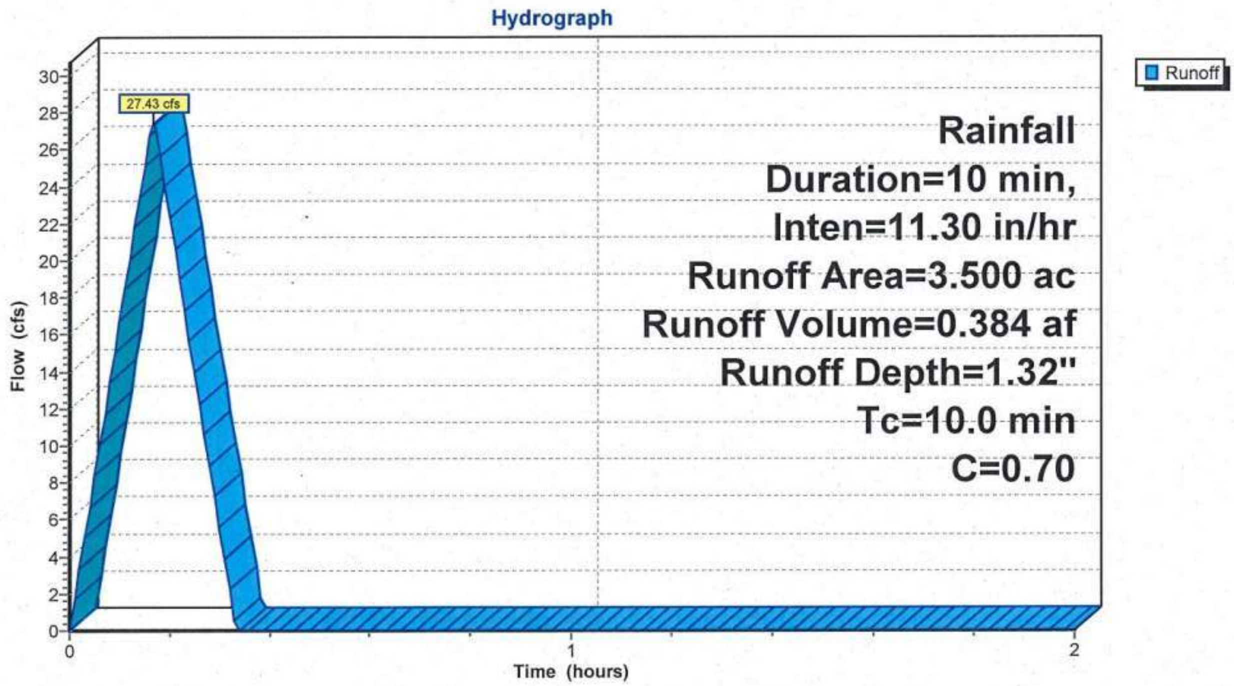
Runoff = 27.43 cfs @ 0.17 hrs, Volume= 0.384 af, Depth= 1.32"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=11.30 in/hr

Area (ac)	C	Description
3.500	0.70	50-75% Grass cover, Fair, HSG C
3.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1S Drainage Area**

Subcatchment B1S (1.0%): B1S Berm Drainage Area



Summary for Subcatchment B1T (0.5%): B1-T Berm Drainage Area

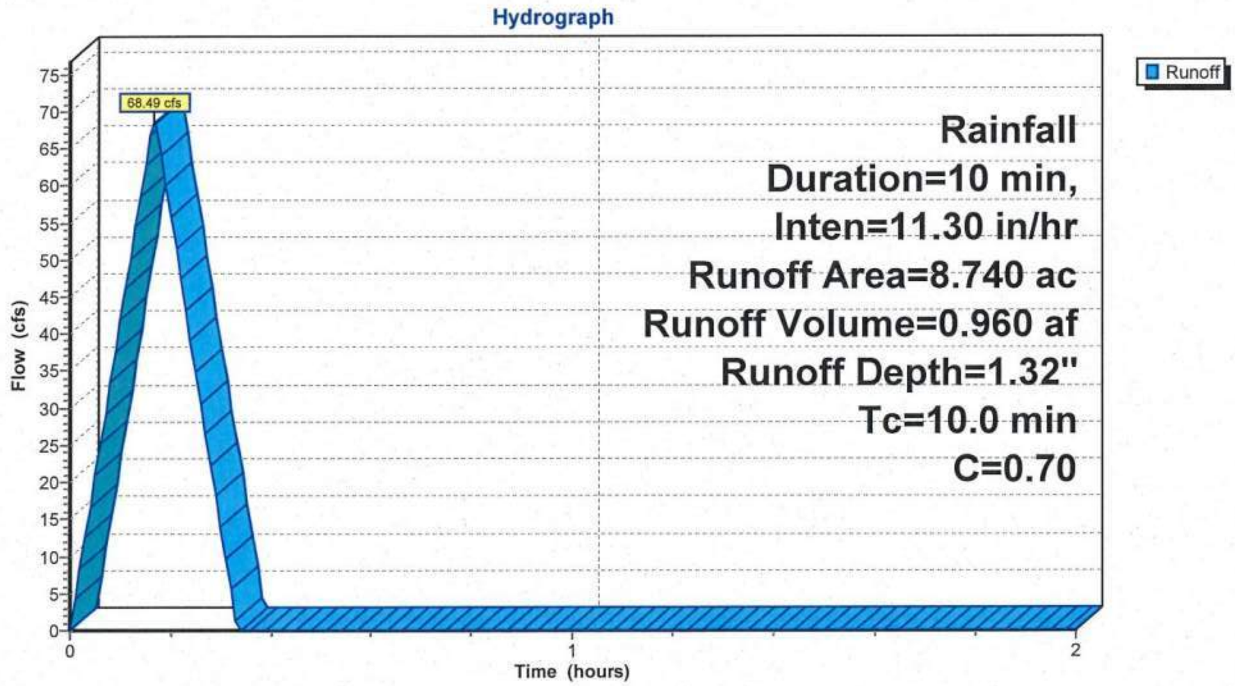
Runoff = 68.49 cfs @ 0.17 hrs, Volume= 0.960 af, Depth= 1.32"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=11.30 in/hr

Area (ac)	C	Description
8.740	0.70	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1T Swale Drainage Area**

Subcatchment B1T (0.5%): B1-T Berm Drainage Area



Summary for Subcatchment B1T (1.0%): B1T Berm Drainage Area

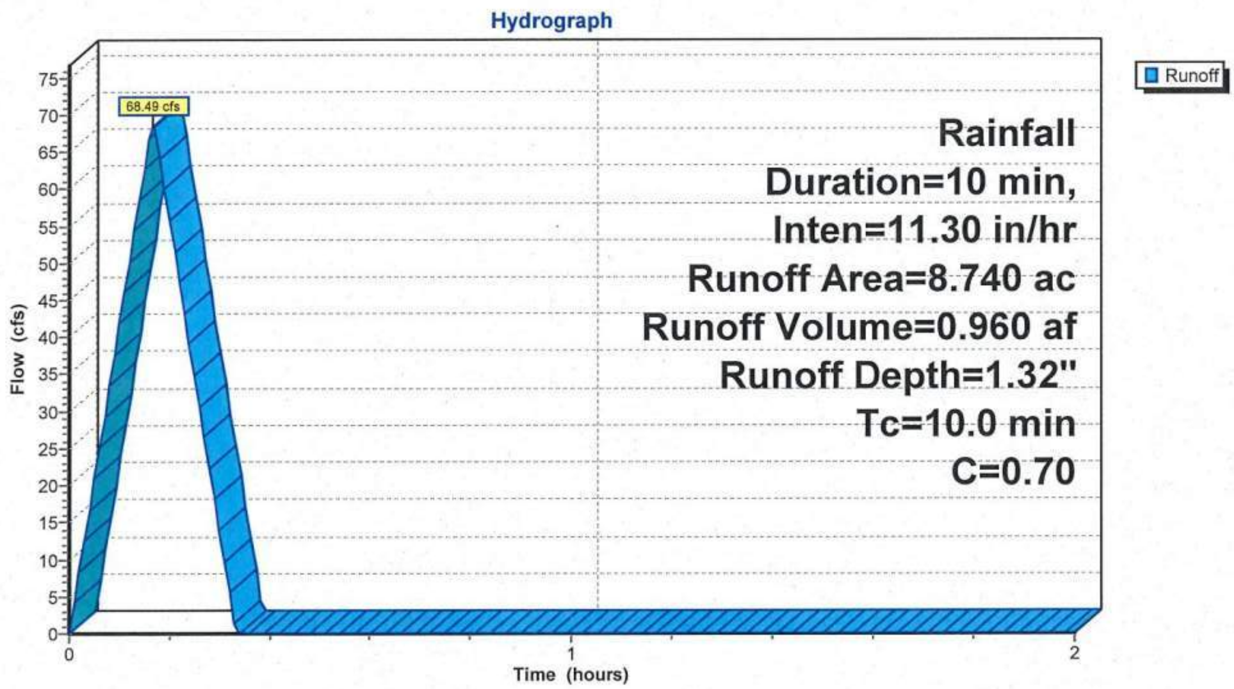
Runoff = 68.49 cfs @ 0.17 hrs, Volume= 0.960 af, Depth= 1.32"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Rainfall Duration=10 min, Inten=11.30 in/hr

Area (ac)	C	Description
8.740	0.70	50-75% Grass cover, Fair, HSG C
8.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, B1T Swale Drainage Area**

Subcatchment B1T (1.0%): B1T Berm Drainage Area



Diversion Berm Analysis Post Rational 100 Yr *Rainfall Duration=10 min, Inten=11.30 in/hr*
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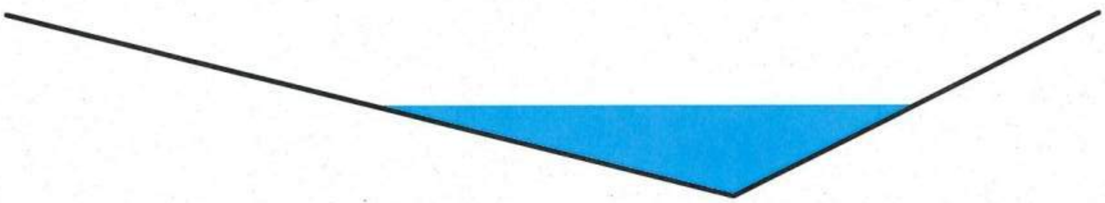
Summary for Reach B1S (.5%): Diversion Berm

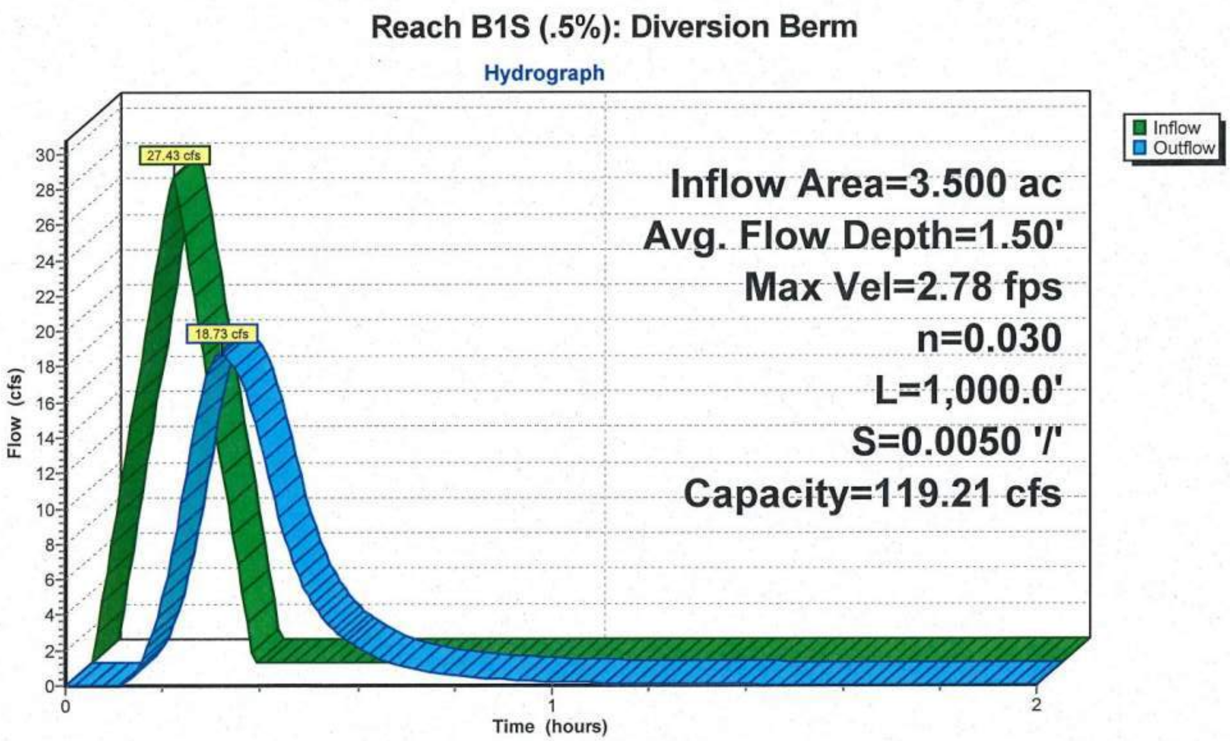
Inflow Area =	3.500 ac,	0.00% Impervious,	Inflow Depth = 1.32"	
Inflow =	27.43 cfs @	0.17 hrs, Volume=	0.384 af	
Outflow =	18.73 cfs @	0.32 hrs, Volume=	0.384 af,	Atten= 32%, Lag= 9.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.78 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 15.2 min

Peak Storage= 6,739 cf @ 0.22 hrs
Average Depth at Peak Storage= 1.50'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 119.21 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0050 '/'
Inlet Invert= 63.00', Outlet Invert= 58.00'





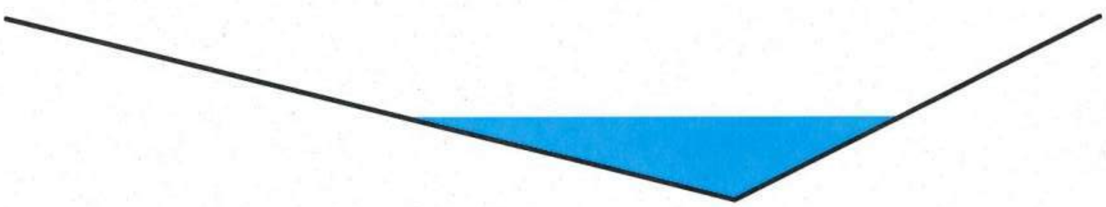
Summary for Reach B1S (1%): Diversion Berm

Inflow Area =	3.500 ac,	0.00% Impervious, Inflow Depth = 1.32"		
Inflow =	27.43 cfs @	0.17 hrs, Volume=	0.384 af	
Outflow =	20.70 cfs @	0.29 hrs, Volume=	0.384 af,	Atten= 25%, Lag= 7.1 min

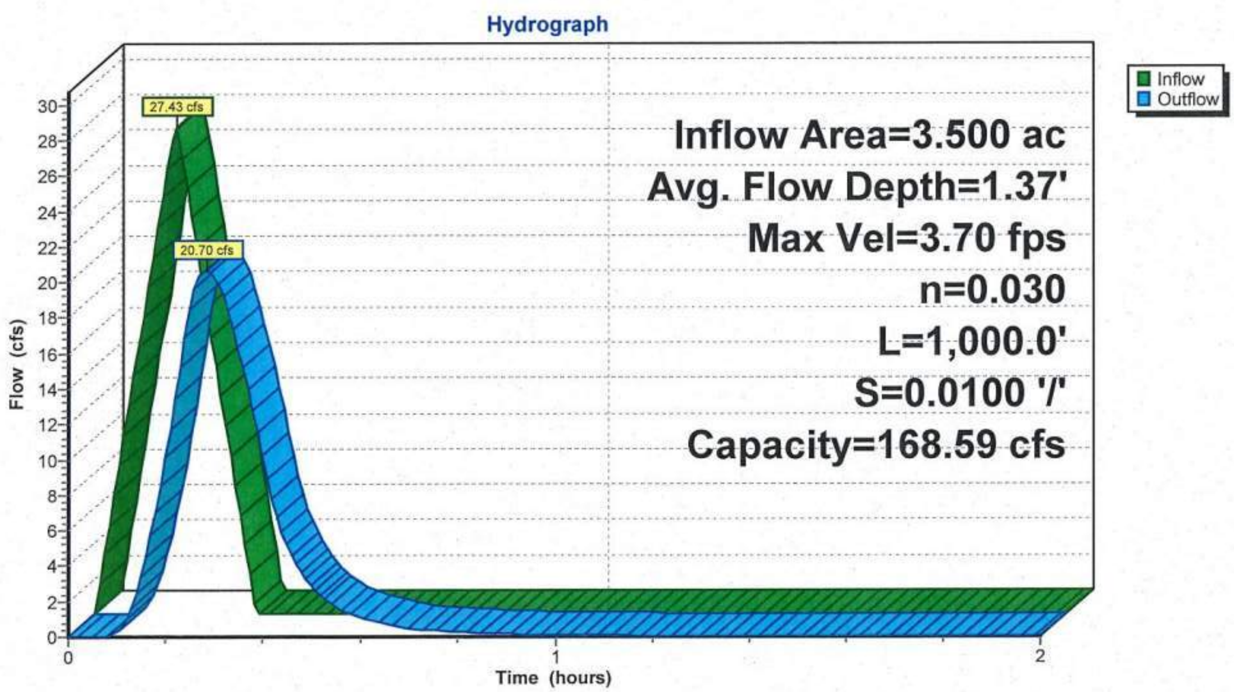
Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.70 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.30 fps, Avg. Travel Time= 12.8 min

Peak Storage= 5,608 cf @ 0.21 hrs
Average Depth at Peak Storage= 1.37'
Bank-Full Depth= 3.00' Flow Area= 27.0 sf, Capacity= 168.59 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 4.0 2.0 '/' Top Width= 18.00'
Length= 1,000.0' Slope= 0.0100 '/'
Inlet Invert= 68.00', Outlet Invert= 58.00'



Reach B1S (1%): Diversion Berm



Summary for Reach B1T (.5%): Diversion Berm

Inflow Area = 8.740 ac, 0.00% Impervious, Inflow Depth = 1.32"
Inflow = 68.49 cfs @ 0.17 hrs, Volume= 0.960 af
Outflow = 52.59 cfs @ 0.28 hrs, Volume= 0.959 af, Atten= 23%, Lag= 6.7 min

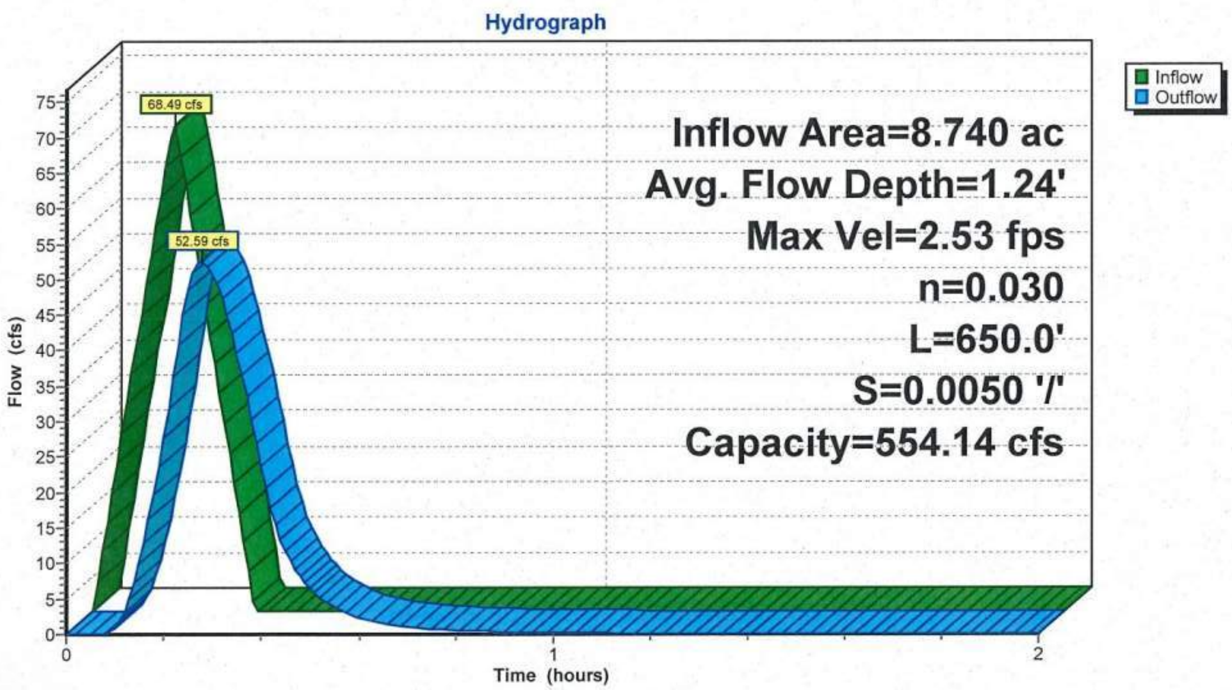
Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.53 fps, Min. Travel Time= 4.3 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 12.4 min

Peak Storage= 13,511 cf @ 0.21 hrs
Average Depth at Peak Storage= 1.24'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 554.14 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0050 '/'
Inlet Invert= 175.25', Outlet Invert= 172.00'

‡

Reach B1T (.5%): Diversion Berm



Diversion Berm Analysis Post Rational 100 Yr *Rainfall Duration=10 min, Inten=11.30 in/hr*
Prepared by Hanson Professional Services Inc. Printed 2/17/2017
HydroCAD® 10.00-17 s/n 09651 © 2016 HydroCAD Software Solutions LLC Page 13

Summary for Reach B1T (1%): Diversion Berm

Inflow Area =	8.740 ac,	0.00% Impervious, Inflow Depth = 1.32"	
Inflow =	68.49 cfs @	0.17 hrs, Volume=	0.960 af
Outflow =	56.63 cfs @	0.25 hrs, Volume=	0.960 af, Atten= 17%, Lag= 5.1 min

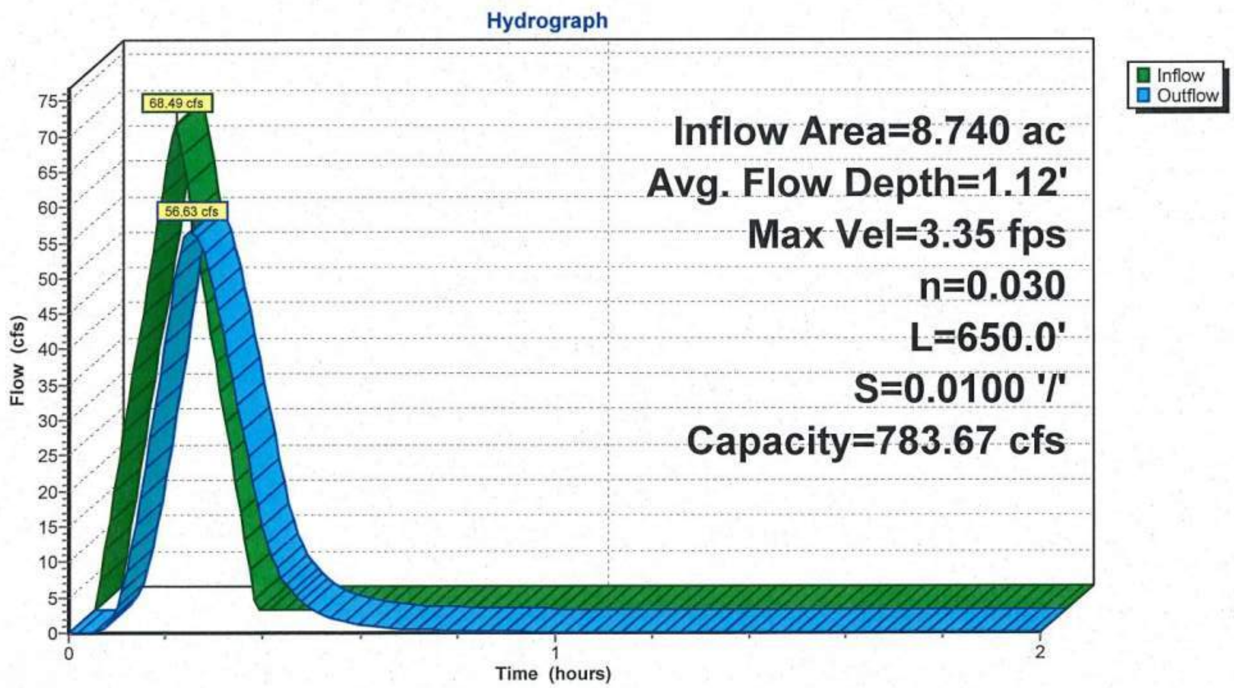
Routing by Stor-Ind+Trans method, Time Span= 0.00-2.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.35 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 10.4 min

Peak Storage= 11,022 cf @ 0.20 hrs
Average Depth at Peak Storage= 1.12'
Bank-Full Depth= 3.00' Flow Area= 121.5 sf, Capacity= 783.67 cfs

0.00' x 3.00' deep channel, n= 0.030 Earth, grassed & winding
Side Slope Z-value= 25.0 2.0 '/' Top Width= 81.00'
Length= 650.0' Slope= 0.0100 '/'
Inlet Invert= 178.50', Outlet Invert= 172.00'

‡

Reach B1T (1%): Diversion Berm



APPENDIX 6B.15.13

SUMMARY OF 100 YEAR INTENSITY FLOW RATES BY RATIONAL METHOD AND NRCS METHOD FOR SWALE DESIGN

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Required: Determine the 100-year intensity flow rates by rational method and NRCS Method
Use the calcuclated flow rates for swale design

Assumptions: Largest Drainage Area for Swale on 25:1 (4% slope) is B1T
Largest Drainage Area for Swale on 4:1 (25% slope) is B1S
Tc = 10 minutes (minimum allowed, TxDOT Hydraulic Design Manual)
CN = 79 (50-75% Grass Cover, Fair, HSG C)
Minimum swale slope = **1** **%**
Manning's n= **0.03** (earth, grassed & winding)

Rational Method

Q = CIA
Where; C = Runoff Coefficient = **0.7** (Use Conservative Runoff Coefficient Value of 0.7)
I = Rainfall intensity, in/hr
A = Drainage Area, Ac

$$I = \frac{b}{(Tc + d)^e}$$

Where; b= 99 TxDOT Hydraulic Design Manual (12-85)
d= 9.4 Values for Kleberg County, 100-year storm event
e= 0.731
Tc= 10
I = 11.3 in/hr

Conclusion:

Max Calculated Swale Depth	**1.38**	ft
Proposed Swale Depth	**3**	ft
Calculated Depth < Proposed Depth	**TRUE**	
Max CalculatedFlow Velocity	**3.73**	ft
Max Design Velocity	5	fps
Calculated Velocity < Design Velocity	**TRUE**	

SUMMARY OF 100-YEAR INTENSITY FLOW RATES BY RATIONAL METHOD AND NRCS METHOD FOR SWALE DESIGN

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth *	Flow Velocity
			Rational Method *	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	68.5	25	2	56.8	**1.12**	3.35
B1S	1.20	0.0019	27.4	4	2	20.9	**1.37**	3.71

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth **	Flow Velocity
			NRCS Method **	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	65.0	25	2	62.4	**1.16**	3.43
B1S	1.20	0.0019	21.9	4	2	21.3	**1.38**	3.73

*** Rational method values as determined by HydroCad comparable to NRCS Method but slightly less . Therefore, use NRCS method for swale design.**

**** NRCS Method as determined by HydroCad swale design.**

Required: Determine the 25-year intensity flow rates by Rational Method and NRCS Method
Use the calcuclated flow rates for swale design

Assumptions: Largest Drainage Area for Swale on 25:1 (4% slope) is B1T
Largest Drainage Area for Swale on 4:1 (25% slope) is B1S
Tc = 10 minutes (minimum allowed, TxDOT Hydraulic Design Manual)
CN = 79 (50-75% Grass Cover, Fair, HSG C)
Minimum swale slope = 1 %
Manning's n= **0.03** (earth, grassed & winding)

Rational Method

Q = CIA

Where; C = Runoff Coefficient = **0.7** (Use Conservative Runoff Coefficient Value of 0.7)
I = Rainfall intensity, in/hr
A = Drainage Area, Ac

$$I = \frac{b}{(Tc + d)^e}$$

Where; b= 93 TxDOT Hydraulic Design Manual (12-85)
d= 8.7 Values for Kleberg County, 25-year storm event
e= 0.761
Tc= 10
I = 10.0 in/hr

Conclusion:

Max Calculated Swale Depth***	**1.30**	ft
Proposed Swale Depth	3	ft
Calculated Depth < Proposed Depth	**TRUE**	
Max CalculatedFlow Velocity	**3.59**	ft
Max Design Velocity	5	fps
Calculated Velocity < Design Velocity	**TRUE**	

SUMMARY OF 25-YEAR INTENSITY FLOW RATES BY RATIONAL AND NRCS METHOD FOR SWALE DESIGN

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth *	Flow Velocity
			Rational Method *	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	60.6	25	2	50.3	**1.07**	3.25
B1S	1.20	0.0019	24.3	4	2	18.2	**1.30**	3.59

Swale	Area (Ac)	Area (Sq. Mi)	Peak Flow Rate (cfs)	Swale Normal Depth Analysis				
				Left slope	Right slope	Bankfull Flow	Normal Depth **	Flow Velocity
			NRCS Method **	(Z hor:1 vert)	(Z hor:1 vert)	(cfs)	(ft)	(fps)
B1T	8.74	0.0137	46.1	25	2	44.2	**1.02**	3.15
B1S	1.20	0.0019	15.5	4	2	15.0	**1.21**	3.42

*** Rational method values as determined by HydroCad comparable to NRCS Method but slightly higher .**

**** NRCS Method as determined by HydroCad swale design.**

***** Check Max Calculated Swale Depth for 100-year storm event**

APPENDIX 6B.15.14

WORKING FACE CONTAINMENT AND DIVERSION BERMS

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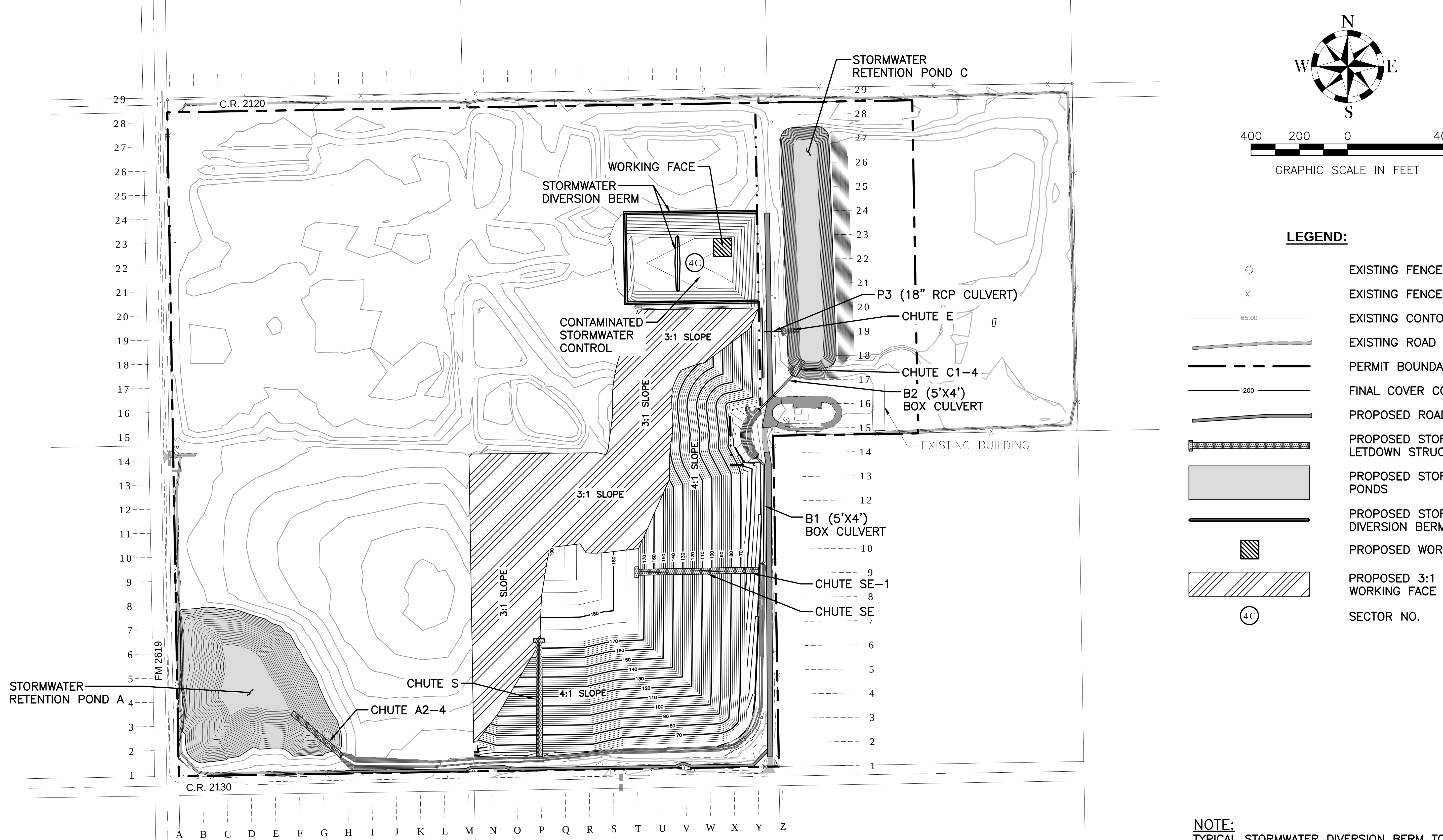

LEGEND:

○	EXISTING FENCE CORNER
—x—	EXISTING FENCE
—65.00—	EXISTING CONTOUR
	EXISTING ROAD
	PERMIT BOUNDARY LIMITS
—200—	FINAL COVER CONTOURS
	PROPOSED ROAD
	PROPOSED STORMWATER LETDOWN STRUCTURE
	PROPOSED STORMWATER PONDS
	PROPOSED STORMWATER DIVERSION BERM
	PROPOSED WORKING FACE
	PROPOSED 3:1 SLOPE WORKING FACE
4C	SECTOR NO.

NOTE:
TYPICAL STORMWATER DIVERSION BERM TO PREVENT STORMWATER RUN-ON AND CONTAMINATED STORMWATER RUN-OFF AT TYPICAL SECTOR 4C CONSTRUCTION SEQUENCE.

SEP 11, 2018 2:29 PM TORRE01809
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NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JOSE C. GARZA
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09/12/18
Jose C. Garza, P.E.

Hanson No. 16L0438
Filename
Scale 1"=400'
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 6, APPENDIX 6B.15.14
WORKING FACE CONTAINMENT & DIVERSION BERMS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.15.14

APPENDIX 6B.16

SOIL LOSS ESTIMATE FOR FINAL COVER

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APPENDIX 6B.16.1

REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE) FOR TOP OF SLOPE (4%) AND SIDE SLOPE (25%) INTERIM COVER & POST CLOSURE

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Jose C. Garza, P.E.

R Factor - Rainfall and Runoff

The R factor is based on the erosive power of rainfall events common to the area. Sometimes called the "erosive index," R values were developed for each region using weather records for maximum rainfall intensity and kinetic energy.

Initial R-factor value - The first option in selecting an R value is to take it directly from the isoerodent maps

R	270

** Refer to Figures 2-1 of the ARS Handbook #703

Adjusted R value - For fields with very low slopes and in ares with high rainfall, the R value will be modified to reflect the absorbtion raindrop impact by ponded water

** Ponding adjustment factors included in chapter 2 - ARS Handbook #703

Rainfall-Runoff Erosivity Factor (R)

Figure 2-1. Isoerodent map of eastern United States. Units are hundreds ft·tonf·in(ac·h·yr)$^{-1}$.

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K Factor - Erodibility

The soil erodibility factor, K, indicates the inherent susceptibility of a soil to erode. Two soil properties, infiltration capacity and structural stability, exert the greatest influence on erosion. These features, in turn, are related to a soil's organic matter and clay content, clay type, depth to an impervious layer, and tendency to crust.

Soils that do not erode readily have K values less than 0.2, while values greater than 0.3 indicate high erodibility.

At sites with more than one soil, select the soil with the greatest K value. Practices that control erosion from this soil control erosion from other site soils.

K	0.24

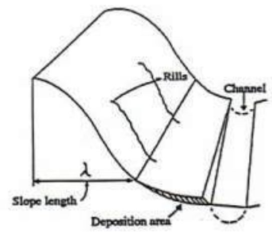
** Max of all site soils (USDA websoil survey)
See USDA websoil survey data downloaded for the Kingsville Landfill area.

K Factor, Whole Soil— Summary by Map Unit — Kenedy and Kleberg Counties, Texas (TX613)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CkA	Clareville clay loam, 0 to 1 percent slopes	.24	22.9	9.3%
CmA	Colmena fine sandy loam, 0 to 1 percent slopes	.20	16.2	6.6%
CmB	Colmena fine sandy loam, 1 to 3 percent slopes	.20	21.1	8.6%
PIT	Pits, quarry		165.9	67.5%
PtB	Premont fine sandy loam, 0 to 3 percent slopes	.20	19.6	8.0%
Totals for Area of Interest			**245.6**	**100.0%**

LS Factor - Topography

The effect of slope length and steepness on water erosion appears in the LS, or topography, factor. Erosion increases when either the length of the slope increases, the steepness of the slope increases, or both.

Step 1. Slope length (λ)	
λ	200
Step 2. Slope steepness	
Rise	1
Run (Z)	4
Percent Slope	25.0
Step 2. Slope Angle	
Slope angle (degrees)	14.04
Slope angle (radians)	0.245
Step 3. slope-length exponent (m)	
Slope-length exponent (m)	0.64
Step 4. Calculate, L, S and LS Factors	
L	1.91
S	3.57
LS Factor	6.84



** Table 4-5, ARS Handbook # 703

** Equations 4-1, ARS Handbook # 703
** Equations 4-7 and 4-8, ARS Handbook # 703

Chapter 4.

Table 4-5.
Slope-length exponents (m) for a range of slopes and rill/interrill erosion classes[1]

Slope (%)	Rill/interrill ratio Low	Moderate	High
0.2	0.02	0.04	0.07
0.5	0.04	0.08	0.16
1.0	0.08	0.15	0.26
2.0	0.14	0.24	0.39
3.0	0.18	0.31	0.47
4.0	0.22	0.36	0.53
5.0	0.25	0.40	0.57
6.0	0.28	0.43	0.60
8.0	0.32	0.48	0.65
10.0	0.35	0.52	0.68
12.0	0.37	0.55	0.71
14.0	0.40	0.57	0.72
16.0	0.41	0.59	0.74
20.0	0.44	0.61	0.76
25.0	0.47	0.64	0.78
30.0	0.49	0.66	0.79
40.0	0.52	0.68	0.81
50.0	0.54	0.70	0.82
60.0	0.55	0.71	0.83

Use 0.64 for 25% Slope

[1]Not applicable to thawing soils

Source: McCool et al. (1989).

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C Factor - Cover Management

The C factor is used to reflect the effect of cropping and management practices on erosion rates. The C factor indicates how the conservation plan will affect the average annual soil loss and how that soil-loss potential will be distributed in time during construction activities, crop rotations, or other management schemes.

Condition	C- Factor	
Interim Conditions	0.042	** 60% ground cover, no appreciable canopy (Table 10, AH_537)
Final Conditions	0.006	** 90% cover, no appreciable canopy (Interpolated from Table 10, AH_537)

tion and developmental areas can be obtained from table 5 if good judgment is exercised in comparing the surface conditions with those of agricultural conditions specified in lines of the table. Time intervals analogous to cropstage periods will be defined to begin and end with successive construction or management activities that appreciably change the surface conditions. The procedure is then similar to that described for cropland.

Establishing vegetation on the denuded areas as quickly as possible is highly important. A good sod has a **C** value of 0.01 or less (table 5-B), but such a low **C** value can be obtained quickly only by laying sod on the area, at a substantial cost. When grass or small grain is started from seed, the probable soil loss for the period while cover is developing can be computed by the procedure outlined for estimating cropstage-period soil losses. If the seeding is on topsoil, without a mulch, the soil loss ratios given in line 141 of table 5 are appropriate for cropstage **C** values. If the seeding is on a desurfaced area, where residual effects of prior vegetation are no longer significant, the ratios for periods SB, 1 and 2 are 1.0, 0.75 and 0.50, respectively, and line 141 applies for cropstage 3. When the seedbed is protected by a mulch, the pertinent mulch factor from the upper curve of figure 6 or table 9 is applicable until good canopy cover is attained. The combined effects of vegetative mulch and low-growing canopy are given in figure 7. When grass is established in small grain, it can usually be evaluated as established meadow about 2 mo after the grain is cut.

C Values for Pasture, Range, and Idle Land

Factor **C** for a specific combination of cover conditions on these types of land may be obtained from table 10 (57). The cover characteristics that must be appraised before consulting this table are defined in the table and its footnotes. Cropstage periods and EI monthly distribution data are generally not necessary where perennial vegetation has become established and there is no mechanical disturbance of the soil.

Available soil loss data from undisturbed land were not sufficient to derive table 10 by direct comparison of measured soil loss rates, as was done for development of table 5. However, analyses of the assembled erosion data showed that the research information on values of **C** can be extended to completely different situations by combining subfactors that evaluate three separate and distinct, but interrelated, zones of influence: (a) vegetative cover in direct contact with the soil surface, (b) canopy cover, and (c) residual and tillage effects.

Subfactors for various percentages of surface cover by mulch are given by the upper curve of

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
Type and height[2]	Percent cover[3]	Type[4]	Percent ground cover 0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.
W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

P Factor - Erosion Control

The support practice factor (P) is the ratio of soil loss with a specific support practice to the corresponding loss with upslope and downslope tillage. These practices principally affect erosion by modifying the flow pattern, grade, or direction of surface runoff and by reducing the amount and rate of runoff.

P Factor	0.9	Post Closure
P Factor	1	Interim Cover

Support Practice	P Factor	
No erosion Control	1	
Terraces	0.5	3-8 % slope
Terraces	0.6	9-12 % slope
Terraces	0.7	13-16 % slope
Terraces	0.8	17-20% slope
Terraces	0.9	21-25 % slope

*** Table reproduced from Table 15 - AH 357

Terracing

The most common type of terrace on gently sloping land is the broadbase, with the channel and ridge cropped the same as the interterrace area. The steep backslope terrace is most common on steeper land. Difficulty in farming point rows associated with contoured terraces led to developing parallel terracing techniques (*16*). Underground outlets, landforming, and variable channel grades help establish parallel terraces. The underground outlets are in the low areas along the terrace line. The ridge is constructed across these areas. Another type of terrace, using a level and broad channel with either open or closed ends, was developed to conserve moisture in dryland farming areas.

Terraces with underground outlets, frequently called impoundment terraces, are highly effective for erosion control. Four-year losses from four such terrace systems in Iowa (*17*) averaged less than 0.4 t/A/year, which was less than 5 percent of the calculated soil movement to the channel. Comparable losses were measured from installations in Nebraska.

Terracing combined with contour farming and other conservation practices is more effective than those practices without the terraces because it positively divides the slope into segments equal to the horizontal terrace interval. The horizontal terrace interval for broadbase terraces is the distance from the center of the ridge to the center of the channel for the terrace below. For steep backslope terraces with the backslope in sod, it is the distance from the point where cultivation begins at the base of the ridge to the base of the frontslope of the terrace below (*44*). With terracing, the slope length is this terrace interval; with stripcropping or contouring alone, it is the entire field slope length.

P Values

Values of **P** for contour farming terraced fields are given in table 15. These values apply to contour farmed broadbase, steep backslope, and level terraces. However, recognize that the erosion control benefits of terraces are much greater than indicated by the **P** values. As pointed out earlier, soil loss per unit area on slopes of 5 percent or steeper is approximately proportional to the square root of slope length. Therefore, dividing a field slope into **n** approximately equal horizontal terrace intervals divides the average soil loss per unit area by the square root of **n**. This important erosion control benefit of terracing is not included in **P** because it is brought into the USLE computation through a reduced **LS** factor obtained by using the horizontal terrace interval as the slope length when entering figure 4 or table 3.

Erosion control between terraces depends on the crop system and other management practices evaluated by **C**. The total soil movement within a contour-farmed terrace interval may be assumed equal to that from the same length of an identical slope that is contoured only. Therefore, if a control level is desired that will maintain soil movement between the terraces within the soil loss tolerance limit, the **P** value for a contour-farmed terraced field should equal the contour factor (col. 2, table 15), and use of these values for farm planning purposes is generally recommended.

With contour stripcropping, the soil deposited in the grass strips is not considered lost because it remains on the field slope. With terraces, most of the deposition occurs in the terrace channels, but research measurements have shown that this deposition may equal 80 percent of the soil moved from the contour-farmed slopes between the terraces (*67*). Use of the contour factor as the **P** value for terracing assumes that all of the eroded soil deposited in the terrace channels is lost from the productive areas of the field. With broadbase terraces, the channels and ridges are cropped the same as

TABLE 15.—*P values for contour-farmed terraced fields*[1]

Land slope (percent)	Farm planning		Computing sediment yield[3]	
	Contour factor[2]	Stripcrop factor	Graded channels sod outlets	Steep backslope underground outlets
1 to 2	0.60	0.30	0.12	0.05
3 to 8	.50	.25	.10	.05
9 to 12	.60	.30	.12	.05
13 to 16	.70	.35	.14	.05
17 to 20	.80	.40	.16	.06
21 to 25	.90	.45	.18	.06

[1] Slope length is the horizontal terrace interval. The listed values are for contour farming. No additional contouring factor is used in the computation.

[2] Use these values for control of interterrace erosion within specified soil loss tolerances.

[3] These values include entrapment efficiency and are used for control of offsite sediment within limits and for estimating the field's contribution to watershed sediment yield.

RUSLE RESULTS

$$A = R * K * LS * C * P$$

Predicted Soil Loss		Condition
A =	2.39 tons/acre/year	Final Conditions

When:	R =	270	Slope:	25	%
	K =	0.24	Length:	200	feet
	LS =	6.84	Cover:	Rangeland (90% Cover)	
	C =	0.006	Practice:	Terraces	
	P =	0.90			

Predicted Soil Loss		Condition
A =	18.61 tons/acre/year	Interim Conditions

When:	R =	270	Slope:	25	%
	K =	0.24	Length:	200	feet
	LS =	6.84	Cover:	Rangeland (60% Cover)	
	C =	0.042	Practice:	No erosion Control	
	P =	1.00			

REVISED UNIVERSAL SOIL LOSS EQUATION (RUSLE) FOR TOP OF SLOPE (4%) INTERIM COVER & POST CLOSURE

STATE OF TEXAS
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R Factor - Rainfall and Runoff

The R factor is based on the erosive power of rainfall events common to the area. Sometimes called the "erosive index," R values were developed for each region using weather records for maximum rainfall intensity and kinetic energy.

Initial R-factor value - The first option in selecting an R value is to take it directly from the isoerodent maps

R	270

** Refer to Figures 2-1 of the ARS Handbook #703

Adjusted R value - For fields with very low slopes and in ares with high rainfall, the R value will be modified to reflect the absorbtion raindrop impact by ponded water

** Ponding adjustment factors included in chapter 2 - ARS Handbook #703

Rainfall-Runoff Erosivity Factor (R)

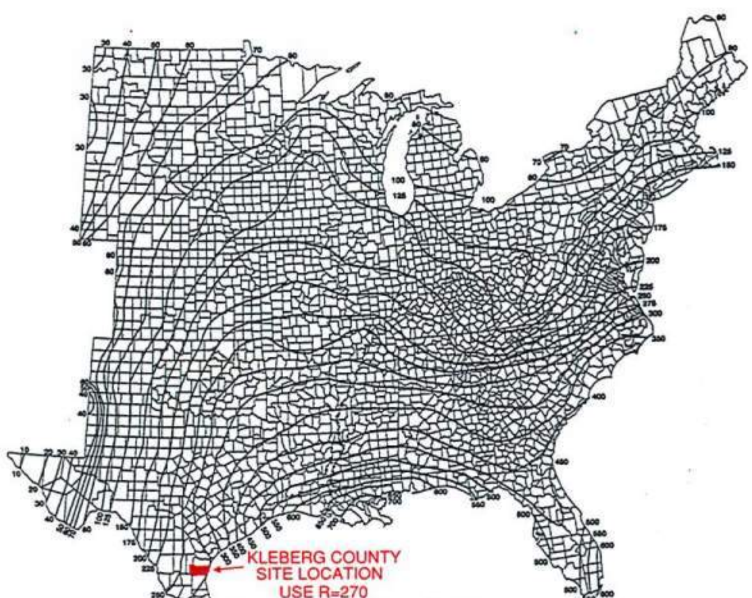


Figure 2-1. Isoerodent map of eastern United States. Units are hundreds ft·tonf·in(ac·h·yr)$^{-1}$.

47

K Factor - Erodibility

The soil erodibility factor, K, indicates the inherent susceptibility of a soil to erode. Two soil properties, infiltration capacity and structural stability, exert the greatest influence on erosion. These features, in turn, are related to a soil's organic matter and clay content, clay type, depth to an impervious layer, and tendency to crust.

Soils that do not erode readily have K values less than 0.2, while values greater than 0.3 indicate high erodibility.

At sites with more than one soil, select the soil with the greatest K value. Practices that control erosion from this soil control erosion from other site soils.

K	0.24

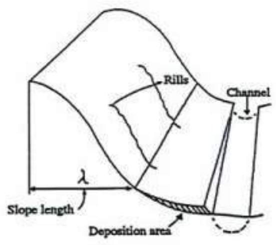
** Max of all site soils (USDA websoil survey)
See USDA websoil survey data downloaded for the Kingsville Landfill area.

K Factor, Whole Soil— Summary by Map Unit — Kenedy and Kleberg Counties, Texas (TX613)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CkA	Clareville clay loam, 0 to 1 percent slopes	.24	22.9	9.3%
CmA	Colmena fine sandy loam, 0 to 1 percent slopes	.20	16.2	6.6%
CmB	Colmena fine sandy loam, 1 to 3 percent slopes	.20	21.1	8.6%
PIT	Pits, quarry		165.9	67.5%
PtB	Premont fine sandy loam, 0 to 3 percent slopes	.20	19.6	8.0%
Totals for Area of Interest			**245.6**	**100.0%**

LS Factor - Topography

The effect of slope length and steepness on water erosion appears in the LS, or topography, factor. Erosion increases when either the length of the slope increases, the steepness of the slope increases, or both.

Step 1. Slope length (λ)		
λ	500	
Step 2. Slope steepness		
Rise	1	
Run (Z)	25	
Percent Slope	4.0	
Step 2. Slope Angle		
Slope angle (degrees)	2.29	
Slope angle (radians)	0.040	
Step 3. slope-length exponent (m)		
Slope-length exponent (m)	0.36	** Table 4-5, ARS Handbook # 703
Step 4. Calculate, L, S and LS Factors		
L	2.00	** Equations 4-1, ARS Handbook # 703
S	0.46	** Equations 4-7 and 4-8, ARS Handbook # 703
LS Factor	0.92	



Chapter 4.

Table 4-5.
Slope-length exponents (m) for a range of slopes and rill/interrill erosion classes[1]

Slope (%)	Rill/interrill ratio Low	Moderate	High
0.2	0.02	0.04	0.07
0.5	0.04	0.08	0.16
1.0	0.08	0.15	0.26
2.0	0.14	0.24	0.39
3.0	0.18	0.31	0.47
4.0	0.22	0.36	0.53
5.0	0.25	0.40	0.57
6.0	0.28	0.43	0.60
8.0	0.32	0.48	0.65
10.0	0.35	0.52	0.68
12.0	0.37	0.55	0.71
14.0	0.40	0.57	0.72
16.0	0.41	0.59	0.74
20.0	0.44	0.61	0.76
25.0	0.47	0.64	0.78
30.0	0.49	0.66	0.79
40.0	0.52	0.68	0.81
50.0	0.54	0.70	0.82
60.0	0.55	0.71	0.83

Use 0.36 for 4% Slope

[1]Not applicable to thawing soils

Source: McCool et al. (1989).

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C Factor - Cover Management

The C factor is used to reflect the effect of cropping and management practices on erosion rates. The C factor indicates how the conservation plan will affect the average annual soil loss and how that soil-loss potential will be distributed in time during construction activities, crop rotations, or other management schemes.

Condition	C- Factor	
Interim Conditions	0.042	** 60% ground cover, no appreciable canopy (Table 10, AH_537)
Final Conditions	0.006	** 90% cover, no appreciable canopy (Interpolated from Table 10, AH_537)

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tion and developmental areas can be obtained from table 5 if good judgment is exercised in comparing the surface conditions with those of agricultural conditions specified in lines of the table. Time intervals analogous to cropstage periods will be defined to begin and end with successive construction or management activities that appreciably change the surface conditions. The procedure is then similar to that described for cropland.

Establishing vegetation on the denuded areas as quickly as possible is highly important. A good sod has a C value of 0.01 or less (table 5-B), but such a low C value can be obtained quickly only by laying sod on the area, at a substantial cost. When grass or small grain is started from seed, the probable soil loss for the period while cover is developing can be computed by the procedure outlined for estimating cropstage-period soil losses. If the seeding is on topsoil, without a mulch, the soil loss ratios given in line 141 of table 5 are appropriate for cropstage C values. If the seeding is on a desurfaced area, where residual effects of prior vegetation are no longer significant, the ratios for periods SB, 1 and 2 are 1.0, 0.75 and 0.50, respectively, and line 141 applies for cropstage 3. When the seedbed is protected by a mulch, the pertinent mulch factor from the upper curve of figure 6 or table 9 is applicable until good canopy cover is attained. The combined effects of vegetative mulch and low-growing canopy are given in figure 7. When grass is established in small grain, it can usually be evaluated as established meadow about 2 mo after the grain is cut.

C Values for Pasture, Range, and Idle Land

Factor C for a specific combination of cover conditions on these types of land may be obtained from table 10 (57). The cover characteristics that must be appraised before consulting this table are defined in the table and its footnotes. Cropstage periods and EI monthly distribution data are generally not necessary where perennial vegetation has become established and there is no mechanical disturbance of the soil.

Available soil loss data from undisturbed land were not sufficient to derive table 10 by direct comparison of measured soil loss rates, as was done for development of table 5. However, analyses of the assembled erosion data showed that the research information on values of C can be extended to completely different situations by combining subfactors that evaluate three separate and distinct, but interrelated, zones of influence: (a) vegetative cover in direct contact with the soil surface, (b) canopy cover, and (c) residual and tillage effects.

Subfactors for various percentages of surface cover by mulch are given by the upper curve of

TABLE 10.—*Factor C for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
Type and height[2]	Percent cover[3]	Type[4]	Percent ground cover					
			0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

P Factor - Erosion Control

The support practice factor (P) is the ratio of soil loss with a specific support practice to the corresponding loss with upslope and downslope tillage. These practices principally affect erosion by modifying the flow pattern, grade, or direction of surface runoff and by reducing the amount and rate of runoff.

P Factor	1	Post Closure
P Factor	1	Interim Cover

Support Practice	P Factor	
No erosion Control	1	
Terraces	0.5	3-8 % slope
Terraces	0.6	9-12 % slope
Terraces	0.7	13-16 % slope
Terraces	0.8	17-20% slope
Terraces	0.9	21-25 % slope

*** Table reproduced from Table 15 - AH 357

Terracing

The most common type of terrace on gently sloping land is the broadbase, with the channel and ridge cropped the same as the interterrace area. The steep backslope terrace is most common on steeper land. Difficulty in farming point rows associated with contoured terraces led to developing parallel terracing techniques (*16*). Underground outlets, landforming, and variable channel grades help establish parallel terraces. The underground outlets are in the low areas along the terrace line. The ridge is constructed across these areas. Another type of terrace, using a level and broad channel with either open or closed ends, was developed to conserve moisture in dryland farming areas.

Terraces with underground outlets, frequently called impoundment terraces, are highly effective for erosion control. Four-year losses from four such terrace systems in Iowa (*17*) averaged less than 0.4 t/A/year, which was less than 5 percent of the calculated soil movement to the channel. Comparable losses were measured from installations in Nebraska.

Terracing combined with contour farming and other conservation practices is more effective than those practices without the terraces because it positively divides the slope into segments equal to the horizontal terrace interval. The horizontal terrace interval for broadbase terraces is the distance from the center of the ridge to the center of the channel for the terrace below. For steep backslope terraces with the backslope in sod, it is the distance from the point where cultivation begins at the base of the ridge to the base of the frontslope of the terrace below (*44*). With terracing, the slope length is this terrace interval; with stripcropping or contouring alone, it is the entire field slope length.

P Values

Values of P for contour farming terraced fields are given in table 15. These values apply to contour farmed broadbase, steep backslope, and level terraces. However, recognize that the erosion control benefits of terraces are much greater than indicated by the P values. As pointed out earlier, soil loss per unit area on slopes of 5 percent or steeper is approximately proportional to the square root of slope length. Therefore, dividing a field slope into n approximately equal horizontal terrace intervals divides the average soil loss per unit area by the square root of n. This important erosion control benefit of terracing is not included in P because it is brought into the USLE computation through a reduced **LS** factor obtained by using the horizontal terrace interval as the slope length when entering figure 4 or table 3.

Erosion control between terraces depends on the crop system and other management practices evaluated by **C**. The total soil movement within a contour-farmed terrace interval may be assumed equal to that from the same length of an identical slope that is contoured only. Therefore, if a control level is desired that will maintain soil movement between the terraces within the soil loss tolerance limit, the **P** value for a contour-farmed terraced field should equal the contour factor (col. 2, table 15), and use of these values for farm planning purposes is generally recommended.

With contour stripcropping, the soil deposited in the grass strips is not considered lost because it remains on the field slope. With terraces, most of the deposition occurs in the terrace channels, but research measurements have shown that this deposition may equal 80 percent of the soil moved from the contour-farmed slopes between the terraces (*67*). Use of the contour factor as the **P** value for terracing assumes that all of the eroded soil deposited in the terrace channels is lost from the productive areas of the field. With broadbase terraces, the channels and ridges are cropped the same as

TABLE 15.—*P values for contour-farmed terraced fields*[1]

Land slope (percent)	Farm planning		Computing sediment yield[3]	
	Contour factor[2]	Stripcrop factor	Graded channels sod outlets	Steep backslope underground outlets
1 to 2	0.60	0.30	0.12	0.05
3 to 8	.50	.25	.10	.05
9 to 12	.60	.30	.12	.05
13 to 16	.70	.35	.14	.05
17 to 20	.80	.40	.16	.06
21 to 25	.90	.45	.18	.06

[1] Slope length is the horizontal terrace interval. The listed values are for contour farming. No additional contouring factor is used in the computation.

[2] Use these values for control of interterrace erosion within specified soil loss tolerances.

[3] These values include entrapment efficiency and are used for control of offsite sediment within limits and for estimating the field's contribution to watershed sediment yield.

RUSLE RESULTS

$$A = R * K * LS * C * P$$

Predicted Soil Loss	Condition
A = 0.36 tons/acre/year	Final Conditions

When:					
R =	270	Slope:	4	%
K =	0.24	Length:	500	feet
LS =	0.92	Cover:	Rangeland (90% Cover)	
C =	0.006	Practice:	No erosion Control	
P =	1.00			

Predicted Soil Loss	Condition
A = 2.52 tons/acre/year	Interim Conditions

When:					
R =	270	Slope:	4	%
K =	0.24	Length:	500	feet
LS =	0.92	Cover:	Rangeland (60% Cover)	
C =	0.042	Practice:	No erosion Control	
P =	1.00			

APPENDIX 6B.17

FEMA MAP-100 YEAR

STATE OF TEXAS
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09/12/18
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LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

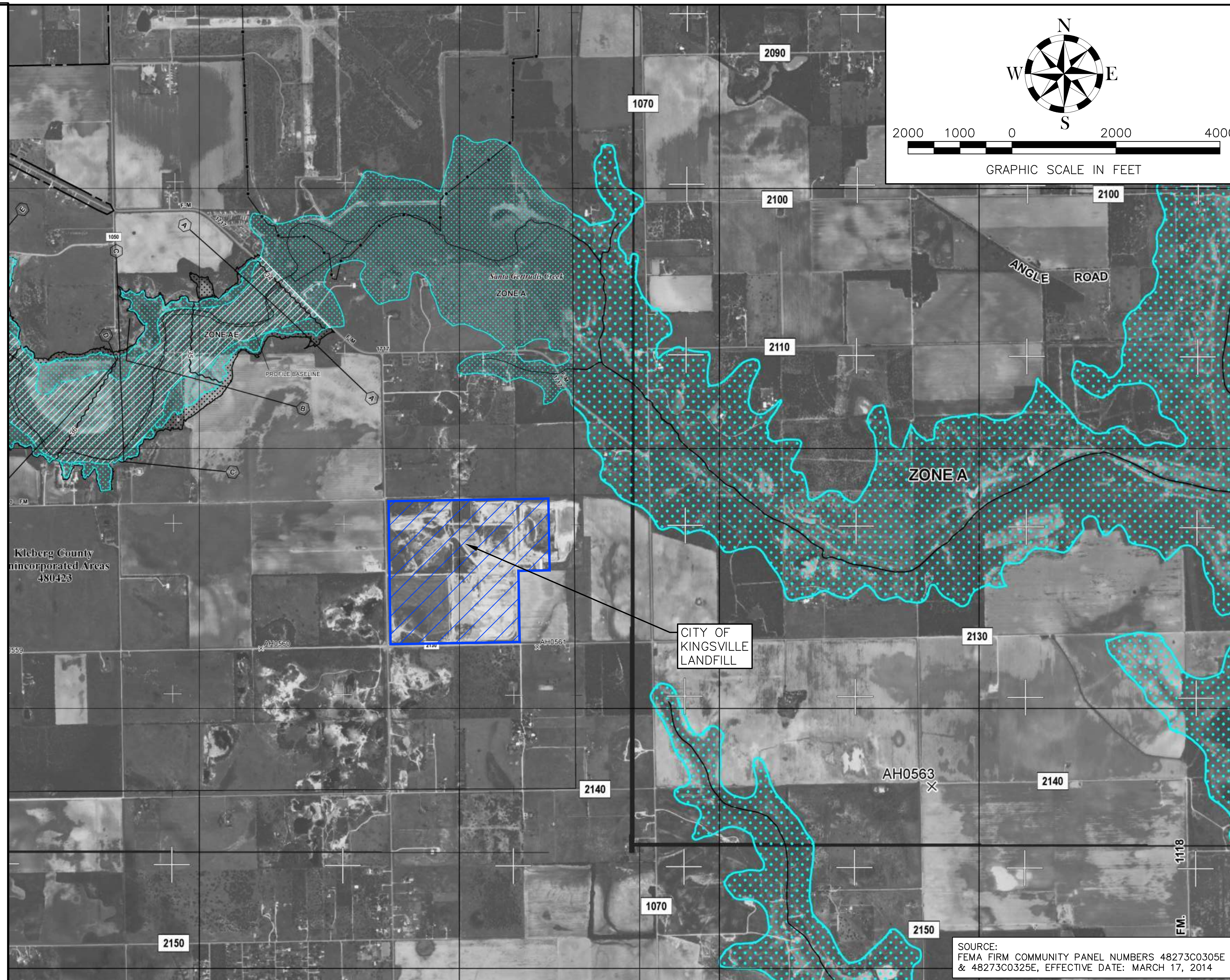
CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Limit of Moderate Wave Action

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 14N
600000 FT	5000-foot grid values: Texas State Plane coordinate system, South zone (FIPSZONE 4205), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile



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09/12/18

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Filename	8514-03-FLOODPLAIN-MAP
Scale	AS SHOWN
Date	09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 6, APPENDIX 6B.17
FLOODPLAIN MAP
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.6-6B.17

APPENDIX 6B.18

TYPICAL DRAINAGE CROSS SECTIONS

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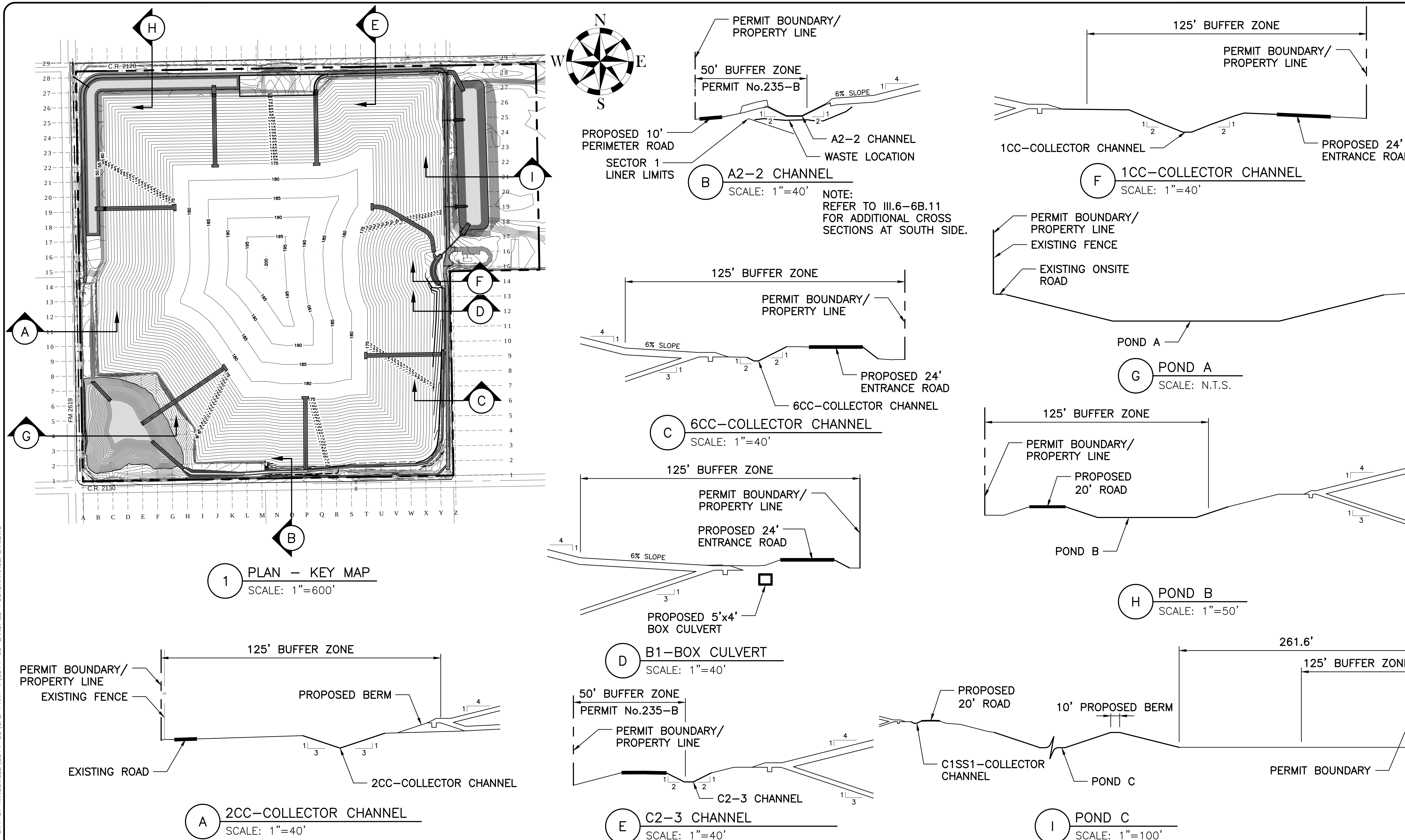

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PART III, ATTACHMENT 6, APPENDIX 6B.18
TYPICAL DRAINAGE CROSS SECTIONS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

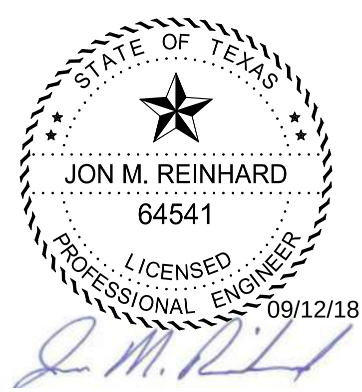
FIGURE:
III.6-6B.18

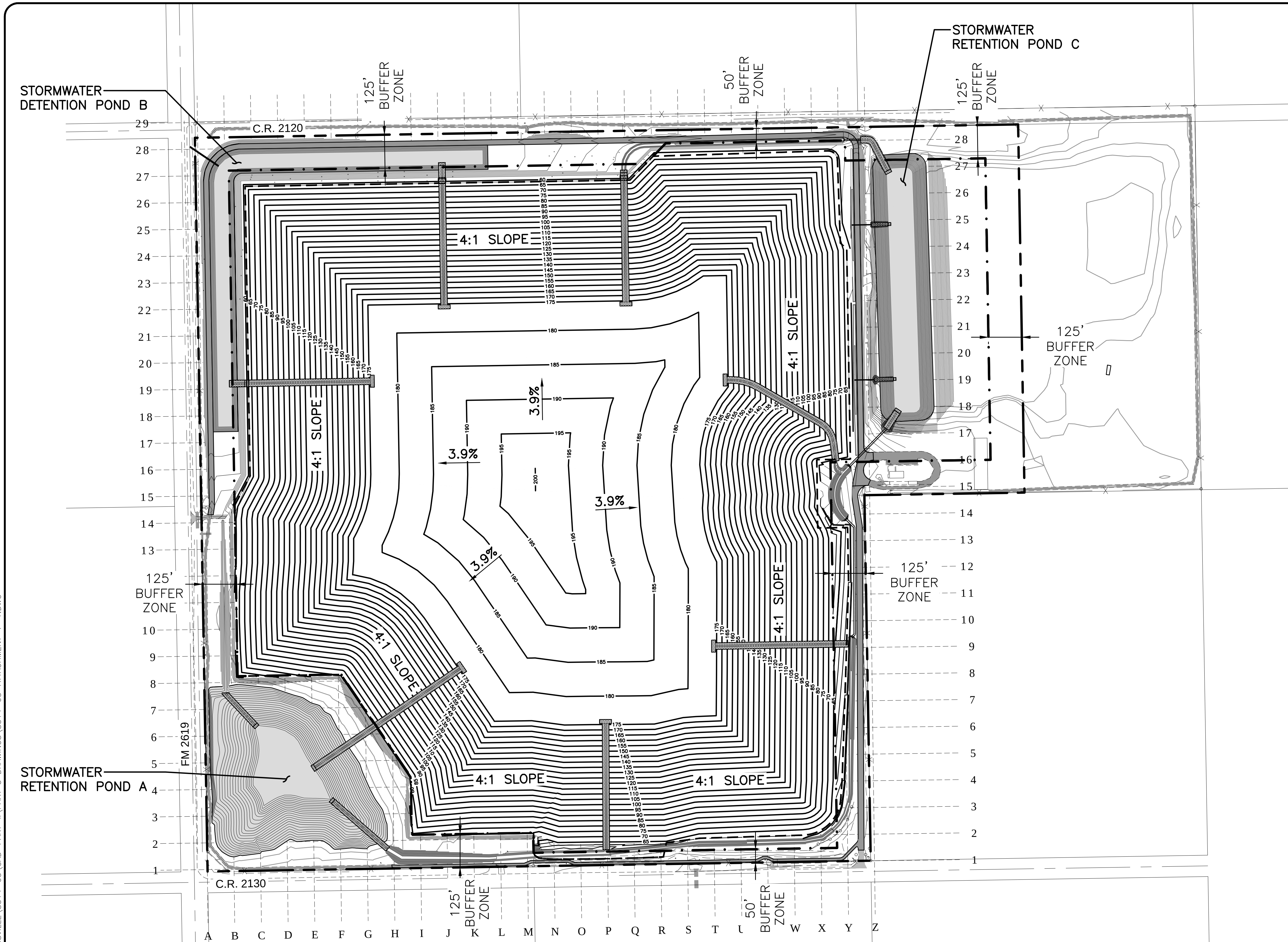
CITY OF KINGSVILLE LANDFILL

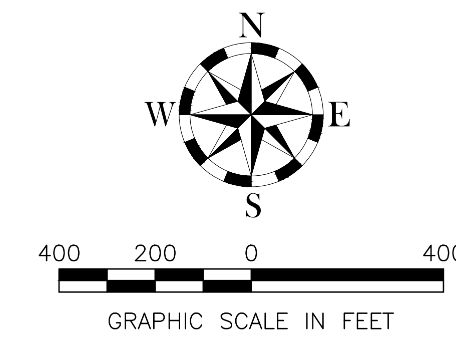
PART III

ATTACHMENT 7

LANDFILL COMPLETION PLAN







LEGEND:

- EXISTING FENCE CORNER
- EXISTING FENCE
- EXISTING CONTOUR
- EXISTING ROAD
- PERMIT BOUNDARY LIMITS
- BUFFER LIMITS
- PROPOSED LIMITS OF WASTE/WASTE FOOTPRINT
- FINAL COVER CONTOURS
- PROPOSED ROAD
- PROPOSED STORMWATER LETDOWN STRUCTURE
- PROPOSED STORMWATER PONDS
- 196.92' MAXIMUM WASTE ELEVATION
- 200.00' MAXIMUM FINAL COVER ELEVATION

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JON M. REINHARD
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LICENSED PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename 8514-03-ATTACHMENT-7-1
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Date 09/12/2018

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REVIEWED	JMR	09/12/2018

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PART III, ATTACHMENT 7
LANDFILL COMPLETION PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE: III.7-1

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CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 8

CLOSURE AND POST CLOSURE

COST ESTIMATES

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 8-A

CLOSURE
COST ESTIMATE

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Texas Commission on Environmental Quality

Closure Cost Estimate Form for Municipal Solid Waste Type I Landfills

This form is for use by applicants or site operators to provide cost estimates for closure of MSW Type I landfills to meet the requirements in 30 Texas Administrative Code (TAC) Chapter 330, Section 330.63(j) and 30 TAC Chapter 330 Subchapter L. The costs to be provided herein are cost estimates for hiring a third party to close the largest waste fill area that could potentially be open in the year to follow and those areas that have not received final cover. If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name and Mailing Address: City of Kingsville P.O. Box 1458 Kingsville, TX 78364

Total Closure Cost Estimate (2018 Dollar Amount): $6,114,221.81

I. Professional Engineer's Statement, Seal, and Signature

I am a licensed professional engineer in the State of Texas. To the best of my knowledge, this Closure Cost Estimate has been completed in substantial conformance with the facility Closure Plan and, in my professional opinion, is in compliance with Title 30 of the Texas Administrative Code, Chapter 330.

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: September 12, 2018

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Professional Engineer's Signature

II. Annual Review of Permit Conditions, Cost Estimates, Inflation Factor, and Financial Assurance

The permittee/site operator acknowledges that he/she will:

1. Review the facility's permit conditions on an annual basis and verify that the current active and inactive waste fill areas of the landfill match the areas on which closure cost estimates are based.
2. Request in writing via a permit modification application for an increase in the closure cost estimate and the amount of financial assurance provided if changes to the closure plan or the landfill conditions increase the maximum cost of closure at any time during the remaining active life of the landfill.
3. Request in writing via a permit modification application for a reduction in the cost estimate and the amount of financial assurance provided if the cost estimate exceeds the maximum cost of closure at any time during the remaining active life of the landfill. The permit modification application will include a description of the situation and a detailed justification for the reduction of the closure cost estimate and the amount of financial assurance.
4. Establish financial assurance for closure of the unit in an amount no less than the current closure cost estimate in accordance with 30 TAC Chapter 37, Subchapter R.
5. Adjust the current cost estimate for inflation within 60 days prior to the anniversary date of the first establishment of the financial assurance mechanism.
6. Provide annual inflation adjustments to the closure costs and financial assurance during the active life of the facility, until the facility is officially placed under the post closure care period and all requirements of the final closure plan have been approved in writing by the TCEQ executive director. The adjustment will be made using an inflation factor derived from the most recent annual Implicit Price Deflator for Gross National Product published by the United States Department of Commerce in its Survey of Current Business, as specified in paragraphs (1) and (2) of 30 TAC §37.131. The inflation factor is the result of dividing the latest published annual Deflator by the Deflator for the previous year.
7. Provide continuous financial assurance coverage for closure until the facility is officially placed under the post-closure care period.

III. Description of the Closure Cost Estimates Worksheet

The following descriptions of the items on the closure cost estimates worksheet provide guidance for identifying the minimum work or cost elements and estimating the unit or lump sum cost of each item as applicable. Enter additional detail for each item in the field following the item as necessary and as site-specific condition warrants. The cost items are grouped under closure costs for engineering, construction, and storage and processing units. Include attachments to detail any additional work and associated costs necessary to close the site that is not already included as a line item on the worksheet. Reference the attachments and list the work or cost items in the fields under "Additional Engineering Cost Items Not Listed on the Worksheet," "Additional Construction Cost Items Not Listed on the Worksheet," or "Additional Storage and Processing Units Items Not Listed on the Worksheet" as applicable. Provide the total cost of the additional work or cost items in each cost category on the worksheet line that precedes the cost subtotal for each cost group.

1. Engineering Costs

   The engineering tasks have been subdivided into seven items and are described below. Other related costs may be added as site-specific issues warrant.

   1.1. Topographic Survey

   A topographic survey will be required to verify the existing elevation and slopes of the landfill to ensure conformance with the final cover system, drainage system, and final grading designs.

   Enter additional topographic survey work or cost element details as site-specific conditions warrant:

   1.2. Boundary Survey

   The metes and bounds description is required for filing of the affidavit of closure and deed recording of any area of the site which has received waste. Other activities to be included here are publication of the public notice of closing activities.

   Enter additional boundary survey work or cost element details as site-specific conditions warrant:

   1.3. Site Evaluation

   The evaluation includes a site inspection to identify waste disposal areas, analyze drainage and erosion protection needs, and to determine other site operational features that are not in compliance with the permit. The site evaluation also includes verifying the need for new or relocation of existing groundwater monitoring wells and landfill gas monitoring probes, analysis of groundwater samples, and review of site operating record. The third party consultant who performed the site evaluation will prepare and submit an engineering report to the executive director to document the status of the site. The report will identify all areas of work and the associated implementation costs necessary to safely close the landfill operations with recommendations on how to fulfill these needs.

Enter additional site evaluation work or cost element details as site-specific conditions warrant:

1.4. Development of Plans

The final closure, plan the final cover system design and specifications, grading and drainage plans, specification for revegetation, design of any other improvements to bring the site into compliance with the permit, the closure schedule, and coordination with the TCEQ and provision of closure notice to the public.

Enter additional development of plans work or cost element details as site-specific conditions warrant:

1.5. Contract Administration (bidding and award)

The third-party consultant will advertise the project, receive the bids, evaluate the bids, award the closure construction contract and administer the contract during construction.

Enter additional contract administration work or cost element details as site-specific conditions warrant:

1.6. Closure Inspection and Testing

The professional of record will observe closure construction, perform cover thickness and permeability verification, and prepare an evaluation report upon completion of closure.

Enter additional closure inspection or testing work or cost element details as site-specific conditions warrant:

1.7. TPDES and other Permits

The third-party consultant will prepare plans, specifications, and other documents necessary for compliance with applicable federal and state laws and requirements, including the Clean Water Act, for the proper closure of the site.

Enter additional TPES or other permits work or cost element details as site-specific conditions warrant:

1.8. Additional Engineering Cost Items Not Listed on the Worksheet

List the Attachment(s) detailing any additional engineering cost items necessary to close the site that is not already included as a line item on the worksheet: Also, reference these Attachments in the "Units" column on this line of the worksheet. Provide the total cost of all additional engineering cost items in the "Cost" column.

1.9. Engineering Costs Subtotal

1.9.1. Enter the sum of engineering costs in Items 1.1 through 1.8.

2. Construction Costs

Closure construction costs include those for construction of the final cover system, site grading, and drainage improvements. Other costs may be added as site-specific issues warrant.

2.1. Mobilization

2.1.1. Mobilization of Personnel and Equipment

The cost of mobilizing personnel and construction heavy equipment must be included as part of the construction costs.

Enter additional work or cost element details for mobilization of personnel and equipment as site-specific conditions warrant:

2.2. Final Cover System

The owner or operator must install a final cover system that is designed to minimize infiltration and erosion. The final cover system is subdivided into the sideslope cover and cap cover with their associated components to facilitate cost calculations. If an alternative final cover is proposed, the closure cost estimate will still be based on a design that utilizes the conventional composite cover system.

Enter additional final cover system work or cost element details as site-specific conditions warrant:

2.2.1. Side Slope Cover

Enter information for Items 2.2.1a through 2.2.1h.

2.2.2. Top Slope Cover

Enter information for Items 2.2.2a through 2.2.2h.

2.2.3. Cells for Class 1 Nonhazardous Industrial Waste

2.3. Site Grading

Site grading includes the final grading of the site, including the landfill cap and sideslopes.

Enter additional site grading work or cost element details as site-specific conditions warrant:

2.4. Site Fencing and Security

Site fencing and security must be included for the area which has received waste and have no existing approved fencing.

Enter additional site fencing and security work or cost element details as site-specific conditions warrant:

2.5. Landfill Gas Monitoring and Control Systems

Enter information for Items 2.5.1 through 2.5.6.

Final installation of the landfill gas monitoring and control systems must include the installation costs of pipes and appurtenances. In the event of a forced closure, the systems may not have been completed, thus, the estimated costs to complete the landfill gas monitoring and control system must be provided.

Enter additional landfill gas monitoring and control systems work or cost element details as site-specific conditions warrant:

2.6. Groundwater Monitoring System

2.6.1. Monitor Well Installation

Upon closure of the site, it may be necessary to relocate the compliance boundary. This requires the installation of new monitor wells.

Enter additional groundwater monitoring system work or cost element details as site-specific conditions warrant:

2.6.2. Piezometer and Monitor Well Plugging and Abandonment

Piezometer or monitor well abandonment is the cost of abandoning (plugging) piezometers or monitor wells that are no longer needed. Determine the number of piezometers or monitor wells to be abandoned and include the total cost.

Enter additional plugging and abandonment work or cost element details as site-specific conditions warrant:

2.7. Leachate Management

2.7.1. Completion of Existing Leachate Collection System

In the event of a forced closure, there may be circumstances where the leachate collection system has not been completed. In this event, the leachate collection system must be closed with a permanent outfalls and permanent cleanouts installed.

Enter additional leachate management work or cost element details as site-specific conditions warrant:

2.8. Stormwater Management

2.8.1. Stormwater Drainage Management System

To reduce the potential long-term impacts of the landfill on surface water quality, drainage features must be incorporated into the final cover design to direct runoff, minimize erosion, control sediments, and avoid ponding of stormwater. The drainage system construction costs must be included.

Enter additional stormwater drainage management work or cost element details as site-specific conditions warrant:

2.9. Additional Construction Cost Items Not Listed on Worksheet

List the Attachments detailing any additional construction cost items necessary to close the site that is not already included as a line item on the worksheet: Also, reference these Attachments in the "Units" column on this line of the worksheet. Provide the total cost of all additional construction cost items in the "Cost" column.

2.10. Construction Costs Subtotal

2.10.1. Enter the sum of construction costs in Items 2.1 through 2.9.

3. Storage and Processing Unit Closure Costs

For landfills that incorporate storage and/or processing operations that are not separately authorized, all waste and processed and unprocessed materials associated with storage and/or processing units must be removed during the closure process.

3.1. Waste Disposal

The cost of disposal of waste at an authorized facility. *Enter additional waste disposal work or cost element information as necessary.*

3.2. Material Removal and Disinfection

The cost of removal, including transportation, of any remaining processed and unprocessed materials to an authorized off-site location. *Enter additional material removal and disinfection work or cost element information as necessary.*

3.3. Demolition and Disposal

The cost of dismantling and/or disinfection of storage and/or processing units and disposal, as applicable. *Enter additional demolition and disposal work or cost element information as necessary.*

3.4. Additional Storage and Processing Unit Closure Cost Items Not Listed in Worksheet

List the Attachments detailing any additional storage and processing unit closure cost items necessary to close the site that is not already included as a line item on the worksheet. Also, reference these Attachments in the "Units" column on this line of the worksheet. Provide the total cost of all additional storage and processing unit closure cost items in the "Cost" column.

4. Sum of Cost Subtotals

4.1. Enter the sum of engineering, construction, and storage and processing unit closure cost subtotals from lines 1.9.1, 2.10.1, and 3.5.1.

5. Contingency

5.1. Add an amount equal to at least 10 percent of the sum of cost subtotals to cover unanticipated events during implementation of closure activities.

6. Contract Performance Bond

6.1. Add an amount equal to at least 2 percent of the sum of cost subtotals for purchase of a surety bond to guarantee satisfactory completion of the closure activities.

7. Third Party Administration and Project Management Costs

7.1. Add an amount equal to at least 2.5 percent of the sum of cost subtotals to cover the cost for a third party hired by TCEQ to administer the closure activities.

8. Total Closure Cost

8.1. Enter the sum of the amounts on lines 4.1, 5.1, 6.1, and 7.1.

IV. Closure Cost Estimates Worksheet

A. Landfill Data

Total Permitted Waste Disposal Area: 121.3 acres

Largest Area Requiring Final Cover in the year to follow: 41.50 acres

Total Filled Area with Constructed Final Cover: acres

Total Area Certified Closed: acres

Number of Monitor Wells to be Installed for Closure: 0

Number of Gas Probes to be Installed for Closure: 0

Total Acreage Needing LFG Collection and Control System: 121.3 acres

The unit or lump sum cost for each item is based on the work items and cost elements described in Section III of this Closure Cost Estimate document:

Yes ☒ No ☐ Partially ☐

(*if "No" or "Partially" is checked, please include attachments describing the additional work items and detailing the unit, quantities, and costs for the additional items*)

B. Facility Drawings and Financial Assurance Documentation

- Facility drawings
  - Attach facility drawings showing the closure areas to which the closure cost estimates apply.
- Financial assurance documentation
  - For an existing facility, attach a copy of the documentation required to demonstrate financial assurance as specified in 30 TAC Chapter 37, Subchapter R.
  - For a new facility, a copy of the required documentation shall be submitted 60 days prior to the initial receipt of waste.

C. Attachments

- Additional Engineering, Construction, and Storage and Processing Units Cost Items Details

D. Closure Cost Estimates Worksheet

If any item listed in this worksheet is not applicable to the subject facility, enter "NA" (Not Applicable) in the affected field.

Table 1. Closure Cost Estimates Worksheet.

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
1. Engineering Costs						
1.1	Topographic Survey	Acres	41.5	81.44	3,379.76	Based on 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
1.2	Boundary Survey	Acres	177	81.44	14,414.88	Based on 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
1.3	Site Evaluation	Acres	177	100.00	17,700.00	Based on experience with similar projects
1.4	Development of Plans	Lump Sum	NA	NA	80,788.48	Based on 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
1.5	Contract Administration (bidding and award)	Lump Sum	NA	NA	9,676.09	Based on 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
1.6	Closure Inspection and Testing	Acres	41.5	12,000.00	498,000.00	Based on 2016 LF Sector construction project costs & 2017 Annual Inflation Factor

Closure Cost Estimate for MSW Type I Landfill

Facility Name: The City of Kingsville Landfill Revision No.: 0

Permit No: 235C Date: September 12, 2018

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
1.7	TPDES and other Permits	Lump Sum	NA	NA	5,000.00	Based on experience with similar projects
1.8	Additional Engineering Cost Items (describe in attachments)	NA	NA	NA	0.00	NA
1.9 Engineering Costs Subtotal						
1.9.1	Engineering Costs Subtotal	NA	NA	NA	628,959.21	NA
2. Construction Costs						
2.1 Mobilization						
2.1.1	Mobilization of Personnel and Equipment	Lump Sum	NA	NA	81,440.00	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2 Final Cover System						
2.2.1 Side Slope Cover						
2.2.1a	Infiltration Layer – Compacted Clay	Cubic Yards	NA	NA	0.00	NA
2.2.1b	Infiltration Layer – Geosynthetic Clay Liner	Square Feet	1,178,616	0.61	718,955.76	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.1c	Flexible Membrane Cover – HDPE	Square Feet	NA	NA	0.00	NA

Closure Cost Estimate for MSW Type I Landfill

Facility Name: The City of Kingsville Landfill　　Revision No.: 0

Permit No: 235C　　Date: September 12, 2018

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.2.1d	Flexible Membrane Cover – LLDPE	Square Feet	1,178,616	0.64	754,314.24	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.1e	Drainage Layer – Aggregate	Cubic Yards	NA	NA	0.00	NA
2.2.1f	Drainage Layer – Drainage Geocomposite Material	Square Feet	1,178,616	0.61	718,955.76	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.1g	Erosion Layer	Cubic Yards	87,305	3.67	320,409.35	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.1h	Vegetation	Acres	27.06	945.00	25,571.70	TXDOT Avearage Low Bid Unit Price #164 6002
2.2.2 Top Slope Cover						
2.2.2a	Infiltration Layer – Compacted Clay	Cubic Yards	NA	NA	0.00	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.2.2b	Infiltration Layer – Geosynthetic Clay Liner	Square Feet	628,190	0.50	314,095.00	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.2c	Flexible Membrane Cover – HDPE	Square Feet	NA	NA	0.00	NA
2.2.2d	Flexible Membrane Cover – LLDPE	Square Feet	628,190	0.53	332,940.70	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.2e	Drainage Layer – Aggregate	Cubic Yards	NA	NA	0.00	NA
2.2.2f	Drainage Layer – Drainage Geocomposite Material	Square Feet	628,190	0.50	314,095.00	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.2g	Erosion Layer	Cubic Yards	46,533	3.67	170,776.11	Based on the average bids received for 2016 LF Sector construction project costs & 2017 Annual Inflation Factor
2.2.2h	Vegetation	Acres	14.44	945.00	13,645.80	TXDOT Avearage Low Bid Unit Price #164 6002

Closure Cost Estimate for MSW Type I Landfill

Facility Name: The City of Kingsville Landfill — Revision No.: 0

Permit No: 235C — Date: September 12, 2018

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.2.3 Cells for Class 1 Nonhazardous Industrial Waste						
2.2.3a	Dike Construction	NA	NA	NA	0.00	NA
2.3 Site Grading						
2.3.1	Site Grading	Acres	177	2,265.12	400,926.24	RSMeans 31 22 13.20 0280
2.4 Site Fencing and Security						
2.4.1	Site Fencing and Security	NA	NA	NA	0.00	Site fencing & security will be in place at closure
2.5 Landfill Gas Monitoring and Control System						
2.5.1	Gas Control Wells	NA	NA	NA	0.00	NA
2.5.2	Gas Header Piping	NA	NA	NA	0.00	NA
2.5.3	Gas Lateral Piping	NA	NA	NA	0.00	NA
2.5.4	Flare Station	Lump Sum			0.00	NA
2.5.5	Condensate Sumps	NA	NA	NA	0.00	NA
2.5.6	Completion of LFG Monitoring System	NA	NA	NA	0.00	NA
2.6 Groundwater Monitoring System						
2.6.1	Groundwater Monitoring Well Installation	Each	NA	NA	0.00	No Additional Groundwater Monitoring Wells will be required at closure
2.6.2	Piezometer and Monitor Well Plugging and Abandonment	Each	NA	NA	0.00	Costs associated with plugging & abandoning Monitoring Wells are included in the post-closure care cost estimate
2.7 Leachate Management						
2.7.1	Completion of Leachate Management System	NA	NA	NA	0.00	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
2.8 Stormwater Management						
2.8.1	Stormwater Drainage Management System	NA	NA	NA	0.00	NA
2.9 Other Cost Items						
2.9.1	Additional Construction Cost Items (describe in attachments)	NA	NA	NA	0.00	NA
2.10 Construction Costs Subtotal						
2.10.1	Construction Costs Subtotal	NA	NA	NA	4,166,125.66	NA
3. Storage and Processing Unit Closure Costs						
3.1	Waste Disposal	☐ Tons ☒ Cubic Yards	12,286	43.94	539,846.84	Based on average rate charge at regional landfill & transport cost from RSMeans 02 41 19.19 3080 & 5000
3.2	Material Removal and Disinfection	NA	NA	NA	0.00	NA
3.3	Demolition and Disposal Units	Lump Sum	1	5,000.00	5,000.00	NA
3.4	Additional Storage and Processing Unit Closure Cost Items (describe in attachments)	NA	NA	NA	0.00	NA
3.5 Storage and Processing Unit Closure Costs Subtotal						
3.5.1	Storage and Processing Unit Closure Costs Subtotal	NA	NA	NA	544,846.84	NA
4. Sum of Engineering, Construction, and Storage and Processing Unit Closure Costs						
4.1	Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals	NA	NA	NA	5,339,931.71	NA
5. Contingency						
5.1	Contingency (10% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	533,993.17	NA

Item No.	Item Description	Units[1]	Quantity	Unit Cost	Cost	Source of Unit Cost Estimate[2]
6. Contract Performance Bond						
6.1	Contract Performance Bond (2% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	106,798.63	NA
7. Third Party Administration and Project Management Costs						
7.1	Third Party Administration and Project Management Costs (2.5% of Sum of Engineering, Construction, and Storage and Processing Unit Closure Cost Subtotals)	NA	NA	NA	133,498.29	NA
8. Total Closure Costs						
8.1	Total Closure Costs (sum of amounts in Sections 4, 5, 6, and 7)	NA	NA	NA	6,114,221.81	NA

[1] For items marked "specify," the responsible professional engineer will enter appropriate unit of measurement

[2] Sources of Unit Costs for Cost Estimates table may include:
(1) Published Cost Estimator Manuals (e.g., RS Means);
(2) Third Party Quotes (e.g., Environmental Field Services Contractors);
(3) Verifiable Data based on Actual Operations; or
(4) Other sources of cost acceptable to the executive director of the TCEQ.

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 8-B

POST CLOSURE
COST ESTIMATE

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Texas Commission on Environmental Quality

Post-Closure Care Cost Estimate Form for Municipal Solid Waste Type I Landfills

This form is for use by applicants or site operators to provide post-closure care cost estimates for post-closure care of MSW Type I landfills to meet the requirements in 30 Texas Administrative Code (TAC) Chapter 330, Section 330.63(j) and 30 TAC Chapter 330 Subchapter L. The costs to be provided herein are cost estimates for hiring a third party to conduct post-closure care of the largest waste fill area that has been certified closed in writing by the TCEQ executive director.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

I. General Information

Facility Name: **The City Of Kingsville Landfill**

MSW Permit No.: **235-C**

Date: **September 12, 2018**

Revision Number: **0**

Site Operator/Permittee Name and Mailing Address: **City of Kingsville P.O. Box 1458 Kingsville, TX 78364**

Total Post-Closure Care Cost Estimate (2018 Dollar Amount): $4,010,324.13

II. Professional Engineer's Statement, Seal, and Signature

I am a licensed professional engineer in the State of Texas. To the best of my knowledge, this Post- Closure Care Cost Estimate has been completed in substantial conformance with the facility Post-Closure Care Plan and, in my professional opinion, is in compliance with Title 30 of the Texas Administrative Code, Chapter 330.

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: September 12, 2018

Company Name: **Hanson Professional Services Inc.** Firm Registration Number: **F-417**

Professional Engineer's Seal

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Signature

III. Annual Review of Permit Conditions, Cost Estimates, Adjustments for Inflation, and Financial Assurance

The site operator/permittee acknowledges that he/she will:

1. Revise and increase the post-closure care cost estimate and the amount of financial assurance provided whenever changes in the post-closure care plan or the landfill conditions increase the maximum cost of post-closure care at any time during the remaining active life of the landfill and until the facility is officially released from the post-closure care period in writing by the executive director.
2. Request a reduction in the post-closure care cost estimate and the amount of financial assurance as a permit modification whenever the post-closure care cost estimate exceeds the maximum cost of post-closure care remaining over the post-closure period. The permit modification will include a detailed justification for the reduction of the post-closure care cost estimate and the amount of financial assurance.
3. Establish financial assurance for post-closure care of the unit in an amount no less than the current post-closure care cost estimate in accordance with 30 TAC Chapter 37
4. Adjust the current post-closure care cost estimate for inflation within 60 days prior to the anniversary date of the first establishment of the financial assurance mechanism.
5. Provide annual inflation adjustments to the post-closure care costs and financial assurance during the active life of the facility and during the post closure care period. The adjustment will be made using an inflation factor derived from the most recent annual Implicit Price Deflator for Gross National Product published by the United States Department of Commerce in its Survey of Current Business, as specified in 30 TAC Chapter 37. The inflation factor is the result of dividing the latest published annual Deflator by the Deflator for the previous year.
6. Provide continuous financial assurance coverage for post-closure care until the facility is officially released in writing by the executive director from the post-closure care period in accordance with all requirements of the post-closure care plan.

IV. Description of Worksheet Items of the Post-Closure Care Cost Estimates

The following descriptions of the worksheet items provide guidance for identifying the minimum work or cost elements for estimating the unit or lump sum cost of each item as applicable. Enter additional detail for each item in the field following the item as necessary and as site-specific conditions warrant. The cost items are grouped under post-closure care costs for engineering, construction, and leachate management. Include attachments to detail any additional work and associated costs necessary for the post-closure care of the unit or facility that is not already included as a line item on the worksheet. Reference the attachments and list the work or cost items in the fields under "Additional Engineering Cost Items Not Listed on the Worksheet," "Additional Construction Cost Items Not Listed on the Worksheet," or Additional Leachate Management Costs Not Listed on the Worksheet" as applicable. Provide the total cost of additional work or cost items in each cost category on the worksheet line that precedes the cost subtotal for each cost group.

1. Engineering Costs

1.1 Site Inspection and Recordkeeping

Regularly scheduled and event-driven site inspection must be performed to identify areas experiencing settlement, subsidence, erosion, or other drainage related problems, and note the conditions of the environmental control and monitoring systems, including leachate collection, groundwater monitoring, and landfill gas monitoring systems*. Enter additional site inspection and recordkeeping work or cost element detail as site-specific conditions warrant.*

1.2 Correctional Plans and Specifications

The cost for an engineering consultant to prepare corrective measure construction plans and specifications to correct problems identified during site inspections. *Enter additional work or cost element details for correctional plans and specifications as site-specific conditions warrant.*

1.3 Site Monitoring

The cost of performing semiannual groundwater (including costs for sampling and analyzing parameters, and assessment and reporting) and quarterly landfill gas monitoring (including costs for sampling and reporting) and the monitoring of other site-specific systems at the landfill during the post-closure period. *Enter additional site monitoring work or cost element details as site-specific conditions warrant.*

1.4 Additional Engineering Cost Items Not Listed on the Worksheet

List the Attachments detailing additional post-closure care engineering cost items not already included as a line item on the worksheet. (Also, reference these Attachments in the "Units" column of this line of the worksheet. Provide the total cost of all additional engineering cost items in the "Cost" column).

2. Construction Costs

2.1 Cap and Sideslopes Repairs and Revegetation

The cost of repair of the cap and cap drainage control structures due to erosion or structural integrity failures and maintaining final cover vegetation to minimize erosion. *Enter additional cap and sideslopes repair and revegetation work or cost element details as site-specific conditions warrant.*

2.2 Mowing and Vegetation Control

The cost of controlling vegetation growth on the final cover and other areas of the landfill. *Enter additional mowing and vegetation control work or cost element details as site-specific conditions warrant.*

2.3 Groundwater Monitoring System Maintenance

The cost of repairs/replacement and routine maintenance. *Enter additional groundwater monitoring system maintenance work or cost element details as site-specific conditions warrant.*

2.4 LFG Monitoring Probes Maintenance

The cost of repairs/replacement and routine maintenance. Enter additional LFG monitoring probes maintenance work or cost element details as site-specific conditions warrant.

2.5 LFG Collection System Maintenance

The cost of repairs and routine maintenance. *Enter additional LFG collection system maintenance work or cost element details as site-specific conditions warrant.*

2.6 Perimeter Fence and Gates Maintenance

The cost of maintaining perimeter fence and gates to restrict unauthorized access to the closed landfill. *Enter additional perimeter fence and gates maintenance work or cost element details as site-specific conditions warrant.*

2.7 Access and Rights of Way Maintenance

The cost of maintaining the access roads and other rights of way to the closed landfill to conduct inspections, environmental sampling, routing maintenance and other post-closure activities. *Enter additional access and rights of way maintenance work or cost element details as site-specific conditions warrant.*

2.8 Drainage System Cleanout and Repairs

The cost to include costs for maintaining and repairing ditches, conveyance structures, and ponds/basins. *Enter additional drainage system cleanout and repairs work or cost element details as site-specific conditions warrant.*

2.9 Additional Construction and Maintenance Cost Items Not Listed on the Worksheet

List the Attachments detailing any additional construction and maintenance cost items necessary for post-closure care that are not already covered on the worksheet. (Also, reference these Attachments in the "Units" column on this line of the worksheet. Provide the total cost of all additional construction and maintenance cost items in the "Cost" column.)

3. Leachate Management Costs

3.1 Leachate Collection and Removal System Operation and Maintenance

The cost of operation, routine maintenance and repairs. *Enter additional work or cost element details for leachate collection and removal system operation and maintenance as site-specific conditions warrant.*

3.2 Leachate Disposal

The cost of leachate disposal off-site. *Enter additional work or cost element details for leachate disposal as site-specific conditions warrant.*

3.3 Additional leachate management cost items not listed on the worksheet. *List the Attachments detailing any additional leachate management cost items necessary for post-closure care that are not already covered on the worksheet.* (Also, reference these Attachments in the "Units" column on this line of the worksheet. Provide the total cost of all additional leachate management cost items in the "Cost" column.)

4. Sum of Cost Subtotals

   Enter the sum of engineering, construction, and storage and leachate management post-closure care cost subtotals from lines 1.5.1, 2.10.1, and 3.5.1.

5. Contingency

   The cost added to cover unanticipated events during implementation of post-closure activities. (Enter additional work or cost element information as necessary)

6. Third Party Administration and Project Management Costs

   The cost for the third party hired by TCEQ to administer the post-closure activities. (Enter additional work or cost element information as necessary)

V. Post-Closure Care Cost Estimates Worksheet

Post-Closure Care Period – 30 years

Total Permitted Acreage: 176.5 acres

Total Permitted Waste Footprint: 121.3 acres

Number of Groundwater Monitoring Wells: 22

Number of GW Monitoring Events: 2 /year

Number of Gas Probes: 15

Number of LFG Monitoring Events: 4 /year

The unit or lump sum cost for each item is based on the work items and cost elements described in Section III of this Post-Closure Cost Estimate document:

Yes ☒ No ☐ Partially ☐

If "No" or "Partially" is checked, please attach a written description of work items and cost elements which form the bases of unit or lump sum cost for the affected items.

(NOTE: If any item listed in this worksheet is not applicable to the subject facility, enter Not Applicable (N/A) in the affected fields)

Attachments

Additional Engineering, Construction, and Leachate Management Cost Items Details.

Post-Closure Care Cost Estimate for MSW Type I Landfills

Facility Name: The City of Kingsville Landfill Revision No.: 0

Permit No: 235-C Date: September 12, 2018

Table 1: Post-Closure Care Cost Estimates

Item No.	Item Description	Units	Annual Qty.	Unit Cost	Annual Cost	Source of Unit Cost Estimate[i]
1.0 Engineering Costs						
1.1	Site Inspection and Recordkeeping[ii]	Each	1	2,500.00	2,500.00	Based on experience with similar projects
1.2	Correctional Plans and Specifications	Each	.10	5,000.00	500.00	Based on experience with similar projects
1.3 Site Monitoring						
1.3.1 Groundwater Monitoring System						
1.3.1(a)	Sampling and Analysis of GW Monitoring Wells (Quantity = 2 x Number of wells)	Wells	44	1,803.08	79,335.39	Based on most recent GW monitoring event at the facility
1.3.1(b)	Piezometers/Well Abandonment	Per well over 30 years	.033	3,729.00	2,735.00	Based on TXDOT Ave Bid #103 2001 & #103 6001
1.3.2 LFG Monitoring System						
1.3.2(a)	LFG Quarterly Monitoring (Quarterly) (Quantity = 4 x Number of wells)	Each	60	88.18	5,290.91	Based on most recent LFG monitoring event at the facility
1.3.2(b)	LFG Probe Plugging and Abandonment	Per probe over 30 years	.033	3,729.00	1,864.00	Based on TXDOT Ave Bid #103 2001 & #103 6001
1.4 Additional Engineering Cost Items (Detail in Attachments)						
1.4.1	Additional Engineering Cost Items (describe in attachments)	NA	NA	NA	0.00	NA
1.5 Engineering Costs Subtotal						

Item No.	Item Description	Units	Annual Qty.	Unit Cost	Annual Cost	Source of Unit Cost Estimate[i]
1.5.1	Engineering Costs Subtotal	NA	NA	NA	92,225.00	NA
2.0 Construction and Maintenance Costs						
2.1	Cap and Sideslopes Repairs and Revegetation	SY (3 times over 30 year)	587,092	3.02	3,659.59	TXDOT Ave #160 2004 & #164 6001
2.2	Mowing and Vegetation Management	Acres	177	29.87	$5,286.99	TXDOT Ave #730 6104
2.3	Groundwater Monitoring System Maintenance	Lump Sum	1	500.00	500.00	Based on experience with similar projects
2.4	LFG Monitoring Probes Maintenance	Lump Sum	1	350.00	350.00	Based on experience with similar projects
2.5	LFG Collection System Maintenance	Each	NA	NA	0.00	NA
2.6	Perimeter Fence and Gates Maintenance	LF (twice over 30 years)	13,164	2.78	2,439.73	TXDOT Ave #772 6009
2.7	Access Roads Maintenance	LF (twice over 30 years)	11,014	4.72	3,462.76	TXDOT Ave #150 6003
2.8	Drainage System Cleanout/Repairs	Lump Sum	1	4,000.00	4,000.00	Based on experience with similar projects
2.9 Additional Construction and Maintenance Cost Items (Details in Attachments)						
2.9.1	Additional Construction and Maintenance Cost Items (details in attachments)	NA	NA	NA	0.00	NA
2.10 Construction and Maintenance Costs Subtotal						

Item No.	Item Description	Units	Annual Qty.	Unit Cost	Annual Cost	Source of Unit Cost Estimate[i]
2.10.1	Construction and Maintenance Costs Subtotal	NA	NA	NA	19,349.07	NA
3.0 Leachate Management						
3.1	Leachate Management System Operation and Maintenance	Each	1	7,250.00	7,250.00	Based on experience with similar projects
3.2	Leachate Disposal	Gals	NA	NA	0.00	NA
3.3 Additional Leachate Management Cost Items (Details in Attachments)						
3.4	Additional Leachate Management Cost Items (details in attachments)	NA	NA	NA	0.00	NA
3.5 Leachate Management Costs Subtotal						
3.5.1	Leachate Management Costs Subtotal	NA	NA	NA	7,250.00	NA
4.0 Sum of Engineering, Construction, and Leachate Management Costs						
4.1	Sum of Engineering, Construction, and Leachate Management Cost Subtotals	NA	NA	NA	118,824.42	NA
5.0 Contingency						
5.1	Contingency (10% of Sum of Engineering, Construction, and Leachate Management Cost Subtotals)	NA	NA	NA	11,882.44	NA
6.0 Third Party Administration and Project Management Costs						
6.1	Third Party Administration and Project Management Costs (2.5% of Sum of Engineering, Construction, and Leachate Management Cost Subtotals)	NA	NA	NA	2,970.61	NA

Item No.	Item Description	Units	Annual Qty.	Unit Cost	Annual Cost	Source of Unit Cost Estimate[i]
7. Total Post-Closure Cost						
7.1	Total Annual Post-Closure Cost (Sum of amounts in Sections 4, 5, and 6)	NA	NA	NA	133,677.47	NA
7.2	30 Year Post-Closure Costs (Total Annual Post-Closure Cost x 30)	NA	NA	NA	4,010,324.13	NA

[i] Sources of Unit Cost Estimates may include:
(1) Published Cost Estimator Manuals (e.g., RS Means);
(2) Third Party Quotes (e.g., Environmental Field Services Contractors); or
(3) Verifiable Data based on Actual Operations

[ii] Example Description for Item No. 1.1 – "Includes costs for site inspection performed at least annually for identification of areas experiencing settlement or subsidence, erosion or other drainage-related problems, inspection of the leachate collection system, gas monitoring system and LFG monitoring system."

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 9

FINANCIAL ASSURANCE

JOHN WOMACK & CO., P.C.
CERTIFIED PUBLIC ACCOUNTANTS

JOHN L. WOMACK, CPA
MARGARET KELLY, CPA

P. O. BOX 1147
KINGSVILLE, TEXAS 78364
(361) 592-2671
FAX (361) 592-1411

INDEPENDENT ACCOUNTANT'S REPORT ON APPLYING AGREED-UPON PROCEDURES

To the City of Kingsville

I have performed the procedures enumerated below, which were agreed to by the City of Kingsville and the Texas Commission on Environmental Quality (TCEQ), solely to assist you with respect to the accounting records of the City of Kingsville for the periods stated below. This engagement to apply agreed-upon procedures was performed in accordance with standards established by the American Institute of Certified Public Accountants. The sufficiency of the procedures is solely the responsibility of the specified users of the report. Consequently, I make no representation regarding the sufficiency of the procedures described below either for the purpose for which this report has been requested or for any other purpose.

My procedures and findings are as follows:

1. My firm issued the City's audited financial statements for the year ended September 30, 2017; and as part of my report, I stated the City's financial statements were presented in conformity with generally accepted accounting principles for governments; and the total annual revenue of $30,697,042 stated in the City of Kingsville's letter to you dated April 15, 2018, is in agreement with that audit.

2. I examined the City's operation information for years ended September 30, 2017 and 2016 and at no time did the City run a total annual deficit in excess of 5% of total revenue.

3. As part of my audit I issued an unqualified opinion as presented in the audit report.

4. I have enclosed a copy of the City's 2017 audit report.

I was not engaged to, and did not perform an audit, the objective of which would be the expression of an opinion on the specified elements, accounts, or items. Accordingly, I do not express such an opinion. Had I performed additional procedures, other matters might have come to my attention that would have been reported to you.

This report is intended solely for the use of the specified users listed above and should not be used by those who have not agreed to the procedures and taken responsibility for the sufficiency of the procedures for their purposes.

John Womack CPA

Kingsville, Texas
April 15, 2018

PRIVATE COMPANIES PRACTICE SECTION. AICPA DIVISION FOR CPA FIRMS

CITY OF KINGSVILLE

City of Kingsville TEXAS

P.O. BOX 1458 - KINGSVILLE, TEXAS 78364

April 15, 2018

TCEQ
Attn: Ms. Kathleen Hartnett White
Executive Director
P.O. Box 13087
Austin, Texas 78711-3097

I am the chief financial officer of the City of Kingsville, P.O. Box 1458, Kingsville, Texas 78364. This letter is in support of this local government's use of the financial test to demonstrate financial assurance, as specified in 30 Texas Administrative Code (TAC) Chapter 37 (relating to Financial Assurance).

1. This local government is the owner and operator of the following facility for which financial assurance for closure, post closure, or corrective action is demonstrated through the financial test specified in 30 TAC 37.271 (relating to Local Government Financial Test). The current cost estimates covered by the test are shown for our facility: see attached schedule.

The fiscal year of this local government ends on September 30, 2017. The figures for the following items marked with an asterisk are derived from this local government's independently audited, year-end financial statements for the latest completed fiscal year, ended September 30, 2017.

BOND RATING INDICATOR OF FINANCIAL STRENGTH

1. Sum of current cost estimates $6,918,871

2. List the following information on all the outstanding, rated, unsecured general obligation bonds issued by the local government; (however, the underlying ratings from Standard & Poors is A+):

   Current bond rating of the four most recent issuances and name of rating service AAA (secured by insurance): Standard & Poors (S&P) There was one new bond in 2016 and none in 2017.

   Date of Issuance of bond March 17, 2016

   Date of maturity of bond August 1, 2036

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TCEQ

Date of issuance of bond April 15, 2014

Date of maturity of bond August 15, 2025

Date of issuance of bond January of 2013

Date of maturity of bond August of 2033

Date of issuance of bond February of 2013

Date of maturity of bond February of 2023

3. Environmental obligations assured by a financial test to demonstrate financial assurance in the following amounts under commission regulations and the Code of Federal Regulations (CFR) or state equivalent rules:

(a) Municipal Solid Waste under 30 TAC Chapter 330 and 40 CFR Part 258 $6,918,871

(b) Hazardous waste treatment, storage and disposal facilities under 30 TAC Chapter 335 and 40 CFR Parts 264 and 265 $ none

(c) Petroleum underground storage tanks under 30 TAC Chapter 334 and 40 CFR Part 280 $1,000,000

(d) Underground Injection Control System facilities under 30 TAC Chapter 331 and 40 CFR Part 144 $ none

(e) PCB commercial storage facilities under 40 CFR Part 761 $ none

(f) Additional environmental obligations not shown above $ none

Total (a)-(f) $7,918,871

*4. Total Annual Revenue $30,697,042

Indicate either "yes" or "no" to the following question.

5. Is line 3 divided by line 4 less than or equal to 0.43? (yes/no) Yes

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TCEQ

I hereby certify that the wording of this letter is identical to the wording specified in 30 TAC 37.371 as such regulations were constituted on the date shown immediately below. I further certify the following: that the local government's financial statements are prepared in conformity with Generally Accepted Accounting Principles for governments, including conformance with General Accounting Standards Board Statement 18, and its financial statements have been audited by an independent Certified Public Accountant (CPA); that the local government has not operated at a deficit equal to 5.0% or more of total annual revenue in each of the past two fiscal years; that the local government is not in default on any outstanding general obligation bonds; that the local government does not have outstanding general obligations rated lower that Baa as issued by Moody's or BBB as issued by Standard and Poor's; and that the local government has not received an adverse opinion, disclaimer of opinion, or other qualified opinion from the independent CPA.

Deborah Balli

Signature

Deborah Balli

Name

Director of Finance

Title

April 15, 2018

Date

CITY OF KINGSVILLE LANDFILL
CLOSURE AND POST CLOSURE ESTIMATES
SEPTEMBER 30, 2017

Permit No.: 235B
Location: East 2130 County Road Kingsville, Texas
Mailing Address: P.O. Box 1458 Kingsville, Texas 78364

Original Closure and Post Closure
Cost Estimates (Dated 6/26/98)

	TOTAL	CLOSE	POSTCLOSURE
Total	$ 4,768,656	$ 2,998,656	$ 1,700,000
Escalation for 1999 (.02%)	95,373	59,973	35,400
Adjusted Estimate for 1999	4,864,029	3,058,629	1,805,400
Escalation for 2000 (.02%)	102,145	61,173	40,972
Adjusted Estimate for 2000	4,966,174	3,119,802	1,846,372
Escalation for 2001 (.022%)	109,256	68,635	40,621
Adjusted Estimate for 2001	5,075,430	3,188,437	1,886,993
Escalation for 2002 (.011%)	55,830	35,073	20,757
Adjusted Estimate for 2002	5,131,260	3,223,510	1,907,750
Escalation for 2003 (.016%)	82,100	51,576	30,524
Adjusted Estimate for 2003	5,213,360	3,275,086	1,938,274
Escalation for 2004 (.021%)	109,481	68,777	40,704
Adjusted Estimate for 2004	5,322,841	3,343,063	1,978,978
Escalation for 2005 (.028%)	149,039	93,628	55,411
Adjusted Estimate for 2005	5,471,880	3,437,491	2,034,389
Escalation for 2006 (.029%)	158,710	99,713	58,997
Adjusted Estimate for 2006	5,630,590	3,537,204	2,093,386
Escalation for 2007 (.029%)	163,287	102,579	60,708
Adjusted Estimate for 2007	5,793,877	3,639,783	2,154,094
Escalation for 2008 (.02%)	115,878	72,796	43,082
Adjusted Estimate for 2008	$ 5,909,755	$ 3,712,579	$ 2,197,176

Page 2

	TOTAL	CLOSE	POSTCLOSURE
Escalation for 2009 (.02%)	118,195	74,252	43,943
Adjusted Estimate for 2009	$ 6,027,950	$ 3,786,831	$ 2,241,119
Escalation for 2010 (.009%)	54,252	34,082	20,170
Adjusted Estimate for 2010	6,082,202	3,820,913	2,261,289
Reclass	-	7,974	(7,974)
Escalation for 2011 (.021%)	127,726	80,407	47,319
Adjusted Estimate for 2011	6,209,928	3,909,294	2,300,634
Escalation for 2012 (.018%)	111,779	70,221	41,558
Additional Cost Per Engineer (.023%)	126,286	79,333	46,953
Adjusted Estimate for 2012	6,447,993	4,058,848	2,389,145
Escalation for 2013 (.015%)	96,720	60,883	35,837
Adjusted Estimate for 2013	6,544,713	4,119,731	2,424,982
Escalation for 2014 (.014%)	91,626	57,676	33,950
Adjusted Estimate for 2014	6,636,339	4,177,407	2,458,922
Escalation for 2015 (.01%)	66,363	41,774	24,589
Adjusted Estimate for 2015	6,702,702	4,219,181	2,483,521
Escalation for 2016 (.013%)	93,832	54,853	38,979
Adjusted Estimate for 2016	6,796,534	4,274,034	2,522,500
Escalation for 2017 (.018%)	122,337	71,060	51,277
Adjusted Estimate for 2017	$ 6,918,871	$ 4,345,094	$ 2,573,777

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 10

LINER QUALITY CONTROL PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

Part III

Attachment 10
Liner Quality Control Plan

City of Kingsville TEXAS

CITY OF KINGSVILLE, TEXAS

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

September 2018
Revision 0

Prepared by

HANSON
Engineering | Planning | Allied Services

HANSON PROJECT NO. 16L0438- 0003

TABLE OF CONTENTS

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18
For Pages i - ii

1. GENERAL

1.1.Scope and Purpose

This Liner Quality Control Plan (LQCP) is applicable to the construction of all landfill liner systems at the City of Kingsville Landfill, a Municipal Solid Waste (MSW) disposal facility in Kleberg County, Texas. This LQCP shall govern the material characteristics, installation and testing for the various construction components for the landfill liners at the facility. Qualifications for quality control personnel are also identified in this LQCP. The provisions of this LCQP were developed based on the latest technical guidelines of the TCEQ, including quality control of construction, testing frequencies and procedures, and quality assurance of sampling and testing procedures.

1.2. Lining and Cover Systems Used for the Landfill

The following lining and/or cover systems will be used at the facility:

1.2.1. Standard Landfill Lining System

The standard landfill lining system will consist of (from bottom to top):

- A prepared subgrade;
- A geosynthetic clay liner (GCL);
- A geomembrane liner consisting of sixty mil (0.06 inch) thick HDPE;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric;
- A two (2) foot protective cover soil layer.

1.2.2. Landfill Cover System

The landfill cover system will consist of (from bottom to top):

- A six (6) inch thick (minimum) prepared soil subgrade layer;
- A geosynthetic clay liner (GCL) layer;
- A forty mil (0.04 inch) thick LLDPE geomembrane layer;
- A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;
- A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.

1.2.3. Piggyback Liner System

This liner system will be used in areas of the landfill where disposal development will occur over existing unlined MSW fill locations and will include components that will provide additional geotechnical stability. The piggyback lining system will consist of (from bottom to top):

- A twenty four (24) inch thick foundation soil layer;
- A six (6) inch thick compacted subgrade soil layer;
- A geogrid layer consisting of two (2) layers of uniaxial geogrid placed perpendicular to each other;
- A geosynthetic clay liner (GCL) layer;
- A sixty mil (0.06 inch) thick HDPE geomembrane layer;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric.
- A two (2) foot protective cover soil layer.

1.3. Roles and Responsibilities of Parties to the Construction

Construction work conducted under this LQCP will involve multiple parties. Their roles and responsibilities are outlined below:

1.3.1. Owner

The Owner shall be the City of Kingsville. The Owner shall be responsible for procuring the services of the other parties to the construction work and coordinating operating requirements at the facility.

1.3.2. Design Engineer

The Design Engineer shall be responsible for preparing the plans and specifications for each individual project to be constructed. Different Design Engineers may be used for different projects or parts of projects. The Design Engineer shall be a professional engineer, licensed to practice in the State of Texas and be experienced in the design and construction of waste containment systems. The Design Engineer may be an employee of the Owner or may be an independent third party. A third party Design Engineer may be either an individual or a firm properly licensed in the State of Texas.

1.3.3. Construction/Material Contractor(s)

The Construction/Material Contractor(s) shall be responsible for executing the construction work in accordance with this LQCP and the individual project plans and specifications, including specified QC testing. The Owner may elect to use one general contractor or different contractors for different parts of the work, and may combine certain parts of the work. The project plans and specifications shall identify the number and type of contractors to be used on a specific project and shall indicate the division of work among the contractors. If multiple contractors are selected, the following requirements shall apply to various parts of the work:

1.3.3.1. Earthwork Contractor

The earthwork contractor shall be responsible for excavation, fill, placement of liner, cover and topsoil materials, preparation and maintenance of the subgrade, excavation and backfill of anchor trenches, and conducting the construction quality control testing outlined in this LQCP.

1.3.3.2. Geosynthetics Materials Supplier

The Geosynthetics Material Supplier (GMS) shall be responsible for the manufacture and transportation of the geosynthetic materials to the job site, and conducting the construction quality control testing outlined in this LQCP.

1.3.3.3. Geosynthetics Materials Installer

The Geosynthetics Material Installer (GMI) shall be responsible for the installation, construction quality control testing and protection of the geosynthetic materials in accordance with the LQCP and the project plans and specifications.

1.3.4. Quality Assurance Organization (QAO)

The Quality Assurance Organization (QAO) shall be responsible for conducting the construction quality assurance testing outlined in this LQCP and the project plans and specifications. Different QAOs may be used for different projects or parts of projects. The QAO shall be an independent third party (not financially related to either the Owner or any of the Construction/Materials Contractors) and shall be either a licensed individual or a registered firm, authorized to practice engineering in the State of Texas. The Design Engineer may serve as the QAO.

1.4. Requirements for Construction Quality

1.4.1. Contractor Quality Control and Owner Quality Assurance

The facility permit and project specifications dictate certain quality requirements for the construction of the facility. Since the Construction/Material Contractor(s) exercise control over the selection of specific materials, workmanship, and installation, the Construction/Material Contractor(s) shall provide primary quality control. The Owner shall retain third-party QAO services to confirm that the various contractors' quality control programs meet the requirements of the permit and the project construction documents ("project requirements.") All requirements set forth in this document that are not specifically assigned to QAO are the responsibility of the Construction/Material Contractor(s).

1.4.2. Quality Control Laboratories

Laboratories conducting quality control testing on behalf of the Construction/Material Contractor(s) shall be properly accredited, certified or licensed as required for the specific analyses being conducted. The Construction/Material Contractor(s) shall obtain written approval of proposed laboratories from the QAO before using those laboratories to conduct quality control testing under this LQCP.

1.4.3. Surveying

Construction/Material Contractor(s) shall provide all surveying necessary for construction to the specified lines, grades and dimensions. At appropriate intervals arranged with the QAO and the Construction/Material Contractor(s), the QAO will coordinate the verification and record surveys in accordance with the LQCP and the project plans and specifications.

1.5. QAO Personnel Requirements

The QAO shall provide the following personnel to provide quality assurance for the construction of the various components at the facility.

1.5.1. Quality Assurance Engineer

The Quality Assurance Engineer (QAE) shall be responsible for the overall quality assurance of the specific component being constructed. Different QAEs may be used for the various components. The QAE(s) shall be a professional engineer, licensed to practice in the State of Texas and be experienced in the design, construction, and quality assurance testing for waste containment systems. The QAE shall be an independent third party, and may be either an individual or a firm properly licensed in the State of Texas.

1.5.2. Quality Assurance Inspector

The Quality Assurance Inspector (QAI) shall be the qualified on-site representative of the QAE. This individual shall be experienced in the construction and quality assurance testing for waste containment systems. The QAE shall be allowed to serve as the QAI. If the QAE does not serve as the QAI, the QAI shall be an engineering technician with at least four (4) years of experience in quality control for waste containment facilities, or shall be a graduate engineer with one (1) year experience in quality control for waste containment facilities. In the event that additional quality control personnel are required, the additional personnel may have less than the above referenced experience if they are directly supervised on-site by personnel meeting these qualifications.

1.5.3. Quality Assurance Laboratory

The Quality Assurance Laboratory (QAL) shall be an independent third party laboratory experienced in performing the tests required by this LQCP. Independent third party shall mean a laboratory that is independent of ownership or control by the Owner or any party to the actual construction of the facility component. The QAL may be the same entity providing the QAE and QAI.

1.5.4. Quality Assurance Surveying

The QAE shall be responsible for coordinating and obtaining all engineering surveys necessary to document the construction of the various components. QA surveying shall be performed under the supervision of a professional land surveyor, registered to practice in the State of Texas. Survey verifications shall be made using appropriate surveying techniques. The entity performing the surveys shall be an independent third party, and may be either an individual or a firm properly licensed in the State of Texas. The survey entity may be the same entity providing the QAE, the QAI or the engineering design.

1.6. Construction Quality Assurance in General

1.6.1. Review of Material Conformance Tests

Prior to use of materials for projects at the facility, the QAE shall review the results of the Material Conformance Tests identified in this LQCP for the components being constructed. Non-conforming material shall not be used and the QAE is vested with the authority by the Owner to reject such non-conforming materials. The QAE shall document that all materials used meet the requirements of the LQCP.

1.6.2. Inspection During Installation

During the installation of all liner components, the QAE or his designated representative shall be on site to make visual observations to verify that the proper equipment and construction techniques are being used. The QAE shall coordinate with the construction contractor to ensure that all portions of the liner construction will be observed.

1.6.3. Voluntary Increase in Testing Frequency

With the approval of the Owner, the QAE may make additional tests or inspections beyond the minimum required by this LQCP. A voluntary increase over the minimum shall not require a commensurate increase in the number of supplementary or related tests or inspections. The QAO may, at his discretion, conduct such additional tests as he deems appropriate to confirm that the completed construction conforms to the requirements of this LQCP and the project plans and specifications.

1.7. Reference Standards

The following standards (most recent version) are referenced in this LQCP:

1.7.1. American Society of Testing and Materials (ASTM)

C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
D 422	Standard Test Method for Particle-Size Analysis of Soils
D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3))
D 792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
D 1004	Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
D 1140	Standard Test Method for Amount of Materials in Soils Finer than the No. 200

	(75µm) Sieve
D 1203	Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting
D 1603	Standard Test Method for Carbon Black Content in Olefin Plastics
D 1777	Standard Test Method for Thickness of Textile Materials
D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 1790	Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact
D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
D 2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D 2672	Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
D 3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates
D 3776	Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
D 3786	Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
D 4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by Muffle-Furnace Technique
D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4437	Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4643	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
D 4716	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
D 4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
D 5035	Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
D 5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D 5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
D 5321	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
D 5993	Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners
D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
D 6241	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
D 6243	Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method
D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
D 7176	Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC) Geomembranes Used in Buried Applications
D 7179	Standard Test Method for Determining Geonet Breaking Force
F 480	Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

1.7.2. Geosynthetics Research Institute

GM13	Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

1.8. Material Conformance Tests for Soils and Gravel

Soil materials used for construction at the facility shall be subjected to the following conformance tests to demonstrate compliance with the LQCP. Unless otherwise specified, one set of tests shall be performed for each material type. If there is a visually distinguishable change in the soil characteristics or a change in the soils Liquid Limit (LL) or Plasticity Index (PI) by more than 10 points, the soil shall be considered a separate borrow source and shall require an additional set of tests. In any condition, a minimum of one (1) complete set of tests must be performed for each type of soil material used. Conformance testing will be conducted by the party identified in sections 2.4 . The results of these tests shall be used for field quality control. The Contractor shall ensure that the required samples are collected and tested in a timely manner to be available for field quality control. Not all tests will be required for all soils; only those tests for which the individual components specify a required material property.

1.8.1. Soil Classification

All soil materials used shall be classified in accordance with the Unified Soil Classification System (USCS - ASTM D 2487).

1.8.2. Gradation

All soil materials used shall be tested to determine the particle size gradation, including the percentage passing the #200 sieve. Gradation shall be determined in accordance with ASTM D 1140. Gravel materials used shall be tested to determine the gradation in accordance with ASTM C 136 or ASTM D 422.

1.8.3. Atterberg Limits

All soil materials used shall be tested to determine the Atterberg Limits (Liquid Limit and Plastic Limit) and the Plasticity Index (ASTM D 4318).

1.8.4. Soil Moisture-Density

The soil moisture/density relationship shall be determined using the Standard Proctor method (ASTM D 698).

1.8.5. Coefficient of Permeability/Hydraulic Conductivity

Where the LQCP indicates to determine the coefficient of permeability or the hydraulic conductivity (in centimeters per second [cm/sec]), use one of the following test procedures:

Constant Head Permeability

Permeability of Granular Soils (Constant Head) – ASTM D 2434

Hydraulic Conductivity

Flexible Wall Permeameter (back pressure saturation) ASTM D 5084.

1.8.6. Calcium Carbonate Content

All gravel materials used shall be tested to determine the calcium carbonate content in accordance with ASTM D 3042.

1.9. Material Quality Control and Conformance Tests for Geosynthetics

Geosynthetic materials (geomembranes, geotextiles, drainage nets, and composites of these materials) shall be subjected to the following tests by the GMS or QAO, as outlined below, to demonstrate compliance with the LQCP.

The GMS shall provide to the QAO the results of quality control testing conducted for the materials supplied for this project. The testing frequency shall be at least one test per 100,000 square feet and per each resin lot. Manufacturing records (inventory) must be provided to verify that the material tested is within the specified frequency. Test results shall be provided, at a minimum, for the properties listed for geomembrane, geonet, and geotextile in Sections 5.2, 6.2.2, and 6.2.1, respectively.

The QAO shall obtain samples and perform conformance testing from the material delivered to the project site. Alternatively, the manufacturer may collect samples at the time of manufacture and ship them directly to the QAL. Unless otherwise specified, a minimum of one (1) set of tests shall be performed for each 100,000 square feet and every resin lot of material used. In any condition, a minimum of one (1) complete set of tests must be performed for each type of material used.

1.9.1. Density/Mass per Unit Area

HDPE geomembrane sheet shall be tested to determine the density in grams per cubic centimeter (gm/cm^3) in accordance with either ASTM D 792, Method B or ASTM D 1505. HDPE drainage net material shall be tested to determine the density in gm/cm^3 in accordance with ASTM D 1505. Geotextile material shall be tested to determine the mass per unit area in accordance with ASTM D 5261.

1.9.2. Carbon Black Content

HDPE materials (geomembrane sheet and drainage net) shall be tested for Carbon Black content in accordance with either ASTM D 1603 or ASTM D 4218.

1.9.3. Carbon Black Dispersion

HDPE materials (geomembrane sheet) shall be tested for carbon black dispersion in accordance with ASTM D 5596.

1.9.4. Tensile Properties

The geomembrane sheet shall be tested for tensile strength and elongation at yield and at break, in accordance with ASTM D 6693. The HDPE drainage net sheet shall be tested for peak tensile strength in accordance with ASTM D 5035 or ASTM D 7179. Geotextile material shall be tested for grab tensile strength and elongation in accordance with ASTM D 4632.

1.9.5. Thickness

Smooth HDPE geomembrane sheet and HDPE drainage net shall be tested for thickness in accordance with ASTM D 5199. Textured HDPE geomembrane sheet shall be tested for thickness in accordance with ASTM D 5994.

1.9.6. Tear Resistance

The geomembrane sheet shall be tested for tear resistance in accordance with ASTM D 1004.

1.9.7. Puncture Resistance

The geomembrane and geotextile materials shall be tested for puncture resistance in accordance with ASTM D 4833 and ASTM D 6241, respectively.

1.9.8. Apparent Opening Size

Geotextile shall be tested for apparent opening size (AOS) in accordance with ASTM D 4751.

2. SUBGRADE PREPARATION AND CONTROLLED FILL

The following requirements govern the subgrade preparation for liners and covers used at the facility:

2.1.Subgrade Description

Subgrade materials shall not exhibit excessive cohesion and shall be free of large particles, rocks or other foreign material. The finished subgrade should be smooth, with no large or protruding items that may damage liner materials placed on the subgrade. Soil materials used as fill to finish the subgrade shall be obtained either from on-site or off-site sources.

2.2.Required Material Properties

Soil materials used for fill to construct subgrade shall be free of sod, trash, roots, and organic matter. The materials shall meet the following minimum requirements:

2.2.1. Soil Materials

2.2.1.1.Classification

Soil materials shall be classified using the USCS. Acceptable classifications are CH CL, ML, SW, SP, SM, or SC.

2.2.1.2.Gradation:

The soil material shall be composed of particles of which no more than ninety six percent (96%) pass the #200 sieve.

2.2.1.3.Atterberg Limits

The soil material used shall have a Liquid Limit of no greater than seventy five percent (75%) and a Plasticity Index (Liquid Limit minus Plastic Limit) of no greater than forty five percent (45%).

2.2.2. Moisture Density for Subgrade Materials Placed as Fill

Subgrade materials placed as fill shall be compacted to at least ninety five percent (95%) of the maximum dry density, Standard Proctor Basis, as per ASTM D698. The moisture content shall range from optimum moisture to five percent (5%) above the optimum moisture content.

2.3.Installation Procedures

The subgrade installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

2.3.1. Excavation

Overlying materials shall be excavated and removed to achieve the required subgrade lines and grades as indicated in the project plans and specifications. The Earthwork Contractor shall exercise care and provide sufficient grade control during the excavation process to minimize or eliminate the placement of fill to meet the required subgrade lines and grades. Soil overburden shall be excavated using standard mobile construction equipment. Where the bedrock is encountered within the planned excavation and cannot be removed using this equipment, it will be removed either through rock saw or blasting. For areas requiring rock removal, the rock will be removed at least 1 foot beyond the lines and grades shown to accommodate the construction of a soil subgrade layer. In the event voids in bedrock are discovered intersecting the limits of the planned excavation, these voids will be hydro or vacuum excavated to remove any loose material and will be filled with cement grout or concrete to align with the limits of the planned excavation. Once allowed to properly cure and set, these filled voids will be covered with subgrade material.

2.3.2. Subgrade Preparation

The subgrade shall be excavated and/or graded to the appropriate lines and grades as shown in the project contract documents. Where subgrade materials are placed as fill, the in-situ material shall be properly scarified and prepared to receive the subgrade material. Any soft areas shall be excavated and replaced with compacted materials to provide a solid working base. In areas where bedrock has been removed to accommodate a subgrade layer, the subgrade may be constructed from on-site soils, off-site soils, millings from the rock saw process or a combination of these sources, with the subgrade material meeting the requirements of this section.

2.3.3. Placement

The subgrade soil materials shall be broken down such that all material is uniformly hydrated. The finished material shall not contain clods that exceed one (1) inch in diameter or that total more than ten percent (10%) by weight. Any gravel size particles shall not be of sufficient number or size to be a detriment to the integrity of the overlying component. When placed as fill, the subgrade material shall be placed in loose lifts as required to obtain compacted lift thickness of six (6) to eight (8) inches, or the pad or prong length of the compactor feet, whichever is less.

2.3.4. Hydration

Prior to compaction, the soil material shall be hydrated so that proper moisture can be maintained during the compaction process. Once water has been added, the soil material shall be worked to provide proper mixing. Soil hydration is allowed either on a stockpile or in-place. The soil material shall be hydrated to a moisture content wet of optimum.

2.3.5. Compaction

The soil material shall be compacted using a pad or tamping foot roller or a prong foot ("sheepsfoot") roller. Bulldozers and/or pneumatic tired compactors will not be used. The lift thickness shall be controlled, as outlined above, such that the compactor feet penetrate through the entire lift under compaction into the top of the previously compacted lift. Therefore, the compacted lift thickness must not be greater than the pad or prong length of the compactor feet. Adequate cleaning devices shall be used to prevent clogging of the compactor from excess soil material. Sections of re-compacted subgrade that do not pass both the density and moisture requirements shall be re-worked and re-tested until the section in question does pass, and to the extent that the re-worked area(s) tie-in to an area which passed the testing. The re-worked area shall be re-worked and re-tested until passing tests are achieved.

2.3.6. Finishing

The subgrade shall be prepared and finished in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

2.3.7. Proof rolling

The top surface of the completed subgrade must be proof rolled with a smooth-wheel roller prior to final grade/thickness surveying and placement of overlying layers. Additional proof-rolling may be employed if it is necessary to minimize desiccation and cracking of the subgrade.

2.3.8. Protection of Subgrade Surface

Prior to and during the installation of overlying components, the Earthwork Contractor shall preserve and protect the exposed surface of the subgrade from desiccation and cracking, rutting, erosion, and ponding using regular watering and proof rolling.

2.4. Quality Assurance Quality Control Requirements

The Earthwork Contractor shall conduct material conformance tests and the QAO shall monitor the placement and finishing of the subgrade, and coordinate the necessary surveys with the project surveyor. Prior to placement of any overlying layers, the QAO shall coordinate with the GMI to execute a subgrade acceptance form for all areas of completed subgrade. In addition, the Earthwork Contractor shall employ testing personnel to conduct the following QC verification activities:

2.4.1. Field Density

A minimum of one (1) field density test per 10,000 square feet (ft^2), or less, for each lift. A minimum of three (3) field density tests are required for each lift.

2.4.2. Sieve Analysis (Percent Passing #200)

A minimum of one (1) test for each 100,000 ft^2 or less, for each lift, shall be performed in accordance with ASTM D 1140. A minimum of one (1) test shall be performed for each lift regardless of the area.

2.4.3. Atterberg Limits

A minimum of one (1) test for each 100,000 ft^2 per lift shall be performed in accordance with ASTM D 4318. A minimum of one (1) test shall be performed for each lift regardless of the area.

2.4.4. Survey Verification

A minimum of one (1) survey verification shall be made per 5,000 ft^2 of surface area. Reference locations will be noted on a drawing of the area.

2.4.5. Repair of Test Holes

All holes in the subgrade created from tests and test samples shall be completely backfilled with soil and shall be tamped into place.

3. GEOGRID

The following requirements govern the geogrid used at the facility:

3.1. Geogrid Description

A geogrid is a reinforcing geosynthetic structure formed by a regular network of tensile members with appropriate apertures to allow interlocking with surrounding soil or aggregate. Geogrid materials shall be High Density Polyethylene (HDPE). Geogrid material will be placed on a prepared subgrade and will underlie the GCL layer. The geogrid shall be stored, handled and installed in accordance with the manufacturer's recommendations.

3.2. Required Material Properties

The geogrid shall have a minimum tensile strength of 2500 pounds per foot at an allowable stress of 5% or less over 50 years. Properties, test methods and minimum values are listed below.

Ultimate Tensile Strength (ASTM D6637)	7810 lb/ft
Tensile Strength @ 5% Strain (ASTM D6637)	3560 lb/ft
Junction Strength (ASTM D7737)	7200 lb/ft
Maximum Allowable Strength for 120 yr Design Life (GRI-GG4)	2860 lb/ft

The manufacturer shall certify that the geogrid has been quality control tested during the manufacturing process and that the liner meets all strength requirements for the intended use.

3.3. Installation Procedures

The geogrid installation procedures shall be conducted by the GMI and observed by the QAO. The installation procedures shall conform to the following requirements:

3.3.1. Surface Preparation

The surface to receive the geogrid shall be prepared in accordance with the requirements specified in Section 2, Subgrade Preparation and Controlled Fill. Prior to placing geogrid materials, the GMI shall execute a subgrade acceptance form. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of the form is included in Appendix A.

3.3.2. Delivery and Storage

All rolls of geogrid delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding, or dragging of rolls or pallets can cause damage and must be avoided. The geogrid rolls shall be dept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geogrid if stored on site for more than six (6) months.

3.3.3. Geogrid Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

3.3.4. Geogrid Deployment

The geogrid shall be deployed in accordance with the procedures recommended by the manufacturer and as outlined below:

- Only those geogrid panels which can be anchored and connected in one (1) day should be deployed.
- Each geogrid panel shall be inspected for damage and manufacturing defects prior to anchoring or connecting to other panels.
- Geogrid panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling and shall be pulled taut to remove slack. Geogrid shall be deployed from a top to bottom direction on slopes.
- Adjacent geomembrane panels shall not be overlapped but shall be deployed side by side. Panel end connections shall be made using a Bodkin connection.
- Geogrid panels shall be anchored in place after placement so as to remain in the deployed alignment. Anchoring can be accomplished using stakes, sandbags, or small quantities of fill soil. Sandbag anchorage must be removed as the subsequent GCL layer is placed. Stakes must be driven flush with the subgrade as the subsequent GCL layer is placed.
- The geogrid panels shall be placed and aligned such that endroll connections on slopes are minimized. Connections should be located as close to the bottom of the slope as possible.
- No construction equipment traffic shall be allowed on the geogrid.
- Personnel working on the geogrid shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geogrid.

4. GEOSYNTHETIC CLAY LINER (GCL)

4.1. General

This section includes the requirements for selection, installation, and protection of GCL.

4.2. Submittals

A. Pre-installation

Submit the following to the QAO for approval prior to GCL deployment.

1. Supplier of the GCL manufacturer results for standard tests described in Table C.1.
2. Written certification the GCL meets the properties listed in Table C.1.
3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table C.1. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

Table C.I –STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL

Test	Item	Type of Test	Standard Test Method	Frequency of Testing
Manufacturer's Quality Control	Bentonite[A]	Swell Index[A]	ASTM D5890	per 100,000-lbs and every truck or railcar
		Moisture Content[A]	ASTM D4643	per 100,000-lbs and every truck or railcar
		Fluid Loss[A]	ASTM D5891	per 100,000-lbs and every truck or railcar
	Geotextile	Grab Tensile Strength[B]	ASTM D4632	per 200,000-ft^2
		Mass/Unit Area	ASTM D5261	per 200,000-ft^2
	GCL Product	Grab Tensile Strength[B]	ASTM D6768 ASTM D4632	per 200,000-ft^2
		Peel Strength[H]	ASTM D 6496 ASTM D 4632	per 40,000-ft^2
		Clay Mass/Unit Area[C]	ASTM D5993	per 40,000-ft^2
		Permeability[D]	ASTM D5887	per week for each production line[E]
		Lap Joint Permeability[D][F]	ASTM D5887	per each material and lap type
Conformance Testing by 3rd Party Independent Laboratory	GCL Product	Clay Mass/Unit Area[C]	ASTM D5993	at least one (1) test per 100,000-ft^2 and ASTM D4254 procedure A
		Permeability[D][F]	ASTM D5084	per 100,000-ft^2
		Direct Shear[F][G][I]	ASTM D5321 ASTM D6243	Per GCL/adjoining material type

Notes:

A - Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-mil.
B - Geotextiles shall meet minimum manufacturer criteria.
C - Minimum Test value – 0.75-lb/sq. ft. MARV at 0% moisture content
D - 5 x 10^{-9} cm/ sec max or as required by the permit.
E - Report last twenty (20) permeability values, ending on production date of supplied GCL.
F - Test at confining/consolidating pressures simulating field conditions.
G - Not applicable for slopes of 7H:IV or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both side of GCL.

H - Peel strength for unreinforced GCL 1 lb/in (1.75 N/cm) min. Peel strength for reinforced GCL 3.5 lbs/in (6.1 N/cm) min.

I - Hydrated internal shear strength for unreinforced GCL 150 psf. Hydrated internal shear strength for reinforced GCL 500 psf.

4.3.Installation

The GCL installation Contractor shall submit to the QAI a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each area covered directly by GCL as installation proceeds.

4.4.Delivery, Storage, and Handling

A. Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

1. Manufacturer's name.
2. Product identification.
3. Roll number.
4. Roll dimensions.
5. Roll weight.

B. Storage and Protection

An onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

4.5.Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. The GCL shall have a coefficient of permeability of 5 x 10^{-9}-centimeters/second (cm/sec) or less and an index flux of 1 x 10^{-8}- (m^3/m^2/sec).

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

4.6.Manufacturer

A. Manufacturing Experience

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar CGL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

4.7.Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include the supply of the replacement GCL material and shall not include the cost of re-installation, defects, or failures due to improper installation.

4.8.Execution

A. Examination

The QAE or his representative will collect samples of material delivered to the site for conformance testing. Alternatively, the QAE may coordinate the collection and shipping of samples collected by the manufacturer and shipped directly to the QAL.

B. Installation

i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
2. Weight the GCL with sandbags or equivalent in the present of wind.
3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
4. Prevent damage to underlying layers during placement of GCL.
5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
7. Do not place GCL in the rain or a times of impending rain.
8. Do not place GCL in areas of ponded water.
9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.

10. In general, only deploy GCL that can be covered during the day by geomembrane.
11. Prepare seam overlap areas as specified by the manufacturer.
12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
13. Avoid dragging GCL on the subgrade.
14. Vehicular traffic other than low contact pressure vehicles such as UTV/ATV's or golf carts are not allowed on deployed GCL.
15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

ii. Overlaps

Overlap GCL to the manufacturer's recommendations that will vary according to seam location and climatic conditions. Prepare the overlap area as required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

iii Defects and Repairs

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

iv Interface with Other Products

Ensure the following when deploying overlying material:

1. GCL and underlying materials are not damaged.
2. Minimal slippage of GCL on underlying layers occurs.
3. No excess tensile stresses occur in GCL.
4. If necessary, bond overlap seams and patches in place prior to placement of overlying materials to prevent dislocating the GCL seam or patch.

4.9. Equipment

A. Installation

1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar and spindle to prevent slings from damaging edges.
2. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
3. Use sealing and securing materials as required by specifications and drawings at attachment or penetration locations.
4. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.

5. GEOMEMBRANE LINERS

The following requirements govern the geomembrane liners used at the facility:

5.1. Geomembrane Description

Geomembrane materials shall be High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The thicknesses of these geomembrane materials will vary based on project documents. Geomembrane sheets will be placed on a prepared subgrade and will be continuously seamed in accordance with the manufacturer's instructions to provide a water-tight seam.

5.2. Required Material Properties

The geomembrane shall be made of new, first quality materials with no more that 10% re-grind manufactured specifically for the purpose of liquid containment.

5.2.1. All HDPE Geomembrane Materials

Minimum specifications for all HDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505)	0.94 gm/cm^3
Percent Carbon Black (ASTM D 1603 or ASTM D 4218)	2.0% to 3.0%

Minimum specifications for all HDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596)	Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3

5.2.2. Smooth HDPE Geomembrane

Thickness (ASTM D 5199)	60 mils (average of all measurements) 54 mils (lowest of any 10 measurements)
Tensile strength @ yield (ASTM D 6693)	126 pounds per inch (ppi)
Tensile strength @ break (ASTM D 6693)	228 ppi
Elongation @ yield (ASTM D 6693)	12%
Elongation @ break (ASTM D 6693)	700%
Tear resistance (ASTM D 1004)	42 pounds
Puncture resistance (ASTM D 4833)	108 pounds

5.2.3. Textured HDPE Geomembrane

Thickness (ASTM D 5994)	60 mils (average of all measurements) 54 mils (lowest for 8 out of 10) 51 mils (lowest of any 10)
Tensile strength @ yield (ASTM D 6693)	120 ppi

Tensile strength @ break (ASTM D 6693)	90 ppi
Elongation @ yield (ASTM D 6693)	12%
Elongation @ break (ASTM D 6693)	100%
Tear resistance (ASTM D 1004)	42 pounds
Puncture resistance (ASTM D 4833)	90 pounds

5.2.4. All LLDPE Geomembrane Materials

Minimum specifications for all LLDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505)	0.939 gm/cm^3
Percent Carbon Black (ASTM D 1603 or ASTM D 4218)	2.0% to 3.0%

Minimum specifications for all LLDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596)	Only near spherical agglomerates, for 10 different view: 9 in Categories 1 or 2 and 1 in Category 3

5.2.5. Smooth LLDPE Geomembrane

Thickness (ASTM D 5199)	40 mils (average of all measurements) 36 mils (lowest of any 10 measurements)
Tensile strength @ break (ASTM D 6693)	152 pounds per inch (ppi)
Elongation @ break (ASTM D 6693)	800%
Tear resistance (ASTM D 1004)	22 pounds
Puncture resistance (ASTM D 4833)	56 pounds

5.2.6. Textured LLDPE Geomembrane

Thickness (ASTM D 5994)	40 mils (average of all measurements) 36 mils (lowest for 8 out of 10)
Tensile strength @ break (ASTM D 6693)	60 ppi
Elongation @ break (ASTM D 6693)	250%
Tear resistance (ASTM D 1004)	22 pounds
Puncture resistance (ASTM D 4833)	44 pounds

The manufacturer shall certify that the geomembrane has been quality control tested during the manufacturing process and that the materials are first quality and free of holes, blisters, undispersed raw materials, and contamination by foreign materials. In addition, the manufacturer shall certify that the liner meets all strength and resistance requirements for the intended use.

5.3. Installation Procedures

The geomembrane liner installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

5.3.1. Surface Preparation

The surface to be lined shall be prepared so as to provide a surface which is relatively free of irregularities, loose earth, desiccation cracks, and abrupt changes in grade. This preparation shall consist of the removal of loose scale materials which might damage the geomembrane. Prior to placing geomembrane materials, the GMI shall execute a subgrade acceptance form unless installed over a GCL. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of this form has been included in Appendix A.

5.3.2. Delivery and Storage

All rolls of geomembrane delivered to the site shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding or dragging or rolls or pallets can cause damage and must be avoided. The geomembrane rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geomembrane if stored on site for more than six (6) months. The rolls shall be stored on level ground in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the geomembrane materials.

5.3.3. Geosynthetic Materials Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

5.3.4. Geomembrane Deployment

5.3.4.1. Weather Conditions

Geomembrane deployment shall not proceed:

- During precipitation events;
- In the presence of excessive moisture (humidity);
- In areas of ponded water; or,
- In the presence of excessive wind.

5.3.4.2. Temporary Geomembrane Anchoring

All unseamed edges of geomembrane panels shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. Similar procedures may be used to temporarily anchor the geomembrane in the anchor trench. Penetrating anchors shall not be used for temporary anchorage unless the penetrations will be beyond the inside wall of the anchor trench and will not require repair. Anchorage shall be sufficient to prevent loss or damage.

5.3.4.3.Panel Placement and Alignment

The geomembrane shall be deployed in accordance with the procedures outlined below:

- Only those geomembrane panels which can be seamed in one (1) day should be deployed.
- Each geomembrane panel shall be inspected for damage and manufacturing defects prior to seaming.
- Geomembrane panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The geomembrane panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Panels shall be placed in such a manner that the geomembrane is not scratched or crimped. Any such damage shall be repaired or removed and replaced in accordance with the procedures described in Section 5.3.7.
- Adjacent geomembrane panels shall be overlapped a minimum of three (3) inches (HDPE) after seaming is completed. The QAI shall visually inspect the placement and overlap of the geomembrane to verify that the material is placed with sufficient overlap. Geomembrane seams with insufficient overlap shall be repaired or replaced.
- Geomembrane panels shall be placed such that there are no horizontal or cross-panel seams on the side slopes unless approved by the QAE and the owner. In addition, geomembrane panels placed on the bottom shall be overlapped from top to bottom in the downslope direction. In this configuration the upslope geomembrane panel will overlie the immediately adjacent downslope panel. This overlap shall be a minimum of three (3) inches.
- The geomembrane panels shall be placed and aligned such that seam joining of the sidewalls and bottom sections must be located in the bottom and at least five (5) feet from the sidewall. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- No vehicular traffic shall be allowed on the geomembrane. Only low-ground pressure supporting equipment may be allowed to traverse the geomembrane. The equipment used for placement and seaming shall not damage the geomembrane by leaking fluids or other means. Areas which are damaged in this manner shall be removed or repaired.
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geomembrane.

5.3.4.4.Panel Identification

As each geomembrane panel is placed, it shall be labeled in bold print visible from a distance of approximately thirty (30) feet. In general, these markings shall be placed in an area which will remain un-obscured until subsequent layers are placed. Panel numbers shall be sequential based on the placement order. The roll number from which the panel is from shall be included with the panel number.

5.3.5. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the geomembrane sheet. For HDPE geomembrane, this will include fusion and extrusion welding.

5.3.5.1.Weather Conditions

Field seaming of the geomembrane shall not be performed at ambient temperatures below 40° Fahrenheit (F) [5° Celsius (C)] unless the geomembrane seam area is preheated, by sun or hot air device, to a temperature in excess of 50°F (5°C). However, in any case, field seaming of the geomembrane shall not be performed at ambient temperatures below 34°F (1°C). The GMI shall consult with the QAE if it is anticipated that seaming will be attempted or performed above 113°F (45°C) ambient air temperature. The QAE shall establish and the GMI shall implement agreed-upon measures to prevent liner stretching and thickness reduction or no seaming shall be performed above 113°F (45°C) ambient air temperature. The temperature shall be recorded at regular, periodic intervals by the GMI.

5.3.5.2.Trial Seams

All personnel responsible for seaming shall perform a trial seam prior to the start of seaming with each apparatus used that day. The beginning of each seaming period is considered to be the morning, and immediately after a break. Whenever seaming with a particular apparatus is discontinued for more than one hour or turned off more than ten (10) minutes, a new trial seam shall be performed. An additional trial seam shall be performed for each seaming period for each apparatus used that day, and for each six (6) hours if a break is not taken. In any instance, a minimum of one (1) trial seam shall be performed for each six (6) hours of operation for each seaming apparatus used.

An additional trial seam shall also be performed for each occurrence of significantly different environmental conditions (i.e., temperature, humidity, dust, etc.), and when fusion seaming different geomembranes (tie-ins and smooth to textured). Both the welder and the machine must be tested for each trial seam when extrusion welding. Only the machine needs to be tested for each new trial seam when fusion welding, since the machine is not as operator dependent. Each individual seaming shall make at least one (1) trial seam each day they actually perform seaming.

Trial seams shall be performed on "fragment" pieces of geomembrane and shall be a minimum of twelve (12) inches in width by three (3) feet in length. A minimum three (3) inch overlap shall be provided and the seam shall be approximately centered throughout the length of the geomembrane fragment used. All trial seams shall be performed under the same conditions as production seaming. Trial seams shall be tested in the field by the GMI for peel and shear performance, as outlined in Sections 5.4.6 and 4.4.7.

5.3.5.3. General Seaming Requirements

All geomembrane seams shall extend to the end of each panel to be anchored. All geomembrane seams shall be clean and free of moisture, oil, dust, dirt, debris of any kind, and foreign matter at the time of welding. No folds, large wrinkles, or fish mouths shall be allowed in the seam. Only normal factory-induced creasing from the blown film process may be acceptable. Where wrinkles or folds occur, the material shall be cut and overlapped, and an extrusion weld applied, in accordance with the procedures outlined in this LQCP. Areas of insufficient overlap shall be repaired in accordance with the procedures detailed in Section 5.3.7. All complete seams shall be tightly bonded and sealed.

If geomembrane seaming operations are performed at night, adequate lighting shall be provided for seaming as well as for inspection of the seaming conditions and the seams.

5.3.5.4. Extrusion Seaming Requirements

The extrusion welding apparatus shall have a temperature gauge which indicates the temperature of the extrudate. Additionally, the temperature of the extrudate at the nozzle will be monitored at the time of trial seaming using a probe (pyrometer). A significant difference (greater than 15°C) in the indicated vs. monitored temperature shall result in investigation and repair of the seaming apparatus. The QAI may request that the GMI check extrudate temperatures at other times as well.

The extruder shall be purged to remove heat-degraded material prior to the beginning of seaming and whenever the extruder is stopped for an appreciable length of time.

Grinding in preparation for extrusion welding should be done carefully. Grinding beyond the area to be covered with extrudate is unnecessary, and will be minimized. Grinding shall not extend more than one-eighth (1/8) inch beyond the edge of the seam.

5.3.5.5. Fusion Seaming Requirements

The fusion welding apparatus shall be a vehicular mounted, automated device. The temperature, pressure and welding speed shall be independently adjustable and the apparatus shall be equipped with a gauge which displays the actual internal temperature.

5.3.6. Nondestructive Seam Continuity Testing

The GMI shall conduct the following nondestructive seam continuity testing:

5.3.6.1.General

Continuous non-destructive testing shall be performed on all seams by the GMI. Air pressure testing shall be performed on all dual track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for geomembrane seams. All leaks identified during testing must be isolated and repaired by the following procedures described in this LQCP.

Areas thought to be potentially inaccessible to nondestructive continuity testing equipment shall be brought to the QAE's attention prior to the start of work.

Nondestructive continuity testing of field seams, including repairs, shall be performed by the GMI as the work progresses to provide the opportunity for immediate rewelding and retesting as necessary. All defects discovered shall be marked, repaired and retested.

5.3.6.2.Testing Procedures

The GMI shall submit the proposed specific nondestructive testing procedures to be employed on this project to the QAE. The testing procedures shall be consistent with the requirements of this specification. The testing procedures must be approved by the QAE.

For vacuum box testing, a suction value of approximately three (3) to five (5) inches of gauge vacuum shall be applied to all extrusion seams that can be tested in this manner. The seam that has been wetted with soapy water must be observed for leaks a minimum of five (5) seconds while subjected to this vacuum. Areas where soap bubbles appear shall be marked, repaired and re-tested. The GMI shall record the test results, including technician ID, date, time and pass/fail condition on the geomembrane near the test location.

For air pressure testing, the air space created by the fusion weld shall be tested for continuity. The ends of the air channel of the dual track fusion weld must be sealed and pressured to a minimum of 30 psi. The air pump must then be shut off and the air pressure observed after five minutes. A loss of less than four (4) psi is acceptable, if it is determined that the air channel is not blocked between the sealed ends. A loss of more than four (4) psi indicates the presence of a seam leak which must then be marked, isolated, repaired and re-tested. The GMI shall record the test results, including technician ID, date, the before and after times and pressures and pass/fail condition at a minimum on the geomembrane near the test location. All openings in air channels must be sealed subsequent to testing.

5.3.7. Defects and Repairs

5.3.7.1.General

All seam and non-seam areas of the geomembrane shall be visually inspected for signs of defective seams, blisters, punctures, undispersed raw materials, and any sign of contamination by foreign matter. Any problems discovered shall be marked, repaired and retested or reevaluated in accordance with this document. The geomembrane surface shall be clean at the time of these inspections.

Any sheets which become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage (inadvertent punctures during installation) shall be repaired by welding a piece of geomembrane over the damaged area. The repairs must comply with the LQCP to be considered adequate.

5.3.7.2. Evaluation

Each suspect location in both seam and non-seam areas shall be inspected and, where appropriate, tested using the methods described in this document. Work shall not proceed with any materials which will cover the locations which require repair or which have been repaired but require testing with passing results.

5.3.7.3. Procedures for Repair

Grinding and welding procedures may be used to repair small sections of deficient extrusion seams and small surface blemishes which do not penetrate the entire thickness of the geomembrane. The geomembrane surfaces requiring repair shall be abraded no more than one hour prior to the repair being made. The allowable time between abrading the surface and making the repair may be reduced if determined necessary by the QAI. Grinding shall be performed only within the area requiring repair and shall not significantly damage the liner.

Defects which do not require replacement of the sheet shall be repaired and covered with a patch or a cap (a patch with an extended length). Patches and caps shall extend a minimum of six (6) inches beyond the limits of the defect and all corners of patches and caps shall be rounded with a radius of approximately two inches. All seaming for patches and caps shall be accomplished by extrusion welding.

The GMI shall record repair information, including technician and seaming apparatus ID, date, and time on the repair or on the geomembrane near the repair.

5.3.8. Permanent Anchorage in Anchor Trench

Following completion of the seaming activities as determined by the GMI, the geomembrane (and any other geosynthetic materials) shall be permanently anchored in the anchor trench. A detail indicating proper anchoring procedures is included in the project contract documents. The anchor trench shall be backfilled and compacted using hand-operated or rubber-tired equipment. Care should be used when backfilling and compacting the anchor trench to prevent damage to the geosynthetic materials. The final configuration of the anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

5.4. Quality Assurance Requirements

The QAO shall review quality control documents, conduct material conformance tests and inspect the placement and installation of the geomembrane, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

5.4.1. Inspection Upon Delivery

The QAI shall inspect the geomembrane material delivered to the site. All rolls of geomembrane shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code and/or roll number, date of manufacture, and roll dimensions. The QAI shall document that the quality control and conformance data has been received and is acceptable for each roll. The QAI shall also verify that the geomembrane rolls are being stored in a manner to protect them from the elements.

5.4.2. Thickness Determination

The QAI shall check the thickness of each roll of geomembrane delivered to the site. Thickness shall be checked with a micrometer on the leading edge at five (5) locations. The geomembrane shall meet the required material properties. See Section 5.2, except that thickness criteria are for five (5) measurements or four of five as appropriate. Geomembrane rolls which fail this thickness determination shall be removed from the site. The QAI shall document the thickness determinations taken for each roll.

5.4.3. Inspection During Deployment

The QAI shall visually inspect the deployment of the geomembrane to ensure that the panels are properly placed and that each seam will have sufficient overlap.

5.4.4. Observation of Non-Destructive Testing

The GMI shall coordinate the non-destructive testing with the QAE to ensure that a QAI is present for non-destructive testing. The QAE or QAI will verify that all non-destructive testing is successfully completed and will document the testing on data forms.

5.4.5. Survey Documentation

The QAE shall locate all seams, destructive test locations and patches for the geomembrane and may coordinate a survey for such purposes if appropriate. Reference locations will be noted on a drawing of the area.

5.4.6. Trial Seam Testing

Each trial test seam shall be at least three (3) feet long by one (1) foot wide. Four (six when possible if using dual track fusion welding) adjoining one (1) inch wide specimens shall be cut in a controlled manner, by die or template from the test seam sample. Two (2) specimens shall be tested in the field for shear, and two (2) for peel (four [4] when possible if testing both inner and outer welds for dual track fusion welding) using testing procedures outlined in the following paragraph. Specimens cut in an uncontrolled fashion to a random width shall not be used.

All trial seam specimens shall be tested by the GMI and observed by a QAI in the field for shear and peel using an electrically operated tensiometer, with the capability of registering the force imparted on a geomembrane test specimen. Hand operated tensiometers shall not be used. The trial seam specimens shall be tested at a cross-head rate of two (2) inches per minute. The GMI shall provide a calibration certificate for each load cell within the tensiometer. Calibration shall have been conducted within 90 days of the start of installation.

The GMI's seaming and testing technician(s) shall record the following information on a remnant portion of the trial seam sample. The remnant portion will be retained until project completion and may then be stored by the Owner. The QAI will log the information on a data form and assign each sample a number.

- Date and time of test;
- The name of the welder and identification of the apparatus used in performing the test;
- The failure mode: either "Pass" indicating a film-tear bond not in the weld or "Fail" for each specimen; and,
- The peak yield load in pounds per inch for each specimen.

5.4.7. Trial Seam Evaluation Criteria

The criteria for evaluating trial seams is as follows:

5.4.7.1.Shear

Two (2) trial seam specimens shall be tested in shear. Each must fail at a strength equal to or greater than ninety five percent (95%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance at less than the specified yield strength for sheet material. Neither trial seam test shall fail in the weld. If both of these criteria are not met, the entire trial seam shall be considered failing.

5.4.7.2.Peel

Two (2) trial seam specimens (four if necessary to test both inner and outer welds) shall be tested in peel and neither shall fail in the weld area. If this criteria is not met, the entire trial seam shall be considered failing. The peel strength of the geomembrane outside of the weld shall be equal to or greater than sixty two percent (62%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance less than 90 ppi for fusion seams and 78 ppi for extrusion seams. Peel seams must exhibit a Film Tear Bond (FTB) failure.

If a trial seam fails, the entire procedure shall be repeated after the appropriate adjustments to the welding apparatus or procedures have been made. This process shall be repeated until two (2) consecutive successful trial seam tests have been achieved. Alternatively, if a successful trial seam is not achieved, the welding apparatus and/or the operator shall not be used for seaming until such time as the deficiencies are resolved.

5.4.8. Destructive Seam Testing

5.4.8.1.Testing Location and Frequency

Destructive seam samples will be obtained at an average minimum frequency of one (1) per five hundred (500) lineal feet of weld. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. The seam destructive test sampling frequency may be increased by the QAE beyond the specified minimum based upon actual welding conditions and the results of other samples obtained.

The sample locations will be selected by the QAI as welding progresses. Additional sample locations may be prompted by suspicion of a poor quality weld.

The GMI will not be informed in advance of seam destructive test locations but will be required to physically obtain the samples from the geomembrane no later than twenty four (24) hours after the location has been selected.

The total footage of individual repairs of leaks of more than ten (10) feet and individual repairs of more than ten (10) feet for failed seams must also be counted and destructively tested using the same frequency of testing described above.

5.4.8.2.Sample Size

The location for the destructive samples shall be marked by the QAI. The dimensions for the destructive samples shall, as a minimum, be twelve (12) inches wide by thirty six (36) inches long with the seam centered widthwise. Sample lengths may be increased at the request of the QAL. The GMI shall obtain two specimens from each end of the marked seam destructive sample, each a minimum of one inch in width for preliminary field testing as described in Section 5.4.8.3.1. If the preliminary field testing exceeds the pass/fail criteria, the sample shall be cut and divided into two parts as described below:

- One portion of the sample, measuring twelve (12) inches by fifteen (15) inches, to be sent by the QAO to the QAL for testing.
- One portion of the sample, measuring twelve (12) inches by twelve (12) inches to be retained by the owner for archiving.
- The sample length shall be increased to accommodate the additional length required by the GMI for laboratory testing or archiving.

5.4.8.3. Testing Procedure

5.4.8.3.1. Preliminary Field Testing

Four (4) specimens, two (2) from each end of the destructive sample seam, are to be removed and tested by the GMI while in the field. One (1) specimen from each end of the original sample is to be tested in shear and the other in peel. Specimen and test procedures shall be the same as described for trial seams in Section 5.4.6. Field testing shall include testing on both tracks on dual track fusion welded seams for each specimen tested for peel.

5.4.8.3.2. Laboratory Seam Destructive Testing

The destructive seam testing will be performed by QAO in an off-site laboratory. This testing is to be completed within seventy two (72) hours of the time the samples are removed from the geomembrane installation. The Contractor may test samples in the field with observation by the QAI.

The testing shall be performed on a total of ten (10) specimens obtained from the field sample described in Section 5.4.8.2. Five (5) specimens shall be tested in each of the shear and peel modes. For the dual-tracked fusion welds, five (5) peel tests shall be performed for each track of weld. These shear and peel specimens shall be selected from the sample alternately so that no two (2) immediately adjacent specimens are tested in the same mode.

The specimens shall be tested in accordance with ASTM D 6392.

5.4.8.3.3. Seam Evaluation Criteria

Each seam sample must meet both the shear and peel criteria before being considered passing. Field tested specimens are determined as passing if the specimen tested in peel fails in FTB and all test specimens meet the criteria listed in this LQCP. The QAL testing must confirm these field results.

5.4.8.3.3.1. Shear

The shear strength must be at least ninety-five percent (95%) of the manufacturer's parent sheet yield strength, but no less than required material properties. The minimum passing criteria for independent laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all the specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered passing. If these criteria are not met then the entire seam destructive sample is considered failing.

5.4.8.3.3.2. Peel

The peel strength must be at least 62% of manufacturer's parent sheet yield strength, but no less than the required material properties. The minimum passing criteria for laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all five specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered as passing. If these criteria are not met, then the entire seam destructive sample is considered failing.

5.4.8.3.4. Seam Destructive Test Failure Procedures

In the instance of the dual-tracked fusion weld, both tracks of the weld will be tested in peel. If either peel test performed on specimens of this weld type fails, the entire specimen is considered failing.

The GMI shall reconstruct the failing seam bound by two passing seam destructive tests. The GMI shall have the option of obtaining additional destructive test samples at a minimum of ten (10) foot intervals in both directions along the failing seam from the failure location. The minimum interval may be increased by the QAE if test failures become excessive.

If both of these samples pass the laboratory seam destructive test then the seam can be reconstructed between them. If one (1) or both of these samples fail the laboratory seam destructive test, then the procedure is repeated until passing laboratory results are obtained. (Note: The tracking procedure described may be extended beyond the limits of an individual seam.)

If a seam is reconstructed to a length in excess of fifty (50) feet, a seam destructive sample may be obtained from the reconstruction zone which must meet the requirements described above.

6. LEACHATE COLLECTION SYSTEM

The following requirements govern the leachate collection system used in the landfill units:

6.1. Leachate Collection System Description

The leachate collection system (LCS) used consists of layers of geotextile fabric, HDPE drainage net, gravel and piping, as described in conjunction with the lining systems in Section 1.2. In general, the LCSs will be sloped to drain to one or more collector pipes running through each landfill unit. The underlying lining system will be sloped to the collector pipe, and along the line of the collector pipe toward the sump. The sump will have a riser pipe for the removal of collected liquids. Detailed design descriptions and drawings of the leachate collection system and geocomposite drainage layer are provided in the project construction documents.

6.2. Required Material Properties

The LCS and geocomposite drainage layer materials shall be new, first quality materials manufactured specifically for the purpose of liquid conveyance and collection. All LCS and geocomposite drainage layer materials shall have sufficient strength and resistance to chemical or ultraviolet radiation attack for the intended use.

6.2.1. Geotextile

All geotextile fabric shall be non-woven polypropylene, meeting the following minimum specifications:

Geotextile fabric for use in drainage geocomposite:

Mass per Unit Areas (ASTM D 5261)	8 ounces per square yard
CBR Puncture Strength (ASTM D 6241)	575 pounds
Grab Tensile Strength/Elongation (ASTM D 4632)	220 pounds/50%
Apparent Opening Size (ASTM D 4751)	0.15 mm
Permittivity (ASTM D4491)	1.3 per second (sec^{-1})

Geotextile fabric for use in leachate collection/leak detection trench:

Mass per Unit Areas (ASTM D 5261)	12 ounces per square yard
CBR Puncture Strength (ASTM D 6241)	925 pounds
Grab Tensile Strength/Elongation (ASTM D 4632)	320 pounds/50%
Apparent Opening Size (ASTM D 4751)	0.15 mm
Permittivity (ASTM D4491)	0.8 per second (sec^{-1})

6.2.2. HDPE Drainage Net

Minimum specifications for HDPE Drainage Net:

Thickness (ASTM D 5199)	250 mils (average of all measurements)
Density (ASTM D 1505)	0.94 gm/cm^3
Peak Tensile strength (ASTM D 5035 or ASTM D 7179)	45 ppi
Percent Carbon Black (ASTM D 1603 or ASTM D 4218)	2.0% to 3.0%
Transmissivity (ASTM D4716)	2×10^{-3} square meters per second (m^2/sec) at a gradient of 0.1 and a loading of 478.8 kilo-newtons per square meter (kN/m^2) [10,000 pounds per square foot]

6.2.3. Piping

Minimum specifications for Liquids Collection Piping:

Material	HDPE or PVC, single wall
Specifications	HDPE – ASTM F714 PVC – ASTM D1785, D2241 or D3034
Standard Dimension Ratio (SDR) [Outside Diameter to Wall Thickness]	21 Maximum
Joint Type	HDPE - Fusion Welded PVC – Fusion or Solvent-Cement Welded
Perforation Type (Where required)	Round
Perforation Size (Where required)	½” Max.
Perforation Area (Where required)	1-1/2 square inches (in^2) per foot

6.2.4. Gravel

Minimum specifications for LCS gravel:

Material Source	Washed, rounded river gravel
Maximum particle size (100% Passing – ASTM C136 or D422)	2”
At least 90% of Material Smaller Than (ASTM C136 or D422)	1-1/2”
No more than 10% of Material Smaller Than (ASTM C136 or D422)	½”
Calcium Carbonate Content (ASTM D3042)	Less than 15%
Coefficient of Permeability (ASTM D2434)	Greater than 0.2 cm/sec

6.3. Installation Procedures

The LCS and GDL material installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

6.3.1. Geotextile

6.3.1.1. Delivery and Storage

All rolls of geotextile delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Damage during unloading must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.1.2. Deployment

Geotextile shall not be deployed in the presence of excessive wind. On slopes, the geotextile shall be secured and rolled down the slope so that it is kept continuously in tension. Geotextile shall be placed parallel to sideslopes, except in special locations approved by the QAI. It shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the geotextile, the GMI shall ensure that it is not clogged with dirt or foreign materials. Geotextile shall be cut only with devices that are recommended by the manufacturer.

6.3.1.3.Panel Placement and Alignment

Geotextile panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches (or as sufficient for seaming.) The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the geotextile.

6.3.1.4.Field Seaming

All field seaming shall be performed by sewing using polymeric thread having chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Thread shall be supplied by the geotextile manufacturer or shall be as recommended by the manufacturer. Provide documentation of the source or recommendation by the manufacturer. Glues and heat bonding are strictly prohibited. In general, horizontal seams or splices should be avoided on side slopes. No two adjacent slope pulls may have a horizontal seam.

6.3.1.5.Procedures for Repair

Holes or tears in the geotextile shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel. Care shall be taken to remove any soil or other material which may have penetrated the damaged geotextile.

6.3.2. HDPE Drainage Net

6.3.2.1.Delivery and Storage

All rolls of HDPE drainage net delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Pushing, sliding or dragging of rolls or pallets can cause damage and must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.2.2.Deployment

HDPE Drainage net shall not be deployed in the presence of excessive wind. On slopes, the net shall be secured and rolled down the slope so that it is kept continuously in tension. Drainage net shall be placed parallel to sideslopes, except in special locations approved by the QAI. The drainage net shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the net, the GMI shall ensure that the net is not clogged with dirt or foreign materials.

6.3.2.3.Panel Placement and Alignment

Drainage net panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches. The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the drainage net.

6.3.2.4.Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the HDPE drainage net. Seaming can be achieved using string, plastic fasteners or ties, or polymer braid. Metallic devices are strictly prohibited. Submit the proposed seam (tie-pattern) with the quality control documents. In general, no horizontal seams are allowed on side slopes.

6.3.2.5. Procedures for Repair

Holes or tears in the drainage net shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel.

6.3.3. Piping

6.3.3.1. Delivery and Storage

All piping delivered to the site shall be marked with the name of the manufacturer, the product type, and applicable specifications under which the material was manufactured. The QAE or QAI must inspect the delivered materials for damage and defects. Piping shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than ten (10) sections high. The piping shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.3.2. Deployment

Piping shall be placed to the lines and grades shown on the project construction documents. Piping shall be temporarily anchored using sand bags, rubber tires or a comparable means that does not damage the piping and ensures proper alignment until covered. During placement of the piping, the GMI shall ensure that dirt or foreign materials do not enter the piping.

6.3.3.3. Field Joints/Seaming

All field joints or seaming shall be performed using fittings and method(s) approved by the manufacturer of the piping. Field joints shall be butt-fusion welded. For PVC piping, joints may be solvent-cement welded with prior written approval by the QAE. If solvent cement joints are to be completed over underlying geosynthetic materials, the GMI shall ensure that a sacrificial impermeable barrier is placed underneath each joint to prevent solvent material from coming in contact with the underlying material. Gasketed joints shall not be used.

6.3.3.4. Procedures for Repair

Damaged piping shall be removed and replaced using procedures consistent with those for installing new piping.

6.3.4. Gravel

6.3.4.1. Delivery and Storage

Gravel to be used for LCS construction shall be stockpiled as near as possible to the construction area. Signage near the stockpile shall identify the source, intended use, and gradation specifications (size). Gravel shall not be placed on wet ground.

6.3.4.2. Deployment

Gravel may be placed using mobile equipment or hand tools (e.g. wheel barrows, etc.). Where gravel placement must traverse underlying geosynthetic materials, the GMI shall use only low-ground pressure supporting equipment. If such equipment is operating over the geosynthetic materials, it must be placed on a sacrificial surface or rub sheet. Areas of underlying geosynthetic materials that are damaged in this manner shall be repaired as required by this LQCP. Gravel shall be placed to the lines and grades shown on the project construction documents. Gravel materials shall not be placed in direct contact with geomembrance materials. Where this is possible to occur, the GMI shall place a layer of geotextile fabric between the gravel and the geomembrane. During placement of the gravel, the GMI shall ensure that it is not obstructed by dirt or foreign materials.

6.4. Quality Assurance Requirements

The GMS or the QAO shall conduct material conformance tests, as outlined in Section 1.9 and the QAO shall review quality control documents, inspect the placement and finishing of the LCS, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

6.4.1. Inspection Upon Delivery

The QAI shall inspect the geosynthetic, piping and gravel materials delivered to the site, and shall document that the quality control and conformance data has been received and is acceptable for each material lot. The QAI shall also verify that the materials are being stored in a manner to protect them from the elements.

6.4.2. Inspection During Deployment

The QAI shall visually inspect the deployment of the drainage net, geotextile, piping and gravel to ensure proper placement as outlined in the LQCP and in the project construction documents.

6.4.3. Sieve Analysis (Gradation) for Gravel

A minimum of one (1) test for each 5,000 cubic yards (cy^3) or less of gravel shall be performed in accordance with ASTM C136 or ASTM D422. A minimum of one (1) test shall be performed regardless of the quantity.

6.4.4. Survey Verification

The QAE shall coordinate a survey to locate the piping and verify that proper grades are achieved. Where required to document grades, a minimum of one (1) survey verification shall be made per 5,000 ft^2 of surface area. Reference locations will be noted on a drawing of the area.

7. PROTECTIVE COVER

The following requirements govern the protective cover that will be installed on top of constructed liner materials and leachate collection systems:

7.1. Protective Cover Description

Protective cover soil material will be placed with a minimum thickness of 2 feet over the drainage layer component of the leachate collection system, including drainage aggregate where applicable.

7.2. Required Material Properties

The protective cover will consist of soils that do not contain any materials detrimental to the underlying geosynthetics. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials.

7.3. Installation Procedures

The protective cover soils shall be placed using low ground pressure equipment. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the underlying installed geosynthetics. Under no circumstances shall the construction equipment come into direct contact with the installed geosynthetics. Unless otherwise specified by the QAE, all lifts of protective cover soil placed over geosynthetics will conform with the following equipment and lift thickness guidelines.

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in)
< 5.0	12
5.1 – 8.0	18
8.1 – 16.0	24
> 16.0	36

Protective cover placed on sideslopes shall be placed from the bottom and pushed up the slope.

7.4. Quality Assurance Requirements

The protective cover soil thickness shall be verified by field surveys using a minimum of one survey point per 5,000 square feet of constructed area. Surveys shall be performed by a licensed Texas land surveyor and the survey results shall be included in the GLER submittal.

During construction the QAE shall:

- Verify that grade control is performed prior to work.
- Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls. Mark damaged geosynthetics and verify and document damage repairs.
- Verify that cover soil for sideslopes is pushed from the toe up the slope.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications.

8. FINAL COVER CONSTRUCTION

The following requirements govern the final cover system used at the facility:

8.1. Final Cover Description

The final cover system will consist of a six (6) inch thick (minimum) prepared subgrade layer, a geosynthetic clay liner (GCL) layer, a forty mil (0.04 inch) thick LLDPE geomembrane liner, a geocomposite drainage layer, and a twenty five (25) inch thick protective cover soil layer. Soil materials used for the final cover system shall be obtained either from on-site or off-site sources.

8.2. Required Material Properties

Soil materials and geosynthetic materials used for final cover construction comply with the following required material properties.

8.2.1. Soil Materials

8.2.1.1. Subgrade Soils

Soil materials shall meet the requirements of Section 2.2.

8.2.1.2. Protective Cover Vegetative Soil Layer:

The soil material for the protective cover vegetative soil layer shall consist of earthen material capable of sustaining native plant gowth and be composed of particles of which at least thirty percent (30%) but no more than ninety six percent (96%) pass the #200 sieve.

8.2.2. Geosynthetic Materials

8.2.2.1. Geosynthetic Clay Liner (GCL)

The GCL material shall meet the requirements of Section 4.2.

8.2.2.2. Geomembrane Liner

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall meet the requirements of Section 5.2.

8.2.2.3. Geocomposite Drainage Layer

The HDPE drainage net and geotextile fabric used in the geocomposite drainage layer shall meet the requirements of Section 6.2.

8.3. Installation Procedures

The final cover installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

8.3.1. Subgrade Preparation

The existing intermediate cover material shall be shaped to the appropriate lines and grades as shown in the project contract documents and should coincide with the bottom of the final cover system. Subgrade soil materials shall be installed in accordance with the procedures specified in Section 2.3.

8.3.2. GCL Installation

The GCL shall be installed in accordance with the procedures specified in Section 4.8.

8.3.3. Geomembrane Liner Installation

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall be installed in accordance with the procedures specified in Section 5.3.

8.3.4. Geocomposite Drainage Layer

The geocomposite drainage layer shall be installed in accordance with the procedures specified in Section 6.3.

8.3.5. Protective Cover Vegetative Soil Layer

A minimum twenty five (25) inch thick layer of protective cover soil shall be placed above the geocomposite drainage layer on the top and side walls of the area to receive cover. Protective cover does not require compaction control; however it should be stable for construction, operations and maintenance traffic. Care shall be exercised in placement so as not to shift or wrinkle or damage the underlying geosynthetics layers. Protective cover shall be placed using low ground pressure dozers (i.e. track pressure less than 5 psi). A 12-inch thickness of protective cover shall be maintained at all times. A greater thickness will be required to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires and sharp turns. Protective cover shall be placed in an upslope direction on sidewalls.

The required thickness of the protective cover layer will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area.

9. GENERAL DOCUMENTATION REQUIREMENTS

The QAE shall be responsible for ensuring that adequate documentation is prepared to comply with the LQCP. Documentation may consist of daily recordkeeping, manufacturer’s test reports, conformance testing and installation reports, nonconformance reports (if necessary), progress reports, and design and specification revisions (if necessary). The appropriate documentation shall be used by the QAE to develop the GCLER, GLER and BER (if required) as well as other reports that may be required by the owner.

9.1. Daily Field Reports

The QAI shall prepare a daily field report. This report shall be prepared on the form included in Appendix C or a form containing similar information and shall be submitted to the owner and the QAE. The QAE shall review and sign all daily field reports. These daily field reports shall describe the work performed during the day.

9.2. Test Results

All tests shall be documented. The QAE shall develop and implement a tracking process to discretely identify each test result, including failures and subsequent re-tests. All laboratory tests shall have a written report prepared to indicate the results. The QAE or QAI shall review all test results and determine whether the test results meet project requirements. The QAE shall track each failing test result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Written and/or tabular summaries of field test results shall be prepared for inclusion in the GCLER/GLER. Copies of laboratory test results shall also be included in the GCLER/GLER.

9.3. Surveying Results

The QAE shall ensure that the surveying results are presented on a project drawing prepared to indicate the as-built condition of the constructed components. The QAE shall work with the surveyor to develop and implement a tracking process to discretely identify each surveyed location and the date on which the survey was conducted, including failures and subsequent re-surveys. The QAE shall track each failing survey result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Calculations supporting the thickness verifications shall be submitted by the surveyor to the QAE for inclusion in the GLER.

9.4. Sample Location Plan

The QAE shall be responsible for preparing and maintaining a site map which depicts the components being constructed on which can be documented the progress of the work, including inspections, sampling, testing and surveying. This map may be supplemented with additional maps and drawings sufficient to maintain proper records.

9.5. Final Reporting Requirements

The QAE shall be responsible for preparing, signing, and sealing the final GCLER/GLER document. The GCLER/GLER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. Submittal shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. If no response is received, either oral or written, within

14 days of receipt at the Waste Permits Division of the TCEQ, the report will be considered accepted. Any notice of deficiency received from the TCEQ will be promptly addressed and incorporated into the GCLER/GLER document. No solid waste will be placed over the constructed liner areas until final acceptance is obtained from the TCEQ.

If a layer of waste has not been placed over the top of protective cover within six months, then the QAE or the design engineer will visually observe that the protective cover has not undergone significant erosion that could compromise the protection of the underlying geosynthetics. A letter report documenting the observation of the cover and the repair measures undertaken to correct any cover damage will be submitted to the TCEQ for review and acceptance. This procedure shall be repeated at six month intervals until all protective cover has been covered with a layer of waste.

The QAE shall be responsible for preparing, signing and sealing the final BER that will document that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner. The BER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. The BER shall also verify that the liner did not undergo uplift during construction. Additional documentation to accompany the BER includes a waste as ballast placement record completed and signed by the site operator, a survey of the top of waste elevations to document that the required waste thickness has been placed, and ballast thickness calculations. Submittal of the BER shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. The ballast placement and BER will not be considered accepted, and the temporary dewatering system must remain operational, until the TCEQ has given confirmation of its acceptance, or 14 days from the date of arrival of the BER at the Waste Permits Division, TCEQ have lapsed.

10. CONSTRUCTION BELOW THE HIGHEST GROUNDWATER LEVEL

10.1. Applicability

Future landfill sectors may be constructed below groundwater levels and could potentially experience uplift due to hydrostatic pressure acting on the liner system. Measures for both short term and long term protection of the liner system against uplift forces are described in this section of the LQCP.

A temporary dewatering system consisting of a dewatering drainage geocomposite and dewatering piping installed in gravel filled collection trenches will be installed below the footprint of future sectors prior to construction of the new liner. The geocomposite will also extend up the sidewalls of each newly developed sector to prevent the buildup of hydrostatic forces on the liner system. The sidewall geocomposite will drain to a toe trench and dewatering pipe collection system that will flow to a dewatering sump at the low point of the sector.

Long term protection of the liner system will be accomplished with the placement of sufficient ballast consisting of a combination of drainage gravel, protective cover soils, waste and final cover as applicable. Sample ballast calculations are provided in Appendix E – Example Ballast Calculations.

The highest groundwater elevation contours are shown on Figure III.10D-1of Appendix D. The contours on this drawing are based upon the highest individual reading in each of the monitor wells shown and do not represent a single event, existing conditions or groundwater flow. This contour map will be updated with the design of each new sector or partial sector to incorporate any higher well level data that has been recorded since the previous sector was constructed.

10.2. Dewatering System

To prevent the buildup of hydrostatic forces on the liner system, each new sector will have a temporary dewatering system installed prior to liner construction. The temporary dewatering system design is presented in Appendix D and consists of a drainage geocomposite extending across the floor of the sector that will transmit captured groundwater to a gravel filled collection trench that drains to a groundwater collection sump. The drainage geocomposite will also extend up the sidewalls and will drain to a gravel filled toe trench that coveys collected water to the groundwater collection sump. Water collected in the sump will be pumped to the facility perimeter stormwater drainage system. The drainage geocomposite will be covered with a 1-foot thick foundation soil layer that will serve as a subgrade for the GCL component of the liner system. The foundation soil layer will consist of on-site or off-site soil material that is free of organics, angular rocks, foreign objects or other deleterious materials.

Operation of the temporary dewatering system will continue until sufficient ballast is placed to offset the potential hydrostatic uplift forces acting on the liner. The liner can only be taken out of service upon the written approval of TCEQ once sufficient documentation of ballast placement has been submitted.

Alternate temporary dewatering systems may be submitted to TCEQ for consideration and approval if circumstances warrant the development of such alternate systems. A permit modification application must be submitted detailing the purpose and details of any such changes to this LCQP.

10.3. Dewatering System Materials

10.3.1. Piping

The dewatering collection trench piping shall meet the requirements of Section 6.2.3. Collection pipes will be 6-inch diameter HDPE SDR 17 or an approved equal. Installation procedures shall be in accordance with Section 6.3.3.

10.3.2. Drainage Gravel

Aggregate for the dewatering system collection trenches shall meet the minimum specifications listed in Section 6.2.4. Calcium carbonate content requirements for the dewatering system drainage gravel will be waived as the groundwater pH is expected to be neutral. Installation of the drainage gravel shall be in accordance with Section 6.3.4.

10.3.3. Drainage Geocomposite

The drainage geocomposite shall meet the requirements specified in Appendix D as well the construction documents for the specific sector development project. Installation of the drainage geocomposite shall be in accordance with Section 6.3.

10.4. Operation of the Dewatering System

The dewatering system shall be kept in operation until the ballast evaluation report is submitted to and approved in writing by TCEQ. Pumps used for pumping out water that collects in the dewatering sumps shall be inspected on a weekly basis to ensure proper operation. The pumps will be controlled with pressure transducers to ensure that the groundwater is below the liner elevations. Alternatives to pressure transducers for measuring groundwater levels in the sump include bubbler levels or graduated measuring rods. The QAE will identify the allowable groundwater level in the dewatering sump for each sector. Water levels in the sump shall be recorded weekly and the volume of water pumped shall be recorded on a monthly basis.

10.5. Liner System Ballast

Liner protection against long-term hydrostatic uplift pressures will be provided by the counteracting weight of the materials placed above the geomembrane liner, referred to as ballast. The ballast includes the weight of the leachate collection system, protective cover soil materials, and compacted waste. Additional soil in excess of the minimum protective thickness may also be used as ballast. Example calculations for determining the height of compacted waste or additional protective cover soils above the liner system are provided in Appendix E. Once ballast has been placed to the calculated height above the liner in a newly constructed sector, the temporary dewatering system below the liner no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. A ballast evaluation report (BER) must be prepared and submitted to TCEQ to document that the adequate height of ballast has been achieved in the sector to offset potential hydrostatic uplift forces, and to request that the temporary dewatering system operations be discontinued. Once the BER is accepted by the TCEQ in writing, operation of the temporary dewatering system may be discontinued.

Ballast calculations will be performed to provide an adequate thickness of soil and/or waste to offset the potential hydrostatic uplift forces for each sector constructed below the groundwater table. A calculated factor of safety against uplift of 1.5 will be required for ballasting with waste and a factor of safety of 1.2 will be used for soil ballast. The unit weight for waste used as ballast will be 1200 pounds per cubic yard. The unit weight for soil used as ballast will be determined by laboratory testing for each specific sector construction project.

Landfill personnel working under the supervision of the landfill superintendent will be on site full time during placement of the first 5 feet of waste over the liner system. The site operator will verify and document on a daily basis that this lower 5 feet of waste does not contain brush or large bulky items that could damage the liner system or that cannot be compacted to the required density. Documentation will also be provided on a daily basis that the waste for ballast has been compacted with compaction equipment which weighs in excess of 40,000 pounds. The site operator will complete and sign a waste-as-ballast placement record that will be attached to the BER. A copy of the form, TCEQ-10073, is included in Appendix F. The latest revision of TCEQ-10073 or an equivalent form will be submitted for each sector associated with the BER.

10.6. Verification of Liner Performance

The QAE will verify that the ballast placed is consistent with the established criteria and that uplift of the liner system did not occur during construction. The QAE shall observe the liner subgrade for evidence of seepage during construction. Any areas of seepage will be documented by the QAE as to seepage location, methods and procedures used to control the seepage, and continued monitoring of the seepage area after control.

To document that short-term uplift has not occurred during construction of the liner, the QAE shall verify that the elevations of the GCL are consistent with the design subgrade elevations on shown on the construction drawings. The QAE shall also verify that the protective cover elevations have not increased from those submitted with the GLER. Survey measurements to check against uplift will be taken at a minimum frequency of 1 point per 10,000 square feet. The protective cover uplift survey will be performed once between submittal of the GLER and the beginning of waste placement.

10.7. Documentation

The GCLER, GLER, and BER will include information relevant to construction of the liner below the groundwater table. The calculations for the constructed liner ballast installed over the liner system will be submitted with the BER. The GCLER and GLER shall include a discussion identifying areas constructed below the highest measured groundwater elevations and a discussion of current groundwater conditions. The GCLER and GLER shall also include a discussion addressing any seepage that may have been encountered during construction. The BER will contain survey information verifying that the appropriate depth of ballast has been installed and that the liner did not experience hydrostatic uplift.

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APPENDIX A

Subgrade Acceptance Form

City of Kingsville Landfill

GCL/GEOMEMBRANE SUBGRADE ACCEPTANCE FORM

PROJECT:		
INSTALLER NAME:		
INSTALLER ADDRESS:		
SUBGRADE LOCATION:		

INSTALLER CERTIFICATION

I, the undersigned representative of the Installer, do hereby accept the surface of the soil subgrade to the limits described above as being suitable for geomembrane placement, in accordance with the project specifications.

SIGNATURE:		
NAME:	TITLE:	DATE:
CERTIFICATION RECEIVED BY QUALITY ASSURANCE ENGINEER		
SIGNATURE:		
NAME:	TITLE:	DATE:
CERTIFICATION RECEIVED BY OWNER		
SIGNATURE:		
NAME:	TITLE:	DATE:

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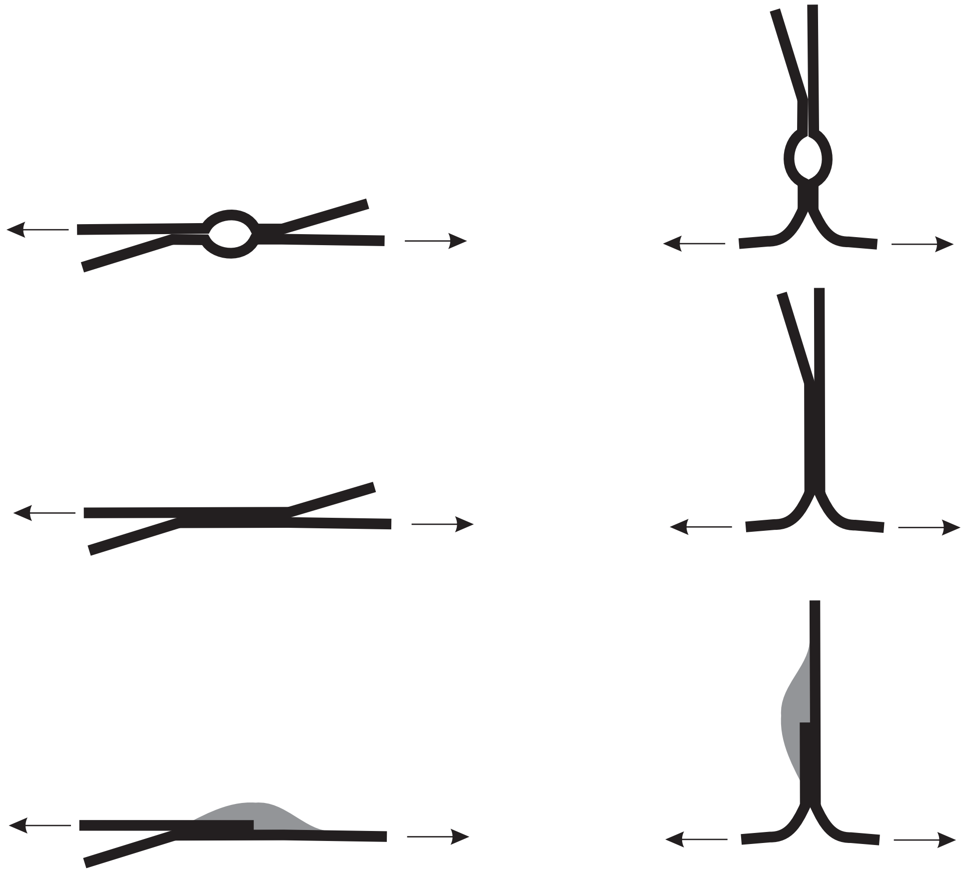
APPENDIX B

Typical Details

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

SHEAR | PEEL | WELD TYPE

NOTE: ARROWS SHOW DIRECTION OF TEST APPARATUS FORCE.



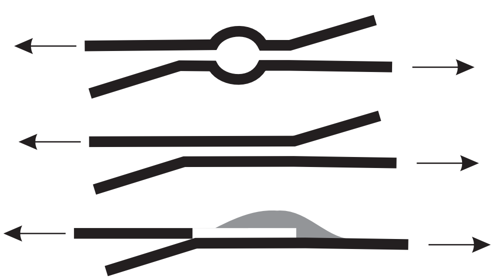
DOUBLE WEDGE

SINGLE WEDGE

EXTRUSION

GEOMEMBRANE TEST MODES

NON-FILM TEAR BOND FAILURE MODE



ADHESION

FAILS IN WELD IN ONE OR BOTH SHEETS

EVALUATE OTHER FAILURE MODES AS PER GRI GM13

City of Kingsville Landfill

TCEQ Permit MSW 235-C

GEOMEMBRANE TEST DETAILS

LINER QUALITY CONTROL PLAN (LQCP)

Part III, Attachment 10, Appendix B

Drawn By: AKM	Appr. By: JMR	Scale: NOTED	Dwg. NO.: III.10-B-1	Sheet 1
Checked By: JMR	Project No.: 16L0438	Date: 09/06/18	Rev.: 0	Of 1

APPENDIX C

Typical Daily Field Report Form

HANSON PROFESSIONAL SERVICES, INC.
TYPICAL PROJECT INSPECTION REPORT

Project Title: City of Kingsville Landfill	
Owner: City of Kingsville	
Owner's Project No.: None	Hanson Project No.:

Date:	Time:	Page of
Contractor:	Type of inspection: ☒ daily ☐ periodic	
Inspector(s):	Persons contacted on-site:	
Visitor(s):		
Weather:	Testing in progress:	
Contractor: ☐ working ☐ not working ☐delayed ___________________________		
Work in progress: (See attached photo log)		
Work completed since last inspection:		
Equipment/materials received on-site since last inspection:		
Summary: (Attach additional sheets as required)		
Problems/Issues:		
Follow-up Actions Required:		
Signature of inspector(s):		
Distribution:		

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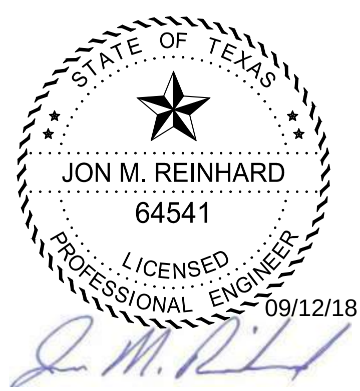
APPENDIX D

Temporary Dewatering System Design



TEMPORARY DEWATERING SYSTEM DESIGN

The liner system for future Sectors 4C, 5, 6 and 7 may be constructed below the historic high groundwater elevations and will therefore require the installation of a temporary dewatering system beneath the liner. The dewatering system will consist of a dewatering drainage geocomposite that will be installed along the floor and sideslopes as these sectors are constructed. The dewatering drainage geocomposite will capture groundwater and convey it to collection trenches located at the centerline of the sector and also along the toe of the sideslopes. The collection trenches will drain to sumps from which the groundwater will be pumped to the perimeter stormwater drainage system.

This appendix includes the design information and supporting calculations for the various components of the temporary dewatering system.

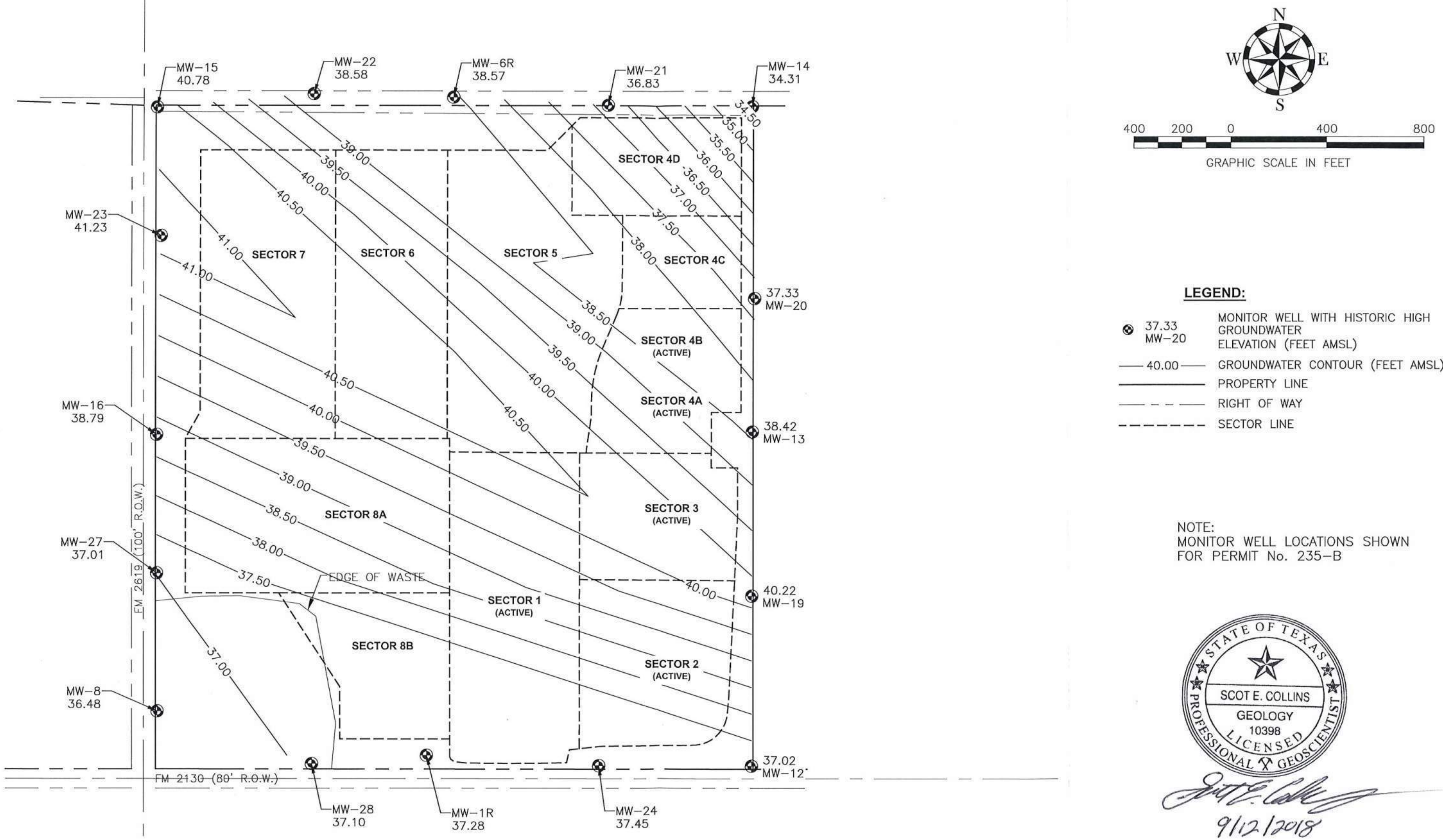
This appendix will present the design of the temporary dewatering system that will be installed beneath the liners in Sectors 4C, 5, 6 and 7 if they are constructed below the highest historic groundwater elevations. The historic high groundwater contour map and design drawings and details are provided in Figures III.10D-1 through III.10D-5.

The process for designing the various components of the temporary dewatering system will be:

A. Estimate the groundwater flow into the dewatering drainage geocomposite
B. Verify the flow capacity of the drainage geocomposite specified
C. Estimate the required flow capacity of the dewatering collection pipes
D. Verify the flow capacity of the dewatering collection pipes specified
E. Provide structural calculations for the dewatering collection pipes
F. Design the sump and identify the dewatering pump performance characteristics

The design calculations will conservatively be performed on the largest sector and the results applied to all remaining sectors to be constructed. Sector 5 will be the basis for design.

A. Estimate the groundwater flow into the dewatering drainage geocomposite installed below the liner system. Groundwater flows will be estimated for two cases – the floor of the sector and the sector sidewalls.



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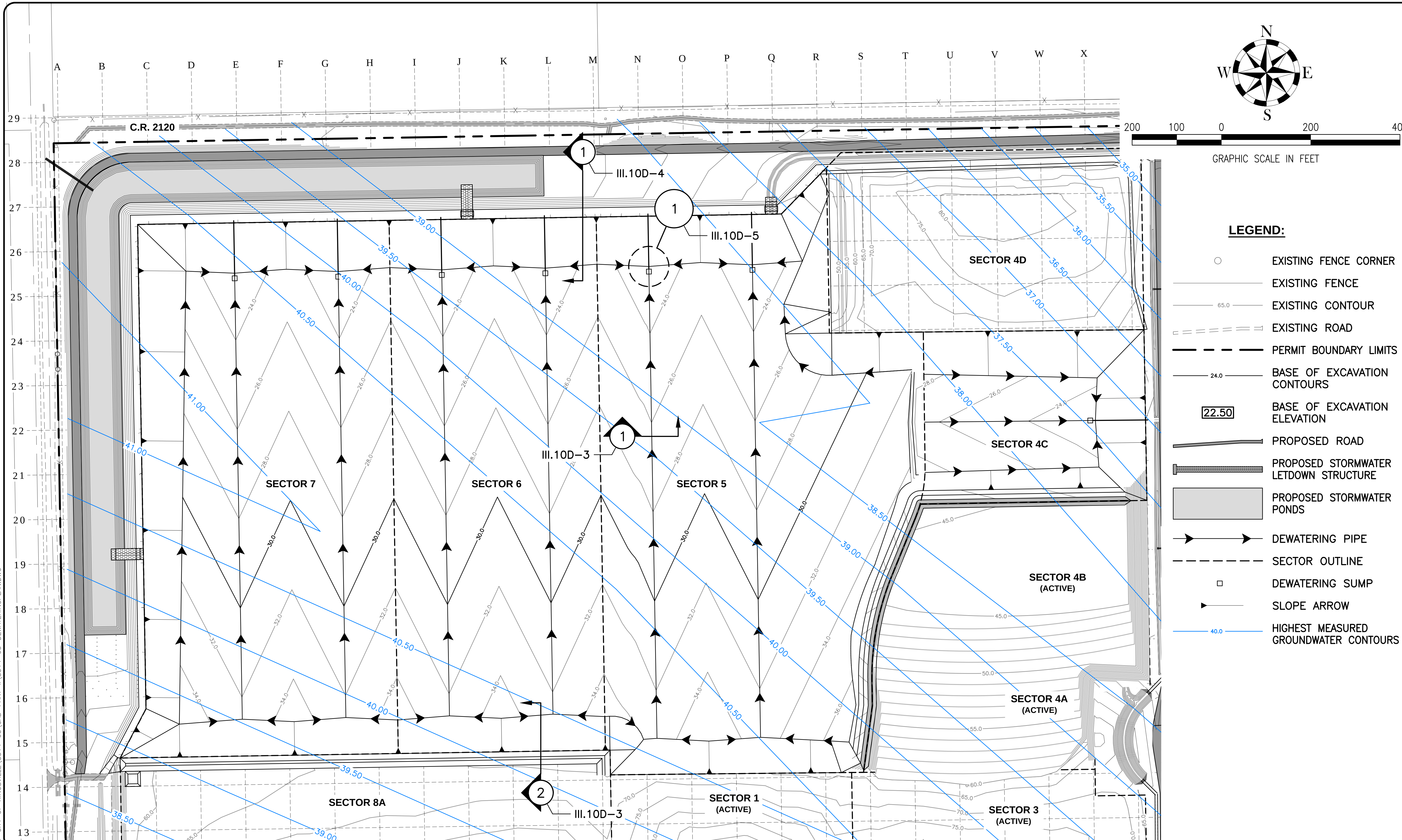
PART III, ATTACHMENT 10, APPENDIX D
HISTORIC HIGH GROUNDWATER CONTOUR MAP (SEPTEMBER 2018)
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.10D-1



NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

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09/12/18

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PART III, ATTACHMENT 10, APPENIX D
DEWATERING PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.10D-2

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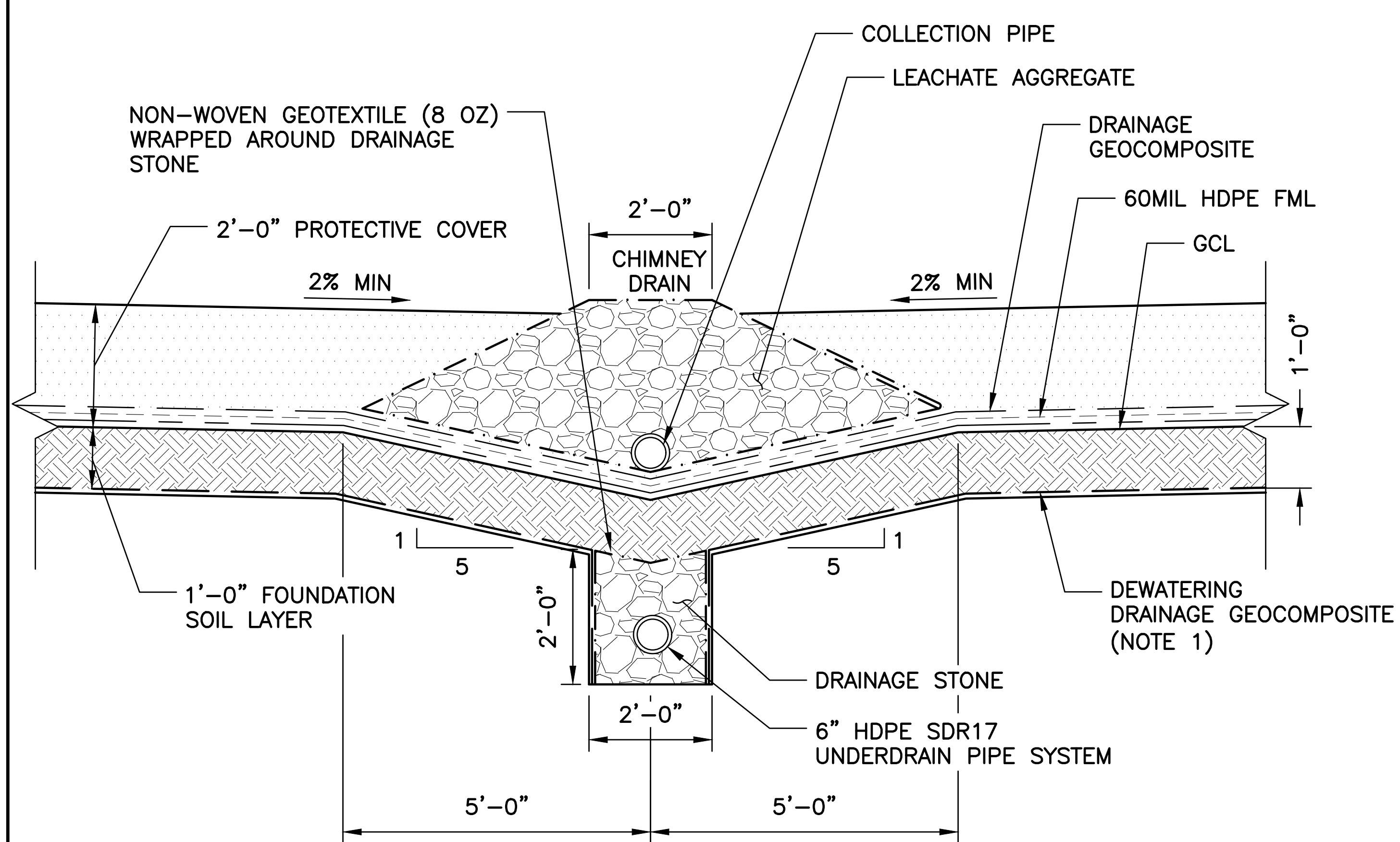
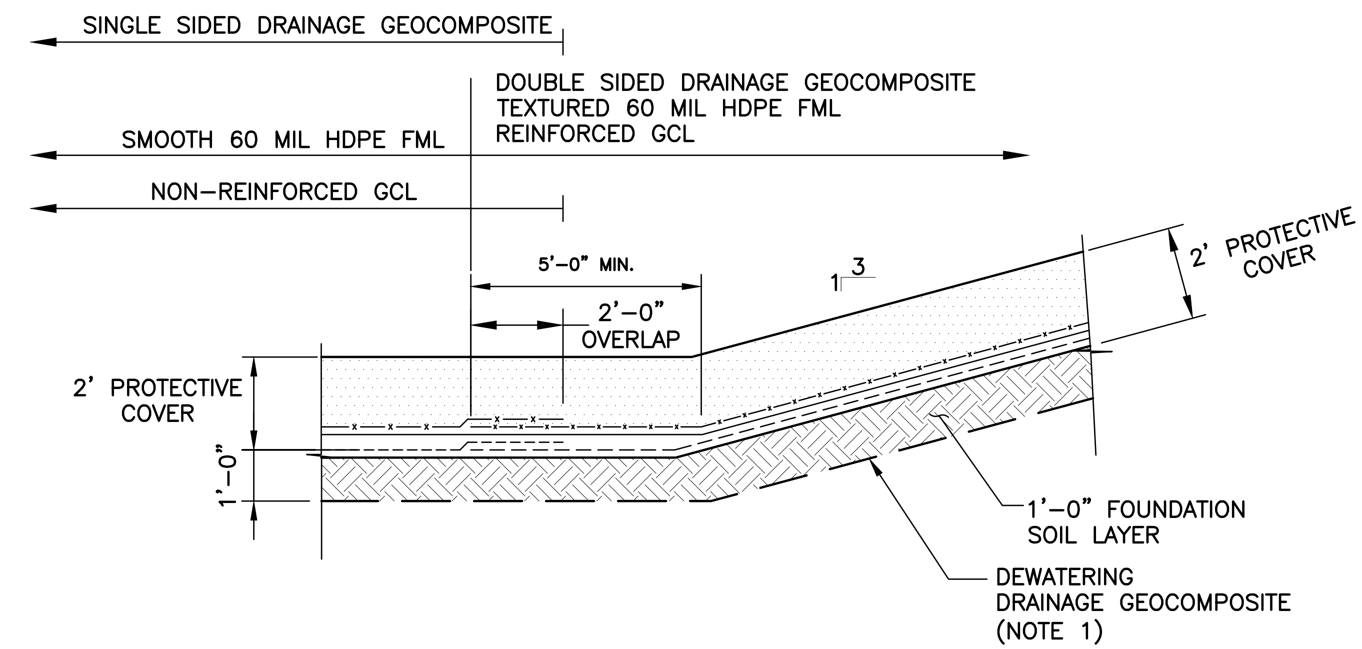


1 DEWATERING TRENCH – DETAIL

SCALE: 1"=3'

III.10D-2



2 SIDEWALL DEWATERING – DETAIL

SCALE: N.T.S.

III.10D-2

NOTE:
DEWATERING DRAINAGE GEOCOMPOSITE IS A DOUBLE SIDED GEOCOMPOSITE, WITH 200 MIL GEONET AND 8 OZ/SY GEOTEXTILE HEAT BONDED TO BOTH SIDES.

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PART III, ATTACHMENT 10, APPENDIX D
DEWATERING SYSTEM DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.10D-3

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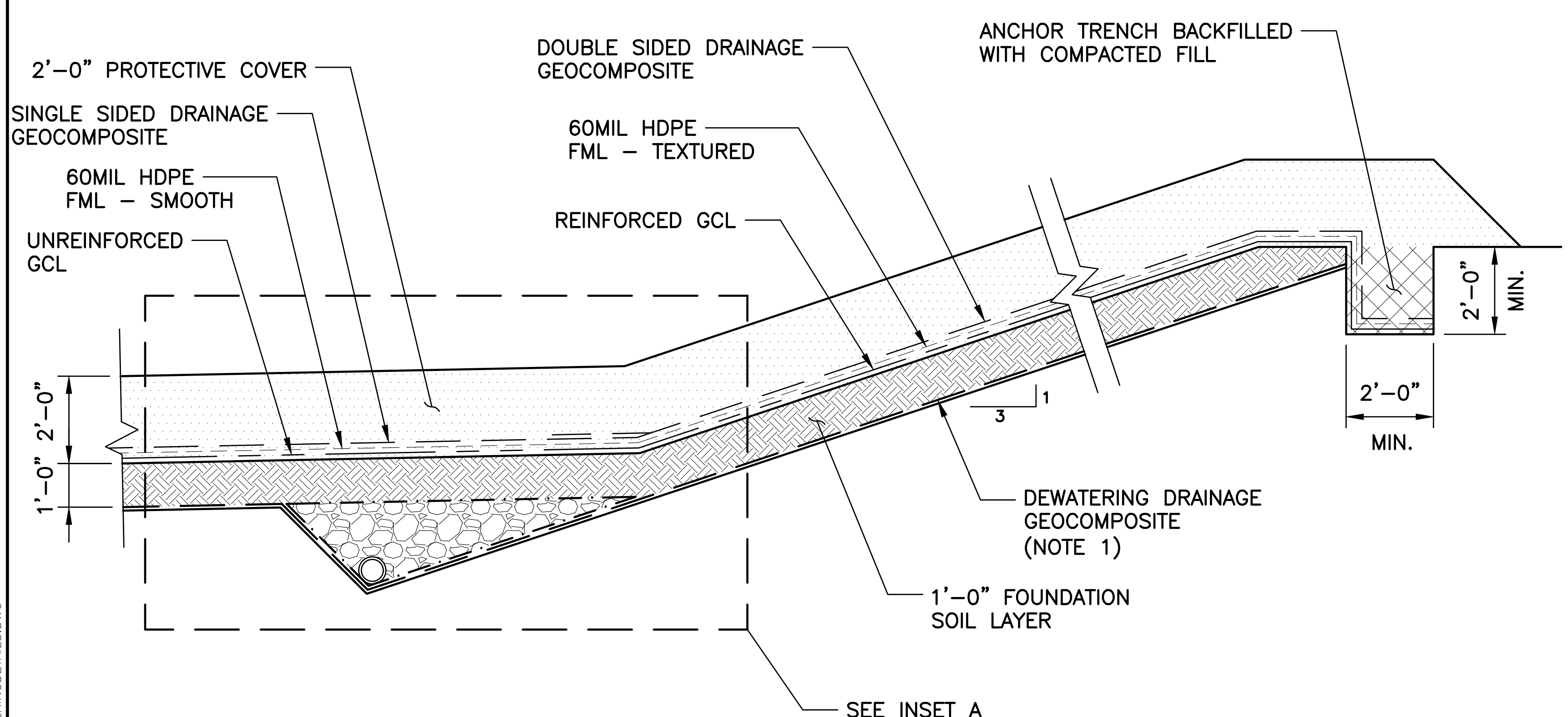

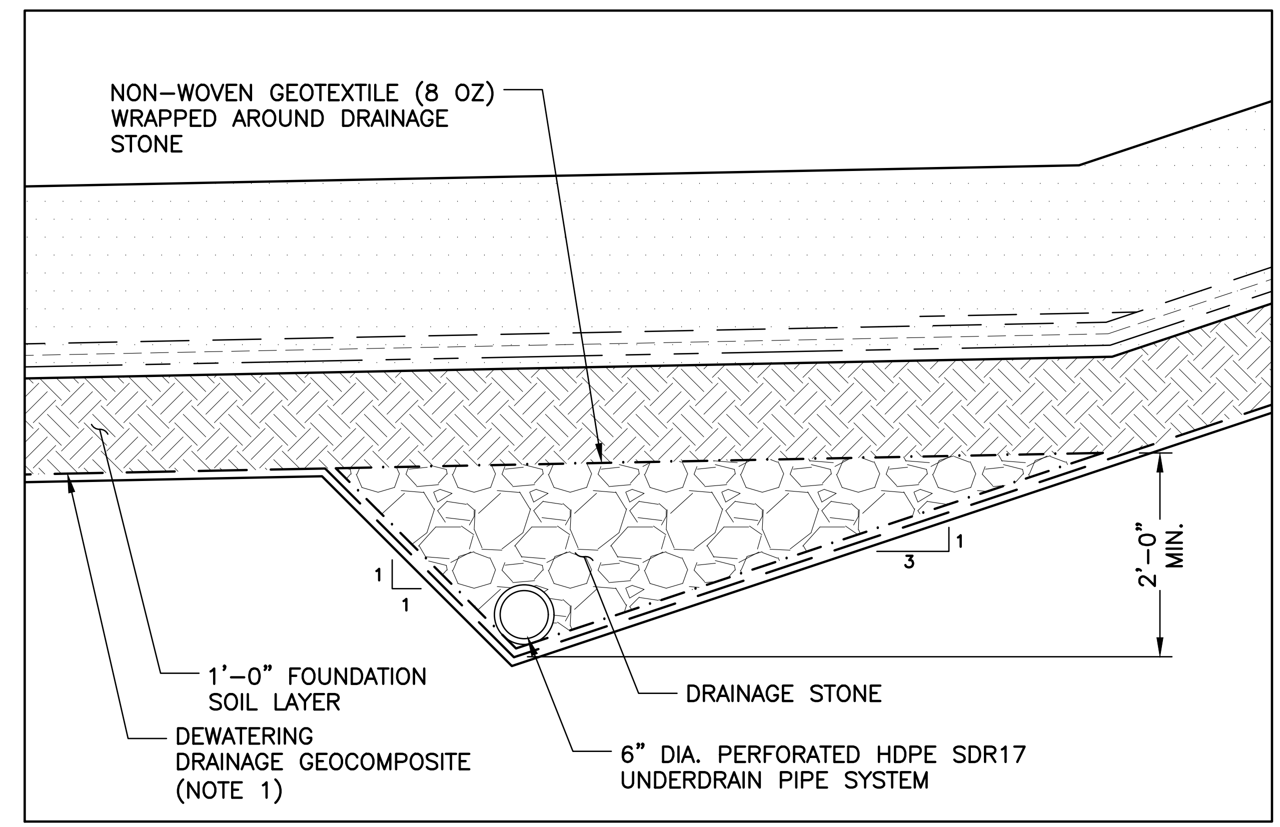

INSET A
SCALE: 1"=2'

1 TOE UNDERDRAIN TRENCH
SCALE: 1"=4'
III.10D-2

NOTE:
DEWATERING DRAINAGE GEOCOMPOSITE IS A DOUBLE SIDED GEOCOMPOSITE, WITH 200 MIL GEONET AND 8 OZ/SY GEOTEXTILE HEAT BONDED TO BOTH SIDES.

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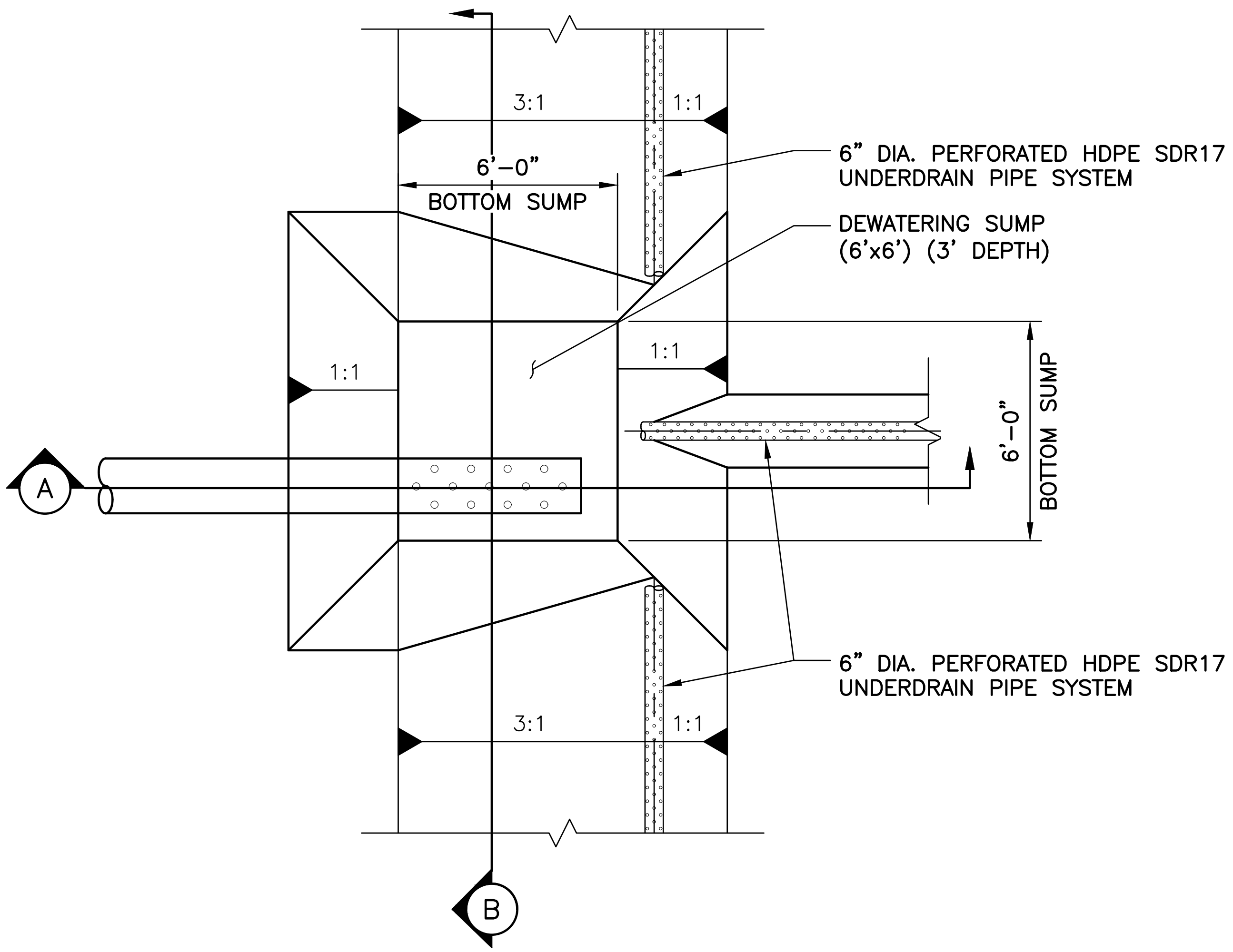
PART III, ATTACHMENT 10, APPENDIX D
DEWATERING SYSTEM DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

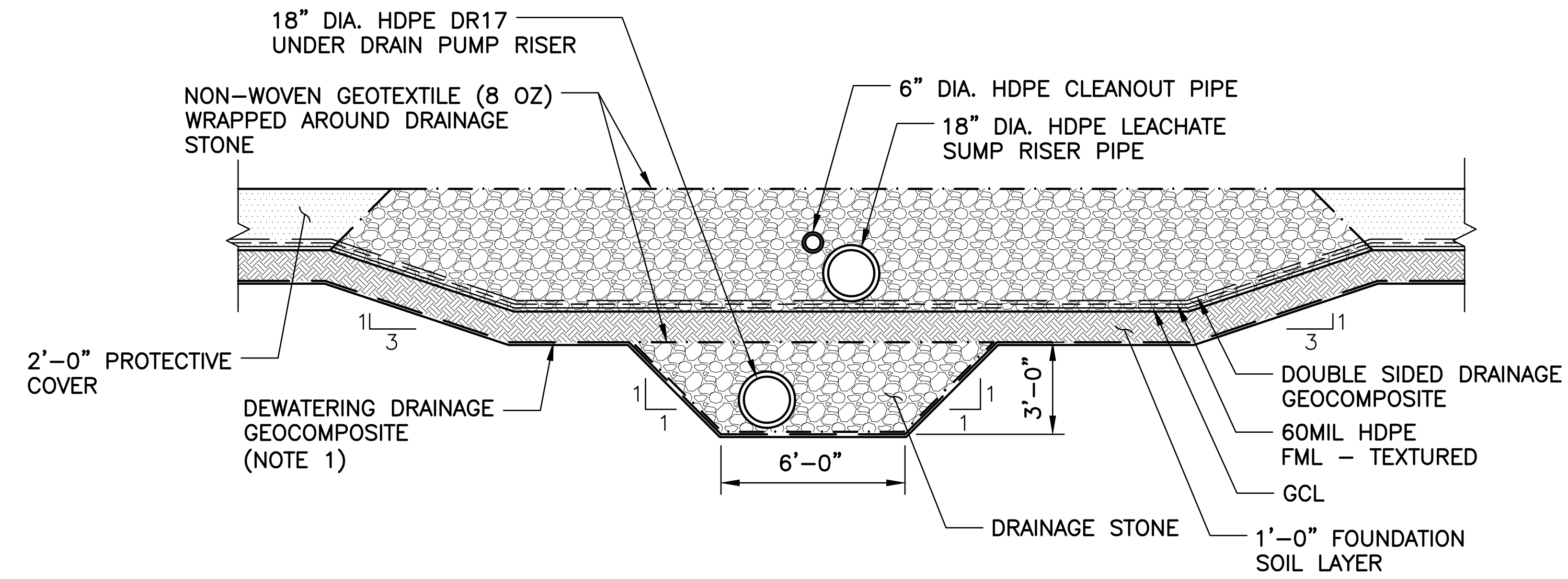
FIGURE:
III.10D-4



1 PLAN – DEWATERING COLLECTION SUMP

SCALE: 1"=5'

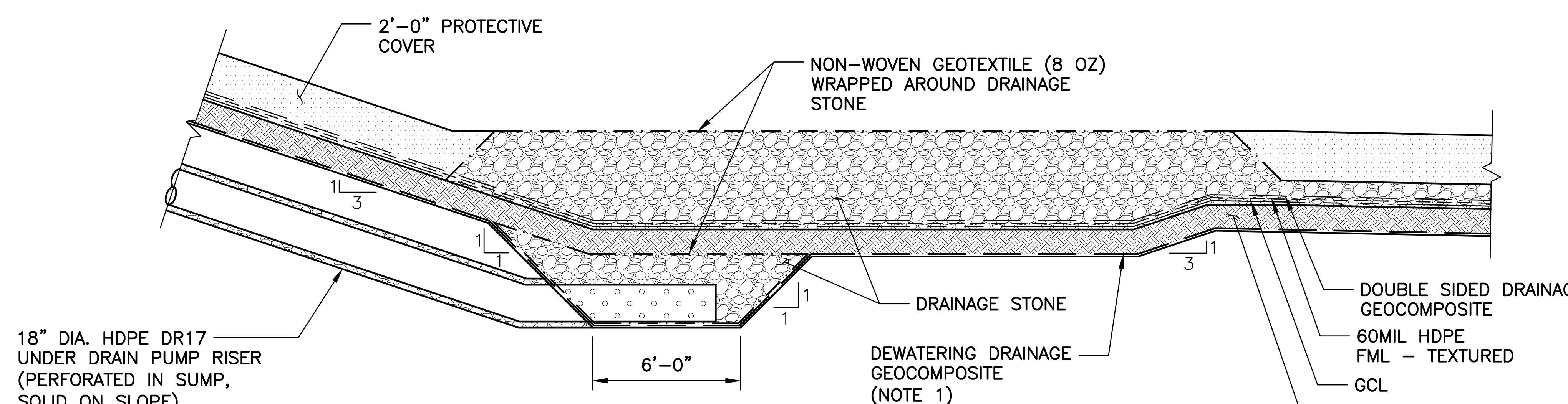
III.10D–2



A SECTION – DEWATERING SUMP SECTION

SCALE: 1"=6'

III.10D–2



B SECTION – DEWATERING SUMP SECTION

SCALE: 1"=6'

III.10D–2

NOTE:
DEWATERING DRAINAGE GEOCOMPOSITE IS A DOUBLE SIDED GEOCOMPOSITE, WITH 200 MIL GEONET AND 8 OZ/SY GEOTEXTILE HEAT BONDED TO BOTH SIDES.

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PART III, ATTACHMENT 10, APPENDIX D
DEWATERING SYSTEM DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.10D-5

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 1
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
A. Groundwater Flow Into the Dewatering Drainage Geocomposite

I. OBJECTIVE: Estimate the groundwater flow into the dewatering drainage geocomposite installed below the liner system. Groundwater flows will be estimated for two cases – the floor of the sector and the sector sidewalls.

II. APPROACH:

A. Review the dimensions of the sector floor layouts and select the sector with the greatest flow distance on the floor perpendicular to the center trench/collection pipe. Determine the greatest sideslope length within the selected sector.

B. Estimate the groundwater flow assuming two cases:

Case 1: Sector floor
Case 2: Sector sideslope

Groundwater flow into the geocomposite will be calculated using the formula

$Q = kiA$

Where:

Where:	Q =	inflow rate (cfs/ft)
	k =	hydraulic conductivity (ft/s)
	i =	gradient (ft/ft)
	A =	inflow area (sf)

III. ASSUMPTIONS:

A. Sector 5 will provide the greatest flow distance on the floor perpendicular to the center trench/collection pipe. This occurs on the eastern section of the floor from the boundary with Sector 4C to the east drainage trench and has a flow distance of approximately 350 feet.

B. The greatest sideslope length in Sector 5 occurs at the sump locations and has a sideslope flow length of approximately 119 feet.

C. Assume the value for k is 2.12×10^{-6} cm/s or 6.94×10^{-8} ft/s. This k value is an average of values for borings 15, 16, 17 and 18 which cover the undeveloped areas that may be constructed below the groundwater table. See the hydraulic conductivity table in Part III, Attachment 4, Appendix 1, page 369.

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 2
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
A. Groundwater Flow Into the Dewatering Drainage Geocomposite

IV. CALCULATIONS

A. Case 1, Sector floor.

Q= kiA

Where:	Q =	inflow rate (cfs/ft)
	k =	hydraulic conductivity (ft/s)
	i =	gradient (ft/ft)
	A =	inflow area (sf)

k = 6.94 x 10^{-8} ft/s
i = 1.0 ft/ft for flow into the geocomposite
A = 350 sf/ft (this is the maximum length multiplied by a unit width of 1 ft)

Q = 2.42 x 10^{-5} cfs/ft

B. Case 2, Sector sideslope.

Q= kiA

Where:	Q =	inflow rate (cfs/ft)
	k =	hydraulic conductivity (ft/s)
	i =	gradient (ft/ft)
	A =	inflow area (sf)

k = 6.94 x 10^{-8} ft/s
i = 1.0 ft/ft for flow into the geocomposite
A = 119 sf/ft (this is the maximum length multiplied by a unit width of 1 ft)

Q = 8.26 x 10^{-6} cfs/ft

CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL
GROUNDWATER GEOCOMPOSITE

Appendix B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY

I. Objective: Verify that the dewatering drainage geocomposite has the flow capacity for the estimated groundwater flows.

II. Approach: Compute the maximum depth of groundwater in the geocomposite for the estimated design flow.

III. Assumptions:

A: Design groundwater flow rate is 2.42×10^{-5} cfs/ft which equates to 11.5 gpm for the flow area of 8.47 ac.

B: Assume 200 mil geocomposite calculations.

IV. Calculations:

for surface area 8.47 ac Q= 11.5 gpm

Q= 0.02562 ft^3/sec

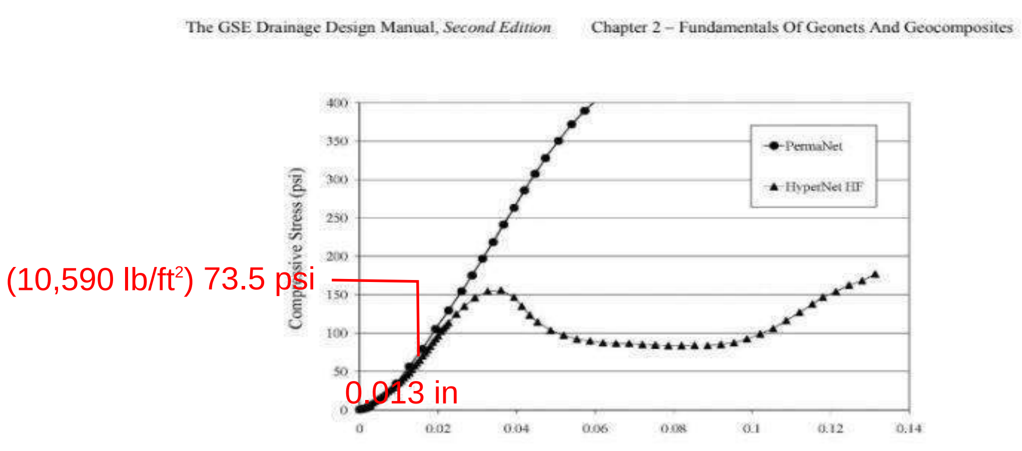
$$T_{max} = L \frac{[4(e/k) + \tan^2 B]^{1/2} - \tan B}{2 \cos B}$$

where,

T_{max}= Thickness of groundwater in the collection layer (meters (m))
L= Length of horizontal projection of groundwater layer (m)
e= impingement rate (m/sec)
k= hydraulic conductivity of drainage layer (m/sec)
B= Slope angle of the base of groundwater collection layer (degrees)

L=350 ft	L=	106.715	m	
use surface area	(1 ac.) e=	2.12E-08	m/sec	
compressed thickness of 187 mils	T=	0.00475	m	Use GSE HyperNet Geonet (200 mil)
2.0×10^{-3} m^2/sec transmissivity	t=	0.000185	m^2/sec	Use t = t allow = 0.002 x [(1/1.5*1*1.2*1.5*4)]
k=t/T	k=	0.039	m/sec	t allow = t ult [(1/RFcr x Rfin x RFcc x RFbc*RFcb)]
				RFcr=Creep Reduction Factor=1.5
	tan B=	0.020003		RFin= Intrusion Reduction Factor=1
	B=arctan(0.02)	1.146	deg	RFcc=Chemical Clogging Reduction Factor=1.2
	T_{max}=	0.002894	m	RFbc=Biological Clogging Reduction Factor=1.5
		0.00949	ft	RFcb=Soil Clogging Reduction Factor=4
		0.1139	in	
		113.9	mils	

Therefore, the selected 200 mil thick drainage geocomposite is adequate.



JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 1
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
C. Required Flow Capacity of Collection Pipes

I. <u>OBJECTIVE:</u> Estimate the required capacity of the dewatering collection pipes.

II. <u>APPROACH:</u>

A. Review the dimensions of the sector floor layouts and select the sector with the greatest contributing drainage area to the center trench/collection pipe and the toe collector trench.

B. Estimate the groundwater flow assuming two cases:

Case 1: Sector floor
Case 2: Sector sideslope

Groundwater flow into the geocomposite will be calculated using the formula

Q= kiA
Where: Q = inflow rate (cfs/ft)
k = hydraulic conductivity (ft/s)
i = gradient (ft/ft)
A = inflow area (sf)

III. <u>ASSUMPTIONS:</u>

A. Sector 5 will provide the greatest contributing drainage area to the center trench/collection pipe. The floor area for Sector 5 is approximately 369,016 sf.

B. The sideslope area in Sector 5 contributing to the toe collection trench is approximately 136,785 sf.

C. Assume the value for k is 2.12×10^{-6} cm/s or 6.94×10^{-8} ft/s as discussed previously.

JOB NO. 8514-3	**HANSON PROFESSIONAL SERVICES INC.**	SHEET NO. 2
DESCRIPTION:	CALCULATIONS – City of Kingsville Landfill C. Required Flow Capacity of Collection Pipes	DATE: 09/11/2018

IV. CALCULATIONS

A. Case 1, Sector floor.

Q= kiA

Where:	Q =	inflow rate (cfs/ft)
	k =	hydraulic conductivity (ft/s)
	i =	gradient (ft/ft)
	A =	inflow area (sf)

k = 6.94 x 10^{-8} ft/s
i = 1.0 ft/ft for flow from soil into the geocomposite
A = 369,016 sf

Q = 2.56 x 10^{-2} cfs

B. Case 2, Sector sideslope.

Q= kiA

Where:	Q =	inflow rate (cfs/ft)
	k =	hydraulic conductivity (ft/s)
	i =	gradient (ft/ft)
	A =	inflow area (sf)

k = 6.94 x 10^{-8} ft/s
i = 1.0 ft/ft for flow from soil into the geocomposite
A = 136,785 sf

Q = 9.49 x 10^{-3} cfs

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 1
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
D. Flow Capacity Verification of Collection Pipes

I. OBJECTIVE: Verify that the selected collection pipe has the required capacity to carry the estimated design flows

II. APPROACH:

A. Analyze the selected collection pipe size with design slopes for the specific installation.

B. Calculate the pipe flow using the formula:

$Q = (1.486/n)AR^{2/3}S^{1/2}$

Where:
- Q = flow rate (cfs)
- n = Manning's number
- A = pipe cross sectional area (sf)
- R = hydraulic radius of pipe (ft)
- S = design slope of pipe (ft/ft)

III. ASSUMPTIONS:

Assume that a 6-inch diameter SDR 17 HDPE pipe is used to collect groundwater flow in the trench. The trench slope follows the sector floor at 1%.

n = 0.009
A = 0.186 sf
R = 0.122 ft
S = .01 ft/ft

IV. CALCULATIONS

$Q = (1.486/n)AR^{2/3}S^{1/2}$

Where:
- Q = flow rate (cfs)
- n = Manning's number
- A = pipe cross sectional area (sf)
- R = hydraulic radius of pipe (ft)
- S = design slope of pipe (ft/ft)

$Q_{full} = 0.755$ cfs

Compare this pipe capacity to the design capacity calculated previously:

$$\mathbf{Q_{full} = 0.755\ cfs \quad > \quad Q_{reqd} = 2.56 \times 10^{-2}\ cfs}$$

The capacity of the 6-inch diameter collection pipe is greater than the estimated flow calculated to be required for the dewatering trench; therefore the design is acceptable.

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 1
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
E. Underdrain Collection System – Pipe Structural

I. OBJECTIVE: Check the structural capacity of the underdrain collector pipe.

II. APPROACH:

A. Review the dimensions of the pipe from manufacturer's literature.

B. Compute the worst case loading condition assuming three cases:

Case 1: 168 ft. of overburden (waste fill) and 4.25 of cover
Case 2: 4.25 ft. of overburden (cover) and AASHTO HS20 point load.

C. Compute the Factor of Safety for wall crushing.

D. Compute the Factor of Safety for wall buckling.

E. Compute the Factor of Safety for excessive ring deflection.

III. ASSUMPTIONS:

A. The ultimate height of the fill will be 168 feet. Assume that the waste fill has a unit weight of 60 lbs. per cubic foot (ft^3).

B. AASHTO H20 loading (32,000 lbs. axle load) is split into 2 - 16,000 lb. point loads. Assume 1 is imposed on top of pipe, after protective soil cover has been placed. Assume protective soil cover has a unit weight of 120 lbs. per cubic foot ($ft^{3).}$

C. Smooth wall HDPE pipe is used. Calculations will be made for nominal 6" and 18" pipe. A Standard Dimension Ratio (SDR) of 17 will be used (100 psi = 14,400 lbs./ft^2).

D. Assume E' (modulus of soil reaction) is 3,000 psi. Soil type bedding material A (Unified Classification System) in pipe envelope on floor.

E. Maximum average unit weight of protective cover soil is 120 lbs./ft^3.

F. Minimum acceptable Factor of Safety is 2.0.

IV. CALCULATIONS

A. Review the dimensions of the pipe from manufacturer's literature.

JOB NO. 8514-3	**HANSON PROFESSIONAL SERVICES INC.**	SHEET NO. 2
DESCRIPTION:	CALCULATIONS – City of Kingsville Landfill E. Underdrain Collection System – Pipe Structural	DATE: 09/11/2018

In accordance with the attached chart, the appropriate dimensions are shown below:

Nominal	Outside Diameter	Inside Diameter	Wall Thickness
6”	6.625”	5.799”	0.390”
18”	18.000”	15.755”	1.059”

B. Compute the worst case loading condition assuming ultimate fill height, and AASHTO H20 point load on top of pipe. The equation describing the loading on the pipe is:

$$\sigma = \gamma * D + C\,[(P * F)/(L * B)]$$

Where,
- σ Stress on pipe (lbs./ft^2)
- γ Unit weight of overburden (lbs./ft^3)
- D Height of fill (ft.)
- C Load Coefficient (from ASCE)
- P Point Load (lbs.)
- F Impact Factor (from ASCE)
- L Effective Length (ft.) (arbitrarily defined as 3ft)
- B Outside diameter of pipe

Case 1 - 168 feet of waste fill and 4.25 feet of cover.

For 6” & 18” $\sigma = 60 * 168 + 4.25 * 120 = 10{,}590$ lbs./ft^2

Case 2 – 16,000 lb. load with 4.25 foot of cover.

The load coefficient is based on the following relationships B/(2D) and L/(2D).

6”
B/(2D) = (6.625/12)/(2*4.25) = 0.138
L/(2D) = 3/(2*4.25) = 0.35
From Table: C = 0.06

18”
B/(2D) = (18.00/12)/(2*4.25) = 0.176
L/(2D) = 3/(2*4.25) = 0.35
From Table: C = 0.117 (LCS Handbook)

For 6” $\sigma = 120 * 4.25 + 0.06[(16{,}000 * 1.5)/(3 * \{6.625/12\})] = 1{,}379$ lbs./ft^2

For 18” $\sigma = 120 * 4.25 + 0.117[(16{,}000 * 1.5)/(3 * \{18.00/12\})] = 1{,}134$ lbs./ft^2

Worst case loading condition for 6” is **10,590 lb./ft^2**
Worst case loading condition for 18” is **10,590 lb./ft^2**

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 3
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
E. Underdrain Collection System – Pipe Structural

C. Compute the Factor of Safety for wall crushing.

$$FS = \frac{2\sigma_{pipe}}{(SDR-1)\sigma_{max}}$$

<u>6”</u> FS = (2 * 1600 * 12^2)/([17-1] * 10,590) = 2.72
<u>18”</u> FS = (2 * 1600 * 12^2)/([17-1] * 10,590) = 2.72

D. Compute the Factor of Safety for pipe wall buckling.

$$FS = (1.2/\sigma_{max}) \ * ([E' * E]\ /SDR^3)^{\ 1/2}$$

<u>6"</u> FS = (1.2/[10,590/144]) * $(3{,}000*130{,}000/17^3)^{1/2}$ = 3.25
<u>18"</u> FS = (1.2/[10,590/144]) * $(3{,}000*130{,}000/17^3)^{1/2}$ = 3.25

E. Compute the Factor of Safety for excessive ring deflection.

$$FS = \frac{dE'}{100\sigma_{max}}$$

<u>6"</u> FS = (5*3,000)/(100 * [10,590/144]) = 2.04
<u>18"</u> FS = (5*3,000)/(100 * [10,590/144]) = 2.04

6”& 18” smooth walled HDPE pipe, with minimum SDR of 17, is acceptable for this installation.

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 1
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
F. Sump and Pump Design

I. OBJECTIVE: Estimate the flows being conveyed to the dewatering sump and size the sump and identify the dewatering pump performance characteristics. A typical sump and pump will be designed for the largest sector and used for all sectors.

II. APPROACH:

A. Utilize the incoming flows from previous calculation for the floor and sideslope drainage for Sector 5 to estimate the total flows being conveyed to the sump.

B. Size the sump to provide an adequate storage volume.

C. Identify the performance characteristics of the sump pump

III. ASSUMPTIONS:

Total flow into the sump for Sector 5 is equal to the sum of the flow from the floor and the flow from the sidewalls. That total flow is 0.0256 cfs (floor) plus 0.00949 cfs (sideslope) which equals 0.035 cfs.

Assume that the porosity of the drainage gravel in the sump is approximately 0.35 %.

IV. CALCULATIONS

Total inflow into the sump is

$Q_{inflow} = 0.035$ cfs = 22,620 gpd

Therefore the required volume of the sump is

$V_{req} = 22,620$ gpd = 3,027 cf/day

Calculate the required sump dimensions.

Total sump volume can be calculated using the formula:

$$V_{tot} = 1/3\ (A_1 + A_2 + (A_1 \text{ x } A_2)^{1/2})h$$

Where:
A_1 = Area of bottom of sump
A_2 = Area of top of sump
h = Depth of sump

$A_1 = 36$ sf
$A_2 = 144$ sf
h = 3 ft

JOB NO. 8514-3 **HANSON PROFESSIONAL SERVICES INC.** SHEET NO. 2
DESCRIPTION: CALCULATIONS – City of Kingsville Landfill DATE: 09/11/2018
F. Sump and Pump Design

V_{tot} = 252 cf

The volume of the sump is reduced by the presence of the drainage gravel. The assumed porosity (P) of the drainage stone is 35% or 0.35.

Therefore the available volume of the sump for groundwater storage is

V_{TOT} = 88.2 cf

Calculate the storage time provided by the proposed sump in hours.

Storage Time = V_{TOT}/ V_{req}

Storage Time = 0.29 days = 42 minutes

Try using a submersible pump with a 40 gpm capacity.

Groundwater production from the sector is 22,620 gpd. Using a 40 gpm pump the average run time for the pump would be 566 minutes per day or 9.4 hours per day.

Therefore a 40 gpm submersible pump will be sufficient for groundwater removal. A smaller size may be used if justified by the engineer of record and the justification will be incorporated into the liner evaluation report.

APPENDIX E

Ballast Thickness Calculations

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

APPENDIX F

Waste-as-Ballast Placement Record

Texas Commission on Environmental Quality
Municipal Solid Waste Facility
Waste-As-Ballast Placement Record

This form is to be completed by the landfill manager or designated representative for all landfilled areas utilizing waste as ballast. One form will be developed for each area (or combination of areas) described by approved liner evaluation reports. This form is to be submitted with the Ballast Evaluation Report (BER) for the evaluated area and may be referenced by the Professional of Record (POR) in order to verify that the placement of ballast is in compliance with the Soils and Liner Quality Control Plan (SLQCP). The site operator must prepare and sign supporting documentation on a daily basis verifying the area of waste placement, the waste material in the first 5 feet of waste was free of brush and large bulky items, daily operation of the pressure relief/dewatering system, and a wheeled trash compactor having a minimum weight of 40,000 pounds was used.

1. General Information

Area documented by this record (provide site grid coordinates of each corner)
____
____
____

Soils and Liner Evaluation Report and Geomembrane Liner Evaluation Report document date(s) and approval date(s) for this area
____
____
____

Date of initial waste placement __________________________________

Date of completion of first 5 feet of waste in place over entire area __________

Total required waste-as-ballast thickness for this area (Note: Calculations for determining the required thickness of waste as ballast are included with the SLQCP/BER for this area.)
____
____

Date when minimum required thickness of waste was achieved _________________

2. Waste Equipment Used

What type of compaction equipment was used? ____________________________

Did the compactor have a minimum gross weight of 40,000 pounds? ______________

Was this compactor used throughout the entire period covered by this record? _______

If a minimum 40,000 pound wheeled trash compactor was not used throughout the period covered by this record, attach documentation of initial and final survey data (if not previously provided as part of the BER) of the ballasted area and measurements of truck weights at the scale house for the time period covered by the BER for use in determining in-place waste density. Is this documentation complete and accurate? ____________

3. First Waste Lift Considerations

Describe type(s) of waste placed in first 5 feet of waste over the top of the liner protective cover ____
____
____

Does the first 5 feet of waste contain any brush or large bulky waste items which would damage the underlying liner system or which cannot be compacted to the required density?
____

4. Waste Compaction Methods

Approximate loose waste layer thickness prior to compaction ___________________

Minimum number of compactor passes for each waste layer ___________________

Maximum slope of compacted waste layers ______________________________

5. Pressure Relief/Dewatering System

Was the pressure relief/dewatering system (if required) operated continuously during the period covered by this record? __________

Is the pressure relief/dewatering system presently in operation? _____________

Signature of Permittee or Operator

The waste overlying the area described in this record has been placed and compacted as described in this record and in accordance with the Soils and Liner Quality Control Plan and Site Operating Plan

___________________________ *(signature)*	___________________________ *(typed or printed name)*
___________________________ *(title)*	___________________________ *(date signed)*
___________________________ *(phone number)*	___________________________ *(fax number*

____
(company or business name)

____
(*address, city, state, zip code*)

Note: This completed form must be submitted with the BER and placed in the Operating Record and be available for review.

TCEQ-10073, Waste-As-Ballast Placement Record (Rev. 4/08) Page 2 of 2

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

PART III, ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

CITY OF KINGSVILLE, TEXAS

September 2018

Revision 0

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

9/11/2018

Prepared by

HANSON

Engineering | Planning | Allied Services

HANSON PROJECT NO. 16L0438-0003

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1.0 INTRODUCTION

The State of Texas promulgated regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter J, Section 330.405 (b) requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill) and provide groundwater sampling procedures, frequencies, analytical parameters, monitoring data evaluation, and reporting requirements.

In accordance with TCEQ regulations, this GWSAP contains the procedures and techniques to be used to conduct Background Monitoring Statistical Evaluations, Detection Monitoring, Assessment Monitoring, and Corrective Action implementation should a significant groundwater impact be determined.

1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture co-existing with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast, residences are widely scattered throughout brush and agricultural areas.

1.2 Groundwater Monitoring System

Based upon an understanding of the local ground water flow regime and site stratigraphy, the groundwater monitoring system will monitor the uppermost aquifer identified in the site Geology and Groundwater Characterization Reports. The completed groundwater monitoring system will be comprised of a total of twenty-two (22) monitoring wells. All monitoring wells will be installed and monitored throughout the active life and post-closure care period of this site. The design will provide for monitoring well spacing of not more than 600 feet at the closest practicable distance to the point of compliance. All parts of the groundwater monitoring system shall be operated and maintained so that they perform at least to design specifications. The design of the monitoring system is based on site specific technical information gathered during multiple site investigations and further discussed in the site Geology Report. The City of

Kingsville Landfill will promptly notify the executive director, and any local pollution agency with jurisdiction that has requested to be notified, in writing of changes in facility construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from a solid waste management unit and that may require the installation of additional monitoring wells or sampling points and that such additional wells or sampling points require a modification of the site development plan.

A topographic map identifying the existing and proposed monitor well locations, installed depths, property boundary, a delineation of the waste management area, and the point of compliance line has been included in Appendix A-Item 1 Site Layout Map. All monitoring wells will be constructed in accordance with 30 TAC §330.421. The Groundwater Monitoring System Design Certification has been included as Appendix A-Item 2.

2.0 HEALTH AND SAFETY

Personnel performing water level measurements, well purging, or sampling will, at a minimum, wear latex or other equivalent non-powdered gloves. The gloves will be changed when they become damaged and when activities begin at a different well location. All personnel that are associated with the purging and sample collections from monitor wells will wear other appropriate Personal Protective Equipment (PPE) such as eye protection, safety vests, chemical resistant clothing and/or aprons, and air purifying respirators, as necessary.

3.0 GROUNDWATER SAMPLING FREQUENCY

3.1 Background Monitoring

At least eight (8) statistically independent background groundwater samples will be obtained on a quarterly basis prior to commencing with Detection Monitoring for each groundwater monitor well at the facility (see Appendix A, Table 1, for parameters). Background monitoring events should allow approximately 90 days between each monitoring event to allow the collection of groundwater data over the different seasons of the year.

3.2 Detection Monitoring

After establishment of background groundwater quality, detection monitoring will be performed on a semi-annual basis at approximately 6-month intervals during the remaining operational life and post-closure care period for this facility. Detection monitoring will begin on the first semi-annual monitoring event following the completion of the background monitoring establishment period.

4.0 GROUNDWATER ANALYTICAL PARAMETERS

The constituents to be analyzed for both background monitoring and detection monitoring are listed in Appendix A-Table 1. The respective Practical Quantitation Limits (PQLs), analytical methods, and Chemical Abstracts Service number (CAS) are also located in Appendix A-Table1 and Table-2.

At the conclusion of the background monitoring period, all the detection monitoring constituents will be thoroughly reviewed. As a result of this review, the City may request that the Executive Director eliminate subsequent monitoring for those constituents that were consistently below the method detection limits (MDL) throughout this period and are not expected to originate from the MSWLF unit.

5.0 GROUNDWATER PURGING AND SAMPLING

The following subsections will summarize tasks involved in the purging and sampling of the groundwater monitoring wells at the facility.

5.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The visual inspection will include the lock, protective casing or collar, concrete pad, and casing for signs of damage by vandalism, animals, heavy equipment, or other causes. All necessary repairs or maintenance needed will be documented on the Monitor Well Field Data Sheet for each respective well. If it is determined that the integrity of the well has been compromised, the necessary information will be documented and the TCEQ will be notified. No additional actions will be taken without prior approval of the TCEQ.

5.2 Well Headspace Screening

Upon the opening of each monitoring well, an appropriately calibrated gas meter capable of measuring methane concentrations in percent volume and combustible gases in a percentage of the Lower Explosive Limit (LEL) will be utilized to screen the well headspace for hazardous concentrations of gasses that the sampling personnel could be exposed to during the well gauging and sampling procedures. The gas meter will contain a methane specific sensor and be able to measure the percent volume of methane in air. The concentration of methane, or percentage of the LEL, will dictate what precautions will be necessary during sampling activities. If methane is detected in excess of 5.0% by volume (100% LEL), the well will be left open and allowed to vent. No work will be performed at the well until methane concentrations fall below 5.0% by volume.

5.3 Equipment Decontamination

All non-dedicated equipment used for water level measurement, purging, and/or the collection of groundwater samples will be decontaminated prior to use at each well location. An appropriate decontamination procedure consists of washing the non-dedicated equipment in a solution of Alconox, or equivalent laboratory-grade detergent, and distilled water followed by a distilled or deionized water rinse. Containers for the collection of rinsates will be utilized, as appropriate, during each sampling event. Rinsates should be containerized along with water generated during purging activities for proper disposal following the completion of the sampling event.

5.4 Water Level Measurements

Immediately prior to purging a well, the static water level below the top of the well casing and the total depth of the well will be measured and recorded on the Monitor Well Field Data Sheet. An electronic water level indicating probe capable of measuring to the nearest 0.01 foot (ft) will be utilized for water level measurements. All measurements will be noted to the nearest 0.01 ft. The measurements will proceed from the most upgradient wells to downgradient wells. All water level measurements will be taken from the top of the well casing at the permanent surveyed measurement mark. All water level measurements will be taken within a 48-hour period to minimize potential temporal variations across the facility. The water level indicating probe will be decontaminated prior to use in each well as described in section 5.3.

A visual check of the probe's condition and operation will be made prior to and during measurements. Notation will be made of any minor damage or irregularities on the water level measurement device. If the tape appears to be elongated, kinked, or twisted, then the tape will be checked against a functional tape to determine if there are any discrepancies in the measurements. If the probe is determined to be non-functional due to wear or damage, it will be replaced prior to proceeding.

Using the surveyed elevation of the Top of Casing (referenced to mean sea level (msl)), depth to water level measurements can be converted to water level elevations by subtracting the depth of the static water from the Top of Casing (TOC) elevation.

Water-Level Elevation (ft msl) = TOC (ft msl)-Depth to Static Water (ft)

5.5 Instrumentation Calibration

Prior to use, all appropriate portable field measurement instrumentation, including temperature, conductivity, and pH probes, will be calibrated on-site according to the manufacturer's procedures and specifications. A record of the calibration will be made for each specific instrument and retained in the field records. If an instrument is procured from a vendor for the sampling event, a certificate of calibration will accompany the instrument and will be made part of the event records. Typically, conductivity probes are factory calibrated, but the accuracy should be confirmed in the field with a solution of known conductance, preferably in the range anticipated in the samples and adjusted as necessary. The pH meter will be standardized in the field with a neutral reference buffer solution (pH7), adjusting as necessary. Depending on the pH range anticipated, an expanded range of reference buffers should be used (4 to 10), and adjusted accordingly, rinsing the instrument between solution measurements with the next solution to be measured. The pH "bulb" should be kept moist during the time between monitoring each well. Distilled or deionized water should not be utilized to keep the pH "bulb" moist between wells or for periods of instrument storage. Before field measurements are collected and at each new monitor well, the contact areas of the instrument(s) will be rinsed with water from the well that is being monitored to insure that instrument's receptors are assessing only the formation water.

5.6 Field Sampling Data Sheets

Field information will be recorded on the Field Conditions Report and Monitor Well Field Data Sheet and will include the date, project name, weather conditions, sampling personnel, type of sampling event, monitor well identification, groundwater measurements, calculated purge volume, formation water parameters (pH, conductivity, temperature) and site observations regarding the condition of the monitor well, riser protector and pad. These forms are found in Appendix C and will be included in the groundwater monitoring report. Information from this form will facilitate completion of the TCEQ-0312 Groundwater Sampling Report Forms.

5.7 Groundwater Purging

The following procedures will be followed for purging each monitor well:

- Prior to purging, the volume of water in the well casing will be calculated based on the static water level, well casing diameter, and total depth measurements.

- The work space around the well will be set-up to provide an area that will minimize potential contamination from the surroundings. Plastic sheeting will be placed around the protective riser on the concrete pad as appropriate to minimize cross-contamination with field conditions.

- The monitor well will be purged of a minimum of three well casing volumes of water using appropriate and industry-accepted methods of mechanical pumping or hand bailing. In the case of mechanical means of removing water, pumps, hoses, connectors and other items lowered into the well will be decontaminated on the interior and exterior surfaces with an Alconox wash, or equivalent, followed by a distilled or deionized water rinse before each use. Hand bailing is normally accomplished by use of dedicated or disposable bailers. If a non-dedicated bailer is used, such as Polyvinyl Chloride (PVC) or Teflon, the bailer will be decontaminated with an Alconox wash, inside and out, and rinsed with distilled or deionized water before each use. Clean, non-dyed rope or cord will be used for the retrieval line on all bailers. During the process of bailing, the bailer rope will be handled in such a way as not to contact the ground. Clean receptacles such as plastic tubs can be used to store bailer rope while retrieving the bailer. New rope will be used for each well.

- Purging will continue until three well volumes have been purged or the well is purged dry. If a well is purged to the point that little or no water can be removed (purged to dryness) by mechanical or hand bailing methods, then purging will be discontinued and the total amount of water removed will be recorded on the Monitor Well Field Data Sheet for the well. It will also be noted on the data sheet that the well was purged to dryness and the volume purged. Measurement of the field parameters pH, temperature, and conductivity should be recorded at the beginning, mid-point, and end of the purging process and monitored for stability.

- If non-dedicated pumps are used for purging, a check valve will be installed on the pump discharge piping to prevent backflow of purge water into the well and the pump will be completely decontaminated between wells.

- Purged groundwater will be stored and disposed of appropriately. The purged water removed from each well will be containerized in dedicated drums until the results of the analysis are known. Once the purged groundwater has been placed into the drums, covers or bungs will be used to secure the drums. If analytical results indicate that all monitored constituents are below background concentrations, the water will be considered uncontaminated and may be applied to the unsaturated soil-on site. The uncontaminated purge water will be applied to in-situ soils only and the purge water will not be placed within any waste cell. If levels of monitored constituents are above background concentrations, the purge water will be managed as leachate/contaminated water and handled in accordance with the facility's leachate and contaminated water plan. If the groundwater meets hazardous classification standards, the water will be transported and disposed of at a facility that is permitted to accept the waste stream.

The following purging information for each well will be noted and recorded on the Monitor Well Field Data Sheet.

1. Well number
2. Date and time
3. Well inspection information
4. Well casing diameter
5. Well headspace screening measurement
6. Static water level and total depth of well
7. Calculated purge volume (three well volumes)
8. Well purging times, volume of water purged

9. Water quality measurements (temperature, pH, and specific conductivity)
10. Duplicates for quality control or any split samples.

5.8 Groundwater Static Depth Stabilization

After purging and prior to sample collection, the water surface should be allowed to stabilize to within a minimum of ninety percent (90%) of the initial static groundwater depth. This provides for a representative and adequate volume of water from the aquifer to enter the well casing for sampling. The well must be allowed to sufficiently recharge and allow for the suspended solids to settle prior to sampling, which generally takes up to 24 hours. If clear groundwater can be retrieved in less than 24 hours, then samples can be collected as appropriate. Samples must be taken within a maximum of seven (7) days of the purge. If after seven days there is still insufficient water for sampling, the situation should be recorded on the Monitor Well Field Data Sheet for that well.

5.9 Low-Flow Purging and Sampling Techniques

Low-flow purging and sampling techniques may be utilized at this facility in lieu of the procedures outlined in Sections 5.7 and 5.8 of this plan and will be performed in accordance with EPA approved low-flow purging and sampling methods. Sampling instrumentation should include a water quality multi-parameter system capable of measuring temperature, pH, conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity, and an appropriate pump capable of managing flow rates for low-flow purging and sampling. The static water level should be monitored to ensure minimal drawdown from the water column. Typically, a flow rate below 1 liter per minute is ideal; however, this is dependent on the site specific hydrogeology.

While purging groundwater, water quality parameters will be monitored and readings recorded in three to five minute intervals. Groundwater will be purged until stabilization occurs. This is achieved when three consecutive readings for each monitored parameter are within the following ranges: ± 0.1 Standard Units for pH, ± 3% for specific conductivity, ± 10 mV for ORP, and ± 10% for DO. Turbidity should be below 10 nephelometric turbidity units (NTUs) before sampling. Once groundwater stability is achieved, laboratory provided sample containers are to be filled from the discharge side of the pump.

5.10 Well Sampling

Sampling personnel will wear, at a minimum, new latex or nitrile gloves during sampling to minimize the chance of cross contamination of the sample. Wells should be sampled within 24 hours of purging or when the well has recovered to within 90% of the initial static water level. Sampling of wells will proceed from the least contaminated well to the most contaminated well if the degree of contamination is known. If the degree of contamination is unknown, the sampling will proceed from the most upgradient to the most downgradient wells. Precautions for avoidance of dust and exhaust generated by vehicles and sampling equipment should be taken. All sampling equipment and containers will be protected to prevent damage or cross-contamination of the samples.

Samples may be collected using disposable polyethylene bailers or dedicated PVC, stainless steel or Teflon bailers. Additionally, electric or air-operated pumps can be utilized if the flow rate can be adjusted to less than 1 liter per minute to minimize turbulence and aeration of the sample during the collection of volatile organic compounds (VOCs).

If a new disposable bailer, not previously utilized for purging, is used for sample collection, then the new bailer will be rinsed once with well water prior to collecting the sample (first bailer volume is discarded into the purged water container). The bailer will be slowly lowered into the water to minimize turbulence and aeration of the sample. The bailer will then be slowly withdrawn and removed from the well and the sample containers filled from the bottom of the bailer using an appropriate bailer-discharging device. VOC samples will be obtained from a single bailer volume. Additional bailer volumes can be collected as sample container volumes require.

If low-flow purging and sampling procedures are utilized, each well will be sampled with the same device used for purging immediately following verification of an adequate purge as described in section 5.9. If an in-line device is used to monitor water quality parameters, it will be disconnected or bypassed during the time of sample collection. Sampling flow rate will remain at the stabilized purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or the loss of volatiles due to extended residence time in the tubing.

The following parameter samples are to be collected from each monitor well in the exact order specified.

- **VOCs** are to be collected in 40-milliliter (ml) glass vials that utilize Teflon-lined lids (septa), preserved with HCI, and immediately chilled to four degrees Celsius (4ºC). The sampling personnel will minimize the introduction of air bubbles by allowing the water to flow down the inside of the container until a positive meniscus forms. VOC samples will be collected with zero headspace. For the collection of the VOCs, the pump flow rate will be adjusted to less than 1L per minute.

- **Metals** are to be collected in a high-density polyethylene (HDPE) or glass containers that are preserved with nitric acid (HNO3) to a pH<2 and immediately chilled to four degrees Celsius (4ºC). Samples will not be field filtered.

- **Other constituents** as required are to be collected in polyethylene or glass containers, and immediately chilled to four degrees Celsius (4ºC) as specified in Appendix B-Item 2, which details preservation, container type, and hold time requirements.

The sampling date and time will be recorded on the Monitor Well Field Data Sheet and the container will be labeled with the following information as appropriate:

- **Facility name and/or owner (i.e. City of Kingsville Landfill)**
- **Monitoring well number (i.e., MW-1)**
- **Sample date and time**
- **Preservatives utilized**
- **Sampler's signature or initials**
- **Analysis requested**

5.11 Field Sampling Quality Assurance/Quality Control

To document that sample collection and handling or site conditions have not affected the quality of the groundwater samples, Quality Assurance/Quality Control (QA/QC) samples shall be prepared and analyzed as detailed below.

- **Equipment Blank:** Following decontamination of all non-dedicated sampling equipment and prior to sample collection, laboratory provided reagent-grade water will be run over the sampling equipment and the rinsate collected in a clean container labeled as an Equipment Blank. One equipment blank will be collected for each day of sampling. This sample will be analyzed for all detection monitoring constituents, to measure the effectiveness of the decontamination procedure in removing contaminants from one sample collection point to another.

- **Field Blank:** A field blank will be prepared in the field by pouring laboratory provided reagent-grade water into empty sample containers. This procedure shall be conducted on the downwind side of the facility or in another appropriate location that is the most representative of site sampling conditions. A minimum of one (1) field blank will be collected per day of sampling or per 10 monitor wells sampled, whichever is greater. The sample will be analyzed for all detection monitoring constituents and will verify field sampling procedures and check for the presence of airborne contaminants that may be present at the facility.

- **Trip Blank:** A minimum of one (1) Trip Blank per sampling event and for each cooler containing VOC samples (whichever is greater) will be prepared by the laboratory with reagent-grade water and shall accompany the VOC sample containing coolers during site activities. The vials are not to be opened in the field. This blank will be analyzed for VOCs in order to determine if any of the samples or containers have become contaminated before, during, or subsequent to the sampling event.

- **Field Duplicates:** One (1) Field Duplicate will be collected per sampling event or per every 10 monitor wells, whichever is greater. The duplicate samples are prepared by collecting two samples from the same monitor well during the same event. The duplicate sample(s) will be labeled as a duplicate, but the only other information on the label is the facility name so that the laboratory is unaware of the relationship between the two samples. The field personnel will note which well was duplicated on the Monitor Well Field Data Sheet. The duplicate will be analyzed for all detection monitoring constituents. The purpose of these samples is to check the precision of the laboratory's techniques.

5.12 Sample Preservation and Holding Times

The proper container, preservation technique, and maximum holding times shall be in accordance with the requirements identified in the U.S. EPA Publication No., SW-846 (Test Methods for Evaluating Solid Waste, Physical/Chemical Methods). This information is provided in Appendix B-Item 2. Preservation of samples may be conducted in the field immediately after the container is filled or the sample container can be pre-preserved by the laboratory in advance of the sampling event based on the specific testing required.

6.0 SAMPLE CHAIN OF CUSTODY

The primary objective of the chain-of-custody is to create an accurate and written verified record that can be used to trace the possession and handling of the samples from the moment of collection until receipt by the laboratory. Adequate sample custody will be achieved by proper completion of an approved Chain-of-Custody (COC) Form. Each party handling the samples will sign the COC and provide the date and time when the samples were relinquished or received. A sample of the type of COC that will be used with each sampling event is included in Appendix C-Item 3.

The Chain-of-Custody Form includes:

1. The unique sample number as obtained from the sample label
2. Source of the sample
3. Date and time of sample collection
4. Name of person taking samples
5. Analysis name and analytical method requested (i.e., DM Metals)
6. Signature of persons involved in the chain-of-custody; and
7. Inclusive dates of possession

7.0 SAMPLE SHIPMENT AND HANDLING PROCEDURES

Subsequent to field activities, all samples collected shall be preserved as appropriate and immediately transported to the laboratory within the required holding times dictated by the specific analytical methods. To maintain sample integrity, the samples shall be kept in appropriate portable coolers that have a constant interior temperature of 4ºC, protect samples from sunlight, and minimize the risk of sample container breakage. Under no circumstances shall dry ice be used as the chilling agent for sample preservation; dry ice has the potential to freeze samples, which can result in container breakage (i.e., glass containers may shatter). Custody seals will be placed on the coolers and will not be broken until the samples arrive in the analytical laboratory and checked in by laboratory personnel.

If samples are shipped by common carrier, the COC will be completed with the signature of the relinquisher and the date and time relinquished. The COC is then placed in a sealable plastic storage bag and placed in the sample cooler. At the time and place of receipt of the samples, the receiving party will attach a copy of the bill of lading to the COC document.

8.0 LABORATORY PROTOCOL

8.1 Introduction

The goal of this quality assurance (QA) and quality control (QC) program is to establish appropriate field and laboratory sampling and analysis procedures for all tested analytes to ensure proper collection, preparation, and analysis of representative samples of waste, soil, water, and other media. In addition, the goal of this QA/QC program is to evaluate completeness, correctness, and conformance or compliance of a specific data set against method, procedural, or contractual requirements. To achieve accuracy (correctness) and completeness, The City of

Kingsville hereby adopts the data quality standards and methods described below to ensure that all sample collection, preparation, analyses, and data management activities are conducted appropriately. These activities will be reviewed at each monitoring event to ensure compliance with the standards. QC checks will be performed and corrective action taken when indicated.

The City of Kingsville will evaluate the QC results prior to submitting the analytical data to the TCEQ in order to ensure compliance with appropriate data quality standards, and the City of Kingsville will also provide discussion of the analytical quality of each specific data set as appropriate.

8.2 Laboratory Report Requirements

Sample analytical results will be reported to the TCEQ in a data package that contains, at a minimum, the analytical test reports documenting the analytical results and methods for each sample and analyte. The test reports will include the method-required quality control information needed to evaluate the analytical results of sampling and analysis with comparison to quality control standards and correction action upon failure. The City of Kingsville will ensure that the results of each test analysis carried out by the laboratory are reported accurately, clearly, unambiguously, and objectively, in accordance with this GWSAP. The analytical results report will include all the information necessary for the interpretation of the test results and all information required for analysis. The City of Kingsville will ensure that each report includes at least the following information, unless the laboratory has valid reasons for not doing so:

(1) a title;

(2) the name and address of the laboratory or facility and the location where the test and calibrations were carried out;

(3) unique identification of the test report, and on each page, an identification to ensure that the page is recognized as a part of the test report;

(4) name and address of The City of Kingsville;

(5) identification of the analytical method used;

(6) dates of measurements, as well as the report date;

(7) procedures used by the laboratory where these are relevant to the validity or application of the results;

(8) the test results and units of measurement;

(9) the names, functions and signatures or equivalent identification of persons authorizing the test report; and

(10) a laboratory case narrative (as further detailed below).

The City of Kingsville will ensure that all quality assurance/quality control records are legible, stored, and maintained in such a way that the records are readily retrievable (in an acceptable environment to prevent damage, deterioration, or loss). If a confirmed statistically significant change occurs, then records will be kept until the issue is resolved. At a minimum, analytical records retention will meet the TCEQ requirement for a five-year record retention schedule.

The City of Kingsville will ensure that matrix spikes and matrix spike duplicate sample recovery percentages and relative percent differences for each matrix and analyte are included in the data package. If analytes are not specified for a project or if only a subset of the project analytes are evaluated with matrix spikes and matrix spike duplicates, the City of Kingsville will ensure that the subset include analytes representative of the chemical properties of the project analytes of concern. The City of Kingsville will ensure that each matrix spike and matrix spike duplicate test report include the spike concentration added to the sample for each matrix spike, the measured concentration of the analyte in the unspiked sample, the measured concentration of the analyte in both the matrix spike and matrix spike duplicate, the calculated percentage matrix spike/matrix spike duplicate recoveries and relative percent difference, and the laboratory and/or method quality control limits (acceptance criteria) for both matrix spike/matrix spike duplicate recovery and relative percent difference. The data set will also include the laboratory batch number and the laboratory identification number of the sample spiked. The City of Kingsville will ensure that the laboratory performs matrix spikes at a minimum frequency of one out of every 20 samples per matrix type, except for analytes for which spiking solutions are not available (e.g., total dissolved solids, total volatile solids, total solids, pH, color, temperature, or dissolved oxygen). When results of the matrix spikes and matrix spike duplicate are outside of the acceptable limits, the City of Kingsville will arrange for the laboratory to check other quality control results (e.g., laboratory control sample), and if appropriate, have the laboratory qualify the results or use another analytical method.

The City of Kingsville will ensure that the laboratory reprocess any sample associated with the contaminated blank that exceeds a concentration greater than one-tenth of the measured concentration of any sample in the associated batch or exceeds the concentration present in the samples and is greater than one-tenth of a specified regulatory limit for analysis or other results reported with appropriate data-qualifying codes and submitted in the data package. These are minimum criteria to be used in cases where blank acceptance criteria are not defined in the referenced methodology used for analysis.

The laboratory control sample and laboratory control sample duplicate are composed of a sample matrix that is free from analytes of interest and spiked with known amounts of analytes or material containing known and verified amounts of analyses. The laboratory control sample and laboratory control sample duplicate are used to established intra-laboratory or analyst-specific precision and accuracy of certain parts of the analytical methodology.

The City of Kingsville will ensure that the laboratory analyze laboratory control samples at a minimum of one of each per batch of 20 samples or less, per matrix type, except for analytes for which spiking solutions are not available (addressed in further detail below). A laboratory control sample duplicate will be processed with the batch where needed to demonstrate precision. The City of Kingsville will ensure that the laboratory calculate the results of the laboratory control sample to assess precision based on the recovery percentages of the analytes of interest within the analytical methodology.

The City of Kingsville will have the laboratory review the surrogate recoveries used to measure method efficiency. The laboratory can, with qualifications, estimate the overall method efficiency.

The City of Kingsville will ensure that a data reviewer consider the project data quality objectives to determine if the sample test results meet the project needs with regard to completeness, representativeness, and accuracy (bias and precision). The City of Kingsville will review all data prior to submittal for TCEQ review. The data review will include examination of the quality control results and other supporting data, including any data review by the laboratory, and will identify any potential impacts such as bias on the quality of the data using qualifiers in the test reports tied to explanations in footnotes and in the laboratory case narrative. The criteria used to evaluate each quality control parameter are defined in the GWSAP, and/or other reference(s) of documented analytical laboratory or method criteria. The City of Kingsville will ensure that the record keeping system allow historical reconstruction of all laboratory activities used in the data reduction, validation, and review of the analytical data, as the history of each sample will be readily understood throughout documentation, including intra-laboratory and inter-laboratory transfers of samples and sample extracts.

The City of Kingsville will ensure that the laboratory document and report problems and anomalies observed during analysis that might have an impact on the quality of the data. The laboratory will document any evidence of matrix interference or any situation where the analysis is out of control (quality control results outside of laboratory or method limits), as well as the measures taken to eliminate or reduce the interference or corrective action to bring the analysis back into control. The City of Kingsville will ensure that if a laboratory dilutes a sample medium to minimize matrix interferences or to bring an analysis back into control, that the dilution factor used by the laboratory be the smallest needed to overcome the problem of matrix interference.

8.3 Chain of Custody and Laboratory Sample Receiving Requirements

Chain of custody forms are used to document custody of the samples during collection, transport, and initial receipt of samples at the analytical laboratory. The shipper's document constitutes part of the chain of custody, and a copy shall be included in chain of custody paperwork. A laboratory may also use chain of custody forms to document the movement and analysis of samples within the laboratory. The City of Kingsville will ensure that the laboratory submits all data packages with completed field chain of custody forms and other documentation, including the following:

(1) field sample identification;

(2) date and time of sample collection;

(3) preservation type;

(4) analytical methods requested and/or analytes requested;

(5) signatures of all personnel with custody prior to receipt by the laboratory;

(6) signature of laboratory personnel taking custody samples; and

(7) date and time of custody transfers.

(a) The City of Kingsville will ensure that the laboratory document if samples are received outside of the recommended holding times for a particular analyte or method.

(b) The City of Kingsville will ensure that upon receipt, the condition of the sample, including any abnormalities or departures from standard conditions as prescribed in the relevant test method, be recorded.

(c) All samples that require thermal preservation will be considered acceptable if the arrival temperature is either within 2 degrees Celsius of the required temperature or the method specified range. For samples requiring thermal preservation to 4 degrees Celsius, a temperature ranging from just above the freezing temperature of water to 6 degrees Celsius, will be acceptable.

(d) The City of Kingsville will ensure that the laboratory have procedures for checking the chemical preservation using readily available techniques prior to or during sample preparation or analysis.

(e) The City of Kingsville will ensure that the laboratory store samples according to the conditions specified by preservation protocols.

8.4 Laboratory Sample Testing Requirements

When possible, the City of Kingsville will collect adequate sample volumes for all analytical needs for subsequent testing or analyses. The City of Kingsville will base sampling plans, whenever reasonable, on appropriate statistical methods. Sampling procedures will describe the selection, sampling plan, collection, and preparation of a sample or samples from the wells. The City of Kingsville will collect representative samples of the groundwater. The concentration of the analyses of interest, the types of analyses, and the sample media will determine the sample volume requirements. The City of Kingsville will ensure that the method and federal regulatory program requirements for these sample management aspects be followed for all methods of testing and, if violated, have the data flagged and qualified. The City of Kingsville will ensure that field personnel have procedures for recording relevant characteristics and other data relating to the sampling operations that form part of the testing or measurement that is undertaken. Chain of custody records and field notes will include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant), and all associated sample identification numbers.

The City of Kingsville will ensure that the laboratory determine detection limits by the protocol in the mandated test method or applicable federal or state regulation. The City of Kingsville will ensure that the laboratory utilize a test method that provides a detection limit that is appropriate and relevant for the intended use of the data and establish procedures to relate method detection limits with the practical Quantitation limits.

The City of Kingsville will ensure that all samples are analyzed according to methods specified in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* United States Environmental Protection Agency Publication Number SW-846, September 1986, 3rd Edition, as revised and updated, or by other methods accepted by the TCEQ. If the protocol for determining detection limits is not specified in the test method, the selection of a procedure will reflect instrument limitations and the intended application of the test method. Whenever possible, analytical methods will have method detection levels that are one-fifth to one-third of the regulatory action level. The City of Kingsville will take particular care to review all quality control data within the data package for compliance with the municipal solid waste program. All laboratory data and analyses submitted for use in TCEQ decisions regarding any matter under the

TCEQ's jurisdiction will include information regarding precision, bias, and accuracy. The TCEQ will evaluate compliance with the quality assurance objectives on a case-by-case basis. Maximum quality control acceptance limits for organic analyses are limits that represent the level of quality control data necessary to support decision making by The City of Kingsville with regard to sample results. Data with quality control results outside of the quality control limits should be flagged in the data package with explanation of problems encountered by the laboratory and the corrective action(s) attempted to resolve the analytical problems. Failure to meet the quality control goals in accordance with the data quality standards of the study does not necessarily mean the data are unusable. The City of Kingsville will ensure that the laboratory document all corrective action associated with the analysis and maintain all records.

The City of Kingsville will ensure that the laboratory maintain equipment in proper working order and calibrate equipment and devices that may not be the actual test instrument, but are necessary to support laboratory operations and measurements as often as recommended by the manufacturer, using National Institute of Standards and Technology (NIST) traceable references when available, over the entire range of their use. These include, but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, and temperature measuring devices. Calibration results will be within the specifications required for each application or measurement for which this equipment is used. The City of Kingsville will ensure that the laboratory maintain records of corrective actions implemented to correct all measurements. Standards used for the calibration of field instruments will be, when available, traceable to certified standards or reference material. The City of Kingsville will ensure that laboratory equipment is calibrated or standardized against NIST traceable reference materials and standards. Documentation of the certificate of analysis and traceability of the standards and reagents will be maintained by field or laboratory personnel. The City of Kingsville will ensure that calibration of field instruments and equipment are performed at approved intervals as specified by the manufacturer or more frequently as conditions dictate. Calibrations may also be performed at the start and completion of each test run. Records of calibration, repair, or replacement will be filed and maintained by the designated field staff. Calibration and standardization of laboratory equipment will be based on procedures described in each contract laboratory quality assurance plan or standard operating procedure. It is the responsibility of the person validating the data to ensure that the proper calibration protocols were used. Records of calibration, repair, or replacement will be filed and maintained by the designated laboratory personnel performing quality control activities in accordance with manufacturer requirements. Calibration records will be filed and maintained at the laboratory location where the work is performed and will be subject to TCEQ review during a quality assurance audit.

The City of Kingsville will ensure that reporting quality control (QC) results (precision and accuracy) within the laboratory case narrative (LCN) explain each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits, and the effect of the failure on the results (positive or negative bias). The City of Kingsville will ensure that the LCN state the exact number of samples, identification numbers, testing parameters, and sample matrix, as well as the name(s) of the laboratory(ies) involved in the analysis. A statement of the test objective regarding the samples will be included. The LCN will also identify the applicable quality assurance (QA) and QC samples that require special attention by the reviewer, including:

(1) field, trip, and laboratory blank(s);

(2) duplicate(s);

(3) field spike(s);

(4) QA audit sample(s); and

(5) laboratory control samples.

The City of Kingsville will ensure that an acknowledgment and reference to current standards regarding sample holding, extraction, and analytical times be included within the LCN along with a statement explaining whether the standards were met. If samples are not analyzed within the prescribed holding times, the City of Kingsville will ensure that the laboratory describe the extent of the delay and if possible, provide an estimate of the bias within the data. The City of Kingsville will ensure that the laboratory conducting the analyses for environmental decision making has a QA program run by a QA officer.

This program may include, but is not limited to, the following:

(A) system audits of field and/or laboratory operations using field surrogate samples;

(B) instrument calibration check samples used to determine the accuracy of the instrumentation;

(C) blind spikes of blanks, where the concentration of the blind spike is known only to the QA officer;

(D) verification of calibration accuracy via calibration check standard;

(E) internal surrogate spikes for determination of analytical extraction recovery; and

(F) overall assessment of the data quality based upon the QC data.

The City of Kingsville will ensure that all QC results included in each data set submitted to the TCEQ that affect the quality of the data be included within the LCN. The City of Kingsville will ensure that the laboratory describe the bias within each data set as either positive or negative, when QC results are outside the method established and/or data quality objectives of the facility groundwater sampling and analysis plan. The City of Kingsville will ensure that the precision and accuracy determinations are clearly presented with all results calculated. The LCN will explain each failed precision and accuracy measurement determined to be outside of the method control limits, and the effect of the failure on the results. The City of Kingsville will ensure that the LCN review includes comments that identify the problems associated with the sample results and explains the limitations on data usability.

The City of Kingsville will ensure that when appropriate and/or requested, the LCN includes a statement on the estimated uncertainty of analytical results of the samples involved and/or within the QC of the analytical method of the permit, project, and/or program required analytical recoveries information. The City of Kingsville will ensure that the LCN includes all deviations from, additions to, or exclusions from the test method, and information on specific test conditions. The City of Kingsville will ensure that where relevant, the LCN includes a statement of compliance/noncompliance with requirements and/or specifications (e.g. holding times, dilutions, matrix interferences).

8.5 Calculation of Practical Quantitation Limit

The Practical Quantitation Limit (PQL) is defined as the lowest concentration reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions and is analogous to the Limit of Quantitation (LOQ) definition in the most recent available NELAC Standard (National Environmental Laboratory Accreditation Conference). The PQL is method, instrument, and analyte specific and may be updated as more data becomes available.

The PQL must be below the groundwater protection standard established for that analyte as defined by 30 TAC 330.409(h) unless approved otherwise by the TCEQ. The precision and accuracy of the PQL shall be initially determined from the PQLs reported over the course of a minimum of eight groundwater monitoring events. The results obtained from these events shall be used to demonstrate that the PQLs meet the specified precision and accuracy as shown in the table below. The PQL will be supported by analysis of a PQL check sample, which is a laboratory reagent grade sample matrix spiked with chemicals of concern at concentrations equal to or less than the PQL. At a minimum, a PQL check sample will be performed quarterly during the calendar year to demonstrate that the PQL continues to meet the specified limits for precision and accuracy as defined in the table following.

QC Specification Limits for the PQL and Lower Limit of Quantitation Check Samples

COC	Precision (% RSD)	Accuracy (% Recovery)
Metals	10	70-130
Volatiles	20	50-150
Semi-Volatiles	30	50-150

Note: COC = Constituents of Concern; RSD=Relative Standard Deviation

For analytes that the established PQL cannot meet the precision and accuracy requirements in the table above, the City of Kingsville will ensure the laboratory will submit sufficient documentation and information to the TCEQ for alternate precision and accuracy limits on a case by case basis. Non-detected results will be reported as less than the established PQL limit that meets these precision and accuracy requirements.

All analytical data submitted under the requirements of this permit will be examined by the owner and/or operator to ensure that the data quality objectives are considered and met prior to submittal for the commission to review. The City of Kingsville will determine if the results representing the sample are accurate and complete. The quality control results, supporting data, and data review by the laboratory must be included when the City of Kingsville reviews the data. Any potential impacts will be reported such as the bias on the quality of the data, footnotes in the report, and anything of concern that was identified in the laboratory case narrative summary.
The City of Kingsville will ensure that the laboratory documents and reports all problems and observed anomalies associated with the analysis. If analysis of the date indicates that the data fails to meet the quality control goals for the laboratory's analytical data analysis program, the City of Kingsville will determine if the data is usable. If the owner and/or operator determines the analytical data may be utilized, any and all problems and correction action that the laboratory identified during the analysis will be included in the report submitted to the TCEQ.

8.6 Laboratory Case Narrative Requirements

A Laboratory Case Narrative (LCN) report for all problems and anomalies observed must be submitted by the owner and/or operator. The LCN will report the following information:

1. The exact number of samples testing parameters and sample matrix.

2. The name of the laboratory involved in the analysis. If more than one laboratory is used, all laboratories shall be identified in the case narrative.

3. The test objective regarding samples.

4. Explanation of each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits.

5. Explanation if the effect of the failed precision and accuracy measurements on the results induces a positive or negative bias.

6. Identification and explanation of problems associated with the sample results, along with the limitations these problems have on data usability.

7. A statement on the estimated uncertainty of analytical results of the samples when appropriate and/or requested.

8. A statement of compliance and/or noncompliance with the requirements and specifications. Exceedance of holding times and identification of matrix interferences must be identified. Dilutions shall be identified and if dilutions are necessary, they must be done to the smallest dilution possible to effectively minimize matrix interferences and bring the sample into control for analysis.

9. Identification of any and all applicable quality assurance and quality control samples that will require special attention by the reviewer.

10. A statement on the quality control of the analytical method of the permit and the analytical recoveries information shall be provided when appropriate and/or when requested.

In addition to the LCN, the following information must be submitted for all analytical data:

1. A table identifying the field sample name with the sample identification in the laboratory report.

2. Chain of custody.

3. An analytical report that documents the results and methods for each sample and analyte to be included for every analytical testing event. These test reports must document the reporting limit/method detection limit the laboratory used.

4. A release statement must be submitted from the laboratory. This statement must state, "I am responsible for the release of this laboratory data package. This data package has been

reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist and no information or data have been knowingly withheld that would affect the quality of the data."

a. If it is an in-house laboratory, it must have the following statement: This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report (for example, the APAR) in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

5. If the data is from soil and/or sediment samples, it must be reported on a dry weight basis with the percent solids and the percent moisture reported so that any back calculations of the wet analysis may be performed.

6. A laboratory checklist. For every response of "No, NA, or NR" that is reported on the checklist, the permittee will ensure the laboratory provides a detailed description of the "exception report" in the summary of the LCN. The permittee will require that the laboratory use a checklist and do an equivalent of an EPA Level 3 review regarding quality control analysis.

The Laboratory Review Checklist found in Appendix C, Item 5, shall be used to aid the permittee in ensuring the laboratory did the quality control analysis and to identify any potential problems, bias, or anomalies during sample analysis. The analytical report, LCN, and the checklist are to be included with the TCEQ-0312 forms for all monitoring events for groundwater. The checklist may be modified as long as the information that is in the enclosure is included in the facility's checklist.

9.0 DATA EVALUATION AND REPORTING

9.1 Background Monitoring

Background sampling results will be evaluated after each event for evidence of releases from the facility to enable a prompt early response to a potential adverse situation. The results of all background groundwater monitoring events will be reported annually unless otherwise requested by the Executive Director.

Once all background monitoring data is obtained (eight statistically independent samples), the Background analytical data will be evaluated for potential outliers using various commonly used statistical testing procedures to ensure that the data is representative of background groundwater constituent concentrations unaffected by waste placement activities at the facility. Once the background dataset is finalized, a Background Data Evaluation Report will be submitted to the TCEQ for review and approval. Following approval, the background dataset will be incorporated into the statistical evaluation procedure.

9.2 Detection Monitoring

Detection monitoring will commence for all facility monitoring wells following the background monitoring period. Detection monitoring will continue on a semi-annual basis during the active and post closure care phases of this facility.

9.2.1 Data Presentation

Upon receipt of the groundwater analytical reports from the laboratory, the data shall be organized in a format that can be clearly understood and analyzed. For each sampling event, the City will make a selection of at least one or more of the following data presentation formats:

- **Tables:** provide an overall summary of the data in a neat, clearly understood format that allows straightforward analysis and comparison to other data points and standards. The following tables may be included as necessary in each monitoring event report:
  Analytical Summary Table
  Purge and Sample Summary Table
  Duplicate Comparison Summary Table
- **Contour Maps:** In the case of significant contamination, placement of contaminant concentrations contours on a map may assist in conveying a clearer picture of contamination distribution.
- **Other Data:** Bar charts, time graphs and other data presentations may be used as necessary to portray useful information that may impact decision making during the monitoring lifetime of the facility.

9.2.2 Data Statistical Evaluation

In conjunction with the various data presentation formats in Section 9.1 and within 60 days of the sampling event, the groundwater data will be analyzed using methods that include averaging, standard deviations, correlations, prediction limits, and statistical distribution methodologies. The goal of the statistical evaluation is to identify evidence of a Statistically Significant Increase (SSI) over background concentrations of any constituent in any monitor well.

9.2.3 Inorganic Parameters

Appropriate statistical method(s) will be selected based on an evaluation of the background groundwater analytical data, and in accordance with TCEQ regulations. The Statistical Evaluation Procedure for this facility will incorporate current guidance and be subject to review.

The statistical evaluation of the analytical data may include, but not necessarily be limited to:

- A parametric analysis of variance (ANOVA) followed by multiple-comparisons procedures to identify statistically significant evidence of contamination.
- An ANOVA based on ranks followed by multiple-comparison procedures to identify statistically significant evidence of contamination.
- A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data and the level of each constituent compared to the upper tolerance or prediction limit; and/or
- A control chart approach that gives control limits (prediction limits) for each constituent.
- Other appropriate methods in accordance with TCEQ rules.

In utilizing a statistical method, seasonal and spatial variability as well as temporal changes shall be considered; these factors may be significant particularly for inter-well versus intra-well comparisons. The selection of inter- or intra-well comparisons will be determined after examination of the background data. The Statistical Evaluation Procedure is included in Appendix B-Item 3.

9.2.4 Volatile Organics

Statistics will not be used for the evaluation of Volatile Organic Compounds (VOC's) listed in Appendix A-Table 1 that are detected in any monitoring well currently in Detection Monitoring. Any VOC detected above the MSW-PQL Benchmark Concentrations listed in Appendix A-Table 2 will be considered an SSI.

9.3 SSI Reporting

If a statistically significant increase (SSI) in the concentration of any monitored constituent over background is identified in any point of compliance monitoring well, the City of Kingsville will notify the Executive Director and any local pollution agency with jurisdiction that has requested to be notified, in writing, within 14 days of the SSI determination. The notification will include either an acceptance of the apparent SSI and a schedule to conduct assessment monitoring or, if the SSI is not accepted, a statement that a verification resample will be collected and data will be submitted within 60 days of the apparent SSI determination. Supporting documentation with the notification will be provided as necessary.

Upon completion of a verification re-sampling, the results of the laboratory analysis will be submitted to the Executive Director in a written report that confirms or invalidates the results of the earlier sampling for the parameters which indicated an apparent SSI. If the results of the re-sampling disprove the apparent SSI, then the well will continue in detection monitoring. If the SSI is verified through resampling, the City will immediately place a notice in the operating record describing the increase, and not later than 90 days after the notice to the Executive Director will perform the following.

- Initiate an approved Assessment Monitoring program satisfying current TCEQ requirements; or
- If there is reasonable cause to think that a source for the SSI is a result of error in sampling, analysis, statistical evaluation, or natural variability in the groundwater quality, the City will submit an Alternate Source Demonstration (ASD).

9.4 Alternate Source Demonstration

If there is evidence that a source other than the landfill caused an SSI, or that an SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality, then a report providing documentation to this effect may be submitted to the Executive Director. The demonstration report will be prepared and certified by a qualified ground water scientist and submitted within 90 days of determining the SSI. If no demonstration is submitted, or if a demonstration is submitted but is not satisfactory to the Executive Director or has not been approved before the deadline, then the facility will initiate an assessment monitoring program meeting TCEQ requirements. If a satisfactory demonstration is made after the deadline, then the facility may cease assessment monitoring and return to detection monitoring following approval from the Executive Director.

If an SSI continues to occur for a constituent in a well for which a demonstration has previously been accepted, the continuing SSI will be reported to the TCEQ within the required time frame. If the circumstances of the continuing SSI are the same, the previously accepted demonstration may still apply. In these cases, the facility will submit documentation, subject to review and acceptance by the TCEQ, explaining how the prior demonstration still applies. If the TCEQ deems that the previously accepted demonstration is no longer satisfactory, a new demonstration will need to be submitted and accepted by the TCEQ or assessment monitoring will be triggered.

9.5 Annual Detection Monitoring Report

Not later than 90 days after the last monitoring event in the calendar year, the City will submit to the Executive Director an annual detection monitoring report containing the following:

- A statement regarding whether a statistically significant increase has occurred over background values in any well during the previous calendar year period and the status of any statistically significant increase events;
- A laboratory case narrative (LCN), a laboratory checklist or the laboratory quality assurance and quality control data, and the laboratory analytical data. The laboratory analytical data will be submitted either electronically or in hard copy form as requested.
- The facility will explain any problems encountered in the laboratory analysis, either by adding additional explanations to the laboratory checklist or by extending the laboratory case narrative.
- Any information required in the laboratory case narrative that cannot be completed by the laboratory will be completed by the city.
- The results of all groundwater monitoring, testing, and analytical work obtained or prepared under the requirements of the permit, including a summary of background groundwater quality values, groundwater monitoring analyses, statistical calculations, graphs, and drawings;
- The groundwater flow rate and direction in the uppermost aquifer. The groundwater flow rate and direction of groundwater flow will be established using the data collected during the preceding calendar year's sampling events from the detection monitoring wells of the detection monitoring program. All documentation used to determine the groundwater flow rate and direction will be included in the report;
- A contour map of piezometric water levels in the uppermost aquifer based on concurrent measurement in all monitoring wells. All data or documentation used to establish the contour map will be included in the report;
- Recommendation for any changes; and
- Any other items requested by the Executive Director.

10.0 ASSESSMENT MONITORING

An Assessment Monitoring (AM) program will be implemented whenever an SSI is identified, and confirmed through resampling, for any of the Detection Monitoring constituents, and a source other than the MSWLF unit cannot be identified. A monitoring well that possesses a confirmed SSI for any of the Detection Monitoring constituents will be placed into an Assessment Monitoring program in accordance with current TCEQ regulations within 90 days of the SSI determination. In addition to the well demonstrating the confirmed SSI, the point of compliance well(s) immediately adjacent to the well exhibiting the confirmed SSI will be sampled for the Assessment Monitoring list of constituents unless an alternate set of wells or constituents is designated by the Executive Director. The Assessment monitoring program includes sampling for the complete Title 40 Code of Federal Regulations, Part 258, Appendix II (40 CFR 258, Appendix II) list of constituents unless otherwise approved by the Executive Director. All samples analyzed for constituents in wells that are currently in assessment monitoring will not be field or laboratory filtered.

Assessment monitoring results will be submitted on a semi-annual basis within 60 days of each sampling event. The City of Kingsville will also determine whether any 40 CFR Part 258, Appendix II constituents were detected at statistically significant levels above the groundwater protection standard within 60 days of each sampling event.

If the concentrations of all assessment monitoring constituents are at or below background values for two consecutive monitoring events, the well will return to detection monitoring following the submittal of a request from the City of Kingsville and approval from the Executive Director.

If the concentration of any assessment monitoring constituent is above the background value but below the applicable groundwater protection standard, the well will remain in assessment monitoring. If the groundwater protection standard has been exceeded, the City of Kingsville will notify the Executive Director and appropriate local government officials in writing within 7 days of the determination. The City of Kingsville will also pursue additional activities such as characterizing the nature and extent of the release, install and sample additional monitoring wells between the monitoring well demonstrating the statistically significant level and the next adjacent wells along the point of compliance line, notifying offsite land owners that may be impacted by the plume of contamination if contaminants have migrated off-site, and initiate an Assessment of Corrective Measures. The City of Kingsville may also demonstrate that a source other than the monitored solid waste management unit caused the contamination or that the statistically significant level resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

11.0 ASSESSMENT OF CORRECTIVE MEASURES

Within 90 days of discovering any 40 CFR Part 258, Appendix II constituents exceeding any groundwater protection standards and a source other than the monitored solid waste management unit cannot be identified, an assessment of corrective measures will be initiated. Assessment monitoring will continue, while an analysis of potential corrective measures is conducted that meets all current TCEQ requirements for a Selection of Remedy. The Assessment of Corrective Measures will be completed within 180 day of initiating the Assessment. The Selection of Remedy will be completed within 30 days of completing the Assessment of Corrective Measures and with approval of the Executive Director.

12.0 IMPLEMENTATION OF CORRECTIVE ACTION

When a schedule has been established from discussions and coordination stemming from the Selection of Remedy process, implementation of a corrective action groundwater monitoring program will be established that meets the requirements of an assessment monitoring program. Corrective actions at a given facility may vary to a great degree. All interim measures will be taken as necessary to protect human health and the environment. All aspects of the chosen remedy will follow current TCEQ requirements and approval.

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDICES

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX A

TABLE 1
DETECTION MONITORING CONSTITUENTS

TABLE 1
DETECTION MONITORING CONSTITUENTS

Chemical Name	CAS RN[1]	EPA Method No.[2]
Inorganic Constituents		
Antimony (Total)	--	6010 or 6020
Arsenic (Total)	--	6010 or 6020
Barium (Total)	--	6010 or 6020
Beryllium (Total)	--	6010 or 6020
Cadmium (Total)	--	6010 or 6020
Chromium (Total)	--	6010 or 6020
Cobalt (Total)	--	6010 or 6020
Copper (Total)	--	6010 or 6020
Lead (Total)	--	6010 or 6020
Nickel (Total)	--	6010 or 6020
Selenium (Total)	--	6010 or 6020
Silver (Total)	--	6010 or 6020
Thallium (Total)	--	6010 or 6020
Vanadium (Total)	--	6010 or 6020
Zinc (Total)	--	6010 or 6020
Organic Constituents		
Acetone	67-64-1	8260
Acrylonitrile	107-13-1	8260
Benzene	71-43-2	8260
Bromochloromethane	74-97-5	8260
Bromodichloromethane	75-27-4	8260
Bromoform (tribromomethane)	75-25-2	8260
Carbon disulfide	75-15-0	8260
Carbon tetrachloride	56-23-5	8260
Chlorobenzene	108-90-7	8260
Chloroethane (ethyl chloride)	75-00-3	8260
Chloroform (trichloromethane)	67-66-3	8260
Dibromochloromethane (chlorodibromomethane)	124-48-1	8260

Chemical Name	CAS RN[1]	EPA Method No.[2]
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	8260
1,2-Dibromoethane (ethylene dibromide, EDB)	106-93-4	8260
o-Dichlorobenzene (1,2-dichlorobenzene)	95-50-1	8260
p-Dichlorobenzene (1,4-dichlorobenzene)	106-46-7	8260
trans-1, 4-Dichloro-2-butene	110-57-6	8260
1,1-Dichloroethane (ethylidene chloride)	75-34-4	8260
1,2-Dichloroethane (ethylene dichoride)	107-06-2	8260
1,1-Dichloroethylene (1,1-dichloroethene, vinylidene chloride)	75-35-4	8260
cis-1,2-Dichloroethylene (cis-1,2-dichloroethene)	156-59-2	8260
trans-1,2-Dichloroethylene (trans-1,2-dichloroethene)	156-60-5	8260
1,2-Dichloropropane (Propylene dichloride)	78-87-5	8260
cis-1,3-Dichloropropene	10061-01-5	8260
trans-1, 3-Dichloropropene	10061-02-6	8260
Ethylbenzene	100-41-4	8260
2-Hexanone (methyl butyl ketone)	591-78-6	8260
Methyl bromide (bromomethane)	74-83-9	8260
Methyl chloride (chloromethane)	74-87-3	8260
Methylene bromide (dibromomethane)	74-95-3	8260
Methylene chloride (dichloromethane)	75-09-2	8260
Methyl ethyl ketone (MEK, 2-butanone)	78-93-3	8260
Methyl iodide (iodomethane)	74-88-4	8260
4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1	8260
Styrene	100-42-5	8260
1,1,1,2-Tetrachloroethane	630-20-6	8260
1,1,2,2-Tetrachloroethane	79-34-5	8260
Tetrachloroethylene (tetrachloroethene, perchloroethylene)	127-18-4	8260
Toluene	108-88-3	8260
1,1,1-Trichloroethane (methylchloroform)	71-55-6	8260
1,1,2-Trichloroethane	79-00-5	8260

Chemical Name	CAS RN[1]	EPA Method No.[2]
Trichloroethylene (trichloroethene)	79-01-6	8260
Trichlorofluoromethane (CFC-11)	75-69-4	8260
1,2,3-Trichloropropane	96-18-4	8260
Vinyl acetate	108-05-4	8260
Vinyl chloride	75-01-4	8260
Xylenes	1330-20-7	8260

[1] Chemical Abstract Service Registry Number (CAS RN) identifies specific chemicals by this industry standard number.

[2] Suggested methods refer to analytical procedure numbers used in EPA Report SW-846 "Test Methods for Evaluating Solid Waste", third edition, November 1986, as revised, December 1987. Analytical details can be found in SW-846 and in documentation on file at the agency. CAUTION: The methods listed are representative SW-846 procedures and may not always be the most suitable method(s) for monitoring an analyte under the regulations.

[3] Standard Methods (SM) Analytical Procedure.

[4] EPA Water/Wastewater Method

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX A

TABLE 2
MSW-PQL BENCHMARK CONCENTRATIONS

Analyte	Method	DW MCL (ug/l)	DW TPCL (ug/l)	Rounded IQE (ug/l)	Rounded IQE PQL Met P&A Criteria (Y/N)	Rounded IQE PQL Met Both Reg Criteria (Y/N)	Initial MSW-PQL (ug/l)
Acetone	SW 846 8260	NA	22000	20	Y	Y	20
Acrylonitrile	SW 846 8260	NA	1.7	50	Y	N	50
Benzene	SW 846 8260	5	5	1	Y	Y	1
Bromochloromethane	SW 846 8260	NA	980	1	Y	Y	1
Bromodichloromethane	SW 846 8260	NA	15	1	Y	Y	1
Bromoform; Tribromomethane	SW 846 8260	NA	120	5	Y	Y	5
Carbon disulfide	SW 846 8260	NA	2400	5	Y	Y	5
Carbon tetrachloride	SW 846 8260	5	5	5	Y	Y	5
Chlorobenzene	SW 846 8260	100	100	1	Y	Y	1
Chloroethane; Ethyl chloride	SW 846 8260	NA	9800	5	Y	Y	5
Chloroform; Trichloromethane	SW 846 8260	NA	240	1	Y	Y	1
Dibromochloromethane: Chlorodibromomethane	SW 846 8260	NA	11	2	Y	Y	2
1,2-Dibromo-3-chloropropane; DBCP	SW 846 8260	0.2	0.2	5	Y	N	5
1,2-Dibromoethane, Ethylene dibromide; EDB	SW 846 8260	0.05	0.05	1	Y	N	1
o-Dichlorobenzene; 1,2-Dichlorobenzene	SW 846 8260	600	600	2	Y	Y	2
p-Dichlorobenzene; 1,4-Dichlorobenzene	SW 846 8260	75	75	2	Y	Y	2
trans-1, 4-Dichloro-2-butene	SW 846 8260	NA	140	100	Y	Y	100
1,1-Dichloroethane ; Ethylidene chloride	SW 846 8260	NA	4900	1	Y	Y	1
1,2-Dichloroethane; Ethylene dichoride	SW 846 8260	5	5	1	Y	Y	1
1,1-Dichloroethylene; 1,1-Dichloroethene	SW 846 8260	7	7	1	Y	Y	1

Analyte	Method	DW MCL (ug/l)	DW TPCL (ug/l)	Rounded IQE (ug/l)	Rounded IQE PQL Met P&A Criteria (Y/N)	Rounded IQE PQL Met Both Reg Criteria (Y/N)	Initial MSW-PQL (ug/l)
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	SW 846 8260	70	70	1	Y	Y	1
trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	SW 846 8260	100	100	1	Y	Y	1
1,2-Dichloropropane; Propylene dichloride	SW 846 8260	5	5	1	Y	Y	1
cis-1,3-Dichloropropene	SW 846 8260	NA	1.7	2	Y	N	2
trans-1, 3-Dichloropropene	SW 846 8260	NA	9.1	5	Y	Y	5
Ethylbenzene	SW 846 8260	700	700	2	Y	Y	2
2-Hexanone, Methyl butyl ketone	SW 846 8260	NA	1500	5	Y	Y	5
Methyl bromide; Bromomethane	SW 846 8260	NA	34	10	Y	Y	10
Methyl chloride; Chloromethane	SW 846 8260	NA	70	5	Y	Y	5
Methylene bromide; Dibromomethane	SW 846 8260	NA	120	1	Y	Y	1
Methylene chloride; Dichloromethane	SW 846 8260	NA	5	5	Y	Y	5
Methyl ethyl ketone; MEK; 2-butanone	SW 846 8260	NA	15000	5	Y	Y	5
Methyl iodide, Iodomethane	SW 846 8260	NA	34	5	Y	Y	5
4-Methyl-2-pentanone; Methyl isobutyl ketone	SW 846 8260	NA	2000	5	Y	Y	5
Styrene	SW 846 8260	100	100	2	Y	Y	2
1,1,1,2-Tetrachloroethane	SW 846 8260	NA	35	2	Y	Y	2
1,1,2,2-Tetrachloroethane	SW 846 8260	NA	4.6	1	Y	Y	1
Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	SW 846 8260	5	5	5	Y	Y	5
Toluene	SW 846 8260	1000	1000	1	Y	Y	1
1,1,1-Trichloroethane; Methylchloroform	SW 846 8260	200	200	1	Y	Y	1

Analyte	Method	DW MCL (ug/l)	DW TPCL (ug/l)	Rounded IQE (ug/l)	Rounded IQE PQL Met P&A Criteria (Y/N)	Rounded IQE PQL Met Both Reg Criteria (Y/N)	Initial MSW-PQL (ug/l)
1,1,2-Trichloroethane	SW 846 8260	5	5	1	Y	Y	1
Trichloroethylene; Trichloroethene	SW 846 8260	5	5	5	Y	Y	5
Trichlorofluoromethane; CFC-11	SW 846 8260	NA	7300	10	Y	Y	10
1,2,3-Trichloropropane	SW 846 8260	NA	0.13	1	Y	N	1
Vinyl acetate	SW 846 8260	NA	24000	NONE	N	N	100
Vinyl chloride	SW 846 8260	2	2	2	Y	Y	2
m, p-Xylenes	SW 846 8260	NA	NA	5	Y	Y	5
o-Xylenes	SW 846 8260	NA	NA	2	Y	Y	2
Total Xylenes	SW 846 8260	10000	10000	10	Y	Y	10
Antimony (Total)	SW 846 6020	6	6	5	Y	Y	5
Arsenic (Total)	SW 846 6020	10	10	5	Y	Y	5
Barium (Total)	SW 846 6010	2000	2000	10	Y	Y	10
Beryllium (Total)	SW 846 6010	4	4	5	Y	N	4
Cadmium (Total)	SW 846 6010	5	5	2	Y	Y	2
Chromium (Total)	SW 846 6010	100	100	20	Y	Y	20
Cobalt (Total)	SW 846 6010	NA	7.3	5	Y	Y	5
Copper (Total)	SW 846 6010	1300	1300	10	Y	Y	10
Lead (Total)	SW 846 6010	15	15	20	Y	N	15
Nickel (Total)	SW 846 6010	NA	490	20	Y	Y	20
Selenium (Total)	SW 846 6010	50	50	50	Y	Y	50

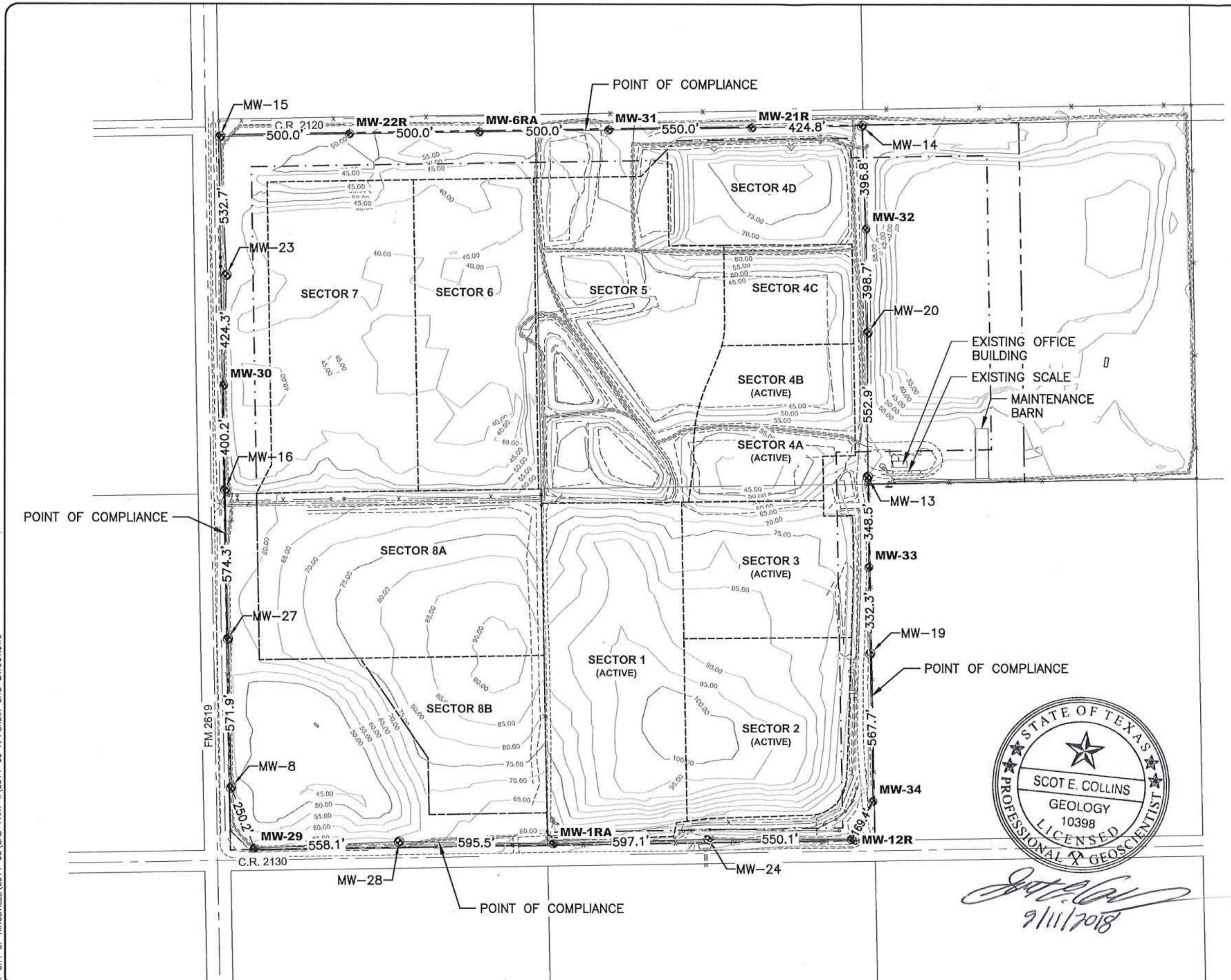
Analyte	Method	DW MCL (ug/l)	DW TPCL (ug/l)	Rounded IQE (ug/l)	Rounded IQE PQL Met P&A Criteria (Y/N)	Rounded IQE PQL Met Both Reg Criteria (Y/N)	Initial MSW-PQL (ug/l)
Silver (Total)	SW 846 6010	120	120	10	Y	Y	10
Thallium (Total)	SW 846 6020	2	2	1	Y	Y	1
Vanadium (Total)	SW 846 6010	NA	170	10	Y	Y	10
Zinc (Total)	SW 846 6010	NA	7300	100	Y	Y	100

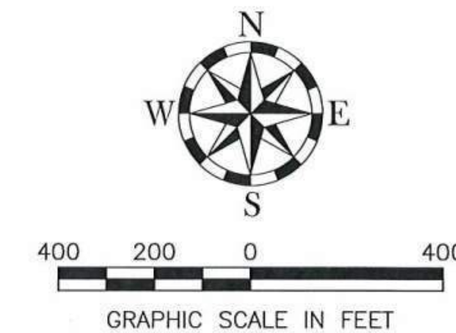
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX A

ITEM 1-SITE LAYOUT MAP





LEGEND:

- MW-20 — MONITOR WELL LOCATION
- EXISTING FENCE
- EXISTING SURFACE CONTOUR (2015)
- SECTOR OUTLINE
- PERMIT BOUNDARY (175.89 ACRES)
- BUFFER ZONE
- 400.2' — POINT OF COMPLIANCE

SITE COORDINATES				
MONITOR WELL LOCATIONS				
MW	Northing	Easting	DEPTH (FT BGS)	STATUS
MW-8	17051473.78	1203673.74	43	EXISTING
MW-13	17052672.16	1206127.95	40	EXISTING
MW-14	17054020.04	1206103.02	35	EXISTING
MW-15	17053976.10	1203628.61	33	EXISTING
MW-16	17052619.76	1203651.21	40	EXISTING
MW-19	17051991.35	1206137.50	43	EXISTING
MW-20	17053225.01	1206127.20	39	EXISTING
MW-23	17053444.05	1203654.88	35	EXISTING
MW-24	17051277.99	1205512.42	33	EXISTING
MW-27	17052045.52	1203661.75	40	EXISTING
MW-28	17051266.46	1204320.24	43	EXISTING
MW-1RA	17051258.70	1204915.66	35	PROPOSED
MW-32	17053623.64	1206120.29	31	PROPOSED
MW-6RA	17053994.38	1204628.44	30	PROPOSED
MW-12RA	17051277.38	1206062.51	35	PROPOSED
MW-21R	17054011.48	1205678.30	32	PROPOSED
MW-22R	17053986.24	1204128.51	30	PROPOSED
MW-29	17051239.92	1203762.81	40	PROPOSED
MW-30	17053019.90	1203644.60	30	PROPOSED
MW-31	17054002.53	1205128.38	31	PROPOSED
MW-33	17052323.65	1206132.04	35	PROPOSED
MW-34	17051423.79	1206147.64	35	PROPOSED

SEP 12, 2018 3:41 PM TORRED1809
I:\16JOBS\16L0438\8514-CITY OF KINGSVILLE\8514-03\CAD-PART-II\8514-03-APPENDIX-SITE-LAYOUT.DWG

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

Hanson No. 16L0438
Filename 8514-03-APPENDIX-SITE-LAYOUT
Scale AS SHOWN
Date 09/10/18

LAYOUT	DT	09/10/18
DRAWN	DT	09/10/18
REVIEWED	TAG	09/10/18

HANSON

Hanson Professional Services Inc.
4501 Gollihar Rd.
Corpus Chrisiti, Texas 78411

TBPE F-417
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PART III, ATTACHMENT 11
APPENDIX A
ITEM - 1
SITE LAYOUT MAP
GROUNDWATER SAMPLING AND ANALYSIS PLAN
CITY OF KINGSVILLE LANDFILL
PA. MSW 235-C
KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

FIGURE:
III.11-A-1

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX A

ITEM 2-GROUNDWATER MONITORING SYSTEM DESIGN CERTIFICATION

Groundwater Monitoring System Design Certification
City of Kingsville Landfill
TCEQ Permit No. MSW 235-C
Kleberg County, Texas

I, Tad A. Gass, a licensed professional geoscientist in the State of Texas and a qualified groundwater scientist as defined in 30 TAC §330.3, certify that the groundwater monitoring system for the above referenced facility has been designed in accordance with the requirements outlined in 30 TAC §330.403, Groundwater Monitoring Systems, and 30 TAC §330.421, Monitor Well Construction Specifications. The groundwater monitoring system design is based on site specific geologic and hydrogeologic conditions based on the Geology Report and Appendices completed by Finch Energy & Environmental Services, Inc. (1998) and the Geotechnical Engineering Study conducted by Tolunay-Wong Engineers, Inc. (2018) as well as the Site Development Plan for the above referenced facility. Once installed, it will provide an adequate groundwater monitoring system for this facility.

STATE OF TEXAS
TAD A. GASS
GEOLOGY
11496
LICENSED
PROFESSIONAL GEOSCIENTIST

Tad A. Gass, P.G.
Hanson Professional Services Inc.

9/11/2018
Date

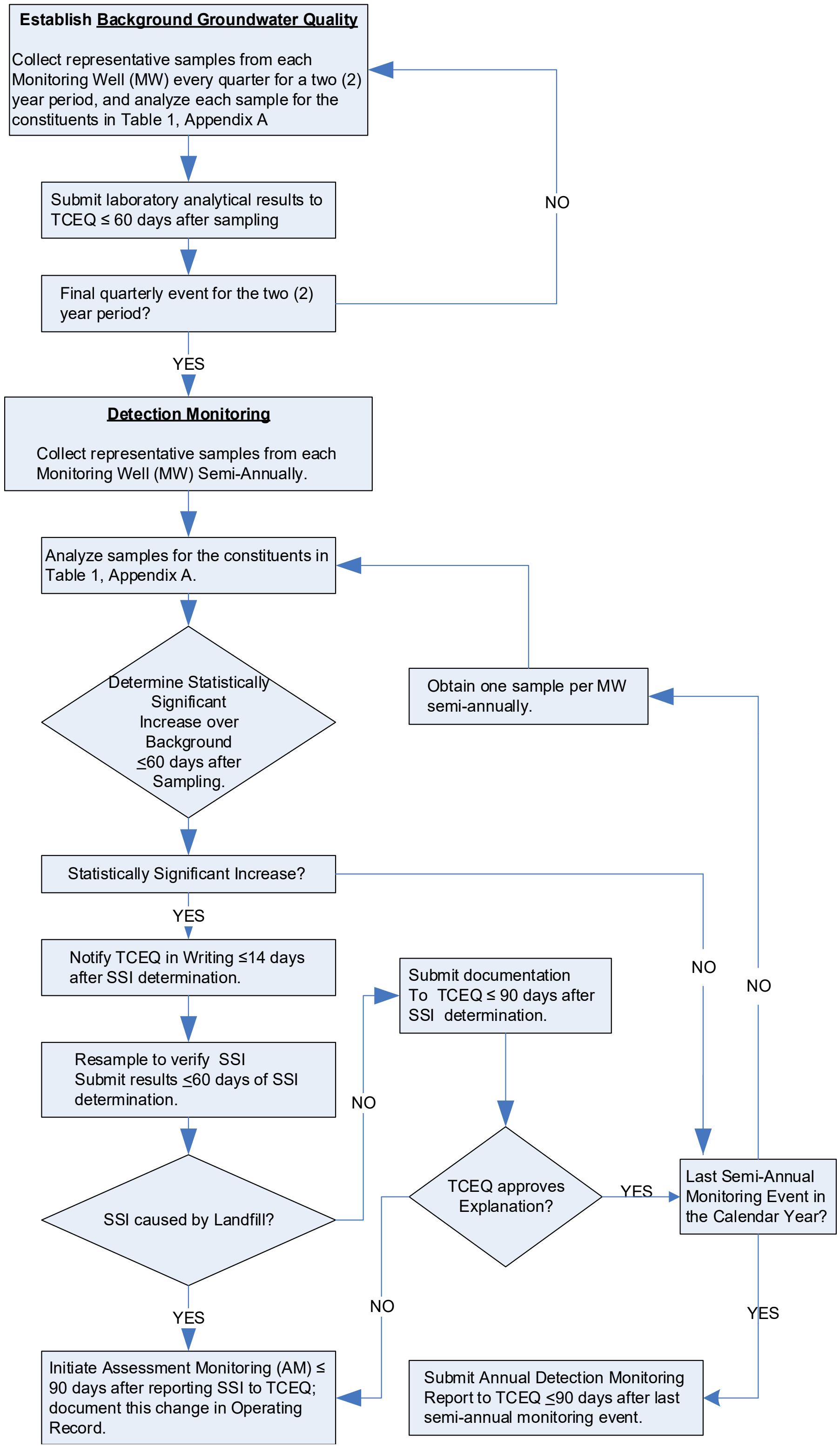
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX B

ITEM 1-MUNICIPAL SOLID WASTE GROUNDWATER MONITORING FLOW CHART

Municipal Solid Waste Groundwater Monitoring Flow Chart



CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX B

ITEM 2-SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIMES

Recommended Sampling, Preservation, and Storage Procedures for Groundwater Monitoring

Parameter	Recommended Containers	Maximum Preservation	Minimum Holding Time	Volume
pH	P, G	None	Analyze immediately	25 ml
Spec. Cond.	P, G	None	Analyze immediately	100 ml
Temperature	P, G	None	Analyze immediately	
Heavy Metals (includes iron and manganese)	P, G	Acidify $wHNO_3$ to pH < 2, 4°C	6 months except 28 days for Hg	1 liter
Calcium, Magnesium, Sodium, Potassium, Fluoride, Sulfate, Chloride, and Hardness	P, G	4°C	28 days	1 liter
TDS (may be included with above parameters)	P, G	4°C	7 days	100 ml
Nitrate	P, G	4°C	48 hrs	100 ml
Ammonia	P, G	4°C; acidify w/H_2SO_4 to pH < 2, 4°C	7 days; 28 days if acidified	500 ml
Alkalinity	P, G	4°C	48 hours	200 ml
NPOC	G amber, T-lined caps	4°C; acidify w/HCl to pH < 2, 4°C	48 hrs; 28 days if acidified	100 ml / replicate
COD	P, G	4°C; acidify w/H_2SO_4 to pH < 2, 4°C	48 hrs; 28 days if acidified	100 ml
SVOC	G, T-lined caps	4°C	7 days until extraction, then analyze within 40 days	1 liter
BOD	P, G	4°C	24 hrs	1 liter
VOC	G, T-lined caps	4°C; acidify w/HCl to pH < 2, 4°C	14 days	2 x 40 ml

P= Polyethylene, G= Glass, T= Teflon.

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX B

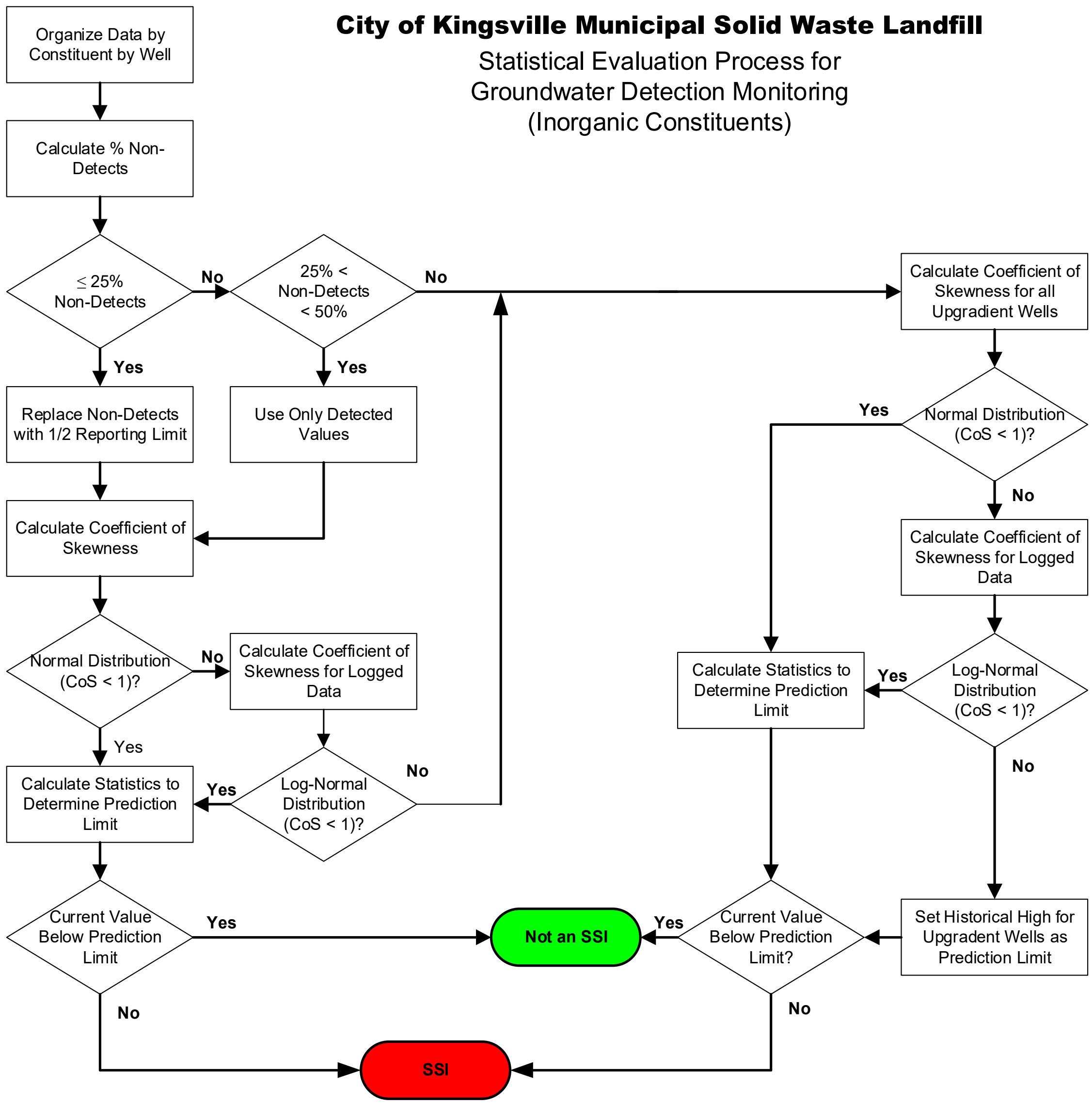
ITEM 3-STATISTICAL EVALUATION PROCEDURE

STATISTICAL EVALUATION PROCEDURE

Evaluation Tools

The laboratory data from each sampling event is entered into a spreadsheet that contains the historic background data for each well. The current data is then evaluated to determine if any Statistically Significant Increases (SSIs) have occurred.

Figure 1 - Statistical Evaluation Process for Inorganic Constituents



Special Evaluation Process for Organic Constituents

Organic constituents will be evaluated using the laboratory reporting limit. A detection of an organic constituent (above the approved laboratory reporting limit) will be considered an apparent SSI with no further statistical evaluation performed.

Determine If Background Data is Normally Distributed

The first statistical procedure is to determine if the data for each inorganic constituent conformed to some type of normal distribution. This evaluation is performed using the "Coefficient of Skewness". In accordance with an EPA guidance document[1], data sets with an absolute value of the Coefficient of Skewness less than 1 were considered to conform to a normal distribution. Those data sets with a Coefficient of Skewness greater than 1 were evaluated to determine if they conformed to a log-normal distribution. This evaluation is performed by determining the Coefficient of Skewness using the natural logarithms of the data. Logged data sets with a Coefficient of Skewness less than 1 are considered to conform to a log-normal distribution.

In accordance with the EPA guidance document, data sets with greater than fifty percent (50%) "non-detects" were assumed to not be normally distributed. Data sets with less than twenty five percent (25%) "non-detects" are evaluated by replacing the "non-detects" with one-half of the laboratory reporting limit. Data sets with greater than twenty five percent (25%) but less than fifty percent (50%) "non-detects" are evaluated using only the "detects".

Determining Parametric Prediction Limits

For those background data sets that are determined to conform to either the normal or log-normal distribution, a parametric prediction limit is determined. As identified in the previously referenced EPA guidance document, the equation for calculating a one-sided (upper) Prediction Limit is:

$$PL = \overline{X} + St\sqrt{1/m + 1/n}$$

where:
$\overline{X}$ is the sample mean
S is the sample standard deviation
t is the t-statistic from the standardized t distribution
m is the number of future samples to be evaluated
n is the number of measurements in the background data set

For this evaluation, the results of the current monitoring event are the only data to be evaluated. There are eight (8) original measurements in the background data set for each well. To determine the "t statistic", a confidence level of 99.0% is used along with "n-1" (7 or 1ess) degrees of freedom for the wells as appropriate. The "t statistic" used for this evaluation is 2.998 for n-1=7. This value is substituted into the equation above to calculate the PL.

[1] "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance", U.S. Environmental Protection Agency, Office of Resource Conservation and Recovery, March, 2009.

If the current value exceeded this prediction limit, the value is considered an SSI.

Determining Parametric Prediction Limits from Pooled Upgradient Background Data

For those data sets that do not conform to either the normal or log-normal distribution, parametric prediction limits are determined from the pooled background data of all upgradient monitoring wells. Prior to establishing prediction limits from the pooled background data, the background data is evaluated to determine if it conformed to a normal or log-normal distribution. This is done using the Coefficient of Skewness, as outlined above.

For those background data sets that are determined to conform to either the normal or log-normal distribution, a parametric prediction limit is determined. The equation for calculating a one-sided (upper) Prediction Limit is:

$$PL = \overline{X} + St\sqrt{1/m + 1/n}$$

where:
$\overline{X}$ is the sample mean
S is the sample standard deviation
t is the t-statistic from the standardized t distribution
m is the number of future samples to be evaluated
n is the number of measurements in the background data set

To determine the "t statistic", a confidence level of 95% (more conservative) is used along with "n-1" degrees of freedom. The "t statistic" used for this evaluation is 1.753 for n-1=15 as appropriate[2].

If the current value exceeds this pooled background dataset prediction limit, the value is considered an apparent SSI.

For pooled background data sets that do not conform to either the normal or log-normal distribution, non-parametric prediction limits are determined. The mean and standard deviation are determined for each of these sets for comparison purposes only. If the current value exceeds the historic high from the pooled background dataset or Municipal Soild Waste-Practical Quantitation Limit (MSW-PQL), whichever is higher, then the value is considered an SSI.

[2] Alfredo H.S. Ang, and Wilson H. Tang, "Probability Concepts in Engineering Planning and Design", John Wiley & Sons, 1975. Table A.2, Page 383.

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 1-FIELD CONDITIONS REPORT

FIELD CONDITIONS REPORT

FACILITY NAME: ____

LOCATION: ____

OWNER: ____

Date: ______________________ Temperature: ______________

Weather: ______________________ Time: ______________

Sampling Team: ____

____

Purpose of Sampling: ___ Background ___ Semi-annual ___ Annual ___ Quarterly

Phase: ___ Detection Monitoring ___ Assessment Monitoring ___

Other____________________

Site Observations: ____

____

____

____

____

____

____

____

____

____

Reported By: ____

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 2-MONITOR WELL FIELD DATA SHEET

MONITOR WELL FIELD DATA SHEET

SITE NAME:	CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL	
PROJECT #:		
DATE:		

MONITOR WELL NO.	CASING DIAMETER (IN.)	DEPTH TO WATER (FT. BTOC)	TOTAL DEPTH (FT. BTOC)	PURGE VOLUME (GAL.)	%Vol. CH_4	TEMP (C°)	CONDUCTIVITY (μS/cm)	pH	TIME	COMMENTS
COMMENTS:										
COMMENTS:										
COMMENTS:										
COMMENTS:										

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 3-CHAIN-OF-CUSTODY FORM

ANALYSYS LABORATORIES

3512 Montopolis Drive, Austin, TX 78744
Ph:(512) 385-5886 Fax: (512) 919-4141

2209 N. Padre Island Dr., Ste K Corpus Christi, TX 78408
Ph:(361)289-6384 Fax: (512) 919-4141

Web: www.analysysinc.com
E-Mail: analysys@analysysinc.com

CHAIN-OF-CUSTODY

COMPANY NAME ______________________ BILL TO COMPANY: ______________ PAGE ____ OF ____
ADDRESS ______________________ BILL TO ADDRESS: ______________
CITY ____________ STATE ______ ZIP ________ PO # ______________
ATTN: ______________________ PROJECT NAME ______________
PHONE ____________ FAX/EMAIL ____________ PROJECT NUMBER ____________ SAMPLER ____________

Special Reporting
TRRP Report ☐
TRRP with no QC ☐
EDD Spreadsheet ☐

5035 Requirements ☐
Petroleum Storage Tank Rule ☐
No Hydrocarbons in C6-C12 Range

Client Sample No. Description/Identification	Date Sampled	Time Sampled	# of Containers	Grab	Composite	Lab I.D. # (Lab Only)	No. of Containers and Preservative: Ice	HNO3	HCL	ZnAc/NaOH	H2SO4 Glass	Unpreserved	Other (Specify)	Matrix: Water-W Soil-S Air-A Waste-WST Liquid Waste-LW Other-Specify	PARAMETERS(1)													TAT* 24hr 48hr 72hr Standard

Special Instructions (such as special QC requirements, lists, methods, etc…)

Additional reports to:

Custody Seal
☐ Intact ☐ Broken ☐ Absent
☐ Absent/Hand Delivered

(1)Unless specifically requested otherwise on this Chain-of-custody and/or attached documentation, all analyses will be conducted using ASI's method of choice and all data will be reported to ASI's normal reporting limits (MDL/PQL). For GC/MS volatiles and extractables, unless specific analytical parameter lists are specified on this chain-of-custody or attached to this chain-of-custody, ASI will default to Priority Pollutants or ASI's HSL list at ASI's option. Specific compound lists must be supplied for all GC procedures.

Sample Relinquished By				Sample Received By			
Name	Affiliation	Date	Time	Name	Affiliation	Date	Time

Temperature upon receipt

°C-observed	°C-corrected	T#:
Temp Blank ☐		Ambient ☐
Lab ID #		

[Tendering of above described samples to AnalySys, Inc. for analytical testing constitutes agreement by buyer/sampler to AnalySys, Inc.'s standard terms.]

* By selecting RUSH/Accelerated TAT, client agrees to additional fees. Please call your Project Manager. ASI will make all reasonable efforts to meet rush requests.

F-0026 V11-081516
Effective Date: 08/15/16
1 of 1

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 4-TCEQ 0312 GROUND-WATER SAMPLING REPORT

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

TCEQ

Facility name________________________ **1. MSW permit no.** ____________ (Essential Field)

Permittee________________________ **2. Monitor well no.** ____________ (Essential Field)

County________________________ **3. Date of sampling** ____________ (Essential Field)

Name of sampler____________________ Most recent previous sampling____________

Affiliation of sampler____________________ Date of water level measurements____________

If split-sampled, with whom?____________________ Datum reference point____________

Integrity of well____________________ Datum elevation*____________

Installation date____________________ Depth to water (below datum)*____________

4. Water level elevation*____________

5. Purging/Sampling method__________ (enter Bailer or Pump)
   Were low-flow methods used? [ ] yes [ ] no (check one)
   If yes, what volume was purged?__________

6. Well volumes purged__________ (enter 1, 2, 2.5, 3, etc)

7. Was the well dry before purging? [ ] yes [ ] no (check one)

8. Was the well dry after purging? [ ] yes [ ] no (check one)

9. How long before sampling?__________ (enter time)

10. Unit of measure?__________ (days, hours, or mins)

11. Sample Event____________
    (enter one of the selections below)
    - Background
    - Corrective Action
    - Detection Monitoring
    - Other
    - Assessment

12. Sample Schedule____________
    (enter one of the selections below)
    - Quarterly
    - Fourth Year
    - Semi-Annual
    - Other
    - Annual

13. Sample Type____________
    (enter one of the selections below)
    - Regular
    - Split
    - Duplicate
    - Other
    - Resample

Field Measurements:

14. pH _______

15. Spec. cond. _______ 16. [ ] umho/cm or [ ] mmho/cm (check one)

17. Temp. _______ 18. [ ] °F or [ ] °C (check one)

Laboratory: 19. Name ____________________ Phone ____________

Address ________________________________

Representative ________________________________
(name) (signature) (date)

Site operator or representative: ________________________________
(name) (signature) (date)

***Report depth to water and elevations to nearest 0.01 foot relative to mean sea level (MSL).**

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
Waste Permits Division, Municipal Solid Waste Permits Section
Groundwater Sampling Report

HEAVY METALS

CONSTITUENT			CONCENTRATION		REPORTING LIMITS [3]		METHOD
Antimony	T [1]	D [2]	________	µg/l	________	µg/l	________
Arsenic	T	D	________	µg/l	________	µg/l	________
Barium	T	D	________	µg/l	________	µg/l	________
Beryllium	T	D	________	µg/l	________	µg/l	________
Cadmium	T	D	________	µg/l	________	µg/l	________
Chromium	T	D	________	µg/l	________	µg/l	________
Cobalt	T	D	________	µg/l	________	µg/l	________
Copper	T	D	________	µg/l	________	µg/l	________
Lead	T	D	________	µg/l	________	µg/l	________
Mercury	T	D	________	µg/l	________	µg/l	________
Nickel	T	D	________	µg/l	________	µg/l	________
Selenium	T	D	________	µg/l	________	µg/l	________
Silver	T	D	________	µg/l	________	µg/l	________
Thallium	T	D	________	µg/l	________	µg/l	________
Vanadium	T	D	________	µg/l	________	µg/l	________
Zinc	T	D	________	µg/l	________	µg/l	________
Iron	T	D	________	mg/l	________	mg/l	________
Manganese	T	D	________	mg/l	________	mg/l	________

[1, 2] Indicate whether analyses for Total (T) or Dissolved (D); use two pages if both are run. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] ___ micron, and whether filtered [ ] in field or [ ] in laboratory.

[3] Indicate if reporting limits are ________ PQLs or ________ MDLs.

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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section

Groundwater Sampling Report

VOLATILE ORGANIC COMPOUNDS (VOCs)[1]

CONSTITUENT	CONCENTRATION (ug/L)	REPORTING LIMIT (ug/L)[2]	METHOD	CAS NO.
Acetone				67-64-1
Acrylonitrile				107-13-1
Benzene				71-43-2
Bromochloromethane				74-97-5
Bromodichloromethane				75-27-4
Bromoform				75-25-2
Carbon disulfide				75-15-0
Carbon tetrachloride				56-23-5
Chlorobenzene				108-90-7
Chloroethane				75-00-3
Chloroform				67-66-3
Dibromochloromethane				124-48-1
1,2-Dibromo-3-chloropropane				96-12-8
1,2-Dibromoethane				106-93-4
o-Dichlorobenzene (1,2)				95-50-1
p-Dichlorobenzene (1,4)				106-46-7
trans-1,4-Dichloro-2-butene				110-57-6
1,1-Dichloroethane				75-34-3
1,2-Dichloroethane				107-06-2
1,1-Dichloroethylene				75-35-4
cis-1,2-Dichloroethylene				156-59-2
trans-1,2-Dichloroethylene				156-60-5
1,2-Dichloropropane				78-87-5
cis-1,3-Dichloropropene				10061-01-5
trans-1,3-Dichloropropene				10061-02-6
Ethylbenzene				100-41-4
2-Hexanone				591-78-6
Methyl bromide				74-83-9
Methyl chloride				74-87-3
Methylene bromide				74-95-3
Methylene chloride				75-09-2
Methyl ethyl ketone				78-93-3
Methyl iodide				74-88-4
4-Methyl-2-pentanone				108-10-1
Styrene				100-42-5
1,1,1,2-Tetrachloroethane				630-20-6
1,1,2,2-Tetrachloroethane				79-34-5
Tetrachloroethylene				127-18-4
Toluene				108-88-3
1,1,1-Trichloroethane				71-55-6
1,1,2-Trichloroethane				79-00-5
Trichloroethylene				79-01-6
Trichlorofluoromethane				75-69-4
1,2,3-trichloropropane				96-18-4
Vinyl acetate				108-05-4
Vinyl chloride				75-01-4
Xylenes (total)				1330-20-7

[1] **Samples for VOCs must not be filtered.**
[2] **Indicate if reporting limits are ________ PQLs or ________ MDLs.**

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TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Waste Permits Division, Municipal Solid Waste Permits Section

Groundwater Sampling Report

OTHER CONSTITUENTS

CONSTITUENT [1]	CONCENTRATION [2]	REPORTING LIMIT [2, 3]	METHOD

[1] Indicate whether analyses for Total (T) or Dissolved (D) concentrations. If analyses for dissolved concentrations, indicate filter pore size [ ] 0.45, [ ] 1, [ ] 10, [ ] __ micron, and whether filtered [ ] in field or [ ] in laboratory.

[2] Indicate if reporting limits are ________ PQLs or ________ MDLs.

[3] Show units of concentration and reporting limit.

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CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 5-LABORATORY REVIEW CHECKLIST

Municipal Solid Waste Laboratory Review Checklist

This data package consists of:

- ☐ This signature page, and the laboratory review checklist consisting of Table 1, Reportable Data (which includes the reportable data identified on this page), Table 2, Supporting Data, and Table 3, Exception Reports.
- ☐ R1 Field chain-of-custody documentation
- ☐ R2 Sample identification cross-reference
- ☐ R3 Test reports (analytical data sheets) for each environmental sample that includes:
  - (a) Items specified in NELAC Chapter 5 for reporting results, e.g., Section 5.5.10 in 2003 NELAC Standard
  - (b) Dilution factors
  - (c) Preparation methods
  - (d) Cleanup methods
  - (e) If required for the project, tentatively identified compounds (TICs)
- ☐ R4 Surrogate recovery data including:
  - (a) Calculated recovery (%R)
  - (b) The laboratory's surrogate QC limits
- ☐ R5 Test reports/summary forms for blank samples
- ☐ R6 Test reports/summary forms for laboratory control samples (LCSs) including:
  - (a) LCS spiking amounts
  - (b) Calculated %R for each analyte
  - (c) The laboratory's LCS QC limits
- ☐ R7 Test reports for project matrix spike/matrix spike duplicates (MS/MSDs) including:
  - (a) Samples associated with the MS/MSD clearly identified
  - (b) MS/MSD spiking amounts
  - (c) Concentration of each MS/MSD analyte measured in the parent and spiked samples
  - (d) Calculated %Rs and relative percent differences (RPDs)
  - (e) The laboratory's MS/MSD QC limits
- ☐ R8 Laboratory analytical duplicate (if applicable) recovery and precision:
  - (a) The amount of analyte measured in the duplicate
  - (b) The calculated RPD
  - (c) The laboratory's QC limits for analytical duplicates
- ☐ R9 List of method quantitation limits (MQLs) for each analyte for each method and matrix
- ☐ R10 Other problems or anomalies
- ☐ The Exception Report for every item for which the result is "No" or "NR" (Not Reviewed)

Release Statement: I am responsible for the release of this laboratory data package. This data package as been reviewed by the laboratory and is complete and technically compliant with the requirements of the methods used, except where noted by the laboratory in the attached exception reports. By my signature below, I affirm to the best of my knowledge, all problems/anomalies, observed by the laboratory as having the potential to affect the quality of the data, have been identified by the laboratory in the Laboratory Review Checklist, and no information or data have been knowingly withheld that would affect the quality of the data.

Check, if applicable: [ ] This laboratory is an in-house laboratory controlled by the person responding to rule. The official signing the cover page of the rule-required report in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

____________	____________	____________	____________
Name (printed)	Signature	Official Title	Date

Table 1. Reportable Data.

Laboratory Name: ____________________

Project Name: ____________________

Reviewer Name: ____________________

LRC Date: ____________________

Laboratory Job Number: ____________________

Prep Batch Number(s): ____________________

Item[1]	Analytes[2]	Description	Result (Yes, No, NA, NR)[3]	Exception Report No.[4]
R1	O, I	**Chain-of-custody (COC)**		
		Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?		
		Were all departures from standard conditions described in an exception report?		
R2	O, I	**Sample and quality control (QC) identification**		
		Are all field sample ID numbers cross-referenced to the laboratory ID numbers?		
		Are all laboratory ID numbers cross-referenced to the corresponding QC data?		
R3	O, I	**Test reports**		
		Were all samples prepared and analyzed within holding times?		
		Other than those results < MQL, were all other raw values bracketed by calibration standards?		
		Were calculations checked by a peer or supervisor?		
		Were all analyte identifications checked by a peer or supervisor?		
		Were sample quantitation limits reported for all analytes not detected?		
		Were all results for soil and sediment samples reported on a dry weight basis?		
		Was % moisture (or solids) reported for all soil and sediment samples?		
		If required for the project, TICs reported?		
R4	O	**Surrogate recovery data**		
		Were surrogates added prior to extraction?		
		Were surrogate percent recoveries in all samples within the laboratory QC limits?		
R5	O, I	**Test reports/summary forms for blank samples**		
		Were appropriate type(s) of blanks analyzed?		
		Were blanks analyzed at the appropriate frequency?		

Item[1]	Analytes[2]	Description	Result (Yes, No, NA, NR)[3]	Exception Report No.[4]
		Were method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?		
		Were blank concentrations < MQL?		
R6	O, I	**Laboratory control samples (LCS):**		
		Were all COCs included in the LCS?		
		Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?		
		Were LCSs analyzed at the required frequency?		
		Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?		
		Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SQLs?		
		Was the LCSD RPD within QC limits?		
R7	O, I	**Matrix spike (MS) and matrix spike duplicate (MSD) data**		
		Were the project/method specified analytes included in the MS and MSD?		
		Were MS/MSD analyzed at the appropriate frequency?		
		Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?		
		Were MS/MSD RPDs within laboratory QC limits?		
R8	O, I	**Analytical duplicate data**		
		Were appropriate analytical duplicates analyzed for each matrix?		
		Were analytical duplicates analyzed at the appropriate frequency?		
		Were RPDs or relative standard deviations within the laboratory QC limits?		
R9	O, I	**Method quantitation limits (MQLs):**		
		Are the MQLs for each method analyte included in the laboratory data package?		
		Do the MQLs correspond to the concentration of the lowest non-zero calibration standard?		
		Are unadjusted MQLs included in the laboratory data package?		
R10	O, I	**Other problems/anomalies**		
		Are all known problems/anomalies/special conditions noted in this LRC and ER?		
		Were all necessary corrective actions performed for the reported data?		
		Was applicable and available technology used to lower the SQL minimize the matrix interference affects on the sample results?		

Table 2. Supporting Data.

Laboratory Name: ______________________

Project Name: ______________________

Reviewer Name: ______________________

LRC Date: ______________________

Laboratory Job Number: ______________________

Prep Batch Number(s): ______________________

Item[1]	Analytes[2]	Description	Result (Yes, No, NA, NR)[3]	Exception Report No.[4]
S1	O, I	**Initial calibration (ICAL)**		
		Were response factors and/or relative response factors for each analyte within QC limits?		
		Were percent RSDs or correlation coefficient criteria met?		
		Was the number of standards recommended in the method used for all analytes?		
		Were all points generated between the lowest and highest standard used to calculate the curve?		
		Are ICAL data available for all instruments used?		
		Has the initial calibration curve been verified using an appropriate second source standard?		
S2	O, I	**Initial and continuing calibration verification (ICCV and CCV) and continuing calibration blank (CCB):**		
		Was the CCV analyzed at the method-required frequency?		
		Were percent differences for each analyte within the method-required QC limits?		
		Was the ICAL curve verified for each analyte?		
		Was the absolute value of the analyte concentration in the inorganic CCB < MDL?		
S3	O	**Mass spectral tuning:**		
		Was the appropriate compound for the method used for tuning?		
		Were ion abundance data within the method-required QC limits?		
S4	O	**Internal standards (IS):**		
		Were IS area counts and retention times within the method-required QC limits?		
S5	O, I	**Raw data (NELAC section 1 appendix A glossary, and section 5.)**		
		Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?		
		Were data associated with manual integrations flagged on the raw data?		

Item[1]	Analytes[2]	Description	Result (Yes, No, NA, NR)[3]	Exception Report No.[4]
S6	O	**Dual column confirmation**		
		Did dual column confirmation results meet the method-required QC?		
S7	O	**Tentatively identified compounds (TICs):**		
		If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?		
S8	I	**Interference Check Sample (ICS) results:**		
		Were percent recoveries within method QC limits?		
S9	I	**Serial dilutions, post digestion spikes, and method of standard additions**		
		Were percent differences, recoveries, and the linearity within the QC limits specified in the method?		
S10	O, I	**Method detection limit (MDL) studies**		
		Was a MDL study performed for each reported analyte?		
		Is the MDL either adjusted or supported by the analysis of DCSs?		
S11	O, I	**Proficiency test reports:**		
		Was the laboratory's performance acceptable on the applicable proficiency tests or evaluation studies?		
S12	O, I	**Standards documentation**		
		Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?		
S13	O, I	**Compound/analyte identification procedures**		
		Are the procedures for compound/analyte identification documented?		
S14	O, I	**Demonstration of analyst competency (DOC)**		
		Was DOC conducted consistent with NELAC Chapter 5C?		
		Is documentation of the analyst's competency up-to-date and on file?		
S15	O, I	**Verification/validation documentation for methods (NELAC Chap 5n 5)**		
		Are all the methods used to generate the data documented, verified, and validated, where applicable?		
S16	O, I	**Laboratory standard operating procedures (SOPs):**		
		Are laboratory SOPs current and on file for each method performed?		

Table 3. Exception Reports.

Laboratory Name: ____________________

Project Name: ____________________

Reviewer Name: ____________________

LRC Date: ____________________

Laboratory Job Number: ____________________

Prep Batch Number(s): ____________________

Exception Report No.	Description

[1] Items identified by the letter "R" must be available as a hard copy or as a .pdf file. Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.
[2] O - organic analyses; I - inorganic analyses (including general chemistry constituents, when applicable).
[3] NA - Not applicable; NR - Not reviewed.
[4] Exception Report identification number; an Exception Report should be completed for an item if the result is "No" or "NR."

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 11

APPENDIX C

ITEM 6-LABORATORY QUALITY ASSURANCE/ QUALITY CONTROL MANUAL

ANALYSYS LABORATORIES

LABORATORY

QUALITY ASSURANCE/QUALITY CONTROL MANUAL

April 2018
Version: 17 - Revision: 17-0404218

Prepared By:

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QUALITY SYSTEMS MANUAL
FOR

ANALYSYS LABORATORIES

Version: 14
Published: November, 2005
by

AnalySys, Inc.
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REVISION 17-040418

EFFECTIVE DATE
April 4, 2018

Tyler M Batchelor

______________________________________ 04/04/2018
Tyler Batchelor – Technical Director/Lab Mng Date

Melanie Molien

______________________________________ 04/04/2018
Melanie Molien - Quality Manager/Lab Mng Date

QUALITY SYSTEMS MANUAL

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ANALYSYS LABORATORIES

ANALYSYS LABORATORIES

QUALITY SYSTEMS MANUAL

QUALITY SYSTEMS MANUAL

1.0 INTRODUCTION/POLICY STATEMENT (5.4.2.2)

AnalySys, Inc. (ASI) is a commercial analytical laboratory emphasizing the analysis of samples from environmental projects and programs for commercial, industrial and governmental clients. ASI is dedicated to the production of technically valid analytical data for our clients. Specifically it is the policy of ASI and ASI's management that:

- ASI's management be committed to good professional practices, the production of high quality, technically defensible environmental test results, and the provision of outstanding service to ASI's customers and clients.
- A Quality System shall be maintained and utilized by ASI management and personnel. This Quality system shall appropriately define and document ASI's policies, systems, programs, procedures and instructions. This documentation and associated training will be utilized to familiarize all appropriate ASI personnel with ASI's quality systems and policies, so that they will, where appropriate, implement relevant requirements in the completion of their work product.
- Management and company personnel must be committed to compliance with the requirements imposed by this quality system.

This Quality Manual summarizes the policies, systems, programs, instructions and operational procedures associated with AnalySys, Inc.'s laboratory facilities. Specific protocols for all laboratory functions related to the production of technically valid analytical data, as specified by NELAP, are defined within this document and related Standard Operating Procedures (SOP's). All policies and procedures are structured in accordance with the NELAP standards, current as of the date of this document (the 2009 TNI standard), and applicable Federal and State requirements, regulations, guidance, and technical standards, where applicable.

The Quality Assurance/Quality Control Manual, ASI's SOPs, and related documentation are controlled materials that describe the quality system for AnalySys, Inc. **All references to the TNI standard in this plan, or associated SOP's, shall be construed to mean the most current**

published version of that standard (at the time of preparation/revision of this document, the 2009 TNI standard).

This manual is considered to be a confidential document by ASI and may not be altered in any manner by other than a duly appointed representative of ASI. If the document has been provided to external users or regulators, it is for the exclusive purpose of reviewing ASI's quality systems and shall not be used in any other way. Neither shall it be copied or distributed without the express written permission of an appointed representative of ASI.

2.0 MANAGEMENT

2.1 Organization

2.1.1 Responsibilities (5.4.1.1 – 5.4.1.2)

AnalySys, Inc. is a Class C Corporation. The company was incorporated in the State of Texas in 1988 (Charter #1093293). ASI's USEPA Labcode# is TX00090.

To accomplish Corporate goals as stated in the Introduction/Policy Statement, ASI and its employees are dedicated to the production of technically and legally defensible analytical data, meeting the requirements of the current TNI standard; with adherence to approved analytical methods published by the USEPA, American Society of Testing and Materials (ASTM), American Society of Agronomy (ASA), and other acknowledged method sources for environmental and environmental related analyses. To accomplish this goal ASI believes that it is necessary to provide technical and administrative support to ASI's clients, to assist in the definition of project scope for such items as analytical requirements, selection and specification of appropriate analytical methods/techniques, sampling protocols and requirements, and preservation of samples prior to arrival at the laboratory.

2.1.2 Scope (5.4.1.3 – 5.4.1.4)

This Quality Assurance/Quality Control Manual, ASI's SOPs, and related documentation describe the quality system for all AnalySys, Inc. facilities involved in environmental testing. Any other activities in which ASI may be involved or become involved are, or will be, carefully monitored to assure that there is no potential conflict of interest that adversely influences conformance with the requirements of this document or the integrity or independence of ASI or its employees with respect to its environmental activities.

2.1.3 Resources (5.4.1.5)

In order to achieve its goals and responsibilities, ASI must provide adequate resources and programs. In order to comply with TNI requirements, these resources and actions shall include:

- Maintaining managerial, technical and support personnel with the authority and resources necessary to carry out their duties as described more fully in Section 3.1. These personnel, where required, are expected to identify the occurrence of departures from ASI's quality system and procedures. They have the authority and mandate to initiate and monitor actions to prevent or minimize such departures. (5.4.1.5.a)
- Defined and documented processes to ensure that ASI management and personnel are free from undue internal and external commercial, financial and other pressures and influences or the involvement in activities that may adversely affect the quality of their work or diminish confidence in their competence, impartiality, judgment or operational integrity. (5.4.1.5.b and d)

ANALYSYS LABORATORIES

- Defined and documented policies and procedures to ensure the protection of ASI's clients' confidential information (including electronic/digital information) and proprietary rights. (5.4.1.5.c)
- A defined and documented organization and management structure; including the relationships between quality management, technical operations and support services. Documentation shall include a clear description of the lines of responsibility in the laboratory and procedures to assure that adequate supervision is maintained. (5.4.1.5.e)
- Job Descriptions (see Section 3.1.5) that define the responsibilities, authority and interrelationships of all personnel who manage, perform or verify work affecting the quality of environmental tests. (5.4.1.5.f)
- Defined and documented procedures to assure that adequate supervision of environmental testing staff is provided by qualified personnel familiar with ASI's methods and procedures, the assessment of environmental test results and the use/purpose for such test procedures. (5.4.1.5.g)
- The provision of senior technical management (meeting the requirements specified in the accreditation process) which has overall responsibility for the technical operations and sufficiency of resources needed to provide laboratory operations of the specified quality. The senior technical management (especially the Laboratory Manager) shall assure, and see that it is documented, that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited. (5.4.1.5.h)
- The appointment of personnel as quality manager (the Quality Manager) who, irrespective of other duties and responsibilities, shall have defined responsibility and authority for ensuring that the quality system is implemented and followed at all times. The Quality Manager shall have direct access to the highest level of management at which decisions are made on laboratory policy or resources. Where

staffing is limited, the Quality Manager may be assigned other duties (for example Technical Director). (5.4.1.5.i)

- The designation of deputies/designees with the authority act, within the bounds of specifically delegated authority; or with full authority to act in the event of the absence of such key personnel as Laboratory Manager and Quality Manager. (5.4.1.5.j)
- Participation in proficiency testing program(s) as necessary to maintain accreditation and/or to meet client or regulatory requirements (such as DMRQA). (5.4.1.5.k)

2.2 Quality System (5.4.2.1, 5.4.2.3, 5.4.2.4 & 5.4.2.6)

With the approval of this QUALITY ASSURANCE/QUALITY CONTROL MANUAL and associated SOP's, ASI is establishing a quality system, which will be implemented and maintained according to TNI specifications. These quality system components document ASI's policies, systems, programs, procedures and instructions as necessary to assure that the company goal of producing technically valid analytical data for our clients. It is the intent of ASI management that this documentation of the quality system be communicated to, understood by, and implemented by all pertinent and involved ASI personnel.

The quality system, in meeting TNI standards will describe and document the technical and administrative policies, systems, programs, procedures and instructions to be implemented by ASI personnel. The roles and responsibilities of all personnel, and especially technical and quality management, with respect to implementation and compliance with the quality system will be defined and documented.

The quality system shall also establish and document the specifics of a data integrity program. This program will:

- Provide for data integrity training.

- Provide for data integrity training and compliance documentation for all personnel.
- Describe the elements of a detailed, periodic review of data integrity performance.
- Provide for confidential reporting of data integrity issues and, where necessary, procedures for further investigation.

2.3 Document Control and Record Keeping (5.4.3)

2.3.1 General (5.4.3.1)

It is ASI policy that records necessary to document conformity to regulatory requirements and the effective operation of ASI's Quality System shall be kept. As a part of its quality system ASI maintains procedures to control all documents that are essential to the documentation of quality system components. Retained documents may represent various media, including hard copy, electronic, digital, analog, photographic or written records.

2.3.2 Document Creation, Approval and Obsolescence (5.4.3.2 – 5.4.3.3)

ASI policies and procedures related to the creation, approval, modification and control of quality system documents such as this QUALITY ASSURANCE/QUALITY CONTROL MANUAL, Standard Operating Procedures (SOP's), Safety Plans and other pertinent documents are codified in ASI SOP S-0001 Document Creation and Control.

2.3.3 Document/Record Control and Storage (5.4.12.2.4)

It is ASI policy that records required to support the reconstruction of sample testing activities, while a sample is under the control of ASI, be maintained for a minimum of five years, unless prior, alternate arrangements between ASI and a client are agreed upon for a longer retention period. Record access procedures and storage/retention procedures to implement ASI policy may be found in ASI SOP S-0001 Document Creation and Control.

2.4 Evaluation of Request(s) for Laboratory Service (5.4.4.1 – 5.4.4.4)

It is ASI policy that specific procedures shall be utilized to evaluate Requests, Tenders and Contracts. These procedures, as described more thoroughly in SOP S-0004 Review of Requests, Tenders, and Contracts and Customer Feedback**,** are designed to appropriately define the scope of a project and thus allow ASI to determine if the company has the capabilities and resources necessary to complete the project.

2.4.1 Elements of Review (5.4.4.1)

For each environmental project, an ASI Project Manager shall endeavor to obtain clear specifications from the client concerning the technical and administrative details of the project. The specific items to be included are found in Section 4.0 of SOP S-0004 Review of Requests, Tenders, and Contracts and Customer Feedback.

Where sufficient and timely advance information is provided to ASI by the client, the ASI-PM shall consult with pertinent ASI operations personnel to establish that ASI has the capability and resources required for each testing project undertaken.

The information developed will be assembled, by the ASI Project Manager, into a written summary of the testing requirements for the project.

2.4.2 Client Participation and Contact (5.4.4.2 – 5.4.4.3 – 5.4.4.4)

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Assuming that information is provided by the client in a timely manner, the ASI Project Manager will work with the client to develop a testing program that meets the clients needs. ASI may propose alternative measures, alternate test methods, or subcontract services for the project. ASI and the client must agree to these alternate measures or develop other alternatives acceptable to both parties before proceeding.

2.4.3 Review Records (Required Records and Record Retention)

The ASI-PM shall maintain necessary documentation pertaining to each project. The ASI-PM shall be responsible for maintaining such records on a project-by-project basis. SOP S-0004 Review of Requests, Tenders, and Contracts and Customer Feedback, Section 6.0 & 7.0 describes the required records in detail.

2.5 Subcontracting Analytical Testing Services (5.4.5)

2.5.1 Reasons for and Limitations on Subcontracting (5.4.5.1)

Subcontracting of analytical testing by ASI is typically performed for test methodologies, needed or requested (knowingly or unknowingly) by a client but not offered by ASI. Such client requests may be as a part of a larger testing program or may be made by a client, strictly for convenience.

Where such requests clearly involve environmental testing on environmental matrices, ASI will make every effort to place such testing with a laboratory accredited by NELAP for such testing or, failing the availability of such a laboratory a non-accredited laboratory that meets applicable statutory and regulatory requirements for performing the work (where such a laboratory exists) will be utilized. If the client/customer makes a specific request for a particular laboratory, ASI will attempt

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to meet the customers stated needs, irrespective of accreditation issues.

Where such requests involve test procedures that, though an adjunct to an environmental test program, are not generally considered as environmental in nature (for example physical tests such as porosity, vapor pressure, etc.) ASI will utilize established laboratories, known to perform such procedures irrespective of NELAP status.

2.5.2 Responsibility and Client Notice (5.4.5.2 – 5.4.5.3)

In cases where subcontracting of testing services is required (environmental or otherwise), a written client notification and release must be completed and signed by the client or the client's representative prior to release of sample material to subcontractors for testing. This documentation, prepared and agreed to, if possible, before receipt of such samples, identifies the client, the specific test work to be subcontracted and other pertinent information

For subcontracted environmental testing services, ASI accepts responsibility to the client for the adequacy of the subcontracted work, unless the client is responsible for specifying the subcontractor or the client specifically releases ASI from any associated responsibility or liability.

2.5.3 Subcontractor Assessment (5.4.5.4)

Qualifying information for each subcontractor utilized by ASI will be maintained. This information is described in ASI SOP S-0003 Qualification and Use of Subcontract Laboratories.

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2.5.4 Subcontract Services Documentation (Required Records and Record Retention)

- Copies of written client notification and release statements, signed by the client or the client's representative, are maintained by the Customer Service Department and/or attached to ASI's copies of relevant test reports.
- Files for each subcontractor utilized by ASI, with associated information as specified in §2.5.3 above and SOP S-0003 Qualification and Use of Subcontract Laboratories, will be maintained by ASI's Customer Service Department.

2.6 Purchasing Services and Supplies

It is ASI policy that purchased supplies and services that affect, or may affect, environmental testing shall be of known quality and verified prior to use. The specific procedures which implement this policy are described in detail in SOP S-0002 Purchasing Controls.

2.6.1 Services and Supplies Covered (5.4.6.1)

All services and supplies which affect or may affect the quality of environmental testing are subject to this policy.

2.6.2 Tracking and Storage of Relevant Supplies (5.4.6.1 – 5.4.6.2 – 5.4.6.4)

Procedures for tracking of consumables (ex. standards) with defined shelf life (expiration dates) and storage procedures for consumables from volatile standards to digestion acids to protective gloves are described in SOP SOP S-0002 Purchasing Controls.

2.6.3 Acceptance Procedure (5.4.6.2 – 5.4.6.4)

The procedures describing how services and supplies are evaluated and approved for use are described in SOP S-0002 Purchasing Controls.

2.6.4 Documentation (Required Records and Record Retention)

Records necessary to document compliance with ASI's purchasing procedures shall be kept. Records concerning vendor and consumable suitability evaluation and to document that purchased materials meet specifications are maintained.

2.7 Client Assistance and Complaint Resolution

2.7.1 Client Services (5.4.7)

It is ASI policy that all clients and representatives of clients be treated in a professional manner and that confidentiallity be maintained as directed by each client.

ASI personnel are responsible for working with all clients, especially via the SOP S-0004 Review of Requests, Tenders, and Contracts and Customer Feedback, to clarify the client's needs. ASI personnel, primarily ASI Project Managers, work with all clients to assist them in monitoring the status of projects.

It is ASI policy that information and reports concerning all clients shall only be released to the client (individual and/or company) and those specifically designated by the client.

2.7.2 Client Complaints (5.4.8)

It is ASI policy that complaints and concerns raised by ASI's clients and other relevant parties shall be treated in a serious manner. Where such complaints can be handled on an immediate basis, it is ASI policy that everything reasonable will be done to attempt to remedy the identified problem. Where complaints or concerns are indicative of a more pervasive or endemic problem, the issues involved shall be referred to ASI's Corrective Action or Preventive Action procedures. It is the responsibility of those ASI personnel dealing directly with clients (primarily the Project Manager, Laboratory Manager, and Technical Director) that they timely refer issues to the Quality Manager for corrective and/or preventive action and notify the President of the issues involved.

2.7.3 Nonconforming Work Policy (5.4.9)

It is the policy of ASI that if any aspect of ASI's work, actions in the performance of environmental testing, or results emanating from such testing do not conform with established ASI policies or procedures (for whatever reason), to the TNI standard, or to alternative requirements and measures that have been requested (or necessitated) by and agreed to by ASI's client(s), that the following procedures shall be followed:

2.7.3.1 Such actions and or activities, when contemplated in advance as necessary measures to meet the needs of the client, must immediately be brought to the attention of the appropriate senior manager as follows:

a. Laboratory Manager and/or Technical Director for all technical issues directly related to the performance of test procedures.
b. Laboratory Manager for issues indirectly related to testing such as, support facility problems, sample control concerns, etc.
c. ASI President for issues related to administrative matters, such as, purchasing or client interface issues.
d. Quality Manager for issues related to QC system requirements, documentation, etc., or any issues that do not clearly fit another category.

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If non-conforming actions have already occurred, the Quality Manager must be notified immediately. The Quality Manager is responsible for assessing the need to involve other management personnel to respond to any issues.

2.7.3.2 The designated manager, once notified, shall immediately:

a. Evaluate the significance of the non-conformance, taking into consideration such factors as:

- the severity of non-conformance found;
- the volume of samples potentially impacted;
- the potential for impact (and the associated level of such impact) upon test results; and
- the possible necessity for non-conformance to achieve the client's stated needs and requirements.

b. Based on their evaluation, define necessary corrective actions. These corrective actions may include:

- stopping the work process where the non-conformance has been identified or is anticipated;
- while maintaining strict compliance with the TNI standard, evaluate modification of the affected SOP to allow additional latitude or to encompass previously unanticipated conditions;
- evaluation of alternatives that may allow completion of the testing while meeting current policies and procedures (ex. change of method) or that will minimize the impact on test data produced;

- completion of the affected work under conditions that do not comply with established procedures and policies.

All managers identified in Sec.2.7.3.1 have the express authority to "stop work".

2.7.3.3 Where alternative procedures can be utilized or modifications of the procedure or policy consistent with the TNI standard can be made, a potential non-conformance can be brought into compliance.

Where the non-conformance has already occurred, the work product must be annotated to document:

- the specific reasons for the non-conformance;
- whether modification of the procedure or policy involved is determined to be acceptable and would have cured the issue;
- whether any test data was or may be impacted.

The client(s) of all potentially affected samples shall be notified in a manner consistent with Section 3.9.2 of this manual. Clients shall also be notified immediately if the designated manager determines that such notice may be time sensitive to the client, or that additional sample(s) or information from the client may be necessary to improve the quality of the test data to be delivered.

2.7.3.4 The designated manager shall be responsible for developing and implementing corrective measures. If the designated manager put in place a "stop work" order as a part of the corrective action, said manager shall authorize resumption of work only when satisfied that implementation of corrective measures have returned the affected process(s) to compliance.

2.7.3.5 The ASI President shall be notified immediately if it is determined that a non-compliance event may have impacted data quality.

2.7.4 Documentation (Required Records and Record Retention)

All documentation collected and developed as a function of a non-conformance incident shall be retained by the designated manager until such time as it is determined that all processes have been returned to compliance with ASI procedures and policies. After compliance has been restored all records, including specifically documentation of client notification and corrective action documents, shall be collected and retained by the Quality Manager.

2.8 Corrective Action Procedures (5.4.10)

2.8.1 General (5.4.10.1 – 5.4.10.6)

Any ASI employee may initiate a corrective action. ASI policies and procedures for the identification of need, initiation, processing, and completion of Corrective Action investigations and responses in response to quality system nonconformance are specified in ASI SOP S-0088 Corrective Actions/Preventative Actions (CAPA) Continuous Improvement.

2.8.2 Documentation (Required Records and Record Retention)

As specified in SOP S-0088 Corrective Actions/Preventative Actions (CAPA) Continuous Improvement, the documentation requirements are to maintain files as necessary, to document the initiation of, status of, and completion of Corrective Action programs. These files shall include copies of completed or in-progress Corrective Action Report Forms, as well as, any supporting documentation associated with each CAPA.

2.9 Preventive Action Policy (5.4.11)

2.9.1 General (5.4.11.1 - 5.4.11.2)

ASI is committed to identifying and correcting potential problems before issues develop; improving ASI systems and policies rather than responding to problems, complaints or crises after the fact. ASI policies and procedures to accomplish this are specified in ASI S-0088 Corrective Actions/Preventative Actions (CAPA) Continuous Improvement.

2.9.2 Documentation (Required Records and Record Retention)

As specified in SOP S-0088 Corrective Actions/Preventative Actions (CAPA) Continuous Improvement, The Quality Manager shall maintain files as required to document Preventive Action Assessments, including an original description/statement, documents developed in completing the assessment, and a statement of the final outcome, decisions, recommendations, and efficacy of implemented changes.

2.10 Internal Audits (5.4.13 & 5.4.15)

2.10.1 Internal Audits (5.4.13.1 – 5.4.13.4 and 5.4.15)

It is the policy of ASI that internal laboratory and administrative activities associated with the ASI environmental quality system will be subjected to scheduled internal audits on a periodic, annual basis. In performing these audits, ASI's audit team(s) will insure that a review of each area, and/or function, is made for any evidence of inappropriate actions or vulnerabilities to data integrity or ethics issues. These audits will be conducted in a manner designed to monitor the performance of each department and assure that each department continues to operate in compliance with pertinent quality system policies and procedures, as described in SOP S-0082 Internal Audits. As a result of such audits, reports that describe the level of compliance with ASI policies and procedures, and if necessary, identifying and referring potential issues and non-conformances to be addressed in S-0088 Corrective Actions/Preventative Actions (CAPA) Continuous Improvement, will be prepared.

2.10.2 Documentation (Required Records and Record Retention)

The Quality Manager will maintain files for each Internal Audit. These files will contain all documentation relevant to the audit, including at least:

- The completed Audit report described above.
- Copies of all Corrective Actions and Preventive Actions initiated as a consequence of the audit.
- Meeting notes and attendance for audit team meetings.
- Documentation of completion of Corrective and Preventive Actions initiated as a consequence of the audit.

2.11 Management Reviews (5.4.14)

2.11.1 Management Review (5.4.14.1)

It is the policy of ASI that a formal Management Review to assess the continuing suitability, adequacy and effectiveness of ASI's quality system and environmental testing activities must be conducted on a regular schedule. In the first quarter of each calendar year, ASI senior management consisting of at least the President, the Laboratory Manager, the Research Director, the Quality Manager and the Technical Director will meet to assess the suitability and effectiveness of ASI's Quality System to meet client needs, and comply with TNI standards and other pertinent certifying authority requirements. More frequent reviews may be completed if warranted.

2.11.2 Areas of Review (5.4.14.1)

The following documentation of the performance of ASI, since the last Management Review meeting, shall be prepared on Form F-0094. These reports and compendiums will provide a starting point for the Management Review process. However, other areas of discussion shall be covered based on the perceived needs of the company by the management team.

1. An assessment of the suitability of ASI's policies and procedures to effectively meet client needs and certifying standards. (5.4.14.1.a & j)
2. The status of all recommendations and actions that arose during previous Management Reviews. (5.4.14.2)
3. A compendium of the status of Corrective Actions, Preventive Actions and Internal Audit results. (5.4.14.1.c & d)
4. A summary of the results of interlaboratory proficiency studies (WP, WS, DMR, etc) and internal "blind" sample QC testing. (5.4.14.1.f)
5. A summary of any assessment(s) by external bodies (external audits). (5.4.14.1.e)
6. A summary of the "status of the Quality System", a concise evaluation of the overall level of compliance by ASI with the Quality System
7. A summary of changes to the analytical workload, volume or types of samples. (5.4.14.1.g)
8. A discussion of client feedback and complaints received since the last management meeting and the action(s) taken to address such issues. (5.4.14.1.h & i)
9. A discussion of ASI resources and the adequacy of such resources to meet client needs and maintain or improve compliance with quality systems. (5.4.14.1.j)

2.11.3 Actionable Findings (5.4.14.2)

Based on the managerial and supervisory reports prepared for the meeting, and meeting discussions, the management team shall, where necessary, make specific and/or non-specific recommendations for changes to the ASI Quality System.

2.11.4 Documentation (Required Records and Record Retention) (5.4.14.2)

The Quality Manager is responsible for maintaining records and files documenting the Management Review process and the actions taken to implement management recommendations.

2.12 Ethical Operation and Data Integrity (5.4.2.6)

2.12.1 Ethics and Data Integrity

ASI is committed to assuring that company functions be performed in an ethical manner, maintaining an ethical environment, and encouraging ethical behavior by all ASI employees. This commitment extends to all company functions with specific emphasis on ensuring the integrity of environmental testing and the results and information supplied by ASI to its clients.

2.12.2 Elements of Ethics and Data Integrity Program (5.4.2.6 and 5.4.2.6.2)

ASI's Ethics and Data Integrity Program consists of a Code of Ethics (Appendix B) and ASI SOP S-0005 Data Integrity Procedures. This SOP describes the elements of the Data Integrity Program and training in data integrity issues. The

SOP also includes ASI's "Ethics and Data Integrity Policy Acceptance Statement", which shall be completed by each ASI employee. This document, to be retained in each employee's training file, indicates they have "read and understand" and received training in ASI's policies with respect to ethical operation and data integrity as it affects their job functions.

Data integrity and ethics issues are an important part of all internal audits (SOP S-0082 Internal Audits). Where issues with data integrity are raised as a result of audit activities, it is ASI policy to require timely notification of ASI management if further or more detailed investigation is deemed necessary. They are also a specific item to be addressed as a part of annual Management Review where the need for modification, or enhancement, of company policies in this area are part of the review.

2.12.3 Confidential Reporting of Data Integrity Issues (5.4.2.6.1)

ASI SOP S-0005 Data Integrity Procedures specifically provides procedures for the confidential reporting of suspected data integrity or ethics issues. These policies are intended to foster an environment that allows all employees to privately address ethics and data integrity issues in a comfortable manner.

2.12.4 Records (Required Records, Record Retention and Confidentiality)

For each employee, a dated and signed copy of the current "Ethics and Data Integrity Policy Acceptance Statement" will be maintained by the Quality Manager in the employee's DOC/QC/Training file. Records of any communication from employees to management concerning data integrity or ethics issues will be maintained in confidential file(s) under the control of the Human Resources Manager and will include documentation that appropriate ASI manager(s) have been made aware of the concern.

3.0 Laboratory Technical Program

3.1 Personnel (5.5.2)

3.1.1 Staff Education, Experience & Skills (4.1.1.1 & 5.5.2.1 – 5.5.2.3)

ASI focuses on selecting competent, qualified individuals to join our laboratory staff. It is the policy of ASI that managers and staff personnel responsible for the operation of equipment and performance of environmental testing, the evaluation and review of resulting test results, and the release of data to ASI's clients be competent in the performance of those environmental testing program elements for which they are responsible. The qualifications, of applicants under the consideration for employment, are evaluated based on a combination of factors including education, training, experience, a management assessment and demonstrated capacity to perform. The ASI organization chart is attached as Appendix C to this document.

The Technical Director and Quality Manager are key Management positions within the ASI organization. It is ASI policy is to appoint deputies for both positions in order to assure continuity of operation in the event of an extended absence of either individual.

- The Deputy for the Technical Director, if so named shall meet TNIs' and TCEQs' requirements for the Technical Director. If the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, the designated Deputy shall temporarily assume the responsibilities of the Technical Director. If the absence of the Technical Director exceeds 65 consecutive calendar days, the primary Accrediting Authority shall be notified in writing.

- The Deputy for the Quality Manager, may be the Technical Director or an assistant named to fulfill the position. If the Quality Manager is absent for a period of time exceeding 15 consecutive calendar days, the designated Deputy shall temporarily assume the responsibilities of the Quality Manager.

The Technical Director, Quality Manager, and/or the Deputies have the authority to sign off on work affecting the quality of testing to include, final reports, revised reports, SOPs, and/or work instructions.

3.1.2 Staff Responsibilities (5.5.2.1)

All ASI personnel are responsible for understanding and complying with ASI standard operating procedures, test methods and policies that pertain to their function within ASI. Analytical staff members are responsible for the quality of the testing they perform and the data they submit. It is ASI policy that employees are responsible for seeking authorization anytime the production of their data deviates from established ASI procedures and policies. All ASI personnel are responsible for understanding and conforming with ASI policies pertaining to data integrity and ethical business practices. Analytical staff members undergoing training in specific tasks/methods are required to work under close supervision until such time as training is completed. The Analyst must complete all necessary demonstration of capability documentation prior to performing job function.

3.1.3 Management Responsibilities (5.5.2.1 & 5.5.2.6.d)

ASI Management is responsible for assuring that the laboratory is sufficiently staffed with competent, qualified personnel trained to meet the demands of ASI's analytical testing workload and that sufficient management personnel are available to supervise ASI's employees. In addition, key personnel (the Technical Director, the Quality Supervisor and the Laboratory Manager in particular) are specifically empowered and granted the authority to appropriately meet the requirements of their job functions. This includes the authority to suspend operation of specific analytical testing or the entire laboratory if such action is required to assure the production of environmental testing in compliance with TNI standards.

ASI personnel may be fulltime ASI employees or contractors. Should contract employees be utilized in the production of environmental test data, ASI will manage such personnel in a manner which fosters compliance with the ASI quality system and require them to acknowledge a mandate to work within the ASI quality system.

3.1.4 Staff Training Program (5.5.2.6 – 5.5.2.7)

It is ASI policy to provide for staff training that:

- assures that new personnel are appropriately and completely trained with respect to procedures and policies pertinent to their day-to-day activities;
- assures that personnel changing position and/or adding new responsibilities have additional training on ASI procedures and policies as necessary to meet the requirements of the new responsibilities.
- on an on-going basis provide additional training that better equips company personnel to meet the responsibilities and duties required of them in the performance of their job, including specifically ethics and data integrity training up-dates.

ASI's job training program is described in more detail in SOP S-0006 Staff Training. ASI's data integrity training procedures are described in ASI SOP S-0005 Data Integrity Procedures, section 6.

3.1.5 Job/Position Descriptions, Personnel Records and Position Authorizations (5.5.2.2 - 5.5.2.4 – 5.5.2.5 – 5.2.2.6)

ASI maintains job descriptions for all positions involved in the production of environmental test data, including testing, review and verification, management and associated administrative functions. These job descriptions contain:

- A discussion of the qualifications, experience and skill-set (including where appropriate basic laboratory skills) required for each position.
- A discussion of the specific duties and responsibilities each position entails.
- The duties associated with each job-position tacitly vest those filling the position with authorization to perform those functions necessary to the successful performance of those duties. Such actions as the operation of certain equipment, the review and issuance of test data and reports, the interpretation of data, the provision of technical opinions, etc. may be included in such tacit authorizations. Job descriptions will describe examples of "tacit authorizations" where they can be identified. In addition, specific authorizations shall also be identified, where appropriate, for each Job description.
- A description of the management and supervisory lines of responsibility and authority pertaining to each position.

These job descriptions are maintained by the Human Resources Department with the assistance of the Technical Director. The personnel records for each employee relevant to qualifications, training, skills, experience, and quality system specific items such as DOC's and other specialized training are maintained by the Quality Manager.

3.1.6 Documentation (Required Records and Record Retention)

Acknowledgement by contract personnel involved in the production of environmental test data that they are aware of and will work within the policies and procedures of ASI's quality system shall be maintained by the Human Resources Department. Job descriptions are maintained by the Human Resources Department. Records pertaining to qualifications, training, skills and experience and quality system specific items such as DOC's and other specialized training are maintained by the Quality Manager in each employee's DOC/QC/Training file or general company Training files as describe in SOP S-0006 Staff training. Records will include a Signature Registry of all staff employed by ASI and will be maintained by the Quality Manager utilizing password protected Form F-0051.

3.2 Facilitation, Utilities and Environmental Conditions

3.2.1 Facilitation Standard (5.5.3.1 – 5.5.3.6)

It is ASI policy to provide Laboratory accommodations; test areas, energy sources, lighting, heating and ventilation, etc. adequate to facilitate the proper performance of environmental testing activities. The environment in which such activities are undertaken shall be of sufficient quality, capacity and variety to assure that facilitation issues do not pose a threat to invalidate environmental testing results or adversely affect the required accuracy of measurement systems.

3.2.2 Monitoring and Control (5.5.3.2 & 5.5.4.7.2.c)

Environmental conditions, as described above, will when determined to have a potential to affect environmental testing results or measurement system accuracy, be monitored to identify situations where negative impacts on data quality could occur; and controlled, to the extent possible, to reduce or eliminate such events from occurring. Environmental conditions to be monitored and, if necessary and possible controlled, include temperatures, humidity, electrical power conditions, etc.. In specific cases, where monitoring or control of environmental conditions is specified in a test method or by regulation, the laboratory shall adhere to such requirements and document compliance, as specified in the ASI SOP for that test/method. When it is determined that environmental conditions may jeopardize environmental test results, relevant testing may be discontinued until environmental conditions are stabilized to the point that there is no detrimental effect upon the systems in question. Environmental conditions of facilities housing ASI's LIMS system computers are controlled to protect against digital data loss. ASI's environmental conditions monitoring is further described in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification.

3.2.3 Building Controls (5.5.3.3)

It is ASI policy to take measures as deemed necessary to reduce or eliminate if possible facility incompatibilities that may impact the performance of test methods or lead to the potential for cross contamination. Major areas of concern are the possible cross contamination of volatile organics testing and prep areas from the solvents and samples used in semi-volatile organics labs and the separation of metals prep areas for water from high dust loads. ASI has taken a number of steps to address these concerns. The best example is the steps taken to separate volatile areas. ASI's volatiles lab is on a separate air handling system from other portions of the lab. It is also physically separated by floor to roof demising walls, and the door to the lab is "self-closing" to reduce air inflow to the lab. Finally it is located as far as possible, within the building, from the semi-volatile areas.

3.2.4 Access Control (5.5.3.4)

Access to and use of all areas where there is a possibility of affecting environmental testing shall be defined and controlled. ASI requires that all visitors (not ASI employees or contractors) must sign in at the front desk and be escorted by laboratory personnel, in order to access other areas of the laboratory. Access to the ASI laboratory building is controlled by either electronic locks integrated into an electronic access monitoring system that automatically locks normal access doors during non-business hours or a manual locking system that is maintained in a "normal-locked" condition at all times. All doors have automatic closures, which lock when closed, except the two main entrances, which are electronically locked at the end of the business day. ASI maintains a contract for building security monitoring services. The alarm/access code and key-cards are distributed to all employees.

In addition, some internal areas such as the "central computer" facilities area are considered controlled access areas and are equipped with separate door locks.

3.2.5 Housekeeping (5.5.3.5)

It is ASI policy to maintain clean work areas. Maintenance of a clean working environment shows pride in what ASI does, reduces potential cross contamination problems, and provides for a safer work environment. ASI provides regular cleaning for common access areas of the laboratory facilities. In addition, all laboratory personnel are strongly encouraged to maintain cleanliness in their work area.

3.2.6 Documentation (Required Records and Record Retention)

The ASI "Visitor Register" is maintained at the front desk and documents visitors to ASI. When the current "Visitor log" is full, a new log is initiated and the old log book is retained by the Quality Manager for a period of at least one year.

Environmental condition monitoring (temperatures, etc.) is documented as specified in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification. The controlled documents used are maintained as specified in the SOP. Long-term storage of completed logs, forms, and documents is the responsibility of the Quality Manager.

3.3 Environmental Test Methods and Method Verification

3.3.1 Environmental Testing (5.5.4.1 & 5.5.4.1.1)

It is ASI policy to use appropriate methods and procedures (Standard Operating Procedures or SOP's) to perform environmental testing activities under our control. Procedures shall be in-place to describe:

- the operation of all laboratory areas and functions,
- the use and operation of equipment and instrumentation,
- the handling and preparation of samples,
- the interpretation and assessment of QC data related to environmental testing performed by ASI for our clients.

These SOP's will be:

- monitored to assure they are current and representative of actual laboratory operation and TNI requirements,

- organized into a Standard Operating Procedure Compendium that is accessible to all ASI personnel,
- clearly defined in terms of the effective date of each SOP, the revision number of the SOP and signed by relevant approving managers.

Significant deviation from laboratory SOP's will not be allowed without safeguards to assure that such deviations are technically justified, authorized by appropriate managers, and documented internally and to the client.

3.3.2 Laboratory Test Methods Manual (5.5.4.1.2)

As stated above, ASI will maintain a compendium of all SOP's. SOP's will be organized by: Sample Receiving SOP's, Method SOP's and Quality SOP's following the Document creation and control procedures. The section of this overall compendium containing the Method SOP's will constitute ASI's Laboratory Methods Manual.

3.3.3 Test Method SOP Format (5.5.4.1.2)

To be complete, a test method SOP must contain or reference information to:

- Identify the test method-by-method number reference;
- Indicate applicable matrices for the procedure;
- Specify the detection and/or quantitation limits the method is capable of achieving as well as other method performance criteria;
- Summarize the method including its scope and application and typical interferences that may be observed;
- Define terms utilized in the method SOP;

- Describe the equipment, supplies, reagents, standards, etc. necessary to perform the testing;
- Describe associated sample control requirements such as sample preservation, sample containers, shipment and storage requirements;
- Describe in detail the test procedure including calibration and standardization, sample preparation, data reduction calculations (including where appropriate tables, diagrams and figures) and data reporting requirements;
- Describe associated quality control (QC) measures and quality control samples including assessment of QC acceptance criteria guidelines, corrective actions for out-of-control situations and contingencies for handling such situations; and
- Discuss waste minimization and management, waste disposal, and safety factors;
- Identify unique recordkeeping or documentation requirements imposed within the SOP.

3.3.4 Administrative SOP Format

Administrative SOP's should include or reference information to:

- Describe the scope and purpose of the SOP;
- Define any special terms utilized;
- Provide details on implementation of the procedures;
- Provide a summary of the SOP; and
- Identify recordkeeping or documentation requirements required by implementation of the procedure(s) described.

3.3.5 Method Selection for Testing (5.5.4.2)

It is ASI policy to select environmental test methods based on client specifications, method capabilities, project needs and other project specific criteria, where appropriate. Whenever possible, it is ASI policy to use approved analytical methods published by such entities as the US EPA, American Society of Testing and Materials (ASTM), American Society of Agronomy (ASA), Standard Methods for the examination of water and waster water (SM), and other acknowledged method sources for environmental testing. Where meeting all of the above criteria cannot be achieved without internal conflicts, ASI will discuss with the client alternative methodologies that may better serve the clients needs.

3.3.6 Method Demonstration of Capability (DOC) (5.5.4.2.2 & 5.5.2.6]

3.3.6.1 ASI requirements for the completion of an initial DOC as well as ASI requirements for repeating a DOC are specified in ASI SOP S-0079 Demonstration of Capability, Limit of Detection, and Limit of Quantitation (especially Sections 1.0 and 4.0).

3.3.6.2 The required elements and procedures necessary to complete a DOC are specified in SOP S-0079 Demonstration of Capability, Limit of Detection, and Limit of Quantitation Section 4.0.

3.3.6.3 ASI's policy and procedures relative to repeating and/or updating DOC's is specified in SOP S-0079 Demonstration of Capability, Limit of Detection, and Limit of Quantitation (especially Section 4.0)

3.3.6.4 The documentation requirements for DOC's are specified in SOP S-0079 Demonstration of Capability, Limit of Detection, and Limit of Quantitation (especially Section 8.0)

3.3.7 Laboratory Developed and Non-Standard Methods (5.5.4.3 – 5.5.4.5)

ASI Laboratory utilizes established, validated analytical test methods for all environmental testing. Should the needs of a particular client require the need to develop non-standard environmental test method(s), ASI will work with the client to establish the intended purpose, method development, validation and documentation required to meet the client's needs and the requirements of ASI (consistent with NELAP) to perform and report such testing.

3.3.8 Control of Data (5.5.4.7)

3.3.8.1 SOP(s) for Data Handling, Review and Evaluation (5.5.4.7.1)

ASI maintains a series of SOP's that describe the procedures in-place for data handling, review, and data evaluation. These SOP's (Quality SOP's) describe ASI's procedures for handling data (both manually observed and computer/instrument generated), completing necessary calculations and data manipulations necessary to prepare the data for ASI's Laboratory Information System and the procedures for review of data at all levels from technician to releasing authority.

3.3.8.2 Validation of ASI Computer Applications (5.5.4.7.2.a)

ASI uses a number of computer aids in the capture, calculation and reporting of analytical observations. These include the ASI proprietary Laboratory Information Management System (LIMS), a database application using the 4th Dimension Database environment, calculation spreadsheets prepared using the Excel program and other applications prepared using the commercial Excel and 4th Dimension applications. ASI's LIMS has been in use in its current form for more than seven years. The LIMS system does not perform calculations on environmental data in terms of calculation of final results from raw instrument readings or test observations. The LIMS system serves a scheduling, tracking and reporting function. The LIM system was thoroughly tested during its development. Known "challenge tests" were repeatedly and consistently used to assure that the LIM performed correctly and as expected. Based on the development procedures used and the historical functioning of the system, the ASI-LIM system has been thoroughly validated to correctly perform the functions it is intended to provide. A "validation statement" and certification for use, as described in SOP S-0011 Validation Procedures for Computer Calculation Forms and Programs, shall be maintained for the ASI LIMS system and any other internally developed database applications.

A number of calculation templates are used by ASI's technicians to correctly, consistently, and repetitively calculate test results. Analyst observations and readings (as opposed to digital instrumental output) are used as the raw input for the calculations. The output from each template is a set of "preformatted" flat-file data lines used to update the template results to ASI's LIMS system, eliminating further manual intervention. When originally developed, these templates were repetitively challenged using data that had been "hand calculated" to assure that template output was correct and reflected the appropriate calculation procedures. These templates have been in use for more than 15 years without incident in terms of calculation errors. The original development process and this extensive history of operation represent validation of these calculation aids. A "validation statement" and certification for use, as described in SOP S-0011 Validation Procedures for Computer Calculation Forms and Programs, shall be maintained for all such calculation template (application).

New programs and applications, developed by ASI, to manage data calculations are subject to validation pursuant to SOP S-0011 Validation Procedures for Computer Calculation Forms and Programs. Included in the validation process are all major modification to the LIM system with the potential to impact environmental accuracy.

3.3.8.3 Digital Data Protection (5.5.4.7.2.b – 5.5.4.7.2.d)

It is ASI policy to provide for secure digital data storage of those elements of the data collection process necessary to verify the environmental testing process. ASI-SOP S-008 Digital Data Security describes the procedures necessary to implement this policy.

3.3.8.4 Documentation (Required Records and Record Retention)

The Quality Manager shall maintain file(s) to document the validation of electronic calculation aids prepared pursuant to SOP S-0011 Validation Procedures for Computer Calculation Forms and Programs. In this same file the Quality Manager and/or Technical Manager shall keep "Validation Statements" by the original developer of both the LIMS system and the "calculation templates" that describe how they were prepared and validated. These "Validation Statements", describing the methodology originally used to verify computer calculation aids and

LIM system calculations and operations shall also describe the outcome of such testing and certify that all such calculation and operations are correct, appropriate and repeatable. These statements shall represent the validation documentation for these digital resources.

3.4 Equipment

3.4.1 Equipment Suitability (5.5.5.1 – 5.5.5.4 – 5.5.5.12)

It is ASI policy to provide to all ASI Laboratory functions the analytical testing equipment (and where relevant associated software) required for the correct performance of the environmental analytical system from sample receiving to sample prep to analysis and reporting. A master list of ASI equipment is maintained by the Quality Manager, in conjunction with the Facilities Supervisor, to document the sufficiency of analytical equipment. Equipment is deemed appropriate and sufficient if it is capable of achieving the accuracy required by the method(s) for which it is used and it meets, where applicable, specifications described in the relevant environmental method(s).

3.4.2 Support Equipment Requirements (5.5.5.2.1)

Support equipment consists of those devices that can impact the quality of environmental test data, though not the actual test instrumentation. Such equipment as balances, ovens, thermometers, temperature control devices, and volume dispensing and measuring equipment (pipettors, volumetric flasks, etc) is typical of this category. This category also includes such items as automated sample prep devices. It is ASI policy that the support equipment used by ASI analysts and technicians are of appropriate quality and type for its intended use. Support equipment shall be maintained in proper working order and calibrated, when appropriate, to verify correct operation over its intended range. SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification, discusses the specific procedures and requirements, including frequency of calibration and documentation, for support equipment.

3.4.3 Instrument Calibration (5.5.5.2.2)

ASI requirements for instrument calibration, both initial and continuing, are provided in method SOP's (the ASI Method Manual as referenced in §3.3.2 of this document) for each method. It is ASI policy that instrument calibration procedures be consistent with the underlying test method referenced or, if pertinent, any applicable regulation.

3.4.4 Equipment Operation & Maintenance (5.5.5.3 & 5.5.5.5 - 5.5.5.9)

It is ASI policy that analytical and support equipment be properly maintained and operated only by authorized ASI personnel or service technicians authorized by ASI to work on the equipment. ASI retains, and makes available to appropriate ASI personnel, relevant operating instructions and manuals for all equipment. Maintenance information; where supplied by the manufacturer, is maintained by ASI's Laboratory Manager as described in SOP S-0009 Laboratory Major Equipment Maintenance.

All major analytical instrumentation and equipment (including associated software) is provided with a unique ASI code number. Support equipment requiring calibration or monitoring (such as ovens, pipettors, scales and balances, etc) is also given a unique ASI code number. ASI documents the maintenance and monitoring (cleaning and inspections as required) of major items of equipment used for environmental testing in accordance with ASI SOP SOP S-0009 Laboratory Major Equipment Maintenance.

When equipment problems are suspected from such things as overload conditions, suspect result generation, etc. it is ASI procedure to remove the suspect instrumentation or equipment from routine data production until such time as necessary corrections, repairs or alterations have been completed and the equipment has been shown to be performing correctly and has been certified for use by the Laboratory Manager.

3.4.5 Documentation (Required Records and Record Retention)

- The Quality Manager with the assistance of the Laboratory Manager maintains a comprehensive list of ASI equipment.
- The Quality Manager maintains the support equipment calibration documentation required in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification.
- The Laboratory Manager and Quality Manager maintain maintenance and service records for all major items of analytical equipment as required by SOP S-0011 Validation Procedures for Computer Calculation Forms and Programs.

3.5 <u>Measurement Traceability</u>

3.5.1 Reference Materials and Standards (5.5.6.1 – 5.5.6.3)
It is ASI policy that all equipment used for environmental testing that may have a significant and measurable effect on the accuracy or validity of environmental testing be checked or calibrated to indicate it is operating properly. Procedures to implement this policy are contained in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification. The pertinent portions of SOP S-0007 (§7.0 - Calibration and Certification of Measurement Devices) are designed to assure that, where possible, equipment calibration and

verification be made against "standards" traceable to national standards of measurement using certified/traceable reference materials and devices (ex. a NIST traceable/certified thermal measurement device for calibrating thermometers, ovens, and other heating/cooling equipment). The results of such equipment calibration and verification shall be documented as specified SOP S-0007.

Where ASI maintains reference materials (ex. certified thermocouples or Class S weights) to be used as internal "reference standards" for verification and calibration of internal measurement devices. These materials shall be used and maintained as specified in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification. These Primary References:

- are purchased from and, when required, recertified using known suppliers and, where available and appropriate, traceable back to national/international standards;
- will be used for internal calibration purposes only, unless other uses can be clearly shown to have no impact on their performance as a reference standard; and
- will be monitored to assure that all retain current calibration/certification status, traceable to a national standard of measurement, where available and appropriate; but also monitored, as and if required, to maintain confidence in their accuracy.

3.5.2 Handling, Storage, Labeling and Tracking of Standards and Chemicals (5.5.6.4)

It is ASI policy that standards, reference materials and consumable chemicals, that have an impact on the validity of environmental test results, be maintained (stored, labeled, tracked, etc.) such that they will not be subject to contamination or deterioration. The ASI procedures to accomplish this are found in ASI SOP S-0010 Handling, Storage, & Tracking of Standards & Chemicals.

3.5.3 Documentation (Required Records and Record Retention)

- The Quality Manager is responsible for assuring and documenting that equipment calibration and verification activities as specified in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification are kept up-to-date.
- The Quality Manager is responsible for assuring and documenting that the calibration/certification status of "internal Primary Reference materials" is maintained.
- The Quality Manager is responsible for assuring and documenting the appropriate reception, storage, and tracking of standards, reference materials and consumable chemicals as specified in SOP S-0010 Handling, Storage, & Tracking of Standards & Chemicals.

3.6 Sampling (5.5.7)

3.6.1 Environmental Field Sample Collection Programs (5.5.7.1 – 5.5.7.3)

At this time AnalySys does not provide sample collection services for clients. Should such services be requested, and agreed to by ASI, a work/sampling plan for any such project conforming with good environmental practices and meeting the client's requirements will be prepared prior to initiation of sampling.

3.6.2 Subsampling of Submitted Samples (5.5.7.1)

ASI procedures for subsampling of sample containers as a part of the analytical process are specified in ASI SOP S-0084 Sub-Sampling of Environmental Samples.

3.7 Sample Handling (5.5.8)

3.7.1 Elements of Sample Handling Program (5.5.8.1)

It is ASI policy that samples, once under the control of ASI, be appropriately controlled such that the integrity of such samples is protected and both ASI and client interests are protected. This policy extends to those functions, which are under the control of ASI or ASI personnel, which impact the transportation, receipt, handling, storage, retention and ultimately the disposal of sample materials placed under ASI's control.

3.7.2 Sample Identification (5.5.8.2)

ASI procedures for the unique identification of environmental samples are described in ASI SOP S-0015 Sample Identification Procedure. These procedures assure that all sample containers are uniquely identified in a manner that will prevent the physical confusion of sample material or "daughter-products" (digestates, extracts, sub-samples).

3.7.3 Sample Receiving Procedures (5.5.8.3)

ASI sample acceptance criteria and procedures for dealing with samples, where the condition of the samples does not conform to "normal" or expected standards, are described in ASI SOP S-0013 Sample Receipt Policy/Procedure – Initial Receipt. Sample receiving procedures, detailing how sample condition is evaluated and documented; and the handling of sample containers and any associated documentation, which accompanies the samples (Chain-of-custody forms, analyte/methods lists, etc.), are specified in ASI SOP S-0014 Sample Receipt Policy/Procedure – Full Evaluation.

3.7.4 Storage & Handling of Samples (5.5.8.4)

Procedures to be followed for the management of sample storage facilities, including sample retention procedures, are specified in SOP S-0017 Sample Repository Procedures. Procedures and documentation requirements for monitoring the environmental conditions (refrigeration temperature, etc.) provided for sample storage are provided in SOP S-0007 Facility Environmental Monitoring & Support Equipment Use Verification.

3.7.5 Sample and Sample By-product Disposition (5.5.8.4.b)

It is ASI policy that samples, related materials and laboratory waste materials shall be disposed of in a manner compliant with all relevant regulatory requirements and in a manner protective of both ASI and our clients' interests. ASI SOP S-0018 Disposal Procedures contains ASI procedures to accomplish this goal.

3.7.6 Documentation (Required Records and Record Retention)

The Quality Manager is responsible for assuring that the documentation required SOP No's S-0013 Sample Receipt Policy/Procedure – Initial Receipt, S-0014 Sample Receipt Policy/Procedure – Full Evaluation, S-0017 Sample Repository Procedures, S-0018 Disposal procedures and the monitoring requirements of S-0007 Facility Environmental Monitoring & Support Equipment Use Verification as they extend to the sample receiving and storage process is maintained.

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3.8 Assuring the Quality of Environmental Test and Calibration Results (5.5.9)

It is ASI policy to maintain procedures to monitor and validate environmental test data and procedures.

3.8.1 Participation in Reference Control Studies (5.5.9.1.b)

ASI participates in a number of interlaboratory comparison/proficiency-testing programs. These programs include but are not necessarily limited to the WP/SP programs and the DMR-QA program. ASI SOP S-0085 Proficiency Testing Programs describes in detail ASI's procedures for such studies to assure compliance with relevant sections of the TNI Proficiency Testing (Chapter 2).

3.8.2 Quality Checks Using Known Reference Standards (5.5.9.1.a)

ASI routinely analyzes certified reference standards as a way to monitor the quality of environmental testing. SOP S-0086 Reference Standard Testing Programs discusses the use of such materials, the implementation of such testing and documentation requirements for such data.

3.8.3 Retesting of Samples (5.5.9.1.c & d)

It is ASI policy that on the authority of the Quality Manager, the Laboratory Manager or the Technical Director; or based on the reasoned request of a client, samples suspected of inconsistencies or inaccuracies for any reason may be submitted for confirmation reanalysis or for testing by an alternate method (if available). The specifics (methods, need for re-prep, etc.) for such reanalyses will be based on the specific concerns evident in each such incident.

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3.8.4 Data Checking (Computerized and Manual) (5.5.9.1.e)

Before release of data to clients, it is mandatory ASI policy that the data be subjected to a number of specific computerized and manual review procedures. The specific requirements and procedures followed in completing these reviews are described in ASI SOP S-0083 Data Review.

3.8.5 Test Method Quality Control (5.5.9.2 and Appendix D of TNI Quality Systems)

ASI believes the use of quality control principles encompassing the inclusion of specific types of control (QC samples or other controls) is mandatory and shall be used for monitoring the quality of environmental test results. It is ASI policy, as described in the ASI Methods Manual SOP's and the SOP's referenced in the following section, that such samples be included at a frequency that meets or exceeds referenced method requirements, regulatory or permit requirements (where they exist or impact submitted samples), and specific client requirements.

3.8.5.1 Blanks (5.5.9.2.a.1)

A blank is a sample of similar matrix type, if feasible or available, that is or should be devoid of the specific analyte(s) or property for which the test is being conducted. A blank is intended to demonstrate the absence of background contamination for the analyt(s) of interest or, if not absent, the potential magnitude of bias imposed by background contamination. ASI utilizes method or prep blanks (PB) that have been subjected to all analytical steps to which the accompanying samples have been subjected. ASI also utilizes calibration blanks (initial calibration blanks [ICB] and continuing calibration blanks [CCB]). In many cases (for example Volatile organics by direct purge), PB's and CCB's are one and the same. Each Method SOP specifies the specific types and frequency of blanks for the test covered. ASI SOP 5.001 describes ASI procedures for evaluating and documenting blank issues. Concerns about elevated blanks are communicated to clients through the use of data qualifiers and, as necessary, comments pertaining to the interpretation of qualifiers and Case Narratives which provide additional information and interpretation of analytical data.

3.8.5.2 Matrix Spikes (5.5.9.2.a.1&2)

A matrix spike (MS) is a sample that prior to any processing, has a known amount of the analyte(s) of interest added to the sample aliquot. The "spiked" sample is then processed and treated in the same manner as the original sample. A matrix spike duplicate (MSD) is a second "spiked" aliquot of a sample. MS and MSD are used to evaluate the impact of "real world" sample matrices on the accuracy and precision of test results. ASI uses comparison of "MS to MSD" to evaluate precision rather than "sample to duplicate sample". Each Method SOP specifies, if appropriate, the use of MS and MSD for the test covered. ASI SOP 5.002 describes ASI procedures for evaluating and documenting MS and MSD results. Concerns about spike recoveries are communicated to clients through the use of data qualifiers and, as necessary, comments pertaining to the interpretation of qualifiers and Case Narratives which provide additional information and interpretation of analytical data.

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3.8.5.3 Laboratory Control Sample (5.5.9.2.a.1&2)

A laboratory control sample (LCS) is effectively a "spiked" prep blank. It is, if feasible, of a similar matrix, spiked with a known quantity of analyte(s) and treated in every respect as a sample during the sample prep and analytical process. LCS are used to evaluate the total performance of the analytical testing system, without the impact of possible matrix effects (e.g. is the test method and equipment operating as intended). Each Method SOP specifies, if appropriate, the use of LCS for the test covered. ASI SOP 5.003 describes ASI procedures for evaluating and documenting LCS results. Concerns about LCS recovery are communicated to clients through the use of data qualifiers and, as necessary, comments pertaining to the interpretation of qualifiers and Case Narratives which provide additional information and interpretation of analytical data.

3.8.5.4 Initial and Continuing Calibration(s) (5.5.9.2.a.3)

The initial calibration is performed according to the requirements of each method as detailed in the Method SOP. Initial calibrations are generally composed of a number of known, different concentrations of the analyte(s) of interest covering the concentration range to be reported without requiring dilution of samples. Continuing calibration samples (CCV's) are quality control samples analyzed in association with each batch of samples. The frequency of repeating both initial calibrations and CCV's and how such results must be interpreted is discussed in each applicable Method SOP. In the rare instance where there may be an issue with calibration data, clients shall be advised of any impact(s) on data quality via Case Narratives which provide additional information and interpretation of analytical data.

3.8.5.5 Surrogate Addition for Organic Analyses (5.5.9.2.a.1)

As required in the specific analytical methods and as further specified in the appropriate Method SOP's, ASI utilizes surrogate compound addition to monitor the performance of analytical test methods (primarily organics by GC and GC/MS although some other types of analysis are also amenable to the use of surrogates) in the specific matrix being analyzed on a sample by sample basis. Surrogate compounds are selected with the intention that they do not interfere with analytes of concern, are not themselves interfered with by sample material, and that they behave, analytically, in a manner similar to the compounds of concern. Surrogates are added prior to sample preparation steps (or as directed in specific methods) in order to provide a measure of analyte recovery achieved for each sample. ASI SOP 5.004 describes ASI procedures for evaluating and documenting surrogate recovery results. Concerns about surrogate recoveries are communicated to clients through the use of data qualifiers and, as necessary, comments pertaining to the interpretation of qualifiers and Case Narratives which provide additional information and interpretation of analytical data.

3.8.5.6 Internal Standards

Internal standards are non-target analytes of known and consistent concentration added to all sample introduction events. Internal standards are added just before analysis and do not reflect preparatory steps and dilutions. The purpose of internal standards is to monitor and correct for those select methods that use this approach (primarily GC/MS and ICP/MS, although other test methods can make use of the technique) for the impact of sample specific matrix effects and for sample introduction variability. Where appropriate or required by the specific test method under consideration, the procedures relative to using and evaluating internal standards are discussed in relevant Method SOP's. Concerns about internal standard recoveries that are believed to have an impact on data quality (ex. low internal recovery due to matrix interferences that require sample dilution and higher quantation levels) are communicated to clients using Case Narratives which provide additional information and interpretation of analytical data.

3.8.5.7 Limit of Detection (LOD or MDL), Limit of Quantitation (LOQ or RQL) and Calibration Range/Linearity (5.5.9.2.a.4)

Limit of detection (LOD), also commonly referred to as the Method Detection Limit (MDL), is the minimum concentration (or amount) of an analyte that can be reliably and repeatedly differentiated from background signal noise (i.e. detected). The Limit of Quantitation (LOQ), also commonly referred to as the Reporting Quantitation Limit or (RQL) is the minimum concentration (or amount) of an analyte that can be reliably, accurately and repeatedly quantified. ASI's LOD, LOQ and Calibration Range/Linearity procedures and requirements are specified in ASI SOP 6.001 (especially Section 5.0, 6.0 and 8.0).

3.8.5.8 Method SOP Provisions (5.5.9.2.a.5 – 5.5.9.a.6)

Method SOP's provide specific detailed data reduction methodologies for each analytical test method. In addition, each Method SOP provides guidance and/or requirements with respect to reagent and standard quality requirements and the need to provide uniform testing conditions (such factors as environmental conditions and uniform DI water quality).

3.8.5.9 Selectivity (5.5.9.2.a.7)

Selectivity is the development of information necessary to validate or confirm the identity of a positive analyte finding in organics testing. Such actions as second column confirmation (for GC-specific detector analyses), mass spectral tuning, ICP interelement correction factors, etc. are typically required for in the analytical methods. The Method SOP for each test method specifies, where required or deemed necessary, pertinent selectivity information appropriate and required for that test method.

3.8.5.10 Estimation of Uncertainty (5.5.1.1, 5.5.1.2 and 5.5.4.6)

The test methods utilized by ASI are, if possible, well recognized methods of analysis that specify limitations in the major sources of uncertainty (ex. SW 846 methods and other USEPA published methods, Standard Methods, ASTM methods, etc.). For these methods, ASI reports results consistent with the reporting instructions specified in the methods. By following this approach, ASI satisfies the estimation of uncertainty measurement criteria for these methods. For methods, procedures or analytes that do not meet the above criteria, ASI SOP S-0090 describes the procedures that shall be applied to estimate uncertainty of measurement.

3.8.6 Quality Control Acceptance Criteria (5.5.9.2.b & c)

ASI's policies and procedures pertaining to the calculation procedures for Limit of Detection (LOD or MDL), Limit of Quantitation (LOQ) and the calculation and development of target criteria (ranges) for such QC monitoring tools as spike recovery criteria, (MS to MSD) precisions, surrogate recovery, etc. are contained in ASI SOP S-0079 Demonstration of Capability, Limit of Detection, Limit of Quantitation (especially Section 7.0 and 8.0).

3.8.7 Documentation (Required Records and Record Retention)

- The Quality Manager is responsible for documentation of interlaboratory Reference Control Study results.
- The Quality Manager is responsible for documenting the results from in-house Reference Sample checks.
- Review of data, both computerized and manual is documented as specified in SOP S-0083 Data Review.
- Documentation of calculations and findings relative to the determination of LOQ's, LOD's, and QC sample target range criteria as specified in SOP S-0079 Demonstration of Capability, Limit of Detection, Limit of Quantitation is the responsibility of Quality Manager.

3.9 <u>Reporting of Results (5.5.10)</u>

3.9.1 General Report Formatting (5.5.10.1 & 5.5.10.7)

It is ASI policy that reporting of environmental test results performed by ASI be provided in a format that is clear and complete; inclusive of information required by the test methods being used and conforming with the TNI Standard. Where specific information is requested by the client for a project, in a timely manner, and the client has agreed to recompense ASI any costs associated with the production of such information ASI shall endeavor to meet the client's needs. ASI has the capability to report environmental results in a wide variety of formats. Where a client has specified a specific format, ASI will use that format to report the test results. If no specific format is requested, ASI will use its judgment to select the most appropriate format for reporting. Alternative formats may be developed at the specific request of a client and simplified summary reporting of results, at client request, can also be accommodated.

3.9.2 Test Report Elements (5.5.10.2 & 3)

ASI final environmental test reports contain as a minimum the following elements in order to assure that ASI's clients have the information necessary to adequately interpret their results.

- the clients name, address, phone numbers and contact person;
- contact information for ASI;
- the client assigned project name (if provided) and sample name;
- the ASI sample number;
- the date and time the sample was collected (if provided by the client);
- the date and time the sample was received by ASI;
- the matrix of the sample;

- for each analyte reported, in addition to the value of the test result, ASI reports, where applicable, the test method reference, the date the analysis was performed, and the units of measure; and
- each final report carries the signature of the final reviewer and the date the report is issued;

Each test report (that is the report pages for each sample) is identified in a manner that uniquely identifies each page with respect to the ASI sample number and report page number. Each report is ended with a page clearly identifying that page as the final page (END OF REPORT) in the report for that sample. This final page also provides a statement as to the condition of the sample on receipt.

Where necessary for interpretation of the report by a client, ASI also includes, with each report or set of reports (a project), supplemental information on the test results provided in the form of a Case Narrative. This supplemental information typically includes such items as:

- Identification of quality control issues that may impact the usability or quality of the data; especially any instances of non-conformance with ASI quality system policies or procedures;
- information on sample condition, uniformity, matrix concerns or other factors that may impact the results for the sample(s) involved;
- where appropriate or requested, assessment of the appropriateness or quality of the environmental test data reported.

3.9.3 Interpretation and Opinion (5.5.10.4)

It is ASI policy that should ASI personnel provide an interpretation or opinion relative to the results presented in a test report, such statements will be clearly identified, either through context or by specific statement, as opinion or interpretation.

3.9.6 Subcontract Test Result Reporting (5.5.10.5)

It is ASI policy that test results supplied by subcontractors shall be supplied in their entirety to ASI's client. ASI does not restate such results but rather passes the entire report through to ASI's client. In this way, the name of the subcontractor and all pertinent details available on the testing are made available to ASI's client.

3.9.7 Electronic Data Reporting (5.5.10.6)

ASI provides for a variety of electronic reporting formats for ASI's clients. In addition to printed hard-copy reports, ASI can make available full copies of reports via FAX, e-mail, or digitized media (CD or DVD). Clients may select digital transmission of reports as their preferred method of test report delivery. Electronic test report delivery provides reports and support information equivalent to printed reports.

3.9.8 Report Amendment (5.5.10.8)

If a material amendment to a test report must be made after the report has been transmitted to the client as a final report, the test report will be carry a Report Date based on the date of the amended report.

Material amendments are interpreted to mean:
- changes to dates or times that appear on the report (sample collection, sample receipt, analysis, etc.);
- any change in the analytical data or quality control data reported;
- changes in the sample name or description;

- the inclusion of revised or additional analytical data based upon a re-analysis requested by the client or ASI personnel; or
- the Technical Director, or designee, has determined that a significant change occurred that is not described in the previous report.

Such re-issued reports retain the original ASI Sample number and are subject to the same controls and reviews as the original report. These reports shall be clearly identified as:

"Amendment to Test Report for ASI Sample######"

If ASI has been requested, by the client, to complete additional analytical testing for a sample that has already been submitted and reported:

- a new unique ASI Sample number will be assigned to the sample (ex. Sample# 100000 would be reassigned as sample 100000a).
- the new sample will be treated independently as a new sample.
- all data and test reports issued pursuant to that new sample number will be subject to the same requirements as if it were newly received sample material.

3.9.9 Non-conforming Report Formats

At the specific request of a client, ASI may report data that does not meet all of the reporting requirements of NELAP. In such cases, non-conforming reports will not carry a statement of compliance as specified at TNI 5.5.10.2.m.

REFERENCES

1. The NELAC Institute. TNI Standard 16, Effective July 1, 2004.
2. The NELAC Institute. TNI Standard , 2009

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APPENDIX A: CERTIFICATION STATEMENT

TNI CERTIFICATION STATEMENT

The applicant understands and acknowledges that AnalySys, Inc. is required to be continually in compliance with the National Environmental Laboratory Accreditation Conference (TNI) standards and shall be subject to the penalty provisions provided therein.

I hereby certify that I am authorized to sign this application on behalf of the applicant/owner and that there are no misrepresentations in my answer to the questions on this application.

AnalySys, Inc.

Michael N. Leva	Michael Leva	04/04/2018
Signature Owner	Name	Date
Melanie Molien	Melanie Molien	04/04/2018
Signature Quality Manager/Lab Manager	Name	Date
Tyler M Batchelor	Tyler Batchelor	04/04/2018
Signature Technical Director/Lab Manager	Name	Date

ANALYSYS LABORATORIES

APPENDIX B: ANALYSYS, INC. CODE OF ETHICS

AnalySys, Inc. (ASI) is committed to assuring that company functions be performed in an ethical manner and in maintaining and encouraging an ethical environment for all ASI employees. To achieve this goal the Management of the Company pledges to assure that company operations are performed according to the following ethical principals. To that end ASI will:

- Deal openly, honestly and fairly in business and financial matters with employees, clients and others.
- Produce environmental testing results that are, to the best of our ability, technically sound and legally defensible.
- Communicate to ASI's clients in a manner that clearly and honestly articulates ASI's capabilities in forthright manner.
- Prepare for ASI employees guidelines describing the ethical and data quality requirements to be achieved.
- Operate ASI facilities in a manner that meets Federal, State and local environmental laws and regulations and that is protective of the environment and employee and public health.
- Strive to improve ASI's products and services, striving to meet the needs of our clients.

Michael N. Leva

Michael Leva, President of AnalySys Inc.

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APPENDIX C: ASI ORGANIZATION CHART

Org Chart.pdf

APPENDIX D: LIST OF STANDARD OPERATING PROCEDURES (SOP's)

Document Control/Document Library

TABLES: NA

FIGURES: NA

END OF DOCUMENT

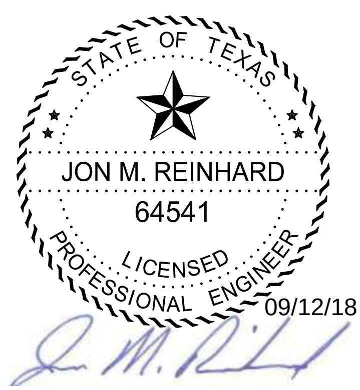
A copy of the most recent version of the contract laboratory's QA/QC plan will be maintained on file.

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 12

FINAL CLOSURE PLAN



Texas Commission on Environmental Quality

Closure Plan for Municipal Solid Waste Type I Landfill Units and Final Facility Closure

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to detail the plan for closure of a landfill unit, closure of associated storage or processing units, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name: City of Kingsville

II. Landfill and Other Waste Management Units and Operations Requiring Closure at the Facility

A. Facility Units

Table 1. Description of Landfill Units.

Name or Descriptor of Unit	Operating Status of Unit	Type of Liner System Under Unit	Above Grade Class 1 Disposal Cells in this Unit	Below Grade Class 1 Disposal Cells in this Unit	Other Class 1 Disposal Cells in this Unit (describe)	Size of Unit's Waste Footprint (acres)	Maximum Inventory of Waste Ever in Unit (cubic yards)	Other Necessary Information that Pertains to the Unit
Type I	Active	Alternate Liner	☐	☐	☐	121.3	17,994,286	
Totals						121.3	17,994,286	

Table 2. Description of Waste Storage or Processing Units or Operations Associated with this Permit.

Type of Storage or Processing Unit or Operation (individual units may be closed at any time prior to or during the final facility closure as described in this plan)	Operational Status of Unit	Size of the Area Used for the Storage or Processing Unit or Operation (Acres)	Maximum Inventory of Waste Ever in Storage or Processing Unit or Operation (indicate cubic yards or tons)	Other Information (enter other necessary information that pertains to the unit)
Tire Storage & Processing Area	Proposed	0.18	200 ☒cubic yards ☐tons	
Liquid Waste Solidification Area	Proposed	0.03	95 ☒cubic yards ☐tons	
Leachate Storage Pond/Tanks	Proposed	1.60	453.50 ☒cubic yards ☐tons	
White Goods & Metal Recycling Storage Area	Proposed	0.46	2,963 ☒cubic yards ☐tons	
Brush Storage & Processing Area	Proposed	1.06	9,028 ☒cubic yards ☐tons	
Totals		3.33	12,739.50	

B. Waste Inventory Summary

Table 3. Maximum Inventory of Wastes Ever On Site.

Item	Quantity (indicate cubic yards or tons)
Maximum inventory of waste in landfill units (total from Table 1)	17,994,286 ☒cubic yards or ☐tons
Maximum inventory of waste in storage or processing units or operations (total from Table 2)	12,739.50 ☒cubic yards or ☐tons
Total Maximum Inventory of Wastes ever on site over the active life of the MSW facility (sum of totals from Tables 1 and 2)	18,007,026 ☒cubic yards or ☐tons

C. Drawings Showing Details of the Waste Management Units at Closure

Table 4. Location of the Drawings showing Details of the Waste Management Units at Closure (outlines, dimensions, maximum elevations of waste and final cover of landfill units, and waste storage or processing units or operations at closure of the facility).

Drawing Location in the SDP	Drawing Figure Number	Drawing Title	Waste Management Units Details Shown
Part III, Attachment 1	III.1-3	Landfill Excavation Plan	Outlines, waste footprints, and dimensions of the landfill units
Part III, Attachment 1	III.1-4	Landfill Completion Plan	Maximum elevations of waste and final cover of the landfill units
Part III, Attachment 1	III.1-14	Support Area Layout	Locations and limits of storage and processing units in the support area

III. Description of the Final Cover System Design

A. Types and Descriptions of the Final Cover Systems

Table 5. Types and Descriptions of the Final Cover Systems Permitted or Proposed for Closure of the Landfill Units.

Landfill Unit Name or Descriptor	Type of Final Cover System	Final Cover System Components Description	Other Information (Enter other information as applicable)
Type I Landfill	Alternative Composite Final Cover	A six (6) inch thick (minimum) prepared soil subgrade layer; A geosynthetic clay liner (GCL) layer; A forty mil (0.04 inch) thick LLDPE geomembrane layer; A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric; A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.	

B. Design Details

Table 6. Design Details of the Final Cover Top and Side Slopes for the Landfill Units.

Landfill Unit Name or Descriptor	Maximum Final Elevation of Waste (feet above mean sea level [ft-msl])	Maximum Elevation of Top of Final Cover (ft-msl)	Minimum Grade of the Final Cover Top Slope (%)	Maximum Grade of the Final Cover Side Slope (%)	Other Information (enter other information as applicable, e.g. above-grade Class 1 Cell Dikes)
Type I Landfill	196.92	200	3.9%	25%	

C. Final Cover Drainage Features

Storm water drainage and erosion and sediment control features incorporated on the final cover of the landfill units to protect the integrity and effectiveness of the final cover system include *(please list and describe the drainage features to be installed on the final cover at or prior to closure for each landfill unit, or list the drainage features and provide cross references on the location(s) of the descriptive and details (drawing) information in other parts of the SDP)*:

Final cover storm water drainage and erosion and sediment control features include top slope berms, side slope berms, drainage chutes, drainage chute outfalls, and vegetation. Details of these features can be found in Part III, Attachment 3, Figures III.3 -2 and III.3-3 of the SDP.

D. Final Cover Vegetation or Other Ground Cover Material

The final cover will be seeded and/or sodded with native plants immediately following the application of the final cover in order to minimize erosion. The estimated percent ground cover to minimize soil loss and maintain long-term erosional stability of the final cover top and side slopes is: **90**%. The minimum material specifications for other ground cover materials are summarized in the table below.

For a landfill with water balance final cover design, the percentage vegetation cover (excluding other ground cover types) will not be less than that assumed in the water balance final cover model.

Table 7. Minimum Specification for Ground Cover Materials Other Than Vegetation, if Applicable.

Other Ground Cover Material	Maximum Particle Size (inches)	Minimum Particle Size (inches)	Material Placement Method	Thickness of Layer (inches)	Percentage Coverage (%)	Other (specify)

E. Final Contour Map

Figure **III.1-4**, a facility final contour map is provided in Part III, Attachment 1 of the SDP. The map shows the final contours of the landfill units and the entire facility at closure.

Figures **III.2-1** through **III.2-5** showing the cross–sections of the landfill units at closure are also in Part III, Attachment 2 of the SDP.

The facility final contour and cross-section maps/drawings depict the following information:

(1) Final constructed contours of the landfill at closure.

(2) Top slopes and side slopes of the landfill units.

(3) Surface drainage features.

(4) 100-year floodplain, as applicable.

(5) Constructed features providing protection of/from the 100-year floodplain.

(6) Other (specify):

IV. Description of the Final Cover System Installation Procedure

A. Mode of Installation

Table 8. Mode of Final Cover Installation on the Landfill Units.

Landfill Unit Name or Descriptor	Largest Area of Unit Ever Requiring Final Cover (Acres)	Check this Column if Final Cover will be Placed in Installments as Permitted Elevation is Reached	Check this Column if Final Cover will be Placed when Entire Unit Area Reaches Permitted Elevation	Final Cover Installation Status
Type I Landfill	41.5	☒	☐	Yet to be installed

B. Installation Drawings for Final Cover and Drainage Features

The following plan and cross-section drawings are provided in Part III, Attachment 1 and 3 of the SDP and show the final cover design details, the largest area requiring final cover, details of the sequence of installation of the final cover system, and all drainage features.

Table 9. List of Installation Drawings for Final Cover and Drainage Features.

Drawing No.	Drawing Title	Description of Information Contained in Drawing
III.1-4	Landfill Completion Plan	Landfill plan showing final contours and drainage features at closure
III.1-5	Landfill Sequencing Plan 1	Landfill Plan that shows landfill current conditions including active fill areas, which depicts the largest area ever requiring closure
III.1-6 through III.1-13	Landfill Sequencing Plan 2 – 9	Landfill sequence plans that depict phasing of landfill closure and new cell construction through the life of the landfill
III.3-3	Drainage Chute Outlet Details	Details of final cover drainage chute outlets
III.3-4	Drainage Chute Details	Details of final cover drainage chutes, top slope berms and side slope berms

C. Final Cover Quality Control Plan

A liner quality control plan (LQCP), is provided in Part III, Attachment 10 of the SDP. The LQCP describes the final cover system design, construction, and evaluation protocol and processes, including the personnel, materials, methods, sampling and testing standards, procedures, and practices to be used in procuring, handling, installing, and evaluating all elements of the final cover system. It establishes the material requirements; personnel qualifications and roles; installation requirements; quality control and quality assurance monitoring, testing, documentation, and reporting programs to be used during construction of each component of the final cover system to assure and to verify that the final cover system is constructed as designed and in accordance with applicable rules and technical standards.

D. Documentation and Reporting of Final Cover System Construction and Testing

The professional of record will document all aspects and stages of the final cover installation, including materials used, equipment and construction methods, and the type and rate of sampling and quality control testing performed. Following completion of construction of the final cover, the site operator/permittee will submit to the TCEQ executive director, a Final Cover System Evaluation Report (FCSER) for each landfill unit.

V. Closure Activities and Completion Schedules for Each Landfill Unit and for the Final Facility Closure

A. Closure of a Landfill Unit

The following activities will be conducted to satisfy the closure criteria for a landfill unit:

(1) Closure Notification to the TCEQ Executive Director:

The site operator will inform the executive director of the TCEQ, in writing, of the intent to close the unit no later than 45 days prior to the initiation of closure activities and place this notice of intent in the operating record.

(2) Stoppage of Waste Acceptance and Commencement of Other Closure Activities for the Unit:

The site operator will stop accepting waste upon receiving the known final receipt of waste. The site operator will ensure that the permitted top elevations of the in-place waste, as depicted in/derived from the unit’s final contour map approved by the TCEQ executive director, are not exceeded at any section or part of the landfill unit. The site operator will begin closure activities for the unit no later than:

- Thirty days after the date on which the unit receives the known final receipt of wastes; or

- One year after the most recent receipt of wastes if the unit has remaining capacity and there is a reasonable likelihood that the unit will receive additional wastes.

(3) Request for Extension Beyond the 1-Year Deadline for Commencing Closure Activities for a Unit:

The site operator may submit a written request to the executive director of the TCEQ for review and approval for an extension beyond the one-year deadline for the initiation of closure. The request will include the following:

(a) All applicable documentation necessary to demonstrate that the unit has the capacity to receive additional waste; and

(b) All documentation necessary to demonstrate that the site operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the MSW landfill unit.

(4) Construction of Final Cover:

The site operator will construct the permitted final cover over the waste mass utilizing methods, procedures, and specifications described in the FCQCP. The final constructed contours, elevations, and slopes of the installed final cover will match the permitted final cover contours, elevations, and slopes shown in closure drawings contained in this closure plan.

(5) Construction of Drainage Features:

The site operator will construct the drainage structures shown in drawings referenced or contained in this closure plan or in the facility surface water drainage report.

(6) Completion of Outstanding or Replacement of Damaged Groundwater or Landfill Gas Monitoring Components:

The site operator will complete installation of any outstanding or replacement of any damaged groundwater or landfill gas monitoring system components and landfill gas control systems as needed to maintain current and effective groundwater or landfill gas monitoring and control systems.

(7) Submittal of Final Cover System Evaluation Report (FCSER) to the TCEQ Executive Director:

Following completion of construction of the final cover for the subject landfill unit, the site operator will submit to the TCEQ executive director for review and acceptance, a FCSER for the unit.

(8) Completion of Closure Activities for the Landfill Unit:

The site operator will complete closure activities for the unit within 180 days following the start of closure activities, unless the executive director of the TCEQ grants an extension as described in Item V.A.8(a) below.

(a) Request for Extension of the Completion of Closure Activities for the Landfill Unit:

The site operator may submit a written request for an extension for the completion of closure activities to the TCEQ for review and approval. The extension request will include:

- All applicable documentation necessary to demonstrate that closure will, of necessity, take longer than 180 days; and
- All applicable documentation necessary to document that all steps have been taken and will continue to be taken to prevent threats to human health and the environment from the unclosed MSW landfill unit.

(9) Submittal of Engineer's Certification of Closure to the TCEQ Executive Director and Request of Closure Inspection to TCEQ Regional Office:

Following completion of all closure activities for the landfill unit, the site operator will submit:

(a) Closure Inspection

A written request to the local TCEQ regional office for a closure inspection of the unit.

(b) Closure Certification

A certification, signed by an independent licensed professional engineer, to the executive director of the TCEQ for review and approval verifying that closure has been completed in accordance with this closure plan. The site operator will submit the certification via registered mail, and the submittal will contain all applicable documentation necessary for certification of closure of the unit, including:

- A final cover system evaluation report (FCSER) documenting the installation of the final cover. The FCSER may be submitted as a separate document for review and approval following the completion of the final cover installation. In that case, the certification of closure will be submitted subsequently;
- A final contour map as described under Section III.E that includes the relevant unit; and
- Copy of the letter to the TCEQ regional office requesting a closure inspection of the relevant unit.

(10) TCEQ's Acknowledgement of Termination of Operation and Closure of a Unit:

Upon receipt, the TCEQ executive director will review the closure documents for completeness and accuracy; and following receipt of the closure inspection report from the agency's regional office verifying proper closure of the MSW landfill unit according to this closure plan, the executive director will, in writing, acknowledge the termination of operation and closure of the unit and deem it properly closed. Thereafter, the site operator will comply with the post-closure care requirements described in the post-closure care plan for the unit.

(11) Deed Recordation for Disposed Regulated Asbestos Containing Materials (RACM):

Upon closure of the unit that accepted RACM, the site operator will place a specific notation that the unit accepted RACM in the deed records for the facility with a diagram identifying the RACM disposal areas. Concurrently, the site operator will submit to the TCEQ executive director, a notice of the deed recordation and a copy of the diagram identifying the asbestos disposal areas.

(12) Placement of all Closure Documentation in the Site Operating Record:

Once approved, the closure certification and all other documentation of closure will be placed in the site operating record.

(13) Closure Schedule for the Landfill Unit:

A closure schedule, Appendix 1 - Landfill Unit and Final Closure Schedule, is attached. The schedule shows all the closure activities listed within Section V.A and the timelines for commencing and completing each activity. Also, the schedule shows that closure activities for the landfill unit will be completed within 180 days following the initiation of closure activities as required, unless an extension is granted by the TCEQ executive director.

(14) Other: (enter as applicable).

B. Closure of the Waste Storage or Processing Units or Operations

Closure of the waste storage or processing units or operations authorized under this permit will include removal of all waste, waste residues, and any recovered materials. The facility units and operations will either be dismantled and removed off-site or decontaminated. The site operator will dispose at the landfill or evacuate all materials (including feedstock, in process, and processed) to an authorized facility and disinfect all leachate handling units, tipping areas, processing areas, and post-processing areas. If there is evidence of a release from a unit or operation, the site operator will conduct an investigation, as approved by the TCEQ executive director, into the nature and extent of the release and an assessment of measures necessary to correct an impact to groundwater.

C. Final Closure of the Facility

In addition to the closure activities listed in Section V.A above for closing a landfill unit, the site operator will conduct the following activities for the closure of the entire facility:

(1) Publish Final Closure Notice and Place the closure Plan in a Public Place:

No later than 90 days prior to the initiation of the final facility closure, the site operator will:

(a) Publication of Notice:

The site operator will publish notice in the newspaper(s) of largest circulation in the vicinity of the facility to inform the public of the final closure of the facility. This notice will include:

- The name of the facility;
- The address, and physical location of the facility;
- The facility's permit number; and
- The last date of intended receipt of waste.

(b) Place Copies of the Closure Plan in a Public Place:

The site operator will also make available an adequate number of copies of the approved final closure and post-closure plans for public access and review at the City of Kingsville City Hall, 400 W. King Avenue, Kingsville, TX 78363 (state public place within the area, including address, where the plan will be available for public access and review).

(2) Submit Written Notice of "Intent to Close the Facility" to the TCEQ Executive Director:

The site operator will provide written notification to the TCEQ executive director of the intent to close the facility. This notice will be provided to the executive director no later than 90 days prior to the initiation of the final facility closure, and thereafter be placed in the site operating record.

(3) Post Signs and Install Barriers:

Upon notifying the executive director of the intent to close the facility and no later than 90 days prior to the initiation of final facility closure, the site operator will:

(a) Post Final Closure Signs:

The site operator will post a minimum of one sign at the main entrance and all other frequently used points of access for the facility notifying all persons who may utilize the facility of the date of closing for the entire facility and the prohibition against further receipt of waste materials after the stated date.

(b) Install Barriers:

Also, the site/operator will install suitable barriers at all gates or access points to adequately prevent the unauthorized dumping of solid waste at the closed facility.

(4) Filling of “Affidavit to the Public” and Performance of the Final Deed Recording:

Upon closure of all the landfill units or upon final closure of the facility, the site operator will:

(a) File Affidavit

File with the county deed records an "Affidavit to the Public" in a form provided by the TCEQ executive director that includes an updated metes and bounds description of the extent of the disposal areas at the facility and the restrictions to future use of the land in accordance with applicable provisions under 30 TAC Chapter 330, Subchapter T.

(b) Record a Notation on the Deed

Record a certified notation on the deed to the facility property, or on some other instrument that is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill facility and use of the land is restricted according to the provisions under 30 TAC Chapter 330, Subchapter T.

(c) Place Documents in the Operating Record

Place a copy of the “Affidavit to the Public” and a copy of the modified deed in the site operating record.

(5) Submittal of a Copy of the "Affidavit to the Public" and the "Modified Deed" to the TCEQ Executive Director:

Within ten days after completion of final closure activities of the facility, the site operator will submit the following to the TCEQ executive director by registered mail:

(a) A certified copy of the "Affidavit to the Public";

(b) A certified copy of the modified deed to the facility property; and

(c) A certification, signed by an independent licensed professional engineer, verifying that final facility closure has been completed in accordance with the approved closure plan. The submittal will contain all applicable documentation necessary for certification of final facility closure, including:

- Final Cover System Evaluation Report (FCSER) documenting the installation of the final cover. The FCSER may be submitted earlier as a separate document for review and approval following the completion of the final cover installation. In that case, the certification of closure will be submitted subsequently;
- A final contour map as described under Item III.G above;
- Copy of a letter to the TCEQ regional office requesting a final closure inspection of the facility; and
- Copies of documents verifying newspaper publication of the notice of the final facility closure.

(6) Other

Additional items relating to the schedule for final facility closure, and additional closure activities specific to the final closure of this facility include:

(7) TCEQ's Acceptance of Termination of Operation and Closure of a Landfill Facility:

Following the TCEQ executive director's receipt and completion of the review of the professional engineer's certification of the completion of facility closure and the final closure documents, and receipt of the inspection report from the agency's regional office verifying proper closure of the facility according to this closure plan, the executive director will, in writing, accept the termination of operation and closure of the facility and deem it properly closed. Thereafter, the site operator will comply with the post closure care requirements described in the post closure plan for the facility.

(8) Final Closure Schedule for the Facility:

The attached Appendix 1, Landfill Unit and Final Closure Schedule, provides the closure schedule for the final facility closure. It incorporates the schedule for closure of a unit as discussed in Section V.A and also shows the commencement and completion timelines for the final closure activities listed within this Section.

VI. Summary of Attachments

A. Drawings and Maps

The following Drawings and Maps are provided in Part III, Attachments 1, 2, and 3 of the SDP, as discussed in Sections III.C, III.E, and IV.B.

- Figure , Final Contour Map.
- Figures , Cross-Section Drawings of the Landfill Units at Closure.
- Figures , Final Cover and Drainage Features Installation Drawings.
- Other Drawings/Maps: Figures

B. Documents

The Liner Quality Control Plan (LQCP) is provided in Part III, Attachment 10 of the SDP, as discussed in Section IV.C.

- Attachment , Final Cover Quality Control Plan (FCQCP).
- Appendix 1, Landfill Unit and Final Closure Schedule Chart.
- Other: Attachment

C. Additional Items Attached (enter as applicable)

VII. Professional Engineer's Statement, Seal, and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: September 12, 2018

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

Signature

THE CITY OF KINGSVILLE LANDFILL
TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

PART III - ATTACHMENT 12

APPENDIX 1

LANDFILL UNIT AND FINAL CLOSURE SCHEDULE

CITY OF KINGSVILLE, TEXAS

September 2018
Revision 0

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Prepared by

HANSON PROJECT NO. 16L0438-0003

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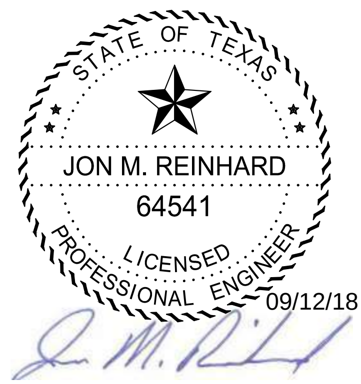

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1.0 SCHEDULE OF UNIT CLOSURE AND FACILITY FINAL CLOSURE §330.457(f) and §330.461

The following describes a general schedule for landfill unit and facility closure activities:

1) The City of Kingsville will publish a public notice of facility closure in the largest circulating newspaper in the area no later than 90 days prior to initiation of final facility closure. The notice will include the name, address, physical location of the facility, permit number, and the date of final receipt of waste. An adequate number of copies of the Final Closure Plan will be made available for public access and review.

2) No later than 45 days prior to the initiation of closure activities for any landfill unit, the City of Kingsville will provide written notification to the Executive Director of the intent to close the unit. That notice of intent to close will be placed in the Site Operating Record (SOR).

3) Following notification of the Executive Director of the final facility closure, a minimum of one sign will be posted at the main entrance to the facility and at appropriate points around the site perimeter notifying persons of the date of final closure. In addition, barriers will be installed at all gates or access points to effectively prevent the unauthorized dumping of solid waste.

4) Final closure activities will begin no later than 30 days after the unit receives the known final receipt of wastes. If it is likely that the unit will receive additional waste, due to remaining capacity in the unit, final closure activities will begin no later than one year after the most recent receipt of waste, unless an extension is requested from the Commission.

5) Final closure activities for the unit will be completed within 180 days following the initiation of closure activities as specified in (4) above. If necessary, a request for an extension of the completion of final closure activities may be submitted to the Executive Director for review and approval.

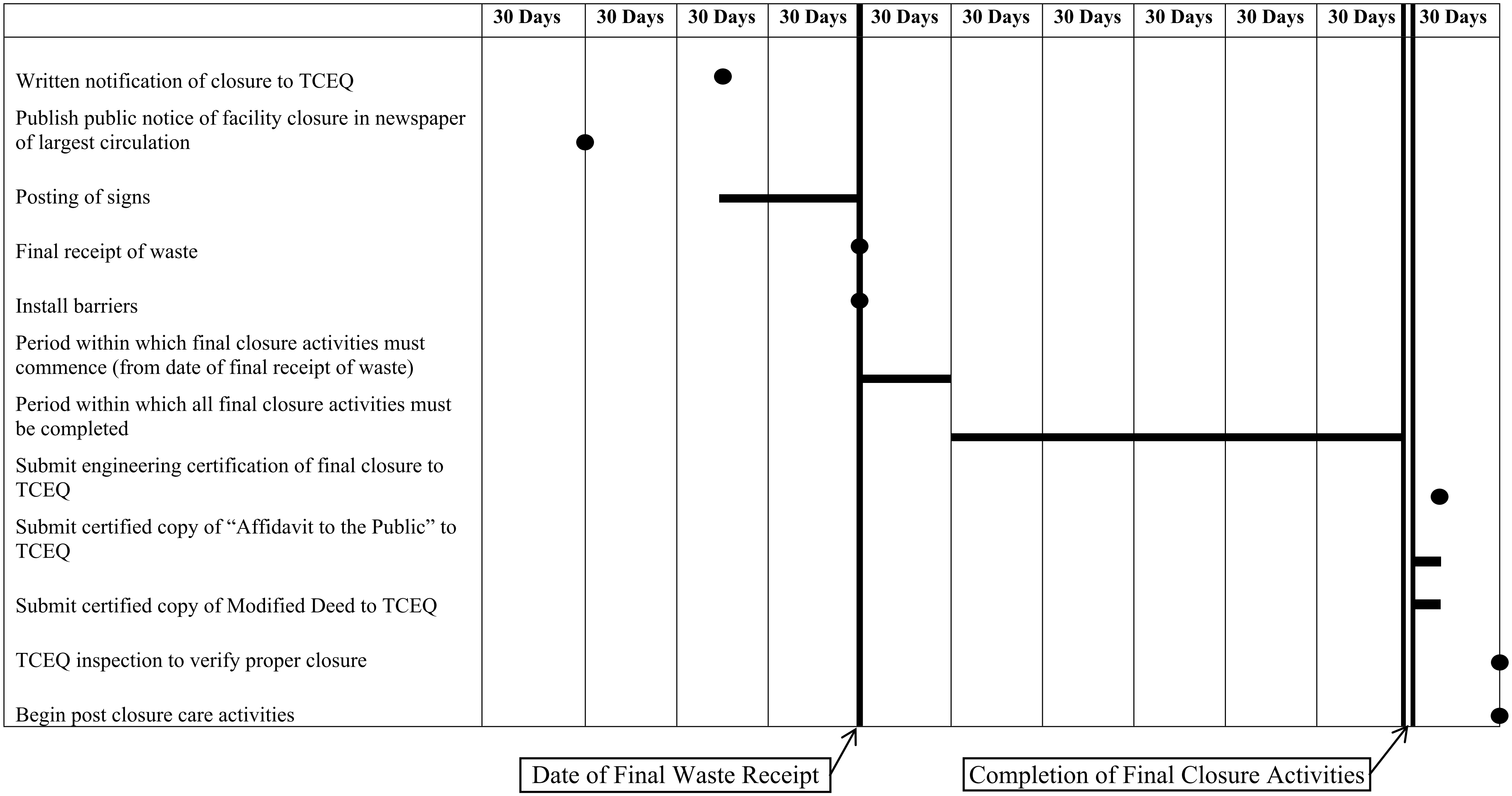
.

6) Following completion of all final closure activities, a documented certification from an independent Professional Engineer will be submitted to the Executive Director verifying that closure has been completed in accordance with the approved Final Closure Plan (this attachment). After the Commission has approved the certification, a copy will be placed in the SOR.

7) Within 10 days after closure of the facility, the City of Kingsville will submit a certified copy of an "Affidavit to the Public" to the Executive Director. The affidavit will include an updated metes and bounds description of the extent of disposal sectors and future land use restrictions/requirements in accordance with the provisions specified in 30 TAC §330.465. In addition, a certified notation on the deed that will in perpetuity inform any potential purchaser of the property that the land has been used as a landfill facility and that future uses of the land are restricted will be filed and recorded in the deeds records of the office of the County Clerk of Kleberg County. A certified copy of the modified deed will be submitted to the Executive Director.

Following receipt of the required final closure documents and an inspection report from the TCEQ Regional Office verifying proper closure of the facility according to the approved Final Closure Plan, the Executive Director may acknowledge the termination of operation and closure of the facility and deem it properly closed. Post-closure care maintenance will begin immediately upon the date of final closure as approved by the Executive Director. All post-closure land use will comply with 30 TAC §330.255 as indicated in the Post-Closure Care Plan.

FIGURE 1: FINAL CLOSURE SCHEDULE



Note: The schedule is based on anticipated date of beginning final closure activities. The thick single vertical line represents the date of final receipt of waste and commencement of final closure activities, and the thick double vertical lines represent the completion of final closure activities.

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 13

POST-CLOSURE CARE PLAN

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Texas Commission on Environmental Quality

Post-Closure Care Plan for Municipal Solid Waste Type I Landfill Units and Facilities

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to provide landfill unit or final facility post-closure care closure plans to meet the requirements in 30 TAC Chapter 330, §330.63(h) and as set out under 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235-C

Site Operator/Permittee Name: City of Kingsville

II. Party Responsible for Overseeing and Conducting Post Closure Care Activities

Name (Person or Office Responsible): City of Kingsville Public Works Department

Position or Title: Director

Mailing Address: P.O. Box 1458

City: Kingsville

State: Texas

Zip Code: 78364

Telephone Number: (361) 595-8041

III. Post-Closure Care Status of Landfill Units at the Facility

Check the applicable box for the post-closure care status of the units at the facility and complete the applicable tables as indicated:

A. ☒ No landfill unit is in post-closure care in this facility at the time this application is submitted (skip Table 1 and complete Table 2 below if you check this item)

B. ☐ This facility includes landfill units currently in post-closure care and landfill units that are not yet in post-closure care (complete Tables 1 and 2 below if you check this item).

C. ☐ This facility contains only landfill units currently in post-closure care (complete Table 1 below if you check this item; do not complete Table 2).

Table 1: Landfill Units Currently in Post-Closure Care

Landfill Unit Name	Drawing Number Showing the Landfill Unit	Date TCEQ Acknowledged Closure of Unit	Date Post-Closure Care Commenced	Projected Date of End of Post-Closure Care
Not Applicable				
Not Applicable				
Not Applicable				

Table 2: Landfill Units Not yet in Post-Closure Care

Category of Landfill Unit (Regarding Status of Waste Receipt)	Landfill Unit Names or Descriptors	Site Development Plan Drawing Titles and Numbers Showing the Units
Stopped Receiving Waste Prior to October 9, 1993		
Received Waste on or after October 9, 1993	Type I	

Category of Landfill Unit (Regarding Status of Waste Receipt)	Landfill Unit Names or Descriptors	Site Development Plan Drawing Titles and Numbers Showing the Units
Proposed to be Constructed		
Other (enter as applicable)		

IV. Post-Closure Care Maintenance Requirements and Activities to be Conducted

A. Categories of Landfill Units and Applicable Post-Closure Care Maintenance Requirements and Activities

Check the appropriate boxes to indicate the categories of landfill units at the facility and complete the applicable section of the post-closure care maintenance requirements and activities below.

This facility includes landfill units that:

☐ Stopped receiving waste prior to October 9, 1993

If you check this item, complete the post-closure care maintenance requirements and activities specified in Subsection IV.B below. Skip Subsection IV.B if this item does not apply to your facility.

☒ Received waste on or after October 9, 1993

If you check this item, complete the post-closure care maintenance requirements and activities specified in Subsection IV.C below. Skip Subsection IV.C if this item does not apply to your facility.

☒ Are proposed to be constructed

If you check this item, complete the post-closure care maintenance requirements and activities specified in Subsection IV.C below. Skip Subsection IV.B, unless your facility also contains units that stopped receiving waste prior to October 9, 1993.

B. Post-Closure Care Maintenance Requirements and Activities for the Landfill Units that Stopped Receiving Waste Prior to October 9, 1993

The site operator will commence and conduct post-closure care maintenance of the units that stopped receiving waste prior to October 9, 1993 for a minimum of the first **five years** following commencement of post-closure care as specified below and in accordance with applicable rules under 30 TAC §330.463(a). Post-closure care maintenance will start on the date the professional engineer's certification of the completion of closure is accepted in writing by the TCEQ executive director and the site operator will carry out the following activities and operations during the period.

1. Maintenance of Right of Entry and Rights of Way

The site operator will retain the right of entry to and maintain all rights-of-way of the closed units in order to conduct periodic inspections of the units throughout the post-closure care period. TCEQ staff will have access to the site to conduct inspection or investigation that may be necessary during the period.

2. Inspection Activities and Correction of Problems

The site operator will conduct inspection of the closed landfill units at the frequencies indicated in Table 3 below, utilizing the inspection protocol maintained in the site operating record, and will correct all identified problems as needed.

Table 3: Inspection Activities Schedule

Post-Closure Care Inspection Item	Frequency of Inspection	Types of Deficiency Conditions to be looked for during Inspection
Final Cover Condition	Not Applicable	
Vegetation	Not Applicable	
Leachate Management Systems	Not Applicable	

Post-Closure Care Inspection Item	Frequency of Inspection	Types of Deficiency Conditions to be looked for during Inspection
Landfill Gas Monitoring and Control Systems	Not Applicable	
Groundwater Monitoring Systems	Not Applicable	
Drainage Structures	Not Applicable	
Ponding of Water	Not Applicable	
Other:	Not Applicable	

3. **Continuation of Monitoring Programs during Post-Closure Care Period**

The site operator will continue the monitoring programs listed in Table 4 during the post-closure care period. The monitoring programs will be conducted as specified in the applicable section of the facility's Site Development Plan and applicable rules.

Table 4: Monitoring and Reporting Schedule

Monitoring Program	Frequency of Monitoring	Frequency of Reporting of Results
Groundwater monitoring	Not Applicable	
Landfill gas monitoring	Not Applicable	
Other:		

4. **Detection of a Release, Nature and Extent Investigation, and Corrective Action to Address Release from the MSW Unit**

Upon detection of any evidence of a release from the landfill or other associated waste management units at the facility, the site operator will:

- Notify the executive director of the TCEQ of the condition detected;
- Investigate, if so directed by the executive director of the TCEQ, whether a release from the landfill or other associated waste management units at the facility has occurred;
- Investigate the nature and extent of the release, if a release is confirmed;
- Assess measures necessary to correct any impact to groundwater;
- Submit a corrective action plan via a permit modification for TCEQ executive director's review and approval; and
- Conduct corrective action as approved by the TCEQ executive director.

5. **Extension of Post-Closure Care Period**

If any of the problems listed in Table 3 occurs, or corrective action as indicated in Subsection IV.B.4 above continues, after the end of the five-year post-closure care period or persists for longer than the first five years of post-closure care, the site operator will be responsible for their correction and will continue to conduct post-closure care maintenance until the TCEQ executive director determines that all problems have been adequately resolved.

6. **Reduction of Post-Closure Care Period**

The site operator may request in writing for the TCEQ executive director to reduce the post-closure care period for the units if all wastes and waste residues have been removed during closure and any new or on-going corrective action to address confirmed releases from the landfill have been completed as acknowledged in writing by the executive director.

C. Post-Closure Care Requirements and Activities for Municipal Solid Waste Landfill Units that Receive Waste on or after October 9, 1993 and for New Units

The site operator will commence and conduct post-closure care maintenance of the units that receive waste on or after October 9, 1993 and new units constructed under this permit as follows and in accordance with applicable rules under 30 TAC §330.463.

1. Commencement of Post-Closure Care

Post-closure care maintenance will start on the date the professional engineer's certification of the completion of closure is accepted in writing by the TCEQ executive director and the site operator will carry out the following activities and operations during the period.

2. Period of Post-Closure Care

The site operator will conduct post-closure care for the landfill units for a period of **30 years**, unless this time period is increased or reduced by the executive director as discussed in Subsection IV.C.11.

3. Maintenance of Right of Entry and Rights of Way

The site operator will retain the right of entry to the closed units and the facility and will maintain all rights-of-way of the closed units in order to conduct periodic inspection and maintenance of the closed units until the end of the post-closure care period.

4. Inspection Activities

The site operator will conduct periodic inspection of the closed units to identify and document deficiency conditions and conduct maintenance and corrective action to maintain compliance. Sections IV.C. 8.(a)-(c) provide information on the inspection items and deficiency conditions that the site operator will look for during inspection of the major components of the landfill and the site during the post-closure care period. Other inspection and maintenance provisions that apply during the post-closure care period as specified in the facility's site operating plan, site development plan, or applicable rules will remain in effect.

5. **Documentation of Inspection**

The site operator will document and maintain records of the post-closure care inspections in the site operating record. The records will include:

- The date of inspection;
- Components and items inspected;
- Problems detected or observed; and
- The name of the personnel who conducted the inspection.

6. **Corrective Actions**

Based on the results of the inspection activities, the site operator will conduct needed restoration and remediation actions on the closed unit no later than the next scheduled inspection event. Also, the site operator will conduct maintenance action on regular periodic schedule in order to:

- Maintain the integrity and effectiveness of all final cover, facility vegetation, and drainage control systems;
- Correct any effects of settlement, subsidence, ponded water, erosion, or other events or failures detrimental to the integrity of the closed unit; and
- Prevent any surface run-on and run-off from eroding or otherwise damaging the final cover system during the post-closure care period.

7. **Documentation of Corrective Actions**

The site operator will document and maintain, in the facility's site operating record, records of the restoration, remediation, and maintenance activities performed, including the date of completion of the activities.

8. **Inspection Activities Schedules**

(a) Final Cover Inspection

Inspection Frequency: Annually

Other Inspection Occasions/Events:

Table 5: Final Cover Inspection Items

Inspection Item	Types of Deficiency Conditions to be looked for during Inspection
Vegetation and other Ground Cover Materials	Areas of dead vegetation or that needs repair
Settlement	Settlement areas, including depressions of more than 4 inches that need to be repaired
Subsidence	Areas of possible subsidence, including sideslope failures
Ponded Water	Areas of ponded water after rain events
Erosion	Eroded areas that need to be filled and revegetated
Other (enter other events or failures detrimental to the integrity and effectiveness of the final cover): Vectors	Damages in the cover due to vectors such as burrowing animals or grass fires

(b) *Drainage Control System Inspection*

Inspection Frequency: Annually

Other Inspection Occasions/Events:

Table 6: Drainage Control System Inspection Items

Inspection Item	Types of Deficiency Conditions to be looked for during Inspection
Vegetation within Drainage Control Structures	Inspect swales and ditches for vegetation loss
Component Failures	Inspect stormwater structures and piping for damage
Wash Outs	Inspect stormwater outfalls to identify scour areas that need repair
Sediment Build Up	Areas that appear to hold sediment, indicating possible erosion upstream

(c) *Access and Rights-of-Way*

Inspection Frequency: Annually

Other Inspection Occasions/Events:

Table 7: Access and Rights of Way Inspection Items

Inspection Item	Types of Deficiency Conditions to be looked for During Inspection
Gates, Gate Locks and Barriers	Inspect these items for proper working order, and note any damage or vandalism
Fence and other Access Control Barriers	Inspect the perimeter fence to identify breaches into the facility
Vegetation Control in Areas of the Facility other than the Final Cover	Note any areas that require vegetation control

Inspection Item	Types of Deficiency Conditions to be looked for During Inspection
Other (enter other access control and rights-of-way inspection items): Facility Roadways	Inspect roadways for potholes and foreign objects that could pose a safety hazard

9. Continuation of Operation and Maintenance of the Leachate Collection and Removal Systems (LCRS)

The site operator will continue the operation and maintenance of the LCRS and disposal of leachate during the post-closure care period in accordance with the facility's leachate management plan found in Part III, Attachment 15 of the Site Development Plan and consistent with applicable provisions under 30 TAC Sections 330.331 and 330.333.

(a) Performance Monitoring and Inspection of the LCRS

During the post-closure care period, the site operator will monitor the performance of the LCRS on a quarterly basis to assure continuous compliance with the design criteria and inspect the LCRS components on a quarterly basis, at a minimum, to determine the need for repair or maintenance. Inspection and monitoring will follow the procedure described in the facility's leachate management plan found in Part III, Attachment 15 of the Site Development Plan or in the written inspection protocol maintained in the facility's site operating record. Results of the monitoring and inspection activities will be documented in the site operating record. The items and components of the leachate collection and removal system to be inspected will include but are not limited to the items in Table 8 below.

Table 8: Leachate Collection and Removal System Inspection

Inspection Item/Component	Types of Deficiency Conditions to be looked for during Inspection
Leachate Collection/Riser	Inspect for proper working order & signs of damage by vandalism, animals, heavy equipment, or other causes
Submersible Pumps	Inspect for proper working order & signs of damage

(b) LCR Maintenance and Repairs

During the post-closure care period, the site operator will perform routine and needed maintenance or repairs of the LCRS items and components based on the monitoring and inspection results. Maintenance and repair will be completed prior to the next scheduled monitoring event and documented within the site operating record.

(c) Discontinuation of Leachate Management

The site operator may submit data and information from the closed units to the TCEQ executive director to demonstrate that leachate no longer poses a threat to human health and the environment. Upon the executive director's approval of the demonstration, the site operator will be allowed to stop managing leachate at the closed unit.

10. **Continuation of Monitoring Systems Operation and Maintenance:**

The site operator will continue to conduct monitoring systems operation and maintenance activities to ensure the integrity of the containment system and to promptly detect and control releases to the environment during the post-closure care period as follows.

(a) Groundwater Monitoring System

The site operator will continue groundwater monitoring activities (including sampling, analysis, reporting, etc.) in accordance with the approved site-specific Groundwater Sampling and Analysis Plan (GWSAP) found in Part III, Attachment 11 of the Site Development Plan, the Groundwater Monitoring System Design found in Part III, Attachment 11 of the Site Development Plan and consistent with the provisions under 30 TAC Chapter 330 Subchapter J. Groundwater monitoring will be conducted semiannually or as otherwise approved by the TCEQ executive director during the post-closure care period.

i. Inspection of the Groundwater Monitoring System

During each groundwater monitoring event, the site operator will perform inspection of all the groundwater monitoring wells that are part of the groundwater monitoring system and other items discussed in the GWSAP or the Groundwater Monitoring System Design. The items and components of the groundwater monitoring system to be inspected are included in Table 9:

Table 9: Groundwater Monitoring Systems Inspection

Inspection Item/Component	Types of Deficiency Conditions to be looked for during Inspection
Lock	Inspect for proper working order & signs of damage by vandalism, animals, heavy equipment, or other causes
Protective Casing	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes
Collar	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes
Concrete Pad & Bollards	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes
Casing	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes

ii. Maintenance and Repair of the Groundwater Monitoring System

The site operator will perform needed maintenance and/or repairs of the groundwater monitoring system items and components based on the inspection results. Maintenance and/or repairs will be performed no later than the next scheduled monitoring event.

iii. Documentation of Inspection, Maintenance, and Repairs

The site operator will document and discuss the results of the groundwater monitoring system inspection, maintenance, and repair activities in the groundwater monitoring report submitted to the TCEQ executive director, and maintain the documents in the site operating record.

(b) Landfill Gas Management System

During the post-closure care, the site operator will continue landfill gas monitoring operations and activities, documentation, and reporting in accordance with the facility's landfill gas management plan and consistent with the requirements under 30 TAC Chapter 330, Subchapter I.

i. LFG Monitoring and Monitoring System Inspection

All structures and perimeter gas monitoring probes will be sampled quarterly or more frequently as approved by the TCEQ executive director. The site operator will conduct routine inspections of the landfill gas management system components as provided in the landfill gas management plan during the post-closure care period. The items and components to be inspected are included in Table 10.

Table 10: Landfill Gas Management System Inspection

Inspection Item/Component	Types of Deficiency Conditions to be looked for during Inspection
Lock	Inspect for proper working order & signs of damage by vandalism, animals, heavy equipment, or other causes
Monitoring Probe	Inspect for proper working order & signs of damage by vandalism, animals, heavy equipment, or other causes
Casing	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes
Concrete Pad & Bollards	Inspect for signs of damage by vandalism, animals, heavy equipment, or other causes

ii. LFG Management System Maintenance

The site operator will perform routine and needed maintenance of the landfill gas management system including calibration of the monitoring equipment. Needed maintenance and/or repair work will be performed based on the inspection and monitoring results no later than the next scheduled monitoring event.

(c) Continuation of Earth Electrical Resistivity Survey

The site operator will, if applicable, continue earth electrical resistivity surveys as applicable at the frequency stated in the approved site development plan or as otherwise approved by the TCEQ executive director.

11. Detection of a Release, Nature and Extent Investigation, and Corrective Action to Address Release from the MSW Unit

If there is evidence of a release from the landfill or other associated waste management units at the facility, the site operator will:

- Notify the executive director of the TCEQ of the condition detected;
- Investigate, if so directed by the executive director of the TCEQ, whether a release from the landfill or other associated waste management units at the facility has occurred;
- Investigate the nature and extent of the release, if a release is confirmed;

- Assess measures necessary to correct any impact to groundwater;
- Submit a corrective action plan via a permit modification for TCEQ executive director's review and approval; and
- Conduct corrective action as approved by the TCEQ executive director.

12. **Revision of the Length of Post-Closure Care Period**

(a) The Post-Closure Care Period May Be Decreased

The length of the post-closure care period may be decreased by the TCEQ executive director if the site operator submits a documented certification signed by a licensed professional engineer and including all applicable supporting documentation that demonstrates that the reduced period is sufficient to protect human health and the environment, and the executive director approves the decrease in writing after review.

(b) The Post-Closure Care Period May be Increased

The length of the post-closure care period may be increased by the TCEQ executive director if it is determined that the longer period is necessary to protect human health and the environment.

V. Recordkeeping

The site operator will place a copy of this post-closure plan in the facility's site operating record by the initial receipt of waste at the units proposed at the time of this application. Also, the site operator will document and maintain records of all inspection, monitoring, maintenance, repair, or remediation activities, and detail the results of any inspection and schedules of any other actions to be taken to maintain compliance, in the site operating record.

VI. Planned Use of the Land during and after the Post-Closure Care Period

Post-closure use of the property will not disturb the final cover, liners, or other containment or monitoring systems unless such disturbance is necessary for the proposed use or to protect human health and the environment and is authorized by the TCEQ executive director consistent with provisions under 30 TAC Chapter 330 Subchapter T.

Description of the Planned Use of the Land during or after the Post-Closure Care Period *(describe the planned use of the land during or after the post-closure care period; if not known at this time, enter "NOT KNOWN")*:

NOT KNOWN

VII. Post-Closure Care and Corrective Action Cost Estimates

A detailed written cost estimate in current dollars for conducting post closure care is provided in *(enter location of the post-closure care cost estimate in the application/permit document)*:

Part III, Attachment 8

The cost estimate for corrective action will be provided as needed, via a permit modification, during the life and/or post-closure care period of the unit or facility.

VIII. Certification of Completion of Post-Closure Care

Upon completion of the post-closure care maintenance period for each municipal solid waste landfill unit, the site operator will submit to the TCEQ executive director for review and approval a certification, signed by an independent licensed professional engineer, verifying that post-closure care has been completed in accordance with the approved post-closure plan. The submittal to the executive director shall include all applicable documentation necessary for the certification of completion of post-closure care. These will include information relating to the condition and status of:

- The final cover integrity and stability, including the condition of the soil, vegetation, drainage structures, etc.
- Groundwater quality at the site, as determined from on-going groundwater detection or assessment monitoring or corrective measures data during the period.
- Landfill gas (methane) migration, as determined from on-going landfill gas monitoring and remediation data during the period.
- Leachate generation rate and quantity as determined from on-going leachate management data over the period.
- The surface water management system.
- Access control structures.

The engineer's certification of post-closure will show that, based on a summary of monitoring and inspection results, the final cover system continues to maintain its integrity, stability, and function; groundwater remains uncontaminated and monitoring is no longer required; landfill gas is not migrating beyond the facility boundary or accumulating in structures at action levels and monitoring is no longer required; leachate generation rate and quantity will not result in greater than 12 inches of head above the liner, no breakouts have occurred, and all slopes remain as approved and leachate management is no longer required; the surface water management system continues to function as designed; and the access control structures remain intact.

Documentation supporting the professional engineer's certification will be furnished to the TCEQ executive director upon request and will be maintained in the site operating record until the executive director acknowledges termination of post-closure in writing.

IX. Voluntary Revocation Request

Upon completion of the post-closure care period for the final unit at the facility, the site operator will submit to the executive director a request for voluntary revocation of the facility permit.

X. Attachments

The following figures and documents are attached as part of this post-closure care plan:

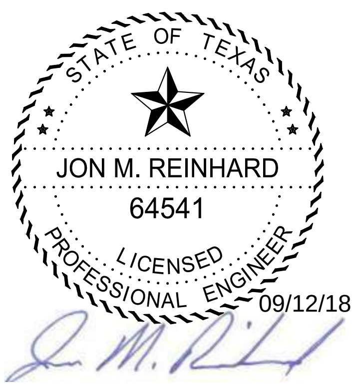
XI. Engineer's Seal and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: September 12, 2018

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal



Signature

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 14

LANDFILL GAS MANAGEMENT PLAN

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION
PART III – ATTACHMENT 14
LANDFILL GAS MANAGEMENT PLAN

City of Kingsville TEXAS

CITY OF KINGSVILLE, TEXAS

September 2018

Revision 0

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Prepared by

HANSON
Engineering | Planning | Allied Services

HANSON PROJECT NO. 16L0438-0003

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APPENDICES

1.0 INTRODUCTION

The State of Texas adopted United States Environmental Protection Agency (EPA) regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter I, Rule 330.371 requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Landfill Gas Management Plan (LGMP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill). This plan presents a program to monitor and control landfill gas. Landfill gas, containing approximately equal amounts of flammable methane and non-flammable carbon dioxide and various other trace gases, is produced by micro-organisms biologically decomposing organic wastes. The purpose of this plan is to ensure that the concentration of methane does not exceed 25 percent of its lower explosive limit (LEL) (1.25% volume) in on-site structures, or exceed the LEL for methane (5.0% volume) at the property boundary. The LEL is defined as the lowest percent by volume of a gas vapor in air capable of propagating a flame in the presence of an ignition source.

When methane is introduced into an area, the air/mixture passes through three specific ranges: lean, explosive and rich. Mixtures in the lean range, which extends from fresh air to the LEL, contain too little gas in relation to the amount of air to burn, (that is, propagation of flame does not occur on contact with a source of ignition). A mixture at the LEL, which is five (5) percent by volume, is the lowest concentration of methane in air that will explode or burn when ignited. Mixtures in the explosive or flammable range, which extends from the LEL to the upper explosive limit (UEL), will propagate flame in the presence of an ignition source. Large volumes of combustible gases or vapors in these concentrations, if ignited, can cause damage and personal injury. A mixture at the UEL (15%) has the highest concentration of combustible gas in air that will burn. Mixtures in the rich range, which extends from the UEL to 100% methane, contain too much gas is relation to air to be combustible. However, since the addition of air to these high concentrations of methane or the dispersion of these high concentrations creates mixtures in the flammable range, they must be considered equally dangerous.

The following maximum allowable methane gas concentrations have been established under 30 TAC§330.371(a)(1)(2) both for facility structures and the permitted boundary:

Table 1: Maximum Allowable Methane Gas Concentrations

Location	Maximum Allowable Percent of the LEL	Equivalent Methane Concentration
Structures	25%	1.25%
Permitted Boundary	100%	5.0%

1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture co-existing with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits, owned by the City of Kingsville, that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast of the facility, residences are widely scattered throughout undeveloped and agricultural areas.

Existing structures on the site include a permanent office building/scale house, a maintenance shop, and a truck scale. There are underground utility lines for water, phone, and electrical that run in a trench along the east permit boundary of the site and service the office/scale house. These utilities exit the site near the entrance on the southeast corner of the property. No structures are positioned on top of current or former waste placement areas.

2.0 REGULATORY SUMMARY

The requirements for the management of landfill gas are presented in 30 TAC § 330.371. 30 TAC § 330.371 is summarized below. The rule states that owners and operators ensure that methane concentrations do not exceed 1.25% volume in facility structures and 5% by volume in monitoring points at the facility boundary. Owners and operators must implement a methane monitoring program based on the specific site conditions including soils, hydrogeologic conditions, location of facility structures, etc. Monitoring must be conducted at a minimum frequency of quarterly. If methane is detected exceeding the limits specified above steps must be immediately taken to protect human health and notifications must be made. Within seven (7) days of the detection a description of the steps taken and notifications must be placed in the site operating record and within 60 days a remediation plan must be submitted to address the exceedance. Gas monitoring and control programs must continue for a period of 30 years following the final closure of the facility and monitoring and control systems must be revised as needed to maintain current and effective monitoring and control. The gas management plan will include a description of how landfill gas will be managed, a description of the proposed system including installation procedures and monitoring procedures, and a backup plan if the main system breaks down. The monitoring network must include provisions for monitoring on-site structures and all probes and structures will be sampled for methane during the monitoring period. More frequent monitoring than quarterly may be required in locations where monitoring results indicate landfill gas migration is occurring and if so, notification must be provided to the executive director.

3.0 REGIONAL AND SITE SPECIFIC GEOLOGY

The regional geology of the area is made up of silt sheet deposits. It is composed of silts, fine sands, and some caliche. It is a locally discontinuous sheet winnowed from other windblown deposits. Typically brush and grass covered, it rests on various Pleistocene deposits. Soil borings installed at the Kingsville Landfill indicate that the area is generally composed of four (4) subsurface layers. The soil borings indicate that typically the layer closest to the surface consists of black to tan silty sands and sandy clays. The second layer typically consists of white silty caliche with increasing sand content. The third layer generally consists of tan silty sand and light tan silty sand/sandstone. The fourth layer consists of a light olive green clay which serves as an aquiclude for the uppermost water bearing zone. Groundwater is typically encountered at 30-35 NGVD (National Geodetic Vertical Datum) within the tan to light tan silty sand layer.

4.0 LANDFILL GAS MONITORING PLAN

The objective of this section is to outline the procedures used to monitor for the presence of landfill gas at the Kingsville Landfill, including the procedures used to monitor for gas accumulation within on-site structures and at the permitted boundary. A final objective of the section is to ensure that the site remains within applicable regulatory and safety guidelines regarding control of landfill gas migration.

The potential for explosive gases to migrate underground at the Kingsville Landfill is affected by pressure gradients caused by the generation of landfill gas, the site geology, hydrogeology, and a number of engineering details. Coarse, porous soils such as sand and gravel allow greater lateral gas migration than finer-grained soils such as clay. Engineering details, including liner and cover systems, will limit, eliminate, or control the movement of landfill gas to desired locations. Landfill gas moves both laterally and upward through the solid waste as it is generated. Gas moving within Subtitle D cells will encounter the liner system that extends along the bottom and sides of the cell and will be directed upward. The amount of gas migrating past this liner system, if any, would be minimal.

The predominant gas generated in the initial stages of decomposition is carbon dioxide. As time passes, methane generation increases while carbon dioxide generation decreases. Methanogenesis (methane generation) continues until accessible moisture or organic material within the solid waste disposal area is consumed. According to Supplement E of the US EPA AP-42, Compilation of Air Pollution Emission Factors, typical landfill gas at steady state generation consists of:

Table 2: Typical Landfill Gas Composition

Gas Constituent	Estimated Concentration
Methane	55%
Carbon Dioxide	40%
Nitrogen (and other gases)	5%
Non-methane Organic Carbon (NMOCs)	trace

4.1 Permit Boundary Monitoring

Permit boundary monitoring will consist of quarterly monitoring of permanently installed gas monitoring probes. The gas monitoring probe network will be installed in phases such that there is at least one (1) permanent perimeter probe within 1,000 feet of any newly constructed sector prior to acceptance of waste. The use of the Gas Monitoring Probe Installation Sequence, provided as Appendix 1, will ensure that gas monitoring probes are present within 1,000 feet of new disposal areas. Based on the geologic and hydrogeological information available and the engineering design of the facility, the likelihood of offsite subsurface gas migration is minimized. Due to these conditions, along with adjacent land use and the proximity of offsite receptors, a maximum spacing of 800 feet between permanent gas monitoring probes should be considered protective of human health and the environment for this facility.

4.1.1 Gas Monitoring Probe Placement

Currently, there are nine (9) permanent gas monitoring probes (GPs) installed at this facility to detect the presence of landfill gas at the permit boundary. The existing gas monitoring probes were referred to as “monitoring gas wells” (MGWs), but will herein be referred to as GPs. Due to the planned depth of waste placement in the new sectors yet to be constructed, the existing GPs are not installed to an adequate depth to ensure that gas migrating within the subsurface and in the direction of the existing gas probes would be detected. Due to these conditions, all existing GPs will be plugged and abandoned and new GPs will be installed. As the site develops fifteen (15) GPs will be required to effectively monitor for the migration of methane from this facility. The perimeter probes are located as close as practical to the permit boundary as indicated on the Gas Monitoring Site Plan included as Appendix 2. Following the installation of each GP, its location will be surveyed to determine actual site coordinates.

The spacing of the permanent GPs is a function of site geology/hydrogeology, adjacent land use, and landfill design. The presence of the synthetic liner system used in the construction of sectors 1 through 8 greatly decreases the potential for landfill gas migration from these areas. Lateral spacing of permanent GPs shall be approximately 800 feet on the east and west sides of the disposal facility. Due to the higher concentration of residences on the north and south sides of the facility, the lateral spacing shall be approximately 600 feet along these boundaries. The locations of the permanent GPs are indicated on the Gas Monitoring Site Plan located in Appendix 2.

GPs will be designed to monitor the unsaturated subsurface zone of the facility. The installation depth of the probes will be equal to the lowest waste placement elevation. The planned gas prove elevations are listed in Appendix 3 – Gas Probe Installation Details.

4.1.2 Gas Monitoring Probe Construction

Gas probes will be installed by a Texas licensed driller and will be supervised by a licensed professional geoscientist or a licensed professional engineer. Soils will be described using the Unified Soil Classification System. The holes will be drilled with a hollow-stem or solid flight auger and will be sampled continuously during installation. All GPs will consist of one (1) inch diameter schedule 40 polyvinyl chloride (PVC) riser and machine slotted well screen. Screened intervals will be from the bottom of the bore hole to within five (5) feet of the surface. The riser will consist of solid PVC pipe and extend to approximately three (3) feet above ground surface. A clean filter pack gravel will be installed to pack the annulus one (1) to two (2) foot above the top of the well screen. The gas probe will be installed to the depth described in the above section. A bentonite seal at least one (1) foot thick will be installed above the filter pack. The gas monitoring probe will extend above grade with a concrete pad and a locking steel protective cover. The top of the riser pipe will be completed with a brass ball valve and ¼” barb fitting to allow attachment of gas sampling equipment. Protective steel pipes (bollards), set in concrete, will be installed separate from the well pad. The construction details for a typical gas monitoring probe are shown in Appendix 4 – Typical Gas Monitoring Probe Detail.

4.1.3 Utility Vents

For all underground utility trenches within the permit boundary, utility vents will be installed and monitored. Presently, there is a utility trench that enters/exits the site near the southeast corner of the facility and contains water, phone, and electrical service lines. These utilities service the scale house, maintenance shop, and the landfills leachate pumps. One (1) vent for each trench will be installed where the trench leaves the site. The utility vent locations are indicated on the Gas Monitoring Site Plan (Appendix 2). Utility vents will be installed within the backfill material of the trench utilizing hydro-excavation technology or another mechanical method of excavation. Once the excavation is complete, the vent pipe will be placed and the hole backfilled with ¼" to 1-1/2" gravel. Bentonite will be used as a surface seal. The design detail for a typical utility trench gas vents appears in Appendix 5. Additional vents will be installed for any other utility trenches constructed on-site in the future.

4.2 Landfill Gas Monitoring

At a minimum, landfill gas monitoring will be performed on a quarterly basis and will continue throughout the active and post-closure period of this facility. More frequent monitoring may be required when methane gas concentrations exceed the limits described in Section 6.0 of this plan and at those locations where results of monitoring indicate that landfill gas migration is occurring or is accumulating in facility structures.

4.2.1 Safety Considerations

Methane, a large component of landfill gas, poses an explosive hazard at concentrations between five percent (5%) and fifteen percent (15%) by volume in air. Personnel monitoring methane concentrations will extinguish all sources of ignition prior to opening enclosed spaces including, but not limited to, gas monitoring probes, buildings, maintenance shops, and vents.

4.2.2 Inspection and Maintenance

Each time gas monitoring is conducted, the integrity of the gas monitoring probe will be inspected. If any damage to the monitoring probe, casing, pad, lock, or bollards is observed the damage will be noted on the Gas Monitoring Field Data Report shown in Appendix 6, and if possible, the damage will be repaired. If damage to the probe is severe enough to render it unsuitable for monitoring, it will be decommissioned and replaced with a new gas monitoring probe.

4.2.3 Monitoring Equipment

Gas probes, facility structures, and utility vents will be monitored for the presence of landfill gases with a portable gas analyzer/analyzers capable of displaying the following parameters: percent volume of methane, percent LEL of methane, and percent volume of oxygen. The gas analyzer will be equipped with flexible tubing that can be connected directly to the fittings on the perimeter gas probes, allowing a sample of the gas to be drawn by a pump into the analyzer. The gas analyzer will be equipped with a hydrophobic inlet filter or water trap to prevent the entrance of water into the analyzer.

4.2.4 Instrument Calibration

The portable gas analyzer will be field-calibrated immediately prior to beginning the perimeter monitoring. The portable gas analyzer will be calibrated to methane gas. Verification of instrument calibration will be repeated at the conclusion of the monitoring activity to ensure data accuracy. Calibration steps will follow the gas analyzer manufacturer's recommended procedures.

4.2.5 Perimeter Gas Probe Monitoring

All perimeter gas probes, facility structures, and utility vents will, at a minimum, be monitored on a quarterly basis. Personnel will utilize the Gas Monitoring Field Data Report provided in Appendix 6, and will operate all equipment in accordance with the manufacturers' instructions. In general, perimeter gas probe monitoring will be conducted as follows:

- Inspect Gas Probe for damage;
- Remove lock and open gas monitoring probe protective cover;
- Ensure the portable gas analyzer has been field calibrated;
- Attach gas analyzer tubing to fitting on gas probe;
- Open the valve on the probe allowing the portable gas analyzer to draw in a sample;
- Record stabilized readings for methane (CH_4) % Volume, (CH_4) % LEL, and Oxygen (O_2) % Volume;
- Close the valve, disconnect the analyzer sampling tube, and replace the cover and lock.
- Notify the landfill manager if any maintenance needs to be undertaken or if any problems were encountered during data collection.

These procedures are listed as a general guide only and may vary throughout the life of the site as equipment types change.

4.2.6 Utility Vent Monitoring

Utility vent monitoring will be conducted, at a minimum, on a quarterly basis. As with the perimeter gas monitoring probes, more frequent monitoring may be required when methane gas concentrations exceed the limits described in Section 6.0. Utility vent monitoring will be conducted as follows:

- Inspect the vent for damage;
- Ensure the portable gas analyzer has been field calibrated;
- Place the gas analyzer hose inside of the utility vent and allow the analyzer to draw in a sample;
- Allow the gas concentrations to stabilize and record the concentrations of the following parameters: (CH_4) % Volume, (CH_4) % LEL, and Oxygen (O_2) % Volume
- Notify the landfill manager if any maintenance needs to be undertaken or if any problems were encountered during data collection.

These procedures are listed as a general guide only and may vary throughout the life of the site as equipment types change.

4.2.7 Building/Structure Monitoring

All facility structures will be monitored, at a minimum, on a quarterly basis for the presence of methane gas. If any other structures are constructed at this facility in the future, they will also be monitored quarterly for the presence of methane gas. Any structures built on top of the waste disposal area will be continuously monitored for methane. No structures currently exist or are planned for construction on top of the waste disposal area. As with the perimeter gas probe and vent monitoring, personnel will utilize the Gas Monitoring Field Data Report form and will operate all equipment in accordance with the manufacturer's instructions. Multiple areas around and underneath each building/structure will be monitored. All enclosed areas will be screened for the presence of methane.

5.0 RECORD KEEPING AND REPORTING

5.1 Monitoring Results / Reporting

All gas monitoring results and observations will be recorded on the Gas Monitoring Field Data Report form (Appendix 6) during each monitoring event. Copies of the completed forms will be furnished to the landfill manager and placed into the site operating record.

Records of all monitoring events will be retained in the site operating record and not submitted to TCEQ unless methane concentrations exceeding the action limits are detected. If the methane concentration at any perimeter gas probe exceeds five percent (5%) by volume (the methane LEL), or the methane concentration in or under any structure exceeds one and one-quarter percent (1.25%) by volume (25% of the LEL), the current methane monitoring results will be submitted to the TCEQ. Monitoring results will be submitted on a quarterly basis thereafter until methane concentrations fall below 5% by volume in the perimeter gas probes and 1.25% by volume in or under facility structures.

5.2 Installation of Gas Monitoring and Control Systems

A record of the installation of each gas monitoring structure and/or control system will be maintained in the site operating record and submitted to the TCEQ. The record will include the following:

- The landfill site plan showing the location, elevation, and identification number of each gas monitoring structure or control system;
- A Gas Monitoring/Control System Installation Report, including a borehole detail or log (if applicable) along with the identification number and the name of the person logging the hole, the construction materials and depths, the extent and the type of filter pack, the thickness and the material used for seals, the extent and the material used for backfill, the size and spacing of the screen slots or perforations, and a description of any other appurtenances. The Gas Monitoring and Control System Installation Report form is included as Appendix 7.

6.0 DATA EVALUATION AND RESPONSE

During any gas monitoring event, the field data will be evaluated to determine if additional actions will be required.

6.1 Methane Gas Assessment Monitoring

If the quarterly monitoring results indicate that excessive concentrations of methane are accumulating under or within any landfill structures or migrating beyond the permit boundary, more frequent monitoring of methane concentrations will be required to assess the gas migration issue. The results of assessment monitoring will also be used to determine the scope of the remediation effort required to alleviate the problem.

If methane concentrations greater than one and one-quarter percent (1.25%) by volume (25% of the LEL) are detected at any of the perimeter gas probes, the gas monitoring frequency at the affected probe/probes location and the probe on either side of the affected probe/probes will be increased to monthly to assess the problem. If methane concentrations greater than three and three-quarter (3.75%) by volume (75% of the LEL) are detected in any of the perimeter gas probes, the gas monitoring frequency for those probes will be increased to biweekly.

If methane concentrations greater than three-quarter percent (0.75%) by volume (15% of the LEL) are detected within or under any landfill structures, the gas monitoring frequency at the affected location will be increased to monthly to assess the problem. If methane concentrations greater than one and one-quarter percent (1.25%) by volume (25% of the LEL) are detected within or under any structures, monitoring will be increased to daily within facility structures. The frequency of assessment monitoring is summarized in Table 3.

Table 3: Assessment Monitoring Frequency

Location	Methane Concentration Detected	Assessment Monitoring Frequency
Perimeter Probe	1.25% by volume (25% LEL)	Monthly
	3.75% by volume (75% LEL)	Biweekly
Landfill Structure	0.75% by volume (15% LEL)	Monthly
	1.25% by volume (25% LEL)	Daily

6.2 Response to Detection of Excessive Methane

If the concentration of methane gas at any perimeter gas probe exceeds five percent (5%) by volume (the LEL) of methane, or the concentration of methane in or under a facility structure (excluding gas control or recovery system components) exceeds one and one-quarter percent (1.25%) by volume (25% of the LEL), the following schedule of notification and corrective action will be instituted by the City of Kingsville:

- Immediately take all necessary steps to ensure protection of human health;
- Notify the TCEQ, all appropriate local and county officials, local emergency response organizations, and the owners of any off-site property or utilities within ¼ mile (1,320 feet) of the probe exhibiting excessive methane gas levels;
- Within seven (7) days of detection, place in the site operating record the methane gas levels detected and a description of the steps taken to protect human health;
- Within sixty (60) days of detection, determine the nature and extent of the methane gas release, and implement the remediation plan outlined in the following sections;
- Place a copy of the remediation plan in the site operating record;
- Provide a copy of the remediation plan to the TCEQ and notify the Executive Director that the plan has been implemented; and,
- Comply with any additional remedial measures required by the TCEQ subsequent to their review of the plan.

Results of assessment monitoring will be submitted to the TCEQ on a quarterly basis during the period of more frequent monitoring.

7.0 METHANE REMEDIATION PLAN

If methane monitoring results indicate that excessive concentrations of methane are accumulating under or within any landfill structures or migrating beyond the permit boundary, a methane gas control system will be installed as part of the methane remediation plan. The following sections outline gas control systems that have been or may be installed at this facility following the implementation of a methane remediation plan.

Once a methane remediation plan has been implemented and a gas control system is in place, assessment monitoring will continue in order to determine the effectiveness of the remediation effort. Monitoring frequency will return to quarterly after the methane concentration has decreased to less than three-quarter percent (0.75%) by volume (15% of the LEL) within or under all landfill structures and to less than one and one-quarter percent (1.25%) by volume (25% of the LEL) at the perimeter gas probes and utility vents for a period of three (3) consecutive months.

8.0 GAS CONTROL SYSTEMS

8.1 Passive Gas Control Systems

The passive gas control system is designed to minimize the migration of landfill gas laterally off-site by either intercepting the gas and diverting it upwards at the perimeter or by reducing the gas pressure within the waste to reduce lateral gas movement. The passive venting methods allow the gas produced by the decomposition of waste to be released to the atmosphere as it migrates through the waste and the surrounding area. There are a number of passive methods available to help control this migration; these include vertical gas vents, vent trenches, and vents placed within the waste. A vertical vent is typically constructed by installing a four (4) inch perforated pipe into a boring that is then backfilled with gravel, and plugged with bentonite. The perforated pipe is attached to a solid riser pipe that extends above ground and is typically terminated with a turbine or a U-shaped downward facing opening. A vent trench is typically constructed by excavating a narrow trench, lining the outermost wall of the trench with a flexible membrane liner (FML), installing perforated pipe with a solid riser in the excavation and backfilling with gravel. The vents within a vent trench are typically terminated similar to the vertical vent method above. Vents placed within the waste are similar to a vertical vent but are bored through the FML in place over the waste and a boot is used to seal the pipe around the FML. Due to the design capacity of this facility, passive venting complies with TCEQ air emissions requirements in 30 TAC § 115 and 30 TAC § 330 at this time.

The methane gas control system currently in place at this facility includes a passive vertical vent system along the southern and eastern permit boundaries adjacent to Sector 1 and Sector 2. At present, there are a total of forty nine (49) gas vents at the facility. Twenty (20) gas vents are located along the eastern permit boundary and twenty nine (29) along the southern boundary. These vertical gas vents were constructed of four (4) inch perforated PVC pipe in a thirty six (36) inch diameter bore hole. The area around the pipe was backfilled with gravel and sealed with bentonite. The gas vents on the southern boundary are set to twenty (20) feet deep and the vents on the eastern boundary are set to twenty five (25) feet deep. This control system was installed to prevent the migration of methane beyond these boundaries. A Site Map showing the locations of the existing gas vents may be found in Appendix 2. The As-Builts for the passive gas vents can be found in Appendix 8. Other alternative passive control systems include the installation of vent trenches along the permit boundaries and the installation of vents within the waste to relieve the gas build-up. These passive gas control systems may be pursued or implemented in the future, if necessary. Construction details for the landfill gas vent trenches can be found in Appendix 9 and design details for vents placed in the waste are provided in Appendix 10.

The number and type of vents installed will depend on the extent of the methane migration problem. If an excessive methane concentration is detected in a gas probe, appropriate gas vents will be installed in the area of the affected gas probe. Additional vents will be installed if gas continues to be detected in individual probes. Prior to the installation of the final landfill cover, installation of passive vents will be limited to the perimeter of the facility and those portions of the landfill that are filled to permitted waste elevations. Due to the current size of the landfill and site specific Tier II Non Methane Organic Chemical (NMOC) Emissions, these types of passive systems can be pursued but are dependent on current New Source Performance Standards (NSPS) regulations and landfill development.

8.1.1 Gas Vent System Installations

Prior to construction, a registered professional engineer will obtain and review all applicable test reports, shop drawings, and manufacturer's certificates to verify that all equipment used in the landfill gas control system has been manufactured in accordance with industry standards. The installation method for the gas vents will vary depending upon the location and type of the vent. All gas vents will be constructed to allow subsequent conversion to a gas collection/extraction system, if required by the continued migration or accumulation of excessive concentrations of methane. A flange will be installed on each vent pipe aboveground to allow connection to a gas collection/extraction system.

Equipment such as a pier drilling rig may be used to drill the well vents within the waste. Perimeter trench vents will be constructed using a backhoe or tracked excavator. The depth of each vent will be at least three-quarters of the waste fill depth at that point. A minimum clearance of five (5) feet will be allowed from the bottom of the vent to the top of the landfill liner system. Survey control will be used to maximize the protection of the liner system. If possible, vents will be installed prior to the construction of the final cover system. If vents must be installed after construction of the final cover system, the FML will first be exposed and penetrated prior to commencing the drilling operation. All cover penetrations will be repaired as indicated on the design drawings in Appendix 10.

Gas vents in the waste shall consist of four (4) inch diameter high density polyethylene (HDPE) perforated pipe and solid riser. The gas vent will be screened from the bottom of the boring up to seven (7) feet below the top of the final cover. A clean one (1) to one and one-half (1 ½) inch diameter gravel will be installed to gravel pack the annulus to at least one (1) foot above the top of the well perforations. Bentonite chips will be installed to seal the annulus up to the pipe boot, depending on the location of the vent. Solid wall pipe and a gas vent riser will extend from the top of the screen to approximately three (3) feet above the final grade. A HDPE flange will be fusion welded to the top of the riser pipe and a turbine ventilator will be installed.

8.2 Active Gas Control System

If the passive gas control system breaks down, is ineffective, or cannot be pursued due to the NSPS regulations, then the conversion of the passive vent system to an active gas control system will be pursued. An active gas control system collects the methane by closing the passive gas vents off from the atmosphere and connecting the gas recovery wells with piping to a vacuum pump or blower. The gas collected by this type of control system is normally incinerated in a flare, which will be permitted under current air regulations. This facility has a design capacity greater than 2.5 million megagrams by mass or 2.5 million cubic meters by volume, and is therefore subject to New Source Performance Standards (NSPS) regulations. An active gas control system will be the only type of system pursued once this facility exceeds current NMOC emissions limits.

The active gas control system will consist of converting any existing passive vents in place in the waste to active gas extraction wells by removing the existing vent termination (turbine ventilator) and replacing it with a wellhead valve assembly as shown in Appendix 10. In addition to these modifications, new collection piping, a blower/flare assembly, and a condensate management system will be installed as shown in Appendix 11. The converted gas extraction wells will be connected to the blower by a belowground gas collection piping system. The gas collection system will use flexible couplings to connect the gas recovery wells to collection headers in order to allow for uneven settlement of the waste over time. Any gas condensate produced during the collection of the landfill gas will be drained from the gas collection system for storage and treatment with landfill leachate. A blower will be used to create a vacuum to extract the landfill gas from the refuse and convey it through the collection piping system to the blower/flare station. The collection piping will be sloped to prevent low points where landfill gas condensate could accumulate and block gas flow.

Each wellhead will be equipped with a flow control valve for adjusting the vacuum and landfill gas extraction rate and a sampling port for monitoring landfill gas parameters (differential pressure, static pressure, temperature, and composition).

The extracted landfill gas will be discharged from the blower to a utility flare installed downstream from the blower outlet. The flare will be designed with a windshield and automated propane pilot ignition system. A flame arrestor will also be installed on the flare to prevent "flashback" or propagation of flame from the flare back into the landfill gas piping system.

A master flow control valve will be installed to control the flow of landfill gas from the main header into the blower. A moisture/condensate knockout tank will be installed immediately upstream from the blower inlet to capture any condensate before it enters the blower.

If methane is present in sufficient quantity, energy can be recovered during incineration of the gas. Landfill gas can be processed and used either as a boiler fuel or to produce electricity using internal combustion engines. Another alternative is to upgrade the landfill gas to pipeline quality for delivery to utility distribution systems. Typical landfill gas contains 300 to 500 British Thermal Units (BTUs) per standard cubic foot (SCF) of energy compared to 1000 BTU/SCF for pipeline-quality gas. In order to be used as a boiler fuel, excess moisture must be removed from the landfill gas using a scrubber, chiller, or other process. In order to upgrade the gas to pipeline quality, moisture, carbon dioxide, hydrogen sulfide, and other trace contaminants usually must be removed.

The landfill gas extraction and process system must be operated and monitored carefully to minimize the explosive risk posed by the high methane gas concentration. The concentration of methane in the landfill gas will be monitored and recorded regularly. In addition, the concentration of methane in the area surrounding the process equipment will be regularly monitored. An alarm will notify the operators of the gas recovery system if the ambient methane concentration rises above twenty-five (25) percent of the LEL (or 1.25 percent by volume), and the landfill gas extraction system will shut down until the source of the gas leak is located and repaired.

Once installed, this system will be operated and maintained throughout the active life of the facility and through the closure and post closure care period.

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 1

GAS MONITORING PROBE INSTALLAION SEQUENCE

Gas Probe Installation Sequence								
MSW Permit Number	235-A	235-B	235-B	235-C	235-C	235-C	235-C	235-C
Probe No.	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8
GP-1	X	X	X	PA	PA	PA	PA	PA
GP-1R	ND	ND	ND	X	X	X	X	X
GP-2	X	X	X	PA	PA	PA	PA	PA
GP-3	X	X	X	PA	PA	PA	PA	PA
GP-3R	ND	ND	ND	X	X	X	X	X
GP-4	X	PA	PA	PA	PA	PA	PA	PA
GP-5	ND	X	X	PA	PA	PA	PA	PA
GP-5R	ND	ND	ND	X	X	X	X	X
GP-6	ND	X	X	PA	PA	PA	PA	PA
GP-6R	ND	ND	ND	X	X	X	X	X
GP-7	ND	X	X	PA	PA	PA	PA	PA
GP-7R	ND	ND	ND	X	X	X	X	X
GP-8	ND	ND	X	X	X	X	X	X
GP-9	ND	X	X	PA	PA	PA	PA	PA
GP-9R	ND	ND	ND	X	X	X	X	X
GP-10	ND	X	X	PA	PA	PA	PA	PA
GP-10R	ND	ND	ND	X	X	X	X	X
GP-11	ND	X	X	PA	PA	PA	PA	PA
GP-11R	ND	ND	ND	X	X	X	X	X
GP-12	ND	ND	ND	ND	ND	X	X	X
GP-13	ND	ND	ND	ND	ND	ND	X	X
GP-14	ND	ND	ND	ND	ND	ND	X	X
GP-15	ND	ND	ND	ND	ND	ND	X	X
GP-16	ND	ND	ND	ND	ND	ND	ND	X
GP-17	ND	ND	ND	ND	ND	ND	ND	X

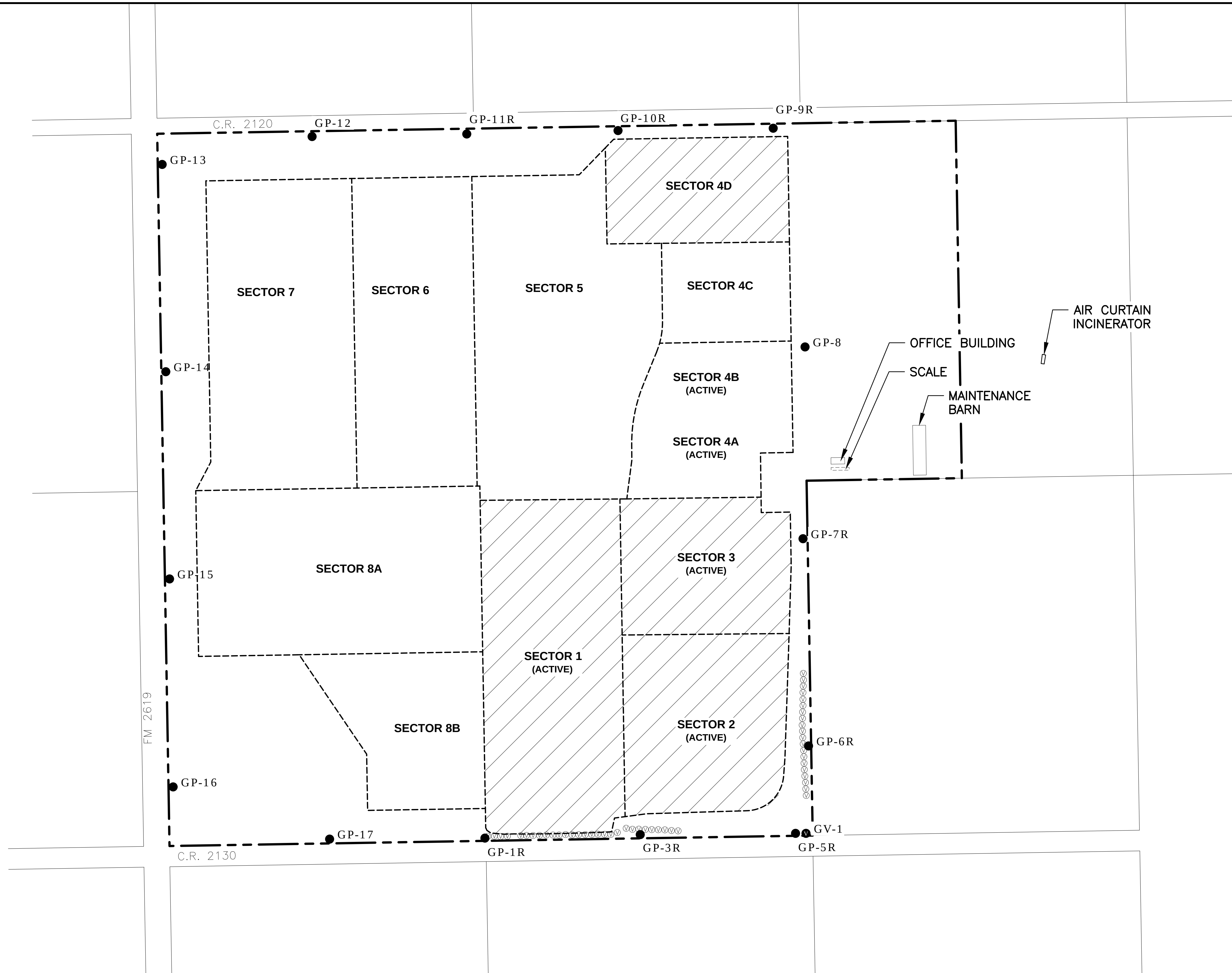
X = An operating gas probe in the current gas monitoring system
ND = A gas monitoring probe which has not been drilled yet
PA = A well that has been Plugged and Abandoned

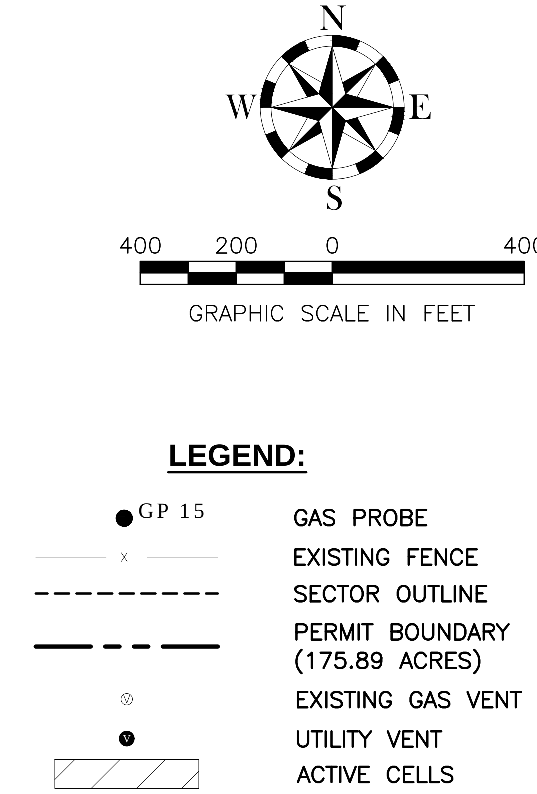
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 2

GAS MONITORING SITE PLAN





GAS PROBE LOCATIONS			GAS PROBE DEPTH (FEET) BGS
	SITE COORDINATES		
GP	NORTHING	EASTING	
GP–1R	17051263.8190	1204888.9816	35.90
GP–3R	17051277.3811	1205488.9816	27.21
GP–5R	17051282.2620	1206088.9816	30.64
GP–6R	17051619.6274	1206139.2150	34.73
GP–7R	17052419.6274	1206117.8621	39.50
GP–8	17053159.9300	1206125.7800	37.39
GP–9R	17054004.2022	1206002.7210	34.86
GP–10R	17053995.2004	1205403.1645	35.38
GP–11R	17053981.8903	1204818.8997	30.12
GP–12	17053972.1570	1204221.4253	27.04
GP–13	17053864.3664	1203642.2362	25.32
GP–14	17053064.3664	1203656.2724	25.88
GP–15	17052264.3664	1203670.6988	35.27
GP–16	17051461.5924	1203684.6171	35.87
GP–17	17051260.0121	1204288.9816	45.23
PROPOSED UTILITY VENT			
GV–1	17051282.2620	1206129.3790	––

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NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename 8514-03-SOIL BORING
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III-ATTACHMENT 14
APPENDIX 2
GAS MONITORING SITE PLAN
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.14-2-1

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 3

GAS PROBE INSTALLAION DETAILS

Gas Probe Installation Details

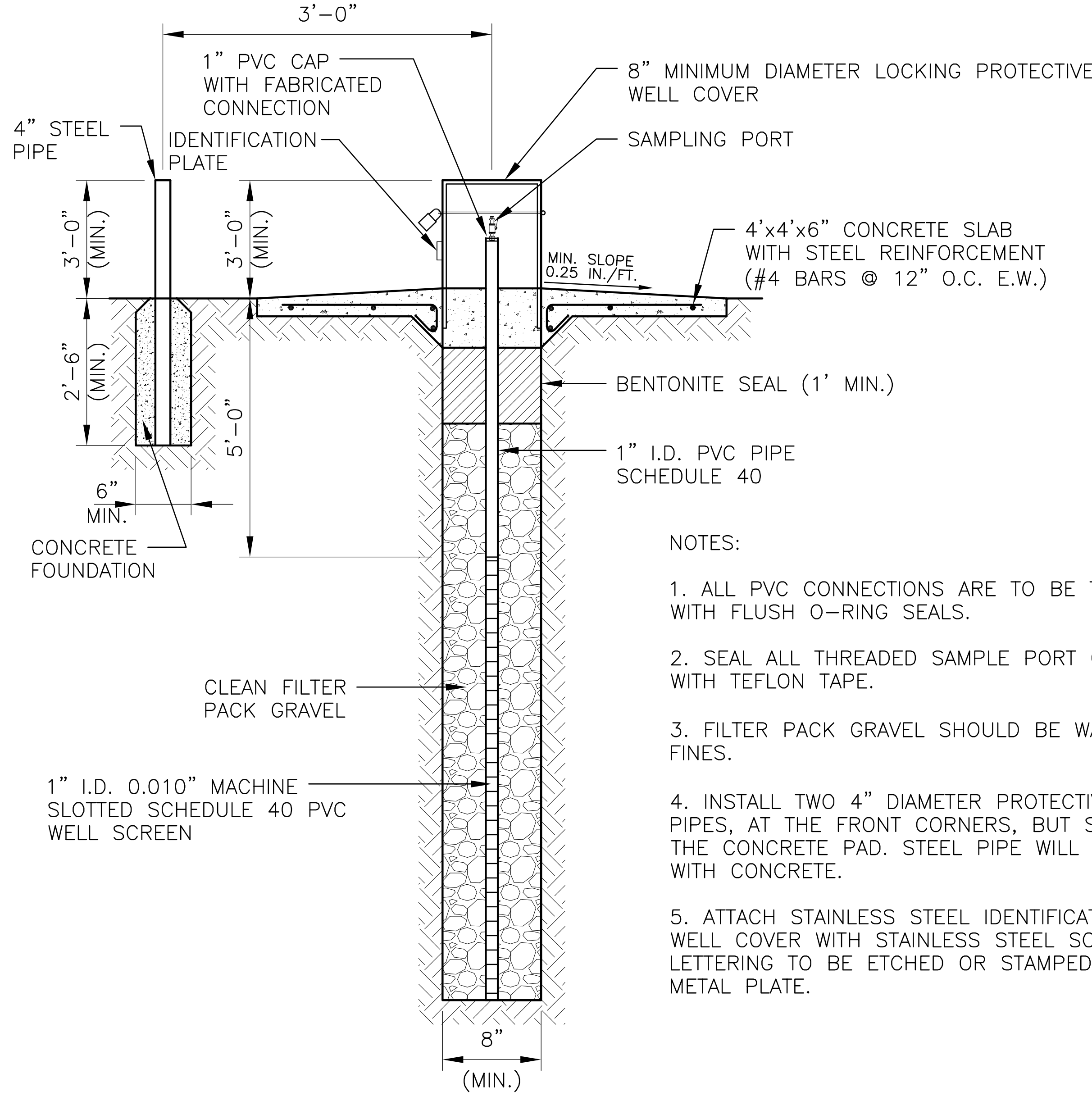
		Gas Probe Borehole Total Depth		Screened Interval	
Gas Probe ID	Ground Elevation (ft NGVD)	(ft bgs)	(ft NGVD)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)
GP-1R	58.40	35.90	22.50	5	35.90
GP-3R	49.71	27.21	22.50	5	27.21
GP-5R	53.14	30.64	22.50	5	30.64
GP-6R	57.23	34.73	22.50	5	34.73
GP-7R	62.00	39.50	22.50	5	39.50
GP-8	59.89	37.39	22.50	5	37.39
GP-9R	57.36	34.86	22.50	5	34.86
GP-10R	57.88	35.38	22.50	5	35.38
GP-11R	52.62	30.12	22.50	5	30.12
GP-12	49.54	27.04	22.50	5	27.04
GP-13	47.82	25.32	22.50	5	25.32
GP-14	48.38	25.88	22.50	5	25.88
GP-15	57.77	35.27	22.50	5	35.27
GP-16	58.37	35.87	22.50	5	35.87
GP-17	67.73	45.23	22.50	5	45.23

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 4

GAS MONITORING PROBE DETAIL



NOTES:

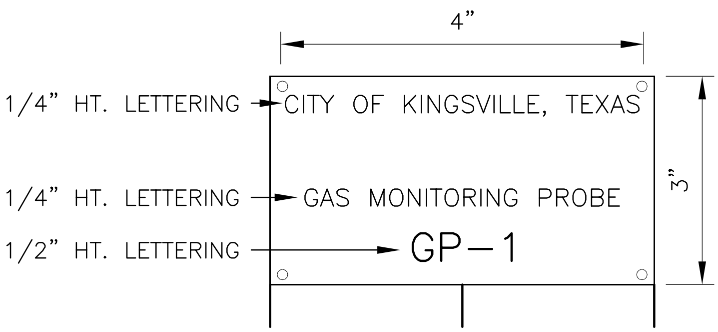
1. ALL PVC CONNECTIONS ARE TO BE THREADED WITH FLUSH O–RING SEALS.

2. SEAL ALL THREADED SAMPLE PORT CONNECTIONS WITH TEFLON TAPE.

3. FILTER PACK GRAVEL SHOULD BE WASHED/ NO FINES.

4. INSTALL TWO 4" DIAMETER PROTECTIVE STEEL PIPES, AT THE FRONT CORNERS, BUT SEPERATE, OF THE CONCRETE PAD. STEEL PIPE WILL BE FILLED WITH CONCRETE.

5. ATTACH STAINLESS STEEL IDENTIFICATION PLATE TO WELL COVER WITH STAINLESS STEEL SCREWS. LETTERING TO BE ETCHED OR STAMPED ON THE METAL PLATE.



IDENTIFICATION PLATE DETAIL
SCALE: N.T.S.

STATE OF TEXAS
JON M. REINHARD
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LICENSED PROFESSIONAL ENGINEER
09/12/18

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PART III-ATTACHMENT 14
APPENDIX 4
GAS MONITORING PROBE DETAIL
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

Drawn By: DT	Appr. By: JMR	Scale: AS SHOWN	Dwg. File: 8514-03-GAS PROBE-CONST	FIGURE: III.14-4-1
Checked By: JMR	Project No.: 16L0438	Date: 09/12/2018	Rev.:	

SEP 10, 2018 1:23 PM TORRE01809
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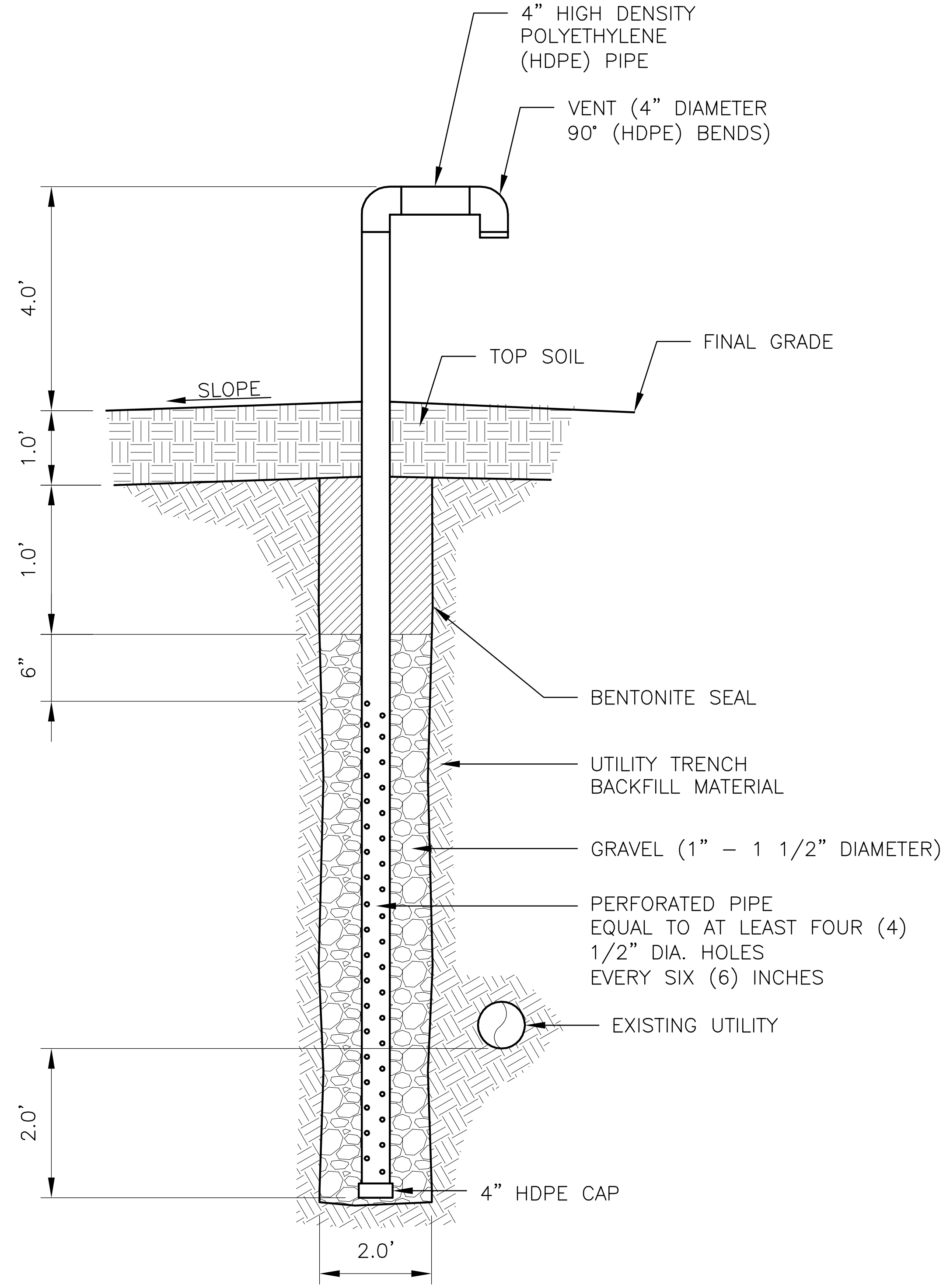
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 5

UTILITY TRENCH VENT DETAIL



STATE OF TEXAS
JON M. REINHARD
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09/12/18

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PART III-ATTACHMENT 14
APPENDIX 5
UTILITY TRENCH VENT DETAIL
CITY OF KINGSVILLE LANDFILL

MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

Drawn By: DT	Appr. By: JMR	Scale: AS SHOWN	Dwg. File: 8514-03-GAS VENT-CONST	FIGURE: III.14-5-1
Checked By: JMR	Project No.: 16L0438	Date: 09/12/2018	Rev.:	

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 6

GAS MONITORING FIELD DATA REPORT

Gas Monitoring Field Data Report

City of Kingsville Landfill, Kleberg County, Texas

TCEQ MSW Permit No. 235-C

Date:	Sampling Personnel:	
Weather Conditions:		
Barometric Pressure (inches of Mercury):	Rainfall Since Last Sampling Event (inches):	Ambient Temperature (°F):

Monitoring Location	Time	CH_4 (%) Vol.	O_2 (%) Vol.	CH_4 (%) LEL	Probe Condition
GP-1R					
GP-3R					
GP-5R					
GP-6R					
GP-7R					
GP-8					
GP-9R					
GP-10R					
GP-11R					
GP-12					
GP-13					
GP-14					
GP-15					
GP-16					
GP-17					
Gas Vent #1					
Scale House					
Under Scale					
Shop					

Signature:

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 7

GAS MONITORING AND CONTROL SYSTEM INSTALLATION REPORT

GAS MONITORING AND CONTROL SYSTEM INSTALLATION REPORT
CITY OF KINGSVILLE LANDFILL, KLEBERG COUNTY, TEXAS
TCEQ MSW Permit No. 235-C

GAS FACILITY INFORMATION	
Identification No.:	Installation by:
Gas Monitoring / Control Type:	☐ Monitoring Probe ☐ Vent ☐ Vent Trench ☐ Recovery Well ☐ Other ________
Date of Installation:	Supervising Engineer/ Geologist:
Site Coordinates:	Natural Ground Elevation:

MATERIALS AND INSTALLATION	
Type of Protective Cover:	Bore Hole/ Trench Width (inches):
Filter Pack Material:	
Bentonite Seal Material:	
Backfill Material:	
Gas Probe/ Vent:	Flexible membrane/ Pipe Boot:
Diameter (inches):	Thickness (mils):
Material:	Material:
Thickness (Schedule):	Dimensions (ft):
Perforation/ Slot Diameter (inches):	Construction of joints:
Perforation/ Slot Spacing (inches):	

Item	Elevation (feet)	Depth (feet)	Notes:
Top of protective cover/ vent			
Surface			
Top of bentonite seal			
Top of filter pack			
Top of screen section			
Bottom of gas probe/ vent screen			
Bottom of bore hole/ trench			
Signature:			

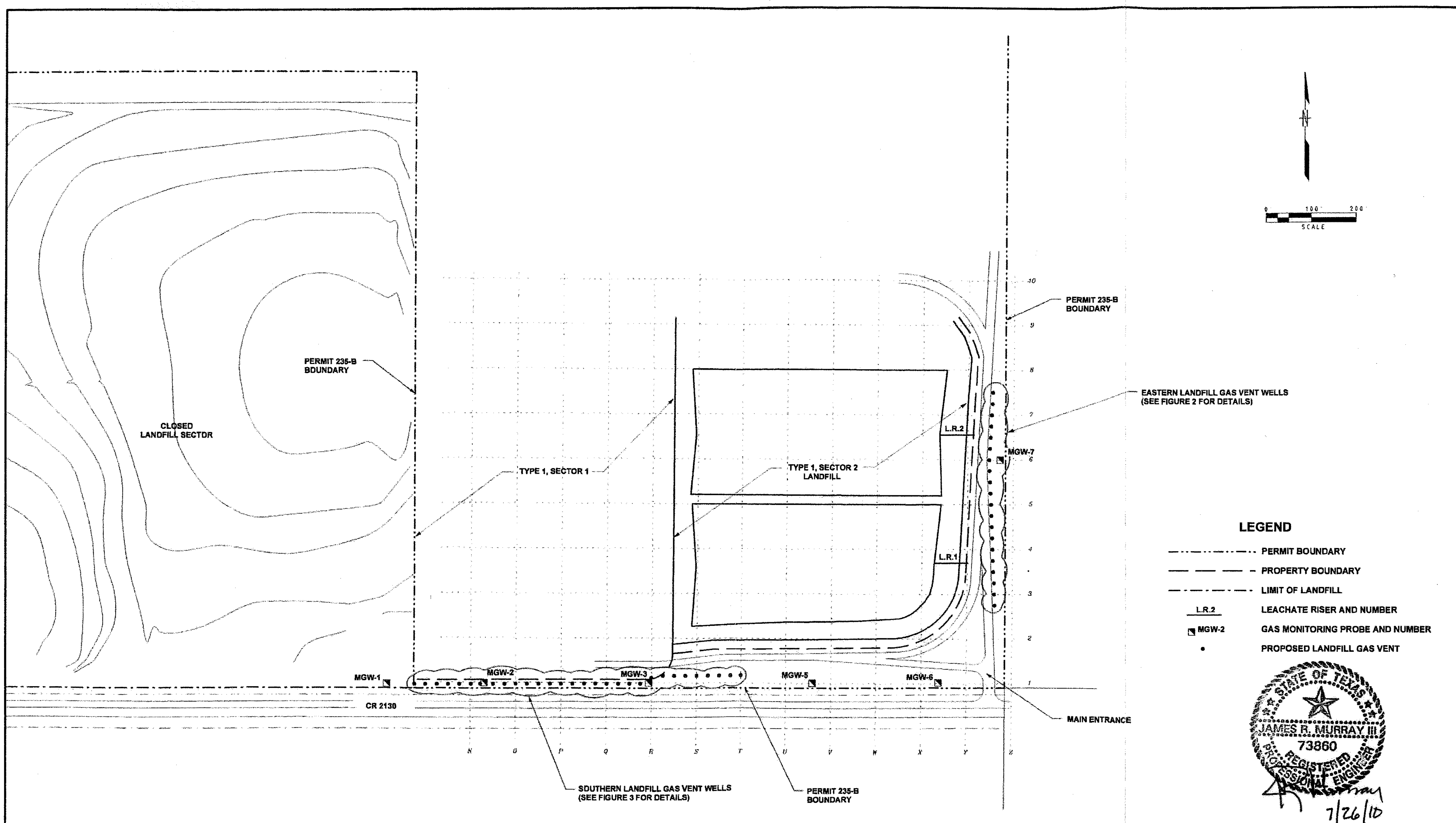
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 8

AS-BUILTS FOR PASSIVE GAS VENTS

FOR PERMIT PURPOSES ONLY

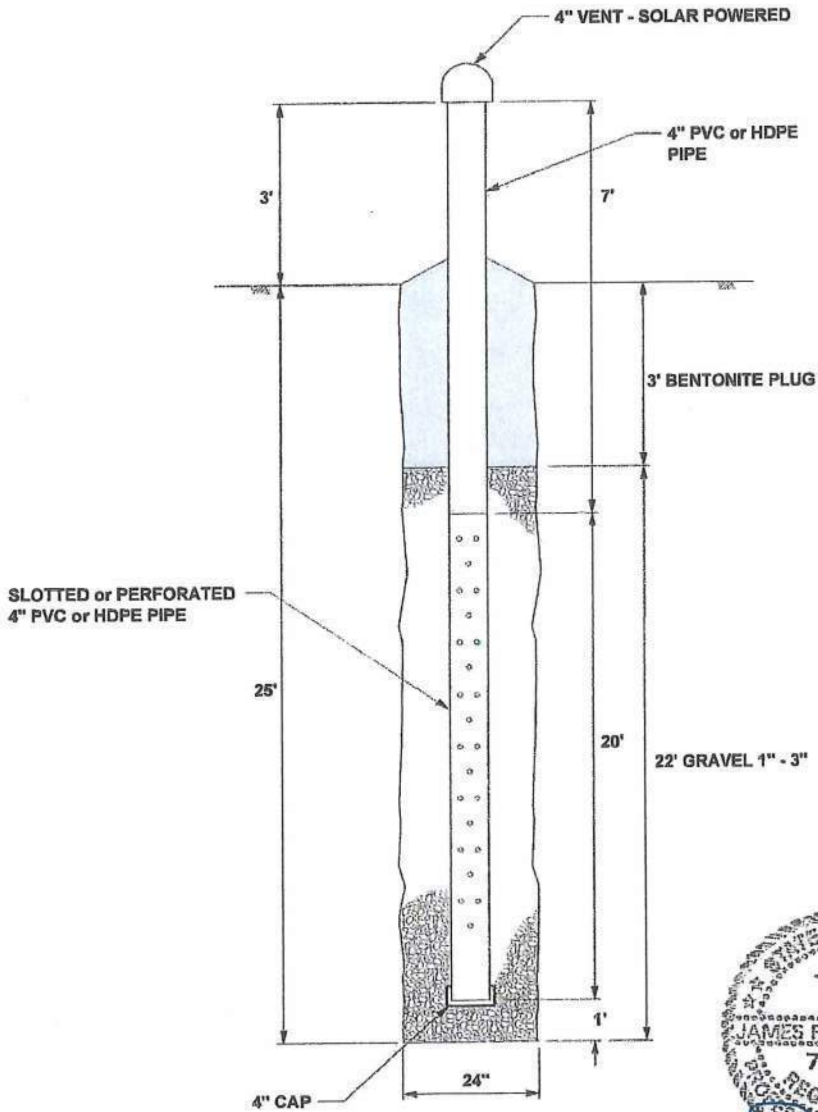


NOTE:

1. ALL LOCATIONS ARE APPROXIMATE. CONTRACTOR TO LOCATE ALL WELLS AND OTHER FACILITIES PRIOR TO BEGINNING CONSTRUCTION.
2. CONTRACTOR TO LOCATE ALL UTILITIES PRIOR TO CONSTRUCTION.

SCS ENGINEERS	July 2010 Project: 162085 File: mgw-7.dgn	CITY OF KINGSVILLE MUNICIPAL LANDFILL PERMIT NO. 235-B KINGSVILLE, KLEBERG COUNTY, TEXAS **LANDFILL GAS MIGRATION PROPOSED INTERCEPTOR VENT LAYOUT** FIGURE 1

...\Cadd\OFFICE\mgw-7.dgn Jul. 27, 2010 15:22:27



STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
7/26/10

NOTE:
GAS VENT WELLS TO BE SPACED AT 25 FEET ALONG SITE ENTRANCE ROAD AS SHOWN ON FIGURE 1.

TEXAS BOARD OF PROFESSIONAL ENGINEERS REGISTRATION NO. F-3407

SCS ENGINEERS	JULY 2010 Project: 16208533.05 File: gaswell.dgn	**CITY OF KINGSVILLE MUNICIPAL LANDFILL** **PERMIT NO. 235-B** **KINGSVILLE, KLEBERG COUNTY, TEXAS** **EASTERN MITIGATION GAS VENT WELL** **FIGURE 2**

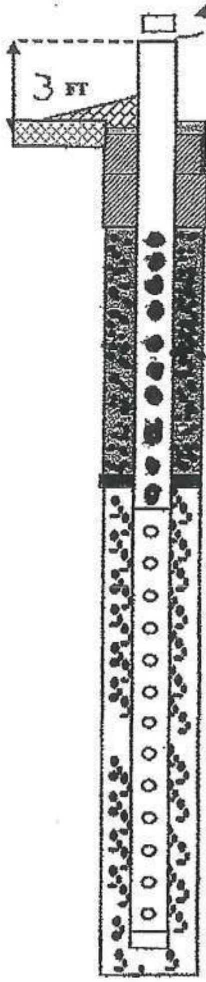
...\Cadd\OFFICE\gaswell.dgn Jul. 27, 2010 14:14:05

10/31/2007 11:21 3612992269 #7530 P.001 /002

Shaw Shaw Environmental, Inc.

DRILLING & COMPLETION LOG

Project Name: Kingsville City
Project No.: 140830
Date:
Well No.



SLIP-ON CAP

Solar Vent

BACKFILL: FT

BENTONITE: 3 FT

4" SCH 40 PVC:
ABOVE: 3 FT
BELOW: 7 FT

BENTONITE: FT

BACKFILL: FT
GEO RING

4" SCH40 PERF PIPE: 20 FT
GRAVEL PACK: 22 FT

WELL DEPTH: FT 25
BOTTOM CAP 1

BORING DIA: 36IN

DRILL	25	WEATHER	
COMP.	25	START	
ABAN.		STOP	
SOLID	7	GRAVEL	
PERF.	20		

DEPTH	COMPOSITION	TEMP	DE-COMPOSITION	AMT OF MOISTURE
0-10	soil		0	Dry
10-20	soil		0	Dry
20-30				
30-40				
40-45				
50-60				
60-70				
70-80				
80-90				
90-97				
110-120				
120-130				
130-140				

TD: 25

COMMENTS:

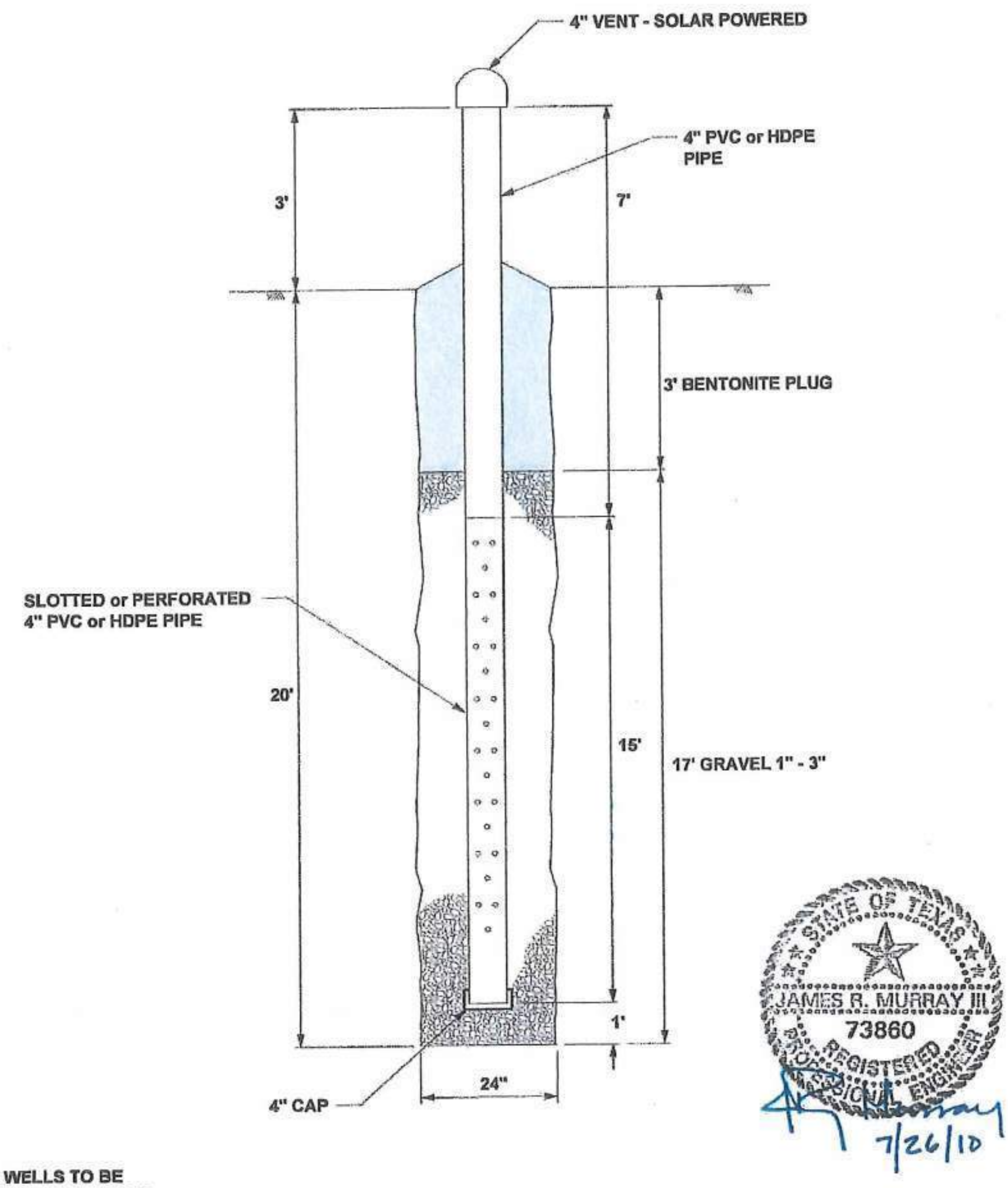
25ft x 20 each

MTRLS LEFT ONSITE: SOLID PERF TOP CAPS BOTTOM CAPS BENTONITE ISO RINGS

CLIENT REPRESENTATIVE DATE
NAME & TITLE

SHAW ENVIRONMENTAL, INC. DATE

419 424 4961



NOTE:
GAS VENT WELLS TO BE SPACED AT 25 FEET ALONG SOUTHERN BOUNDARY AS SHOWN ON FIGURE 1.

TEXAS BOARD OF PROFESSIONAL ENGINEERS REGISTRATION NO. F-3407

SCS ENGINEERS	JULY 2010 Project: 16208533.05 File: gaswell4.dgn	**CITY OF KINGSVILLE MUNICIPAL LANDFILL** **PERMIT NO. 235-B** **KINGSVILLE, KLEBERG COUNTY, TEXAS** **SHOUTHERN MITIGATION GAS VENT WELL** **FIGURE 3**

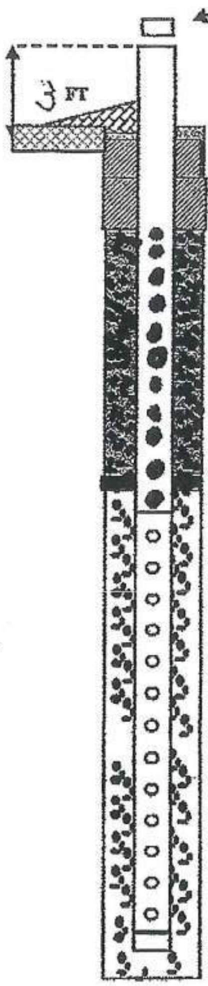
...\Cadd\OFFICE\gaswell4.dgn Jul. 27, 2010 14:12:26

10/31/2007 11:22 3612992269 #7530 P.002 /002

Shaw Shaw Environmental, Inc.

DRILLING & COMPLETION LOG

Project Name: Kingsville City
Project No.: 140830
Date:
Well No.



SLIP-ON CAP
Solar Vent

BACKFILL: FT

BENTONITE: 3 FT

4" SCH 40 PVC:
ABOVE: 3 FT
BELOW: 4 FT

BENTONITE: FT

BACKFILL: FT
GEO RING

4" SCH40 PERF PIPE: 16 FT
GRAVEL PACK: 17 FT

WELL DEPTH: FT 20
BOTTOM CAP

DRILL	20	WEATHER	
COMP.	20	START	
ABAN.		STOP	
SOLID	7	GRAVEL	
PERF.	16		

DEPTH	COMPOSITION	TEMP	DE-COMPOSITION	AMT OF MOISTURE
0-10	Soil		0	Dry
10-20	Soil		0	Dry
20-30				
30-40				
40-45				
50-60				
60-70				
70-80				
80-90				
90-97				
110-120				
120-130				
130-140				

BORING DIA: 36IN

COMMENTS:

TD: 20

20 FT X 29 Each

MTRLS LEFT ONSITE: SOLID PERF TOP CAPS BOTTOM CAPS BENTONITE ISO RINGS

CLIENT REPRESENTATIVE NAME & TITLE DATE

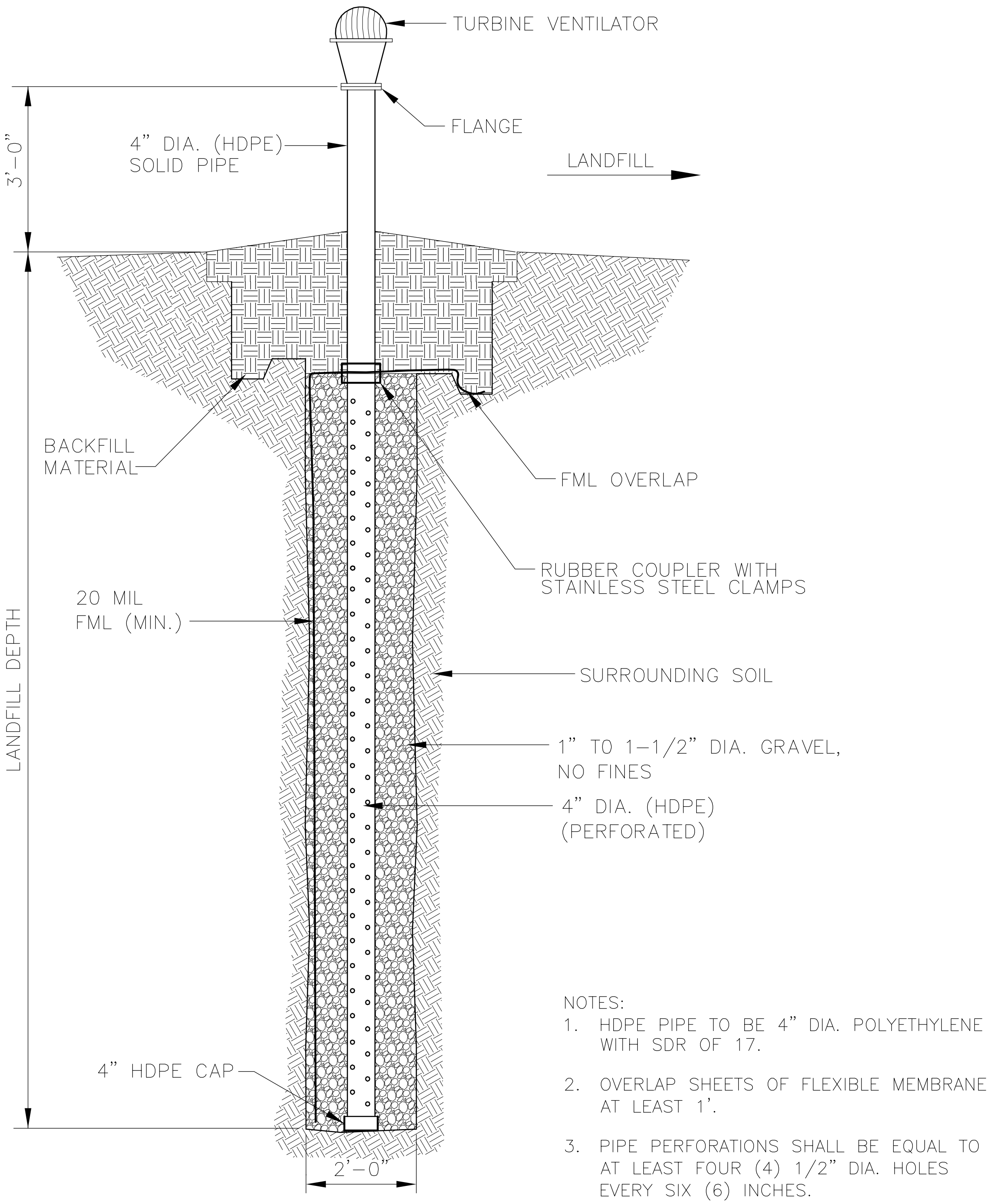
SHAW ENVIRONMENTAL, INC. DATE

CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

APPENDIX 9

VENT TRENCH DETAIL



NOTES:

1. HDPE PIPE TO BE 4" DIA. POLYETHYLENE WITH SDR OF 17.
2. OVERLAP SHEETS OF FLEXIBLE MEMBRANE AT LEAST 1'.
3. PIPE PERFORATIONS SHALL BE EQUAL TO AT LEAST FOUR (4) 1/2" DIA. HOLES EVERY SIX (6) INCHES.

STATE OF TEXAS
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PART III-ATTACHMENT 14
APPENDIX 9
VENT TRENCH DETAIL
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

Drawn By: DT	Appr. By: JMR	Scale: N.T.S.	Dwg. File: 8514-03-GAS-LGMP	FIGURE: III.14-9-1
Checked By: JMR	Project No.: 16L0438	Date: 09/12/2018	Rev.:	

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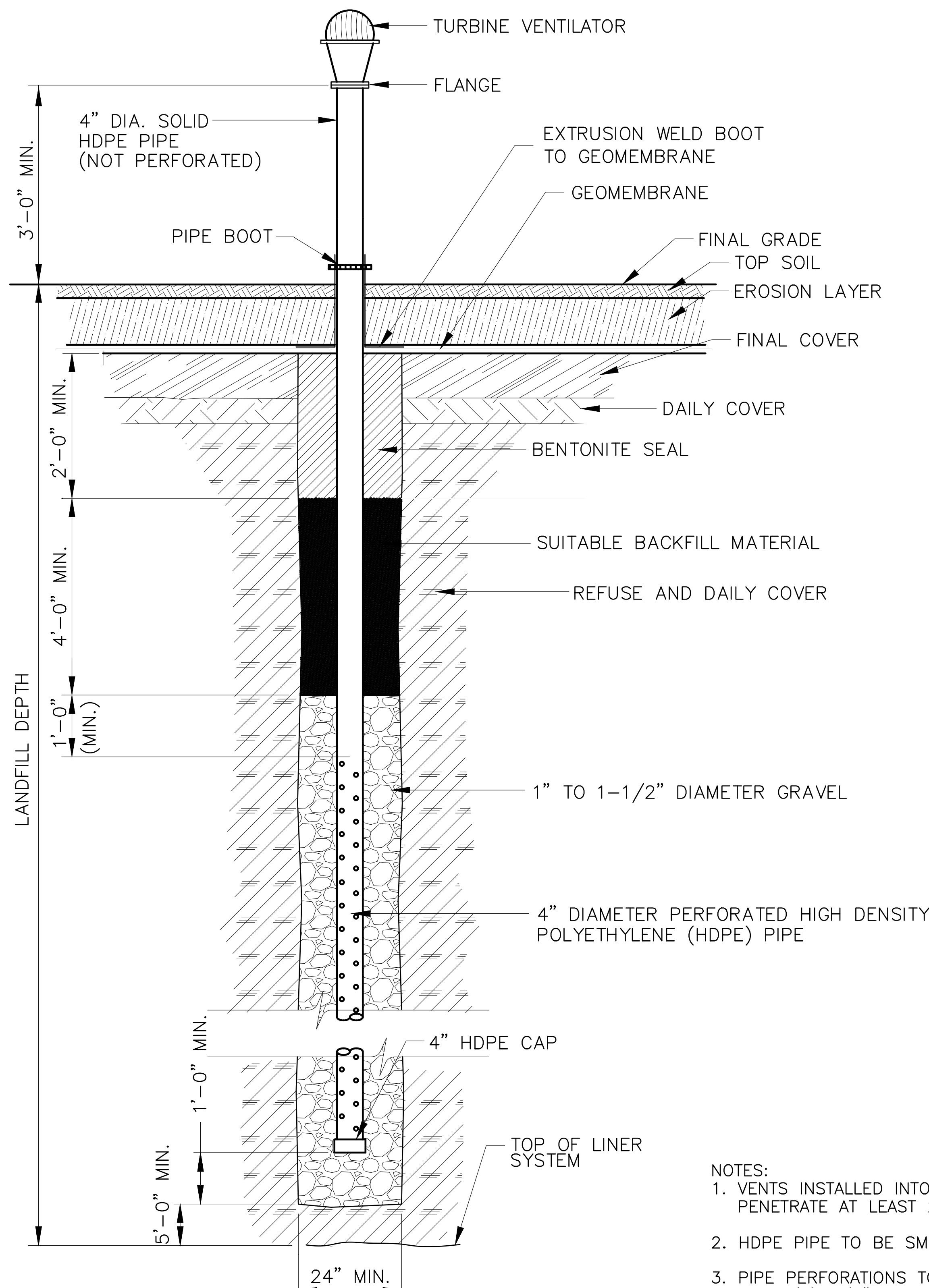
CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 14

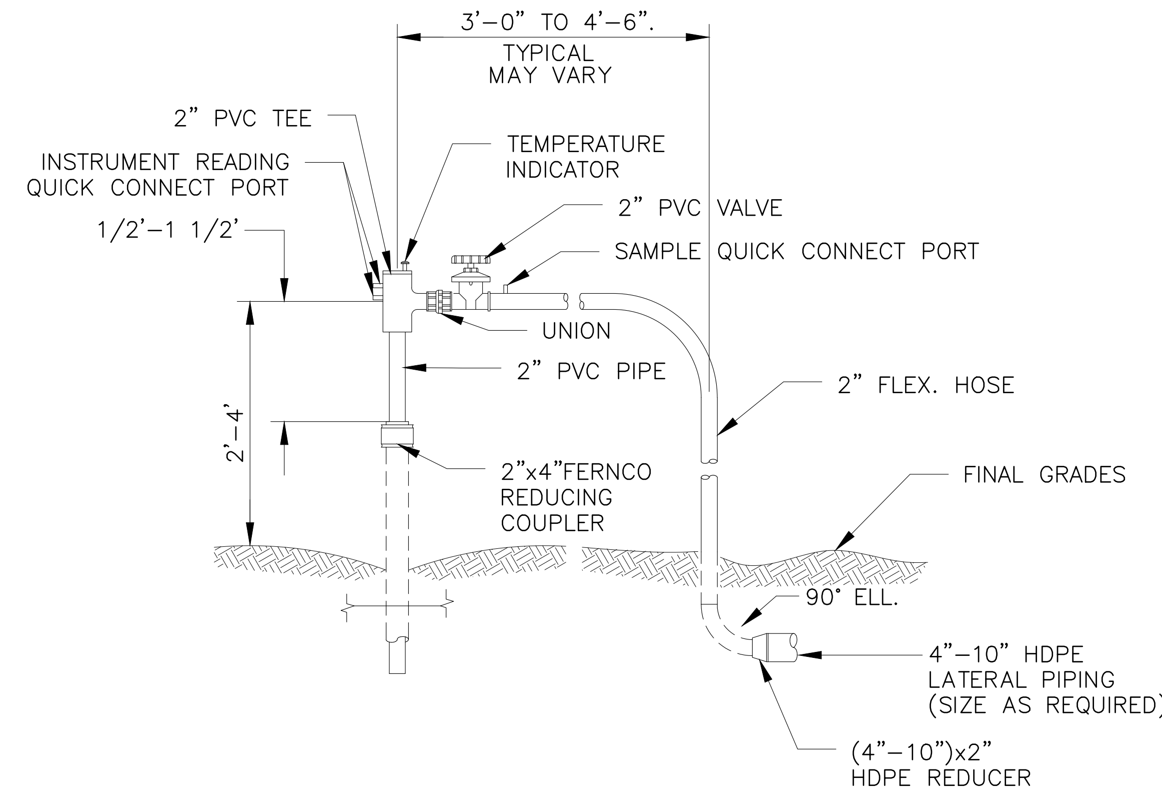
APPENDIX 10

PASSIVE/ACTIVE GAS VENT DETAIL

PASSIVE GAS VENT DETAIL



ACTIVE GAS COLLECTION WELL DETAIL



NOTES:
1. VENTS INSTALLED INTO THE SOLID WASTE SHOULD PENETRATE AT LEAST 2/3 OF LANDFILL DEPTH.
2. HDPE PIPE TO BE SMOOTH WALL WITH SDR OF 17.
3. PIPE PERFORATIONS TO BE EQUAL TO AT LEAST FOUR (4) 1/2" DIAMETER HOLES EVERY SIX (6) INCHES.
4. ALL HDPE JOINTS BY FUSION WELD (EXCEPT FLANGE CONNECTION).

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename 8514-03-GAS
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III-ATTACHMENT 14
APPENDIX 10
PASSIVE / ACTIVE GAS VENT DETAIL
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

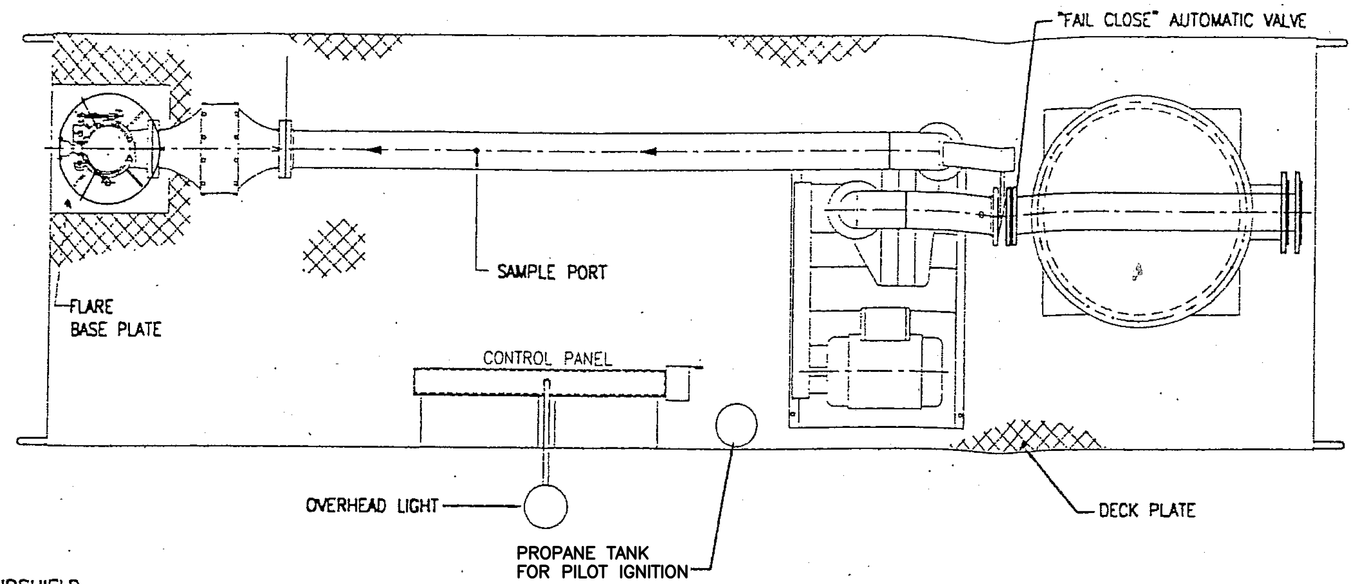
FIGURE:
III.14-10-1

CITY OF KINGSVILLE LANDFILL

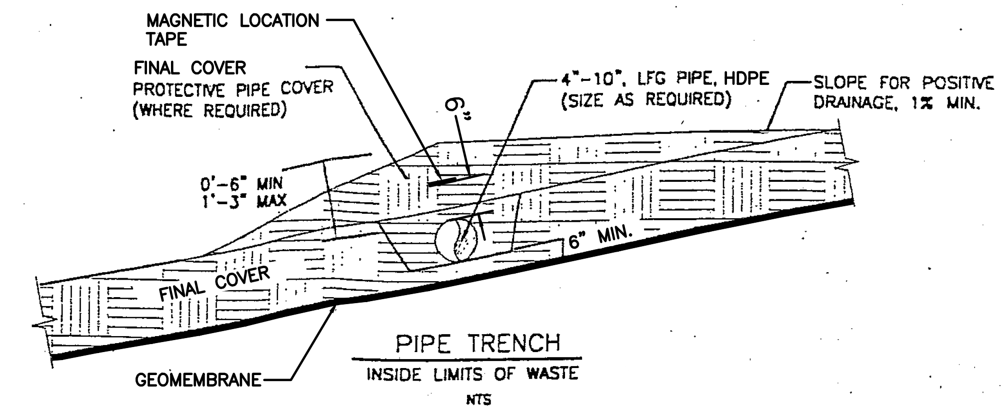
PART III, ATTACHMENT 14

APPENDIX 11

FLARE/BLOWER ASSEMBLY SYSTEM DETAILS

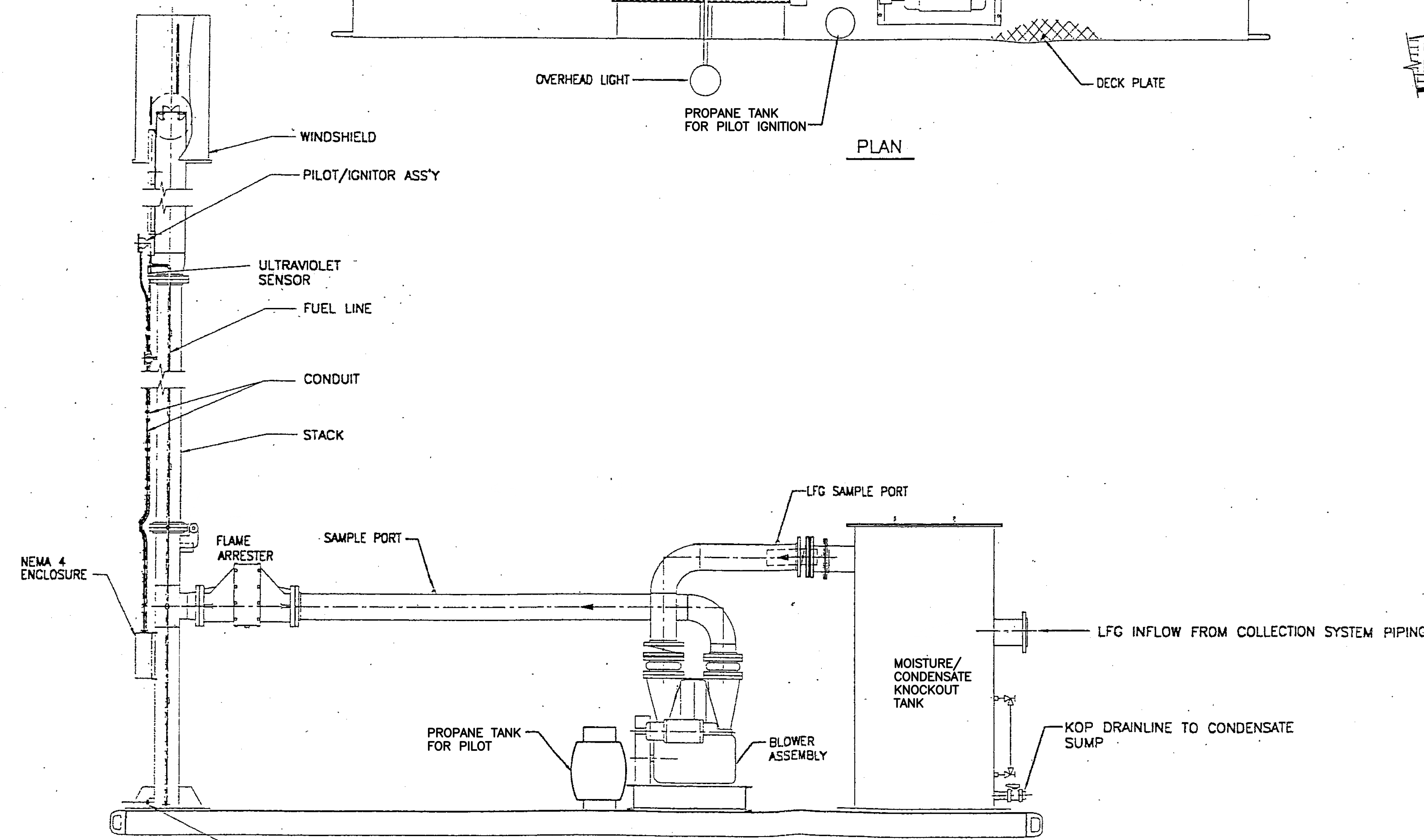


PLAN



PIPE TRENCH
INSIDE LIMITS OF WASTE
NTS

NOTE: ALL PIPE SIZES AND DIMENSIONS ARE APPROXIMATE



ELEVATION
NTS

LFG HANDLING AND FLARE SKID

NUMBER	REVISION	DATE	DRAWN	DESIGNED	REVIEWED

STATE OF TEXAS
JON M. REINHARD
64541
LICENSED
PROFESSIONAL ENGINEER
09/12/18

Hanson No. 16L0438
Filename 8514-03-GAS
Scale AS SHOWN
Date 09/12/2018

LAYOUT	DT	09/12/2018
DRAWN	DT	09/12/2018
REVIEWED	JMR	09/12/2018

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PART III-ATTACHMENT 14
APPENDIX 11
FLARE / BLOWER ASSEMBLY SYSTEM DETAILS
CITY OF KINGSVILLE LANDFILL
MSW PERMIT No. 235-C
KINGSVILLE, TEXAS
KLEBERG COUNTY, TEXAS

FIGURE:
III.14-11-1