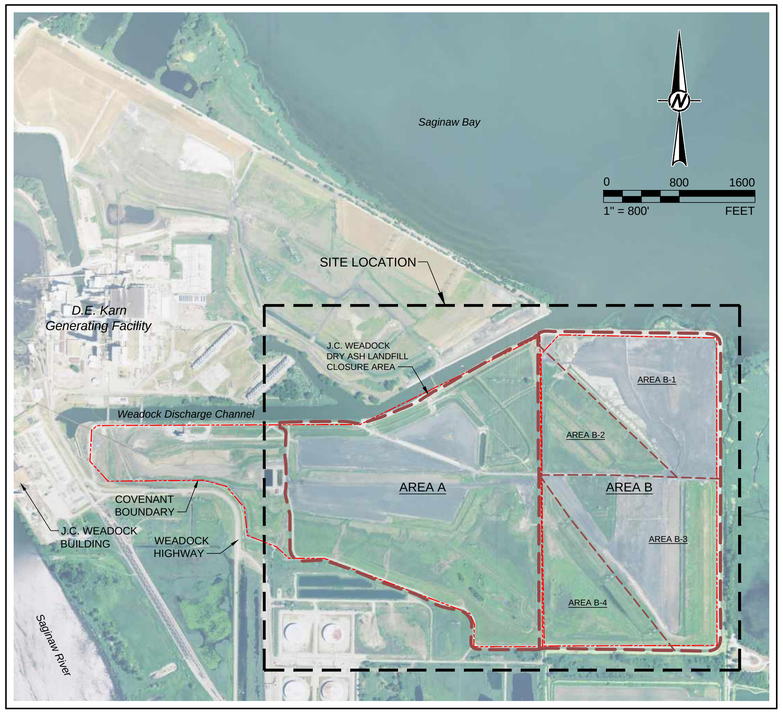
APPENDIX A
DRAWINGS

CONSUMERS ENERGY COMPANY
J.C. WEADOCK GENERATING FACILITY
DRY ASH LANDFILL CLOSURE PLAN

ISSUED FOR MDEQ REVIEW



REFERENCE: AERIAL BASE MAP IMAGE FROM NATIONAL AGRICULTURE IMAGERY PROGRAM (NAIP), PHOTO DATE OCTOBER 2016.

LOCATION MAP
SCALE 1" = 800'

SECTION 1 AND 2, HAMPTON TOWNSHIP,T14N-R5E
BAY COUNTY, MICHIGAN

PREPARED FOR:

CONSUMERS ENERGY COMPANY
J.C. WEADOCK GENERATING FACILITY
2742 NORTH WEADOCK HIGHWAY
ESSEXVILLE, MICHIGAN 48732

PREPARED BY:

GOLDER ASSOCIATES INC.
15851 SOUTH US 27
SUITE 50
LANSING, MI 48906

DRAWING LIST		
SHEET NUMBER	DRAWING TITLE	DRAWING REVISION
1	COVER SHEET	0
2	EXISTING CONDITIONS SITE PLAN	0
3	PROPOSED TOP OF ASH PLAN	0
4	PROPOSED TOP OF FINAL COVER PLAN	0
5	PROPOSED STORMWATER MANAGEMENT PLAN	0
6	SECTIONS - 1	0
7	SECTIONS - 2	0
8	DETAILS - 1	0
9	DETAILS - 2	0
10	DETAILS - 3	0
11	DETAILS - 4	0

ISSUED FOR REGULATORY REVIEW ONLY

REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO

REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO
0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

SIGNATURE
NAME
JOHN D. PULS
MICHIGAN P.E. No.
6201055778

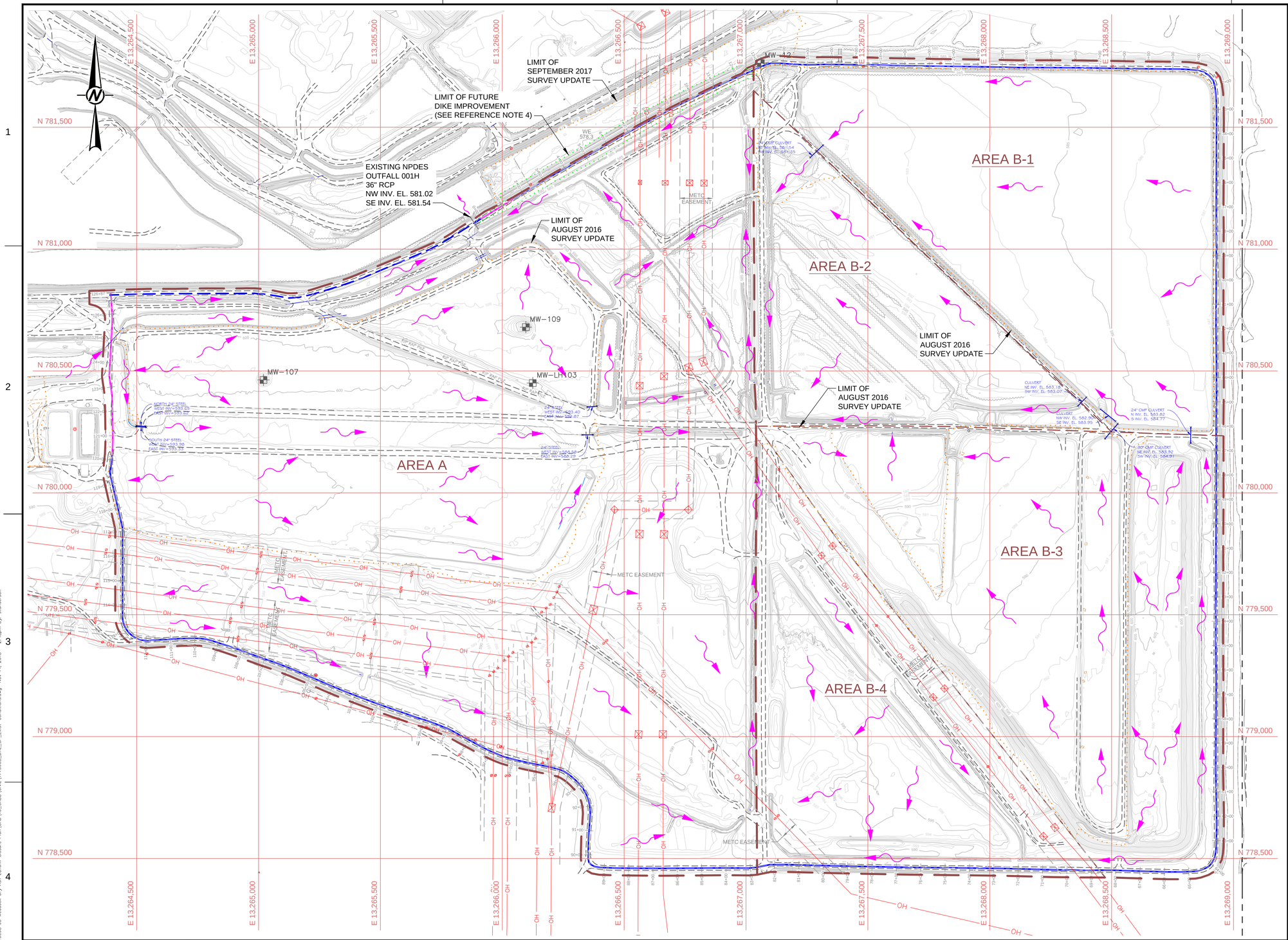
Consumers Energy
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

COVER SHEET

DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 1
REV. 0

P:\0 projects\Consumers Energy\1773608 JC Weadock Dry Ash Landfill Closure Plan\CAD\02_CADD\CIVIL\1773608_DAL_CP_COVER-SHEET.dwg Nov 14, 2018 - 2:17pm By: standerson



LEGEND

- EXISTING SLURRY WALL TYPE A CAP (10 TON MAX LOAD RATING)
- EXISTING SLURRY WALL TYPE B CAP OPTION 1 (80 TON MAX LOAD RATING)
- EXISTING SLURRY WALL (2018 ADDITION)
- EXISTING SHRUB/TREE LINE
- EXISTING ELECTRIC (OVERHEAD)
- EXISTING TRANSMISSION TOWER
- EXISTING TRANSMISSION POLE
- EXISTING EASEMENT
- EXISTING STORMWATER CULVERT
- EXISTING GROUND ELEVATION CONTOUR (5ft INTERVAL)
- EXISTING GROUND ELEVATION CONTOUR (1ft INTERVAL)
- EXISTING ACCESS ROAD
- EXISTING GROUND SURVEY UPDATE BOUNDARY
- FUTURE DIKE IMPROVEMENT BOUNDARY
- EXISTING SURFACE WATER FLOW DIRECTION
- PROPOSED DRY ASH LANDFILL CLOSURE PLAN AREA BOUNDARY

NOTE

1. CONTRACTOR SHALL MAINTAIN OVERHEAD CLEARANCE REQUIREMENTS WHILE WORKING UNDER POWER LINES. POWERLINE CLEARANCE IS 20 FEET FOR 345kV AND 15 FEET FOR 138kV LINES.

REFERENCES

1. HORIZONTAL DATUM AND COORDINATES SHOWN BASED ON MICHIGAN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD83), SOUTH ZONE, INTERNATIONAL FOOT.
2. VERTICAL DATUM AND ELEVATIONS SHOWN BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.
3. BASE MAP AND GROUND SURFACE ELEVATION CONTOURS DEVELOPED FROM SURVEYS DATED APRIL 2013, AUGUST 2016, AND SEPTEMBER 2017. APRIL 2013 OVERALL SURVEY BASED ON AERIAL PHOTOGRAPHY; AUGUST 2016 SURVEY IS SITE SPECIFIC AND BASED ON GROUND SURVEY; SEPTEMBER 2017 SURVEY IS SITE SPECIFIC AND BASED ON BATHYMETRIC SURVEY. SEE SURVEY UPDATE BOUNDARY LIMITS SHOWN ON PLAN.
4. FUTURE DIKE IMPROVEMENT CONTOURS SHOWN BASED ON GOLDER ASSOCIATES ISSUED FOR BID DESIGN PLANS DATED SEPTEMBER 28, 2018. CONTOURS SHOWN REPRESENT PROPOSED TOP OF RIPRAP / FINAL GRADE. SEE PROJECT BOUNDARY LIMITS SHOWN ON PLAN.

0 200 400
1" = 200' FEET

ISSUED FOR REGULATORY REVIEW ONLY

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO

REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO
0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

SIGNATURE

NAME: JOHN D. PULS

MICHIGAN P.E. No.: 6201055778

Consumers Energy

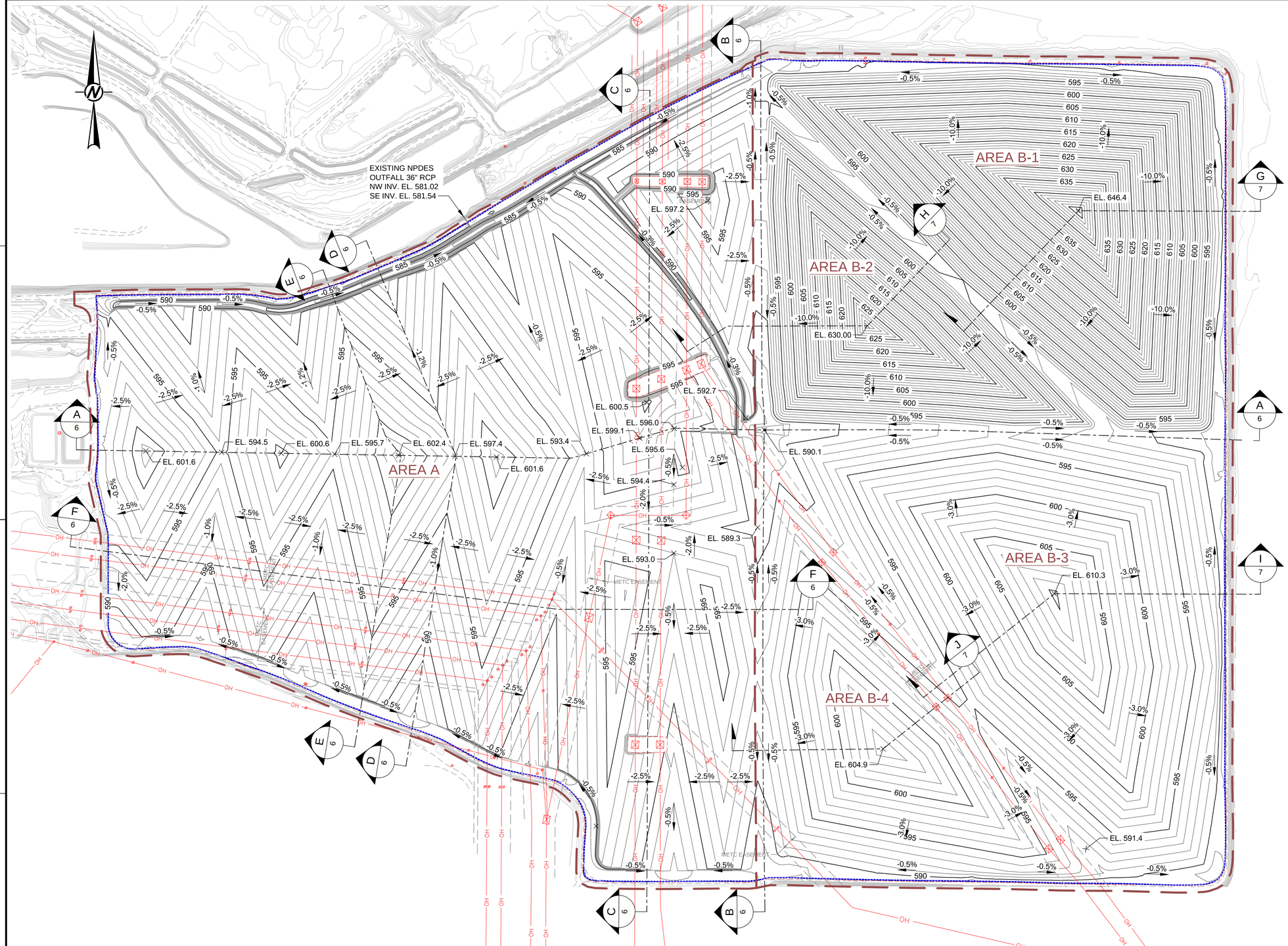
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

EXISTING CONDITIONS SITE PLAN

DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 2
REV. 0

P:\0_projects\Consumers Energy\1773608_JC Weadock Dry Ash Landfill Closure Plan\CAD\10_CADD\Civil\1773608_DAL_CP_Exist-Conditions.dwg Nov 14, 2018 - 2:45pm By: standerson



LEGEND

- EXISTING SLURRY WALL (INCLUDING FUTURE 2018)
- EXISTING ELECTRIC (OVERHEAD)
- EXISTING TRANSMISSION TOWER
- EXISTING TRANSMISSION POLE
- 575 — EXISTING GROUND ELEVATION CONTOUR (5ft INTERVAL)
- 574 — EXISTING GROUND ELEVATION CONTOUR (1ft INTERVAL)
- EXISTING ACCESS ROAD
- MW-12 — EXISTING MONITORING WELL
- PROPOSED DRY ASH LANDFILL CLOSURE PLAN AREA BOUNDARY
- 595 — PROPOSED TOP OF ASH CONTOUR (5ft INTERVAL)
- PROPOSED TOP OF ASH CONTOUR (1ft INTERVAL)
- -0.5% — PROPOSED GRADE SLOPE AND SURFACE WATER FLOW DIRECTION

NOTE

1. CONTRACTOR SHALL MAINTAIN OVERHEAD CLEARANCE REQUIREMENTS WHILE WORKING UNDER POWER LINES. POWERLINE CLEARANCE IS 20 FEET FOR 345kV AND 15 FEET FOR 138kV LINES.

REFERENCES

1. HORIZONTAL DATUM BASED ON MICHIGAN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD83), SOUTH ZONE, INTERNATIONAL FOOT.
2. VERTICAL DATUM BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.
3. BASE MAP AND GROUND SURFACE ELEVATION CONTOURS DEVELOPED FROM SURVEYS DATED APRIL 2013, AUGUST 2016, AND SEPTEMBER 2017. APRIL 2013 OVERALL SURVEY BASED ON AERIAL PHOTOGRAPHY; AUGUST 2016 SURVEY IS SITE SPECIFIC AND BASED ON GROUND SURVEY; SEPTEMBER 2017 SURVEY IS SITE SPECIFIC AND BASED ON BATHYMETRIC SURVEY. SEE SURVEY UPDATE BOUNDARY LIMITS SHOWN ON PLAN.

0 200 400
1" = 200' FEET

ISSUED FOR REGULATORY REVIEW ONLY

REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO
	0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

SIGNATURE	
NAME	JOHN D. PULS
MICHIGAN P.E. No.	6201055778

Consumers Energy

J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

PROPOSED TOP OF ASH PLAN

DRY ASH LANDFILL CLOSURE PLAN

SCALE:	AS SHOWN		SHEET	REV.
JOB:	1773608.0003		3	0

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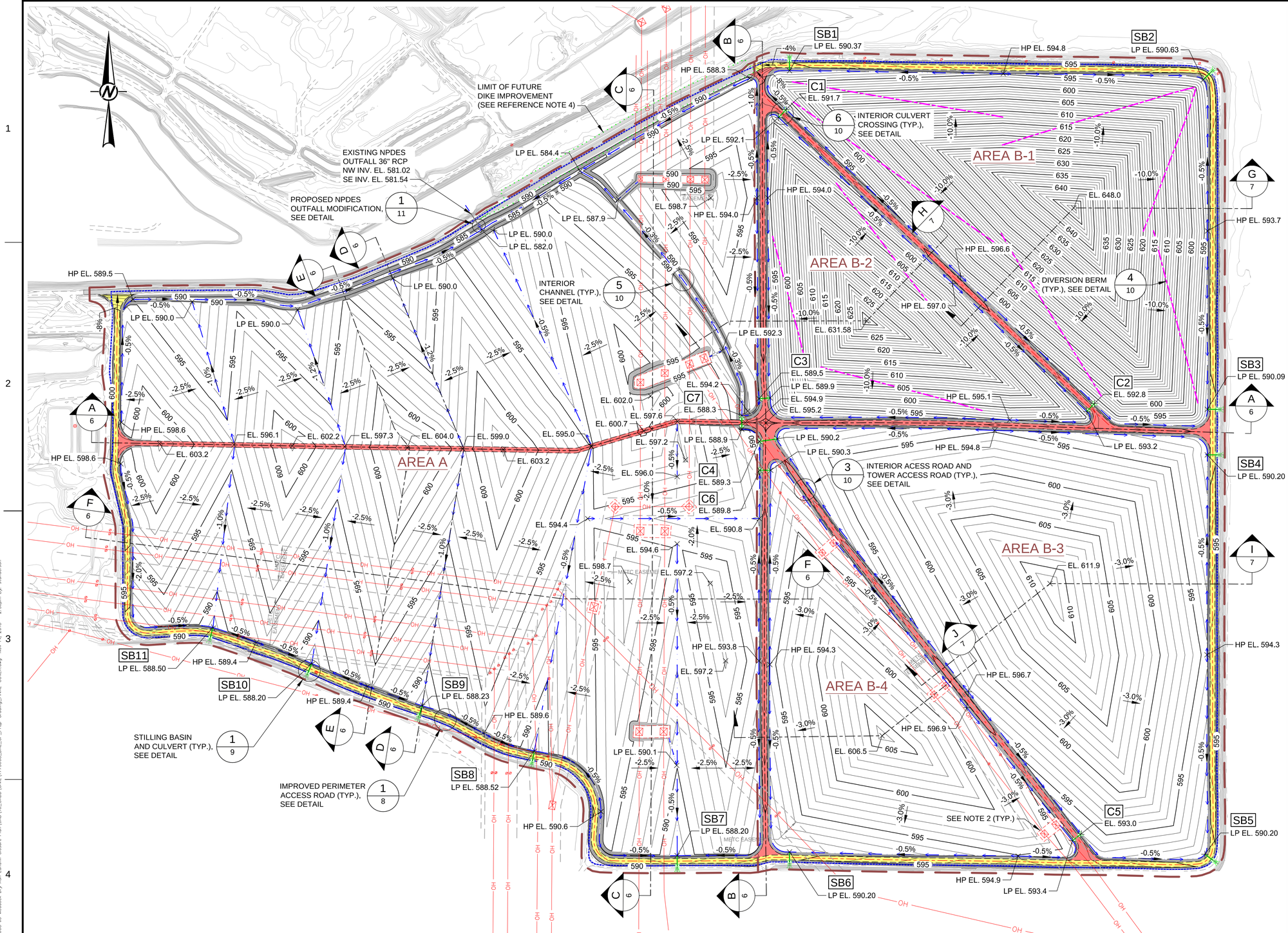

LEGEND

- EXISTING SLURRY WALL (INCLUDING FUTURE 2018)
- EXISTING ELECTRIC (OVERHEAD)
- EXISTING TRANSMISSION TOWER
- EXISTING TRANSMISSION POLE
- EXISTING GROUND ELEVATION CONTOUR (5ft INTERVAL)
- EXISTING GROUND ELEVATION CONTOUR (1ft INTERVAL)
- EXISTING ACCESS ROAD
- EXISTING MONITORING WELL
- FUTURE DIKE IMPROVEMENT BOUNDARY
- PROPOSED DRY ASH LANDFILL CLOSURE PLAN AREA BOUNDARY
- PROPOSED TOP OF FINAL COVER CONTOUR (5ft INTERVAL)
- PROPOSED TOP OF FINAL COVER CONTOUR (1ft INTERVAL)
- PROPOSED GRADE SLOPE AND SURFACE WATER FLOW DIRECTION
- PROPOSED INTERIOR ACCESS ROAD
- PROPOSED PERIMETER ACCESS ROAD
- PROPOSED STILLING BASIN AND CULVERT
- PROPOSED INTERIOR CULVERT
- PROPOSED DITCH CENTERLINE AND FLOW DIRECTION
- PROPOSED DIVERSION BERM CENTERLINE AND SLOPE
- PROPOSED 10ft OFFSET FROM ELECTRIC TRANSMISSION TOWERS (SEE NOTE 2 AND DETAIL 8/10)

NOTES

1. CONTRACTOR SHALL MAINTAIN OVERHEAD CLEARANCE REQUIREMENTS WHILE WORKING UNDER POWER LINES. POWERLINE CLEARANCE IS 20 FEET FOR 345kV AND 15 FEET FOR 138kV LINES.
2. CENTRAL TOWERS BETWEEN AREAS B-3 AND B-4 TO BE RAISED PER METC APPROVAL. A MAXIMUM 4:1 SLOPE TRANSITION AND 10-FOOT OFFSET TO FINAL COVER WILL BE PROVIDED AS AN ALTERNATIVE TO RAISING THE TOWERS IF REQUIRED.

REFERENCES

1. HORIZONTAL DATUM BASED ON MICHIGAN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD83), SOUTH ZONE, INTERNATIONAL FOOT.
2. VERTICAL DATUM BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.
3. BASE MAP AND GROUND SURFACE ELEVATION CONTOURS DEVELOPED FROM SURVEYS DATED APRIL 2013, AUGUST 2016, AND SEPTEMBER 2017. APRIL 2013 OVERALL SURVEY BASED ON AERIAL PHOTOGRAPHY; AUGUST 2016 SURVEY IS SITE SPECIFIC AND BASED ON GROUND SURVEY; SEPTEMBER 2017 SURVEY IS SITE SPECIFIC AND BASED ON BATHYMETRIC SURVEY. SEE SURVEY UPDATE BOUNDARY LIMITS SHOWN ON PLAN.
4. FUTURE DIKE IMPROVEMENT CONTOURS SHOWN BASED ON GOLDER ASSOCIATES ISSUED FOR BID DESIGN PLANS DATED SEPTEMBER 28, 2018. CONTOURS SHOWN REPRESENT PROPOSED TOP OF RIPRAP / FINAL GRADE. SEE PROJECT BOUNDARY LIMITS SHOWN ON PLAN.

0 200 400
1" = 200' FEET

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REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO
	0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO

SIGNATURE

NAME: JOHN D. PULS

MICHIGAN P.E. No.: 6201055778

Consumers Energy

J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

PROPOSED TOP OF FINAL COVER PLAN

DRY ASH LANDFILL CLOSURE PLAN

SCALE:	AS SHOWN	SHEET	REV.
JOB:	1773608.0003	4	0

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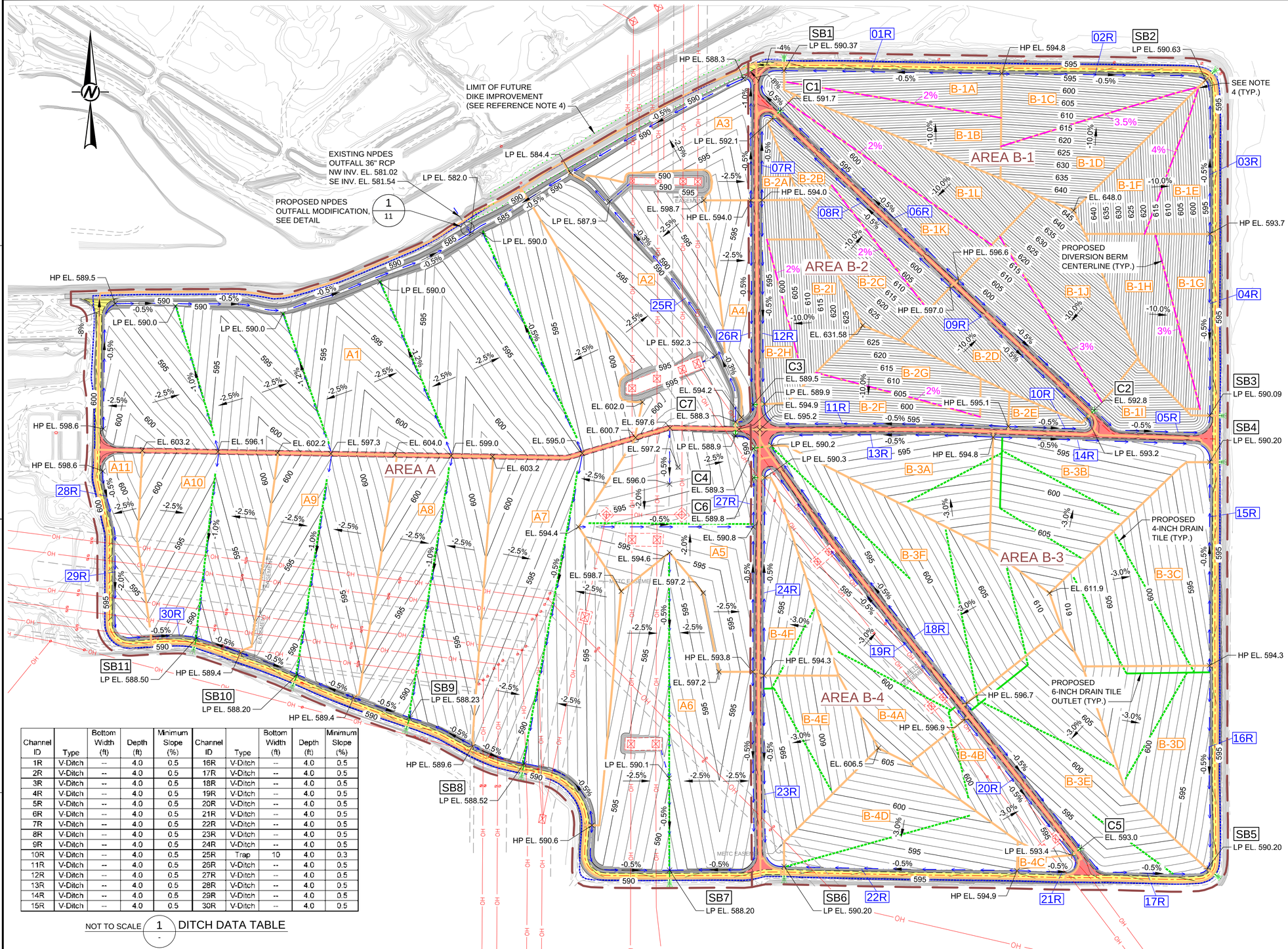

Channel ID	Type	Bottom Width (ft)	Depth (ft)	Minimum Slope (%)	Channel ID	Type	Bottom Width (ft)	Depth (ft)	Minimum Slope (%)
1R	V-Ditch	--	4.0	0.5	16R	V-Ditch	--	4.0	0.5
2R	V-Ditch	--	4.0	0.5	17R	V-Ditch	--	4.0	0.5
3R	V-Ditch	--	4.0	0.5	18R	V-Ditch	--	4.0	0.5
4R	V-Ditch	--	4.0	0.5	19R	V-Ditch	--	4.0	0.5
5R	V-Ditch	--	4.0	0.5	20R	V-Ditch	--	4.0	0.5
6R	V-Ditch	--	4.0	0.5	21R	V-Ditch	--	4.0	0.5
7R	V-Ditch	--	4.0	0.5	22R	V-Ditch	--	4.0	0.5
8R	V-Ditch	--	4.0	0.5	23R	V-Ditch	--	4.0	0.5
9R	V-Ditch	--	4.0	0.5	24R	V-Ditch	--	4.0	0.5
10R	V-Ditch	--	4.0	0.5	25R	Trap	10	4.0	0.3
11R	V-Ditch	--	4.0	0.5	26R	V-Ditch	--	4.0	0.5
12R	V-Ditch	--	4.0	0.5	27R	V-Ditch	--	4.0	0.5
13R	V-Ditch	--	4.0	0.5	28R	V-Ditch	--	4.0	0.5
14R	V-Ditch	--	4.0	0.5	29R	V-Ditch	--	4.0	0.5
15R	V-Ditch	--	4.0	0.5	30R	V-Ditch	--	4.0	0.5

NOT TO SCALE — 1 - DITCH DATA TABLE

LEGEND

- EXISTING SLURRY WALL (INCLUDING FUTURE 2018)
- EXISTING ELECTRIC (OVERHEAD)
- EXISTING TRANSMISSION TOWER
- EXISTING TRANSMISSION POLE
- 575 — EXISTING GROUND ELEVATION CONTOUR (5ft INTERVAL)
- 574 — EXISTING GROUND ELEVATION CONTOUR (1ft INTERVAL)
- EXISTING ACCESS ROAD
- MW-12 — EXISTING MONITORING WELL
- FUTURE DIKE IMPROVEMENT BOUNDARY
- PROPOSED DRY ASH LANDFILL CLOSURE PLAN AREA BOUNDARY
- 595 — PROPOSED TOP OF FINAL COVER CONTOUR (5ft INTERVAL)
- PROPOSED TOP OF FINAL COVER CONTOUR (1ft INTERVAL)
- -0.5% — PROPOSED GRADE SLOPE AND SURFACE WATER FLOW DIRECTION
- PROPOSED INTERIOR ACCESS ROAD
- PROPOSED PERIMETER ACCESS ROAD
- SB1 — PROPOSED STILLING BASIN (SB) AND CULVERT
- C1 — PROPOSED INTERIOR CULVERT (C)
- PROPOSED DITCH CENTERLINE AND FLOW DIRECTION
- 2% — PROPOSED DIVERSION BERM CENTERLINE AND SLOPE
- PROPOSED 4-INCH DRAIN TILE
- PROPOSED 6-INCH DRAIN TILE OUTLET
- 1R — PROPOSED CHANNEL ID
- A-1 — PROPOSED BASIN BOUNDARY AND ID

NOTES

1. CONTRACTOR SHALL MAINTAIN OVERHEAD CLEARANCE REQUIREMENTS WHILE WORKING UNDER POWER LINES. POWERLINE CLEARANCE IS 20 FEET FOR 345KV AND 15 FEET FOR 138KV LINES.
2. DRAIN TILES AND OUTLET LOCATIONS MAY BE ADJUSTED AND DOCUMENTED ON THE FINAL COVER CERTIFICATION DRAWINGS.
3. DRAIN TILE TO CONSIST OF 4-INCH DIAMETER PERFORATED ADS PIPE WITH SOCK OR EQUIVALENT.
4. RIPRAP OR EROSION MATTING MAY BE PLACED AT ALL DIVERSION BERM OUTLETS.

REFERENCES

1. HORIZONTAL DATUM BASED ON MICHIGAN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD83), SOUTH ZONE, INTERNATIONAL FOOT.
2. VERTICAL DATUM BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.
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4. FUTURE DIKE IMPROVEMENT CONTOURS SHOWN BASED ON GOLDER ASSOCIATES ISSUED FOR BID DESIGN PLANS DATED SEPTEMBER 28, 2018. CONTOURS SHOWN REPRESENT PROPOSED TOP OF RIPRAP / FINAL GRADE. SEE PROJECT BOUNDARY LIMITS SHOWN ON PLAN.

0 200 400
1" = 200' FEET

ISSUED FOR REGULATORY REVIEW ONLY

REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO

REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO
0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

SIGNATURE
NAME: JOHN D. PULS
MICHIGAN P.E. No.: 6201055778

Consumers Energy

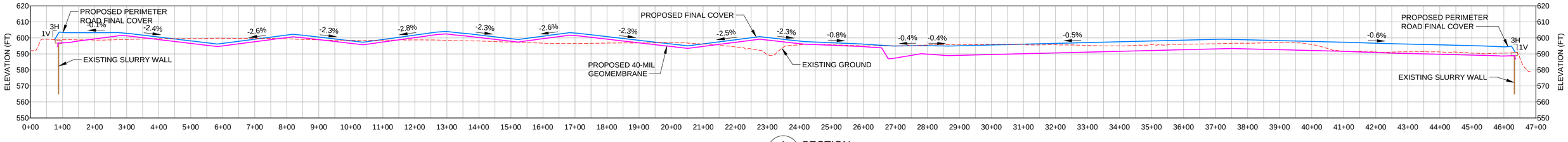
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

PROPOSED STORMWATER MANAGEMENT PLAN

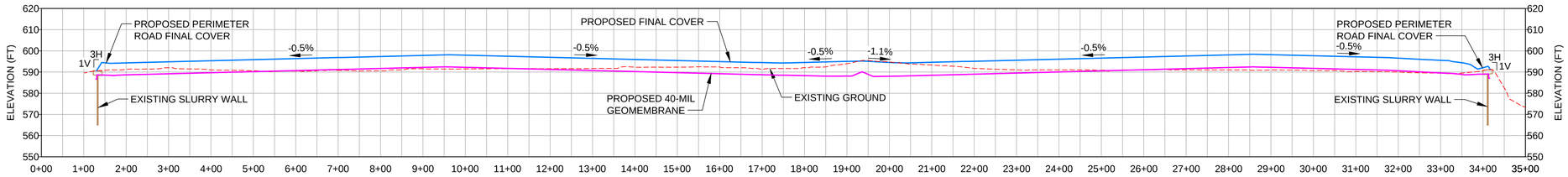
DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 5
REV. 0

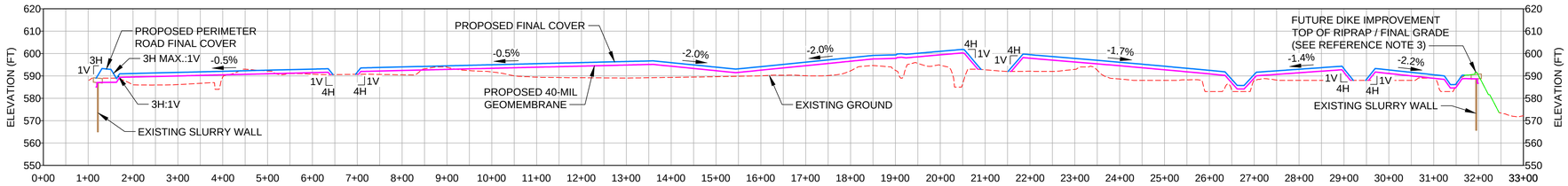
P:\0 projects\Consumers Energy\1773608 JC Weadock Dry Ash Landfill Closure Plan\CAD\10-CAD\Civil\1773608_DAL_GP_Prop-Grading_STORMWATER.dwg Nov 14, 2018 - 3:07pm By: stonderson



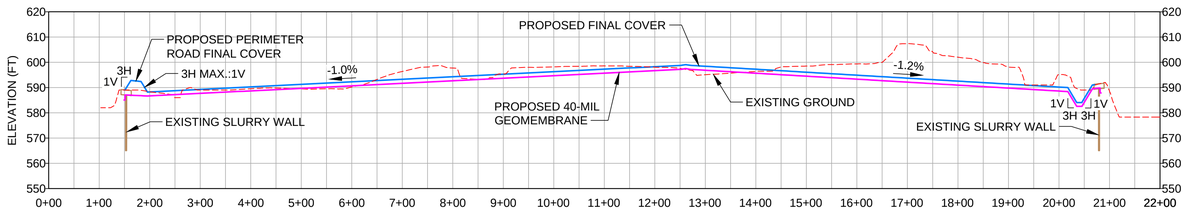
SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — A / 6 — SECTION



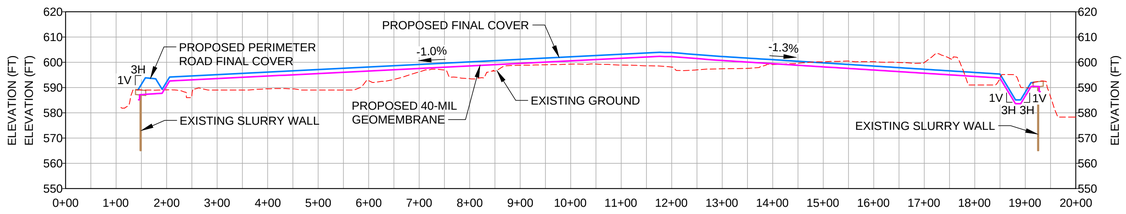
SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — B / 6 — SECTION



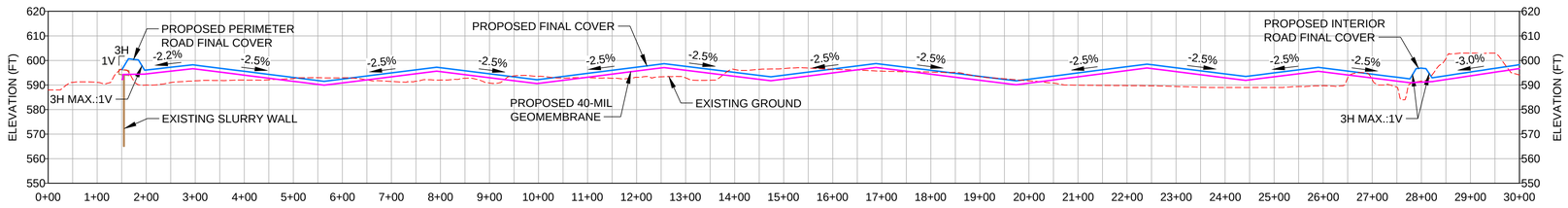
SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — C / 6 — SECTION



SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — D / 6 — SECTION



SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — E / 6 — SECTION



SCALE: 1" = 150' HORIZ. 1" = 30' VERT. — F / 6 — SECTION

LEGEND

- EXISTING GROUND (SEE REFERENCE 1 AND 2)
- PROPOSED TOP OF FINAL COVER
- PROPOSED 40-MIL GEOMEMBRANE / TOP OF ASH

REFERENCES

1. ELEVATIONS BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.
2. EXISTING GROUND DEVELOPED FROM SURVEYS DATED APRIL 2013, AUGUST 2016, AND SEPTEMBER 2017. SEE SURVEY UPDATE BOUNDARY LIMITS SHOWN ON EXISTING CONDITIONS SITE PLAN, SHEET 2.
3. FUTURE DIKE IMPROVEMENT GRADE SHOWN BASED ON GOLDER ASSOCIATES ISSUED FOR BID DESIGN PLANS DATED SEPTEMBER 28, 2018. GRADE SHOWN REPRESENTS PROPOSED TOP OF RIPRAP / FINAL GRADE. SEE PROJECT BOUNDARY LIMITS SHOWN ON EXISTING CONDITIONS SITE PLAN, SHEET 2.

0 150 300
1" = 150' HORIZ. FEET

0 30 60
1" = 30' VERT. FEET

ISSUED FOR REGULATORY REVIEW ONLY

REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO
0	2018-11-15	ISSUED FOR MDEQ REVIEW	JSH	SDA	JDP	DML	

REFERENCE DRAWINGS

SIGNATURE

NAME: JOHN D. PULS

MICHIGAN P.E. No.: 6201055778

Consumers Energy

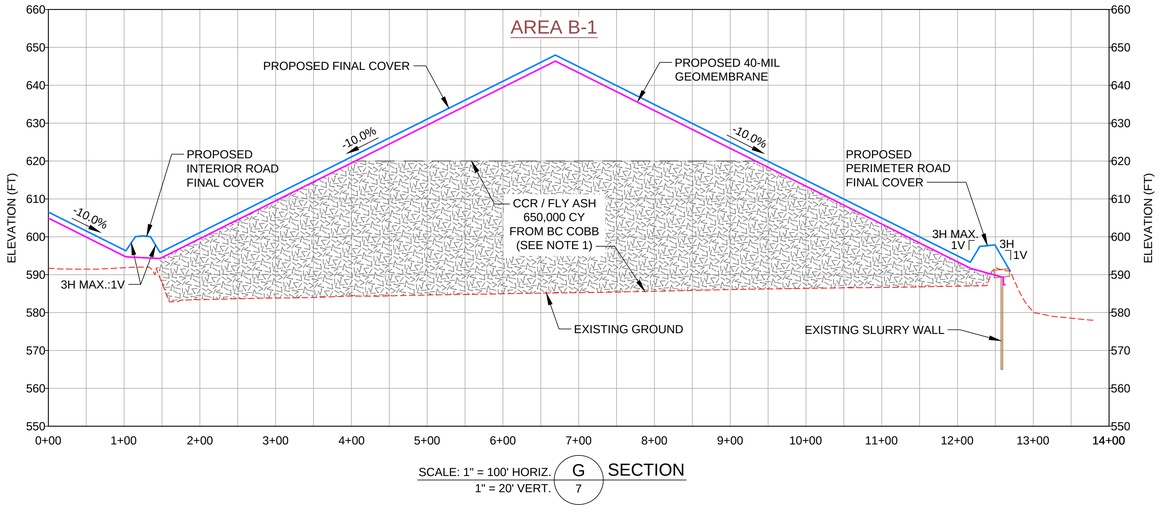
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

SECTIONS - 1

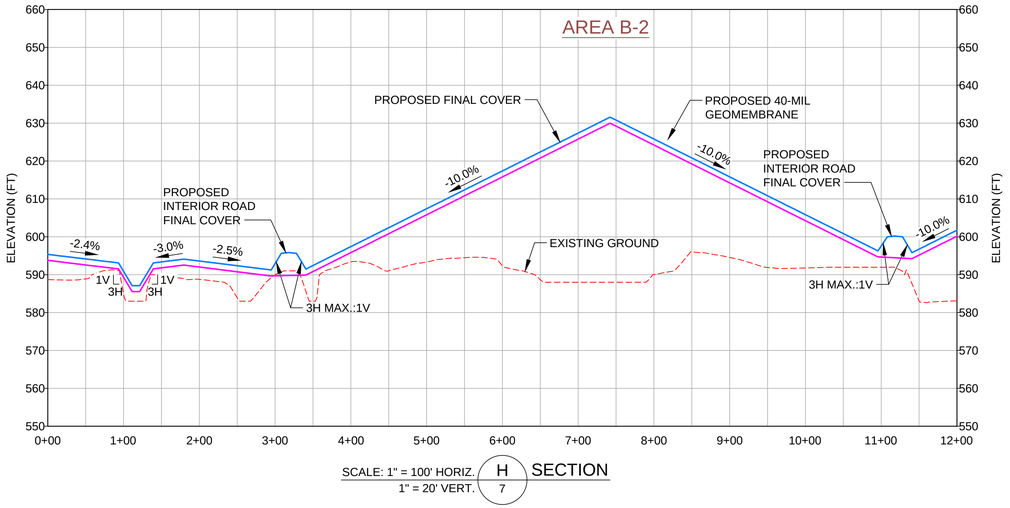
DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET: 6
REV.: 0

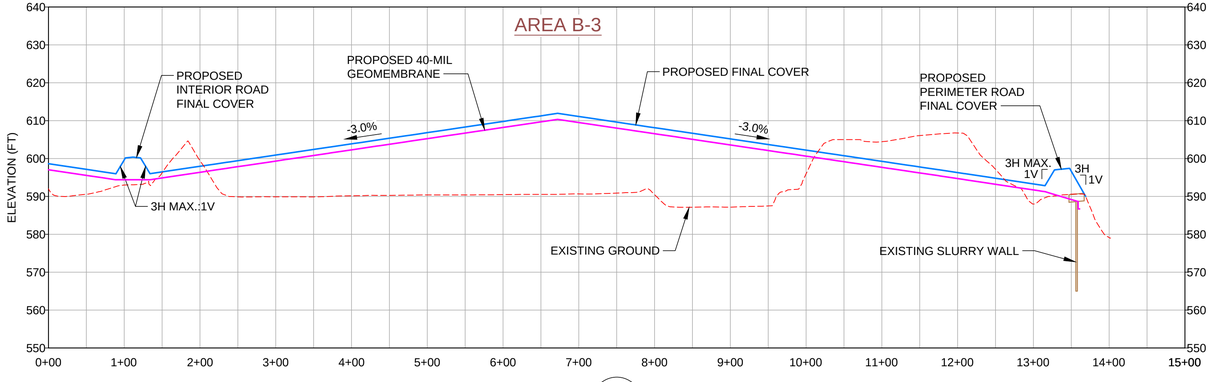
P:\0 projects\Consumers Energy\1773608 JC Weadock Dry Ash Landfill Closure Plan\CAD\10_CAD\CIVIL\1773608_DAL_DP_Prop-Grading_SECTIONS.dwg Nov 14, 2018 - 3:02pm By: standerson



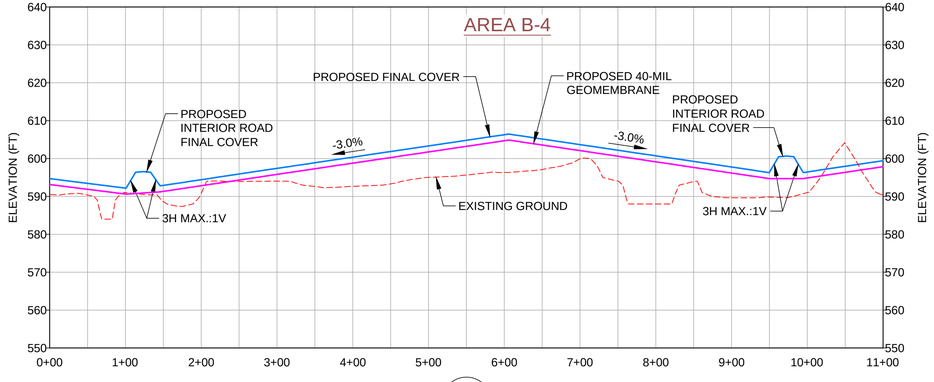
SCALE: 1" = 100' HORIZ.
1" = 20' VERT.
G 7 SECTION



SCALE: 1" = 100' HORIZ.
1" = 20' VERT.
H 7 SECTION



SCALE: 1" = 100' HORIZ.
1" = 20' VERT.
I 7 SECTION



SCALE: 1" = 100' HORIZ.
1" = 20' VERT.
J 7 SECTION

LEGEND

- EXISTING GROUND (SEE REFERENCE 1 AND 2)
- PROPOSED TOP OF FINAL COVER
- PROPOSED 40-MIL GEOMEMBRANE / TOP OF ASH

NOTE

1. CCR / FLY ASH FROM BC COBB MAY BE PLACED IN OTHER AREAS OF THE LANDFILL AS DIRECTED BY OWNER.

REFERENCES

1. ELEVATIONS BASED ON NORTH AMERICAN VERTICAL DATUM (NAVD) 1988, FEET.

2. EXISTING GROUND DEVELOPED FROM SURVEYS DATED APRIL 2013, AUGUST 2016, AND SEPTEMBER 2017. SEE SURVEY UPDATE BOUNDARY LIMITS SHOWN ON EXISTING CONDITIONS SITE PLAN, SHEET 2.

0 100 200
1" = 100' HORIZ. FEET

0 20 40
1" = 20' VERT. FEET

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REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO

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NAME
JOHN D. PULS
MICHIGAN P.E. No.
6201055778

Consumers Energy
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

SECTIONS - 2

DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 7
REV. 0

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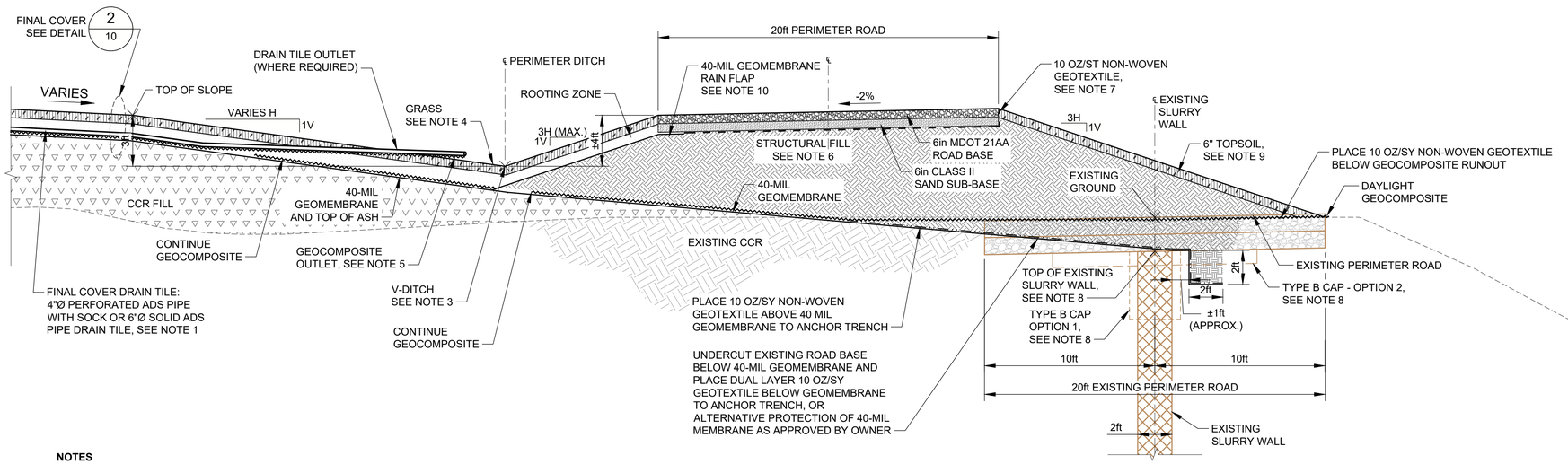
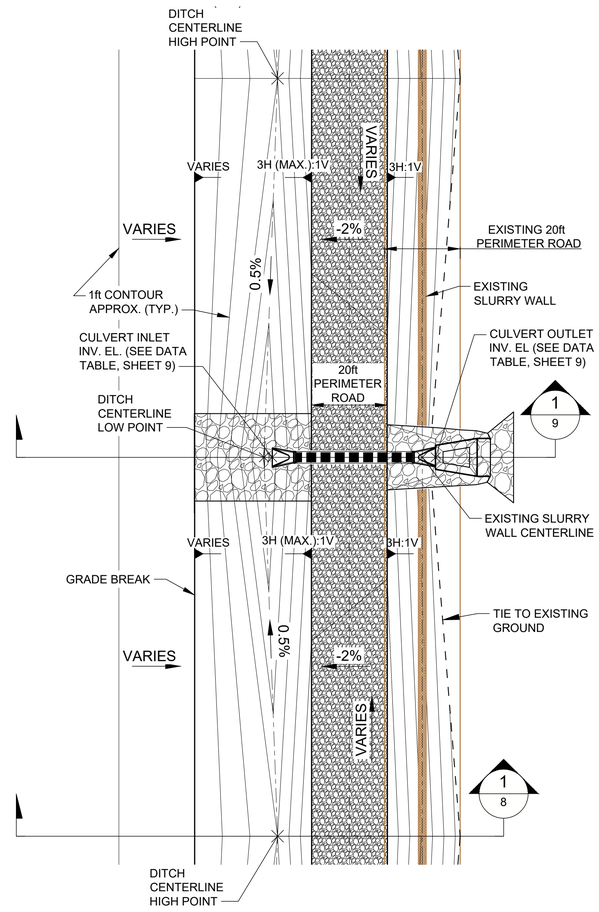


SCALE: 1" = 4' 1/8 IMPROVED PERIMETER ACCESS ROAD DETAIL



NOT TO SCALE 2/8 PERIMETER DITCH CONCEPTUAL PLAN

NOTES

1. DRAIN TILE PLAN VIEW LOCATIONS PROVIDED ON SHEET 5.

2. ALTERNATIVE ROAD BASE AND SUBBASE MATERIAL MAY BE PROPOSED TO BE APPROVED BY OWNER. PERIMETER ROAD CROSS SECTION MAY BE MODIFIED BY OWNER TO ACCOMMODATE VARIABLE ROOTING ZONE MATERIAL.

3. V DITCH MAY BE REPLACED WITH TRAPEZOIDAL CHANNEL WITH EQUIVALENT CAPACITY.

4. EROSION MATTING MAY BE PLACED AS APPROVED BY THE OWNER. 12" THICK (6" D50) RIPRAP AND 6" BEDDING MAY BE PLACED AT CHANNEL BENDS OR WHERE FLOW VELOCITY MAY EXCEED 5 FPS AS APPROVED BY OWNER.

5. ALTERNATIVE GEOCOMPOSITE OUTLET DESIGN MAY BE APPROVED BY THE OWNER.

6. STRUCTURAL FILL ABOVE THE LINER SHALL NOT BE CCR MATERIAL.

7. GEOTEXTILE MAY BE MODIFIED AS APPROVED BY THE OWNER.

8. TOP OF EXISTING SLURRY WALL IS ESTIMATED BASED ON EXISTING GROUND SURFACE AT SLURRY WALL CENTERLINE MINUS 2-FEET OF EXISTING ROAD BASE. ACTUAL TOP OF EXISTING SLURRY WALL MAY VARY AND WILL BE DETERMINED IN THE FIELD. TOP OF EXISTING SLURRY WALL IS DEFINED AS; THE TOP OF EXISTING TYPE A CAP (SOIL-BENTONITE), OR THE TOP OF EXISTING TYPE B CAP-OPTION 1 (CEMENT-BENTONITE), OR THE TOP OF EXISTING TYPE B CAP-OPTION 2 (REINFORCED CONCRETE SLAB), ALL BELOW EXISTING GEOGRID AND EXISTING GEOTEXTILE LAYERS PER 04/27/2009 AND 10/30/2018 RECORD DRAWINGS.

9. EROSION MATTING MAY BE PLACED OR TOPSOIL MAY BE REPLACED WITH RIPRAP UNDERLAIN BY 10-OZ NON-WOVEN GEOTEXTILE AS APPROVED BY OWNER.

10. ALTERNATIVE TO OR REMOVAL OF RAIN FLAP MAY BE APPROVED BY OWNER.

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J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

DETAILS - 1

DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 8
REV. 0

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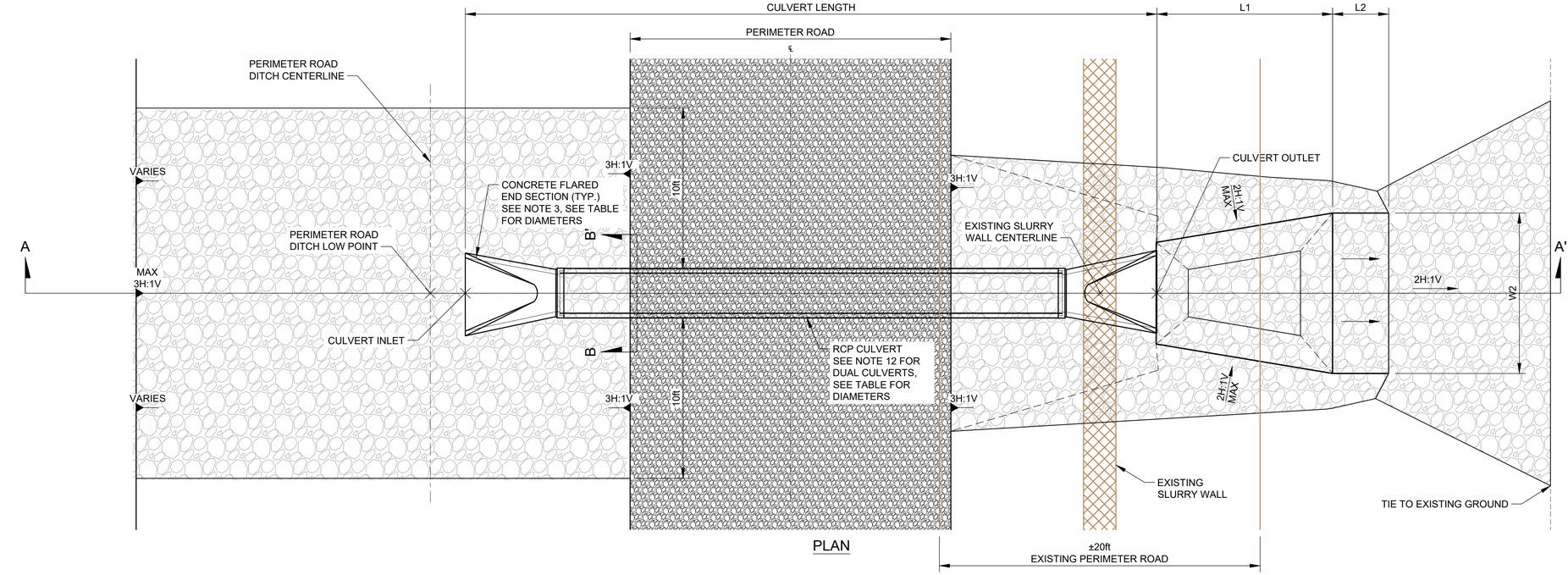
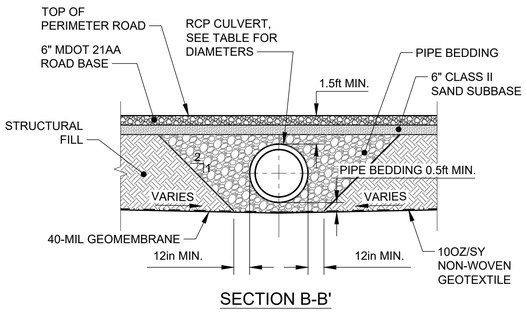
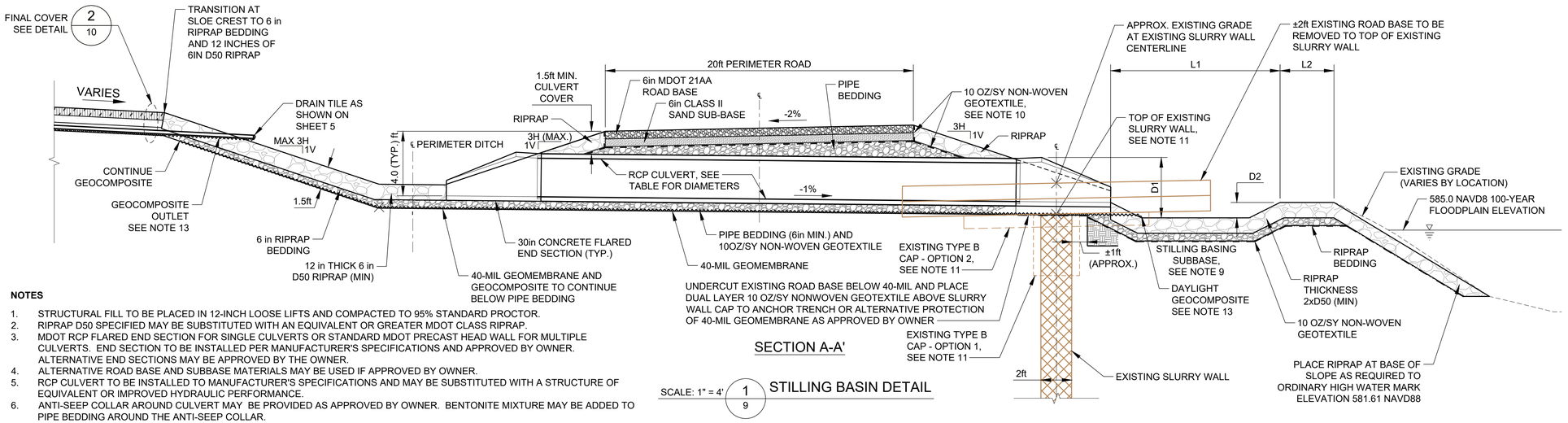


PLAN



SECTION B-B'

Structure ID	Number of Culverts	Culvert Diameter (in)	Culvert Length (ft)	Culvert Slope (%)	Design Inlet Invert Elevation (MSL)	Design Outlet Invert Elevation (MSL)
SB1	2	30	43	1.00	590.37	589.94
SB2	2	30	43	1.00	590.63	590.20
SB3	2	30	43	1.00	590.10	589.67
SB4	2	30	43	1.00	590.20	589.77
SB5	2	30	43	1.00	590.20	589.77
SB6	2	30	43	1.00	590.20	589.77
SB7	2	24	43	1.00	588.20	587.77
SB8	2	24	43	1.00	588.52	588.09
SB9	1	30	43	1.00	588.23	587.80
SB10	1	30	43	1.00	588.20	587.77
SB11	2	24	43	1.00	588.50	588.07



SECTION A-A'

SCALE: 1" = 4' 1/9 STILLING BASIN DETAIL

Stilling Basin	Stilling Basin Width	Stilling Basin Pool Length	Appron Length	Stilling Basin Total Depth	Stilling Basin Pool Depth
	W2	L1	L2	D1	D2
	(ft)	(ft)	(ft)	(ft)	(ft)
SB1	9.50	7.50	3.00	3.25	0.75
SB2	9.50	7.50	2.50	3.00	0.50
SB3	9.50	7.50	2.50	3.00	0.50
SB4	9.50	7.50	2.50	3.00	0.50
SB5	9.50	7.50	2.50	3.00	0.50
SB6	9.50	7.50	2.50	3.00	0.50
SB7	7.50	6.00	2.50	2.50	0.50
SB8	7.50	6.00	2.50	2.50	0.50
SB9	9.50	7.50	2.50	3.00	0.50
SB10	9.50	7.50	2.50	3.00	0.50
SB11	7.50	6.00	2.00	2.50	0.50

NO SCALE 2/9 STILLING BASIN DATA TABLES

NOTES
1. MINIMUM DIMENSIONS PROVIDED, INCREASED STILLING BASIN SIZE DIMENSIONS MAY BE APPROVED BY OWNER.
2. INLET AND OUTLET ELEVATIONS MAY BE ADJUSTED PENDING CONFIRMATION OF SLURRY WALL CAP ELEVATIONS.

NOTES

1. STRUCTURAL FILL TO BE PLACED IN 12-INCH LOOSE LIFTS AND COMPACTED TO 95% STANDARD PROCTOR.
2. RIPRAP D50 SPECIFIED MAY BE SUBSTITUTED WITH AN EQUIVALENT OR GREATER MDOT CLASS RIPRAP.
3. MDOT RCP FLARED END SECTION FOR SINGLE CULVERTS OR STANDARD MDOT PRECAST HEAD WALL FOR MULTIPLE CULVERTS. END SECTION TO BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS AND APPROVED BY OWNER. ALTERNATIVE END SECTIONS MAY BE APPROVED BY THE OWNER.
4. ALTERNATIVE ROAD BASE AND SUBBASE MATERIALS MAY BE USED IF APPROVED BY OWNER.
5. RCP CULVERT TO BE INSTALLED TO MANUFACTURER'S SPECIFICATIONS AND MAY BE SUBSTITUTED WITH A STRUCTURE OF EQUIVALENT OR IMPROVED HYDRAULIC PERFORMANCE.
6. ANTI-SEEP COLLAR AROUND CULVERT MAY BE PROVIDED AS APPROVED BY OWNER. BENTONITE MIXTURE MAY BE ADDED TO PIPE BEDDING AROUND THE ANTI-SEEP COLLAR.
7. EXISTING PERIMETER ROAD MATERIAL AND/OR CCR MAY BE OVER-EXCAVATED AND REPLACED WITH SUITABLE FILL AS APPROVED BY THE OWNER.
8. ROOTING ZONE LAYER WITH 10 OZ/SY GEOTEXTILE MAY BE USED FOR RIPRAP BEDDING AS APPROVED BY THE OWNER.
9. SUBBASE OF STILLING BASIN MAY BE IMPROVED AS APPROVED BY THE OWNER.
10. GEOTEXTILE MAY BE MODIFIED AS APPROVED BY THE OWNER.
11. TOP OF EXISTING SLURRY WALL IS ESTIMATED BASED ON EXISTING GROUND SURFACE AT SLURRY WALL CENTERLINE MINUS 2-FEET OF EXISTING ROAD BASE. ACTUAL TOP OF EXISTING SLURRY WALL MAY VARY AND WILL BE DETERMINED IN THE FIELD. TOP OF EXISTING SLURRY WALL IS DEFINED AS; THE TOP OF EXISTING TYPE A CAP (SOIL-BENTONITE), THE TOP OF EXISTING TYPE B CAP-OPTION 1 (CEMENT-BENTONITE), OR THE TOP OF EXISITNG TYPE B CAP-OPTION 2 (REINFORCED CONCRETE SLAB), ALL BELOW EXISTING GEOGRID AND EXISTING GEOTEXTILE LAYERS PER 04/27/2009 AND 10/30/2018 RECORD DRAWINGS.
12. WHERE MULTIPLE CULVERTS ARE REQUIRED, MAINTAIN ADEQUATE SPACE BETWEEN CULVERTS TO COMPACT BEDDING.
13. ALTERNATIVE GEOCOMPOSITE OUTLET DESIGNS MAY BE APPROVED BY OWNER.

0 4 8
1" = 4' FEET

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SIGNATURE
NAME JOHN D. PULS
MICHIGAN P.E. No. 6201055778

Consumers Energy
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

DETAILS - 2

DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 9
REV. 0

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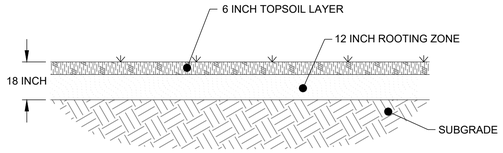
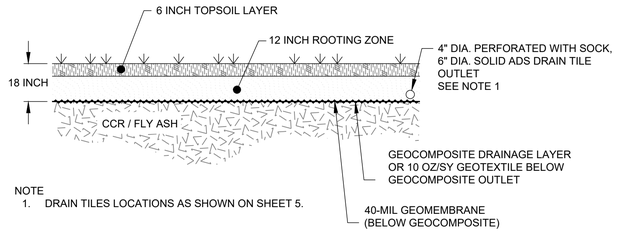


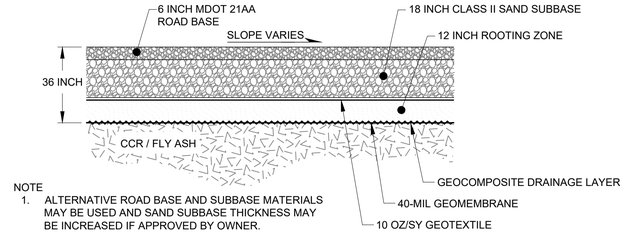
NOTE
1. 18 INCH COVER SOILS TO BE FEATHERED IN BETWEEN ANCHOR TRENCH AND EXISTING TOWERS TO CREATE POSITIVE DRAINAGE AS REQUIRED.

NOT TO SCALE 1/10 TRANSMISSION TOWER FOUNDATION DETAIL



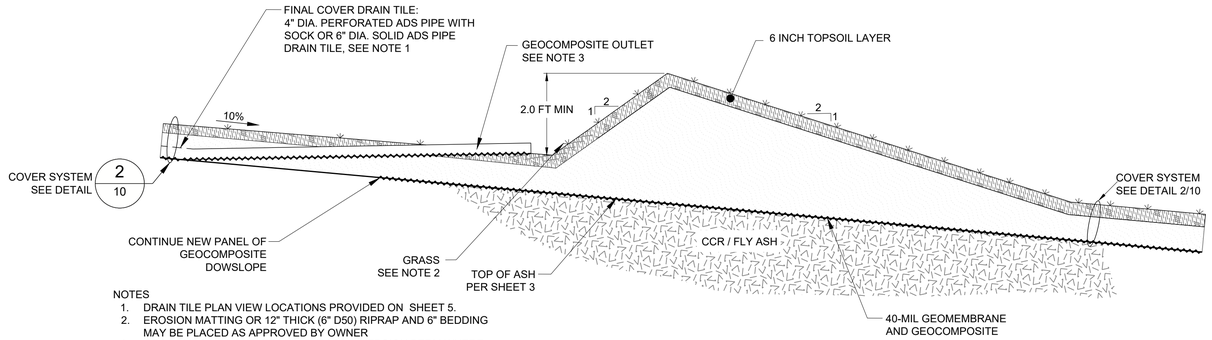
NOTE
1. DRAIN TILES LOCATIONS AS SHOWN ON SHEET 5.

NOT TO SCALE 2/10 COVER SYSTEM WITH 6" TOPSOIL LAYER, 12" ROOTING ZONE, GEOCOMPOSITE, AND GEOMEMBRANE DETAIL



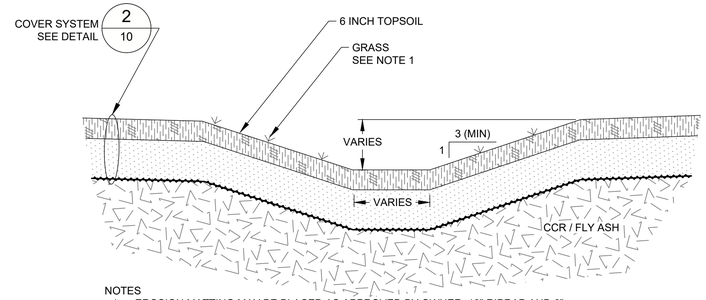
NOTE
1. ALTERNATIVE ROAD BASE AND SUBBASE MATERIALS MAY BE USED AND SAND SUBBASE THICKNESS MAY BE INCREASED IF APPROVED BY OWNER.

NOT TO SCALE 3/10 INTERIOR ACCESS ROAD & TOWER ACCESS ROAD DETAIL



NOTES
1. DRAIN TILE PLAN VIEW LOCATIONS PROVIDED ON SHEET 5.
2. EROSION MATTING OR 12" THICK (6" D50) RIPRAP AND 6" BEDDING MAY BE PLACED AS APPROVED BY OWNER
3. GEOCOMPOSITE OUTLET MAY BYPASS DIVERSION BERM WHERE BERM INVERT IS WITHIN 150 FT OF THE PERIMETER CHANNEL. ALTERNATIVE GEOCOMPOSITE OUTLET DESIGN MAY BE APPROVED BY THE OWNER.

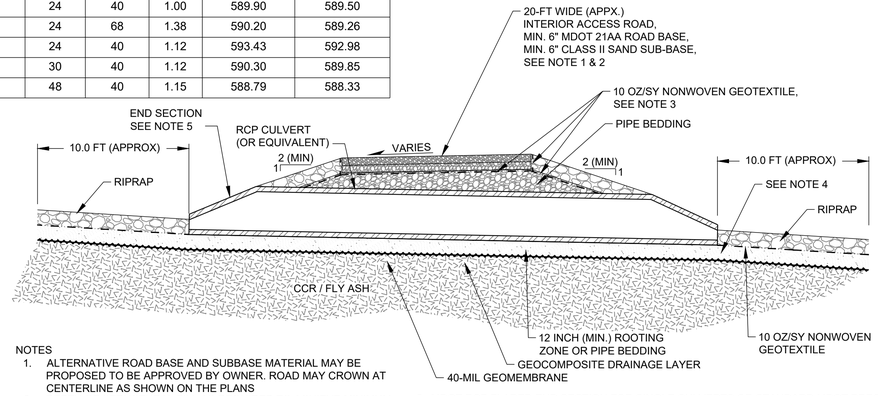
NOT TO SCALE 4/10 DIVERSION BERM DETAIL - TYPICAL



NOTES
1. EROSION MATTING MAY BE PLACED AS APPROVED BY OWNER. 12" RIPRAP AND 6" BEDDING MAY BE PLACED AT CHANNEL BENDS OR WHERE FLOW VELOCITY MAY EXCEED 5 FPS AS APPROVED BY OWNER.
2. INTERIOR CHANNEL MAY BE CONSTRUCTED AS V DITCH PROVIDING EQUIVALENT HYDRAULIC CAPACITY.
3. GEOCOMPOSITE AND DRAIN TLIE OUTLETS TO CHANNEL MAY BE ADDED AS APPROVED MY OWNER.

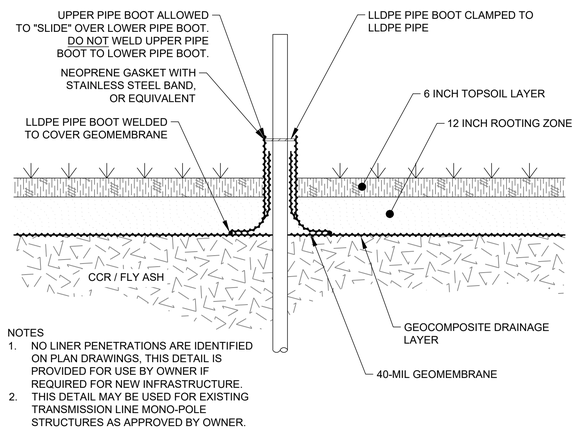
NOT TO SCALE 5/10 INTERIOR CHANNEL DETAIL - TYPICAL

Structure ID	Number of Culverts	Culvert Diameter (in)	Culvert Length (ft)	Culvert Slope (%)	Design Inlet Invert Elevation (MSL)	Design Outlet Invert Elevation (MSL)
C1	1	30	40.6	1.11	592.10	591.65
C2	1	24	40.6	1.11	593.22	592.77
C3	2	24	40	1.00	589.90	589.50
C4	2	24	68	1.38	590.20	589.26
C5	1	24	40	1.12	593.43	592.98
C6	1	30	40	1.12	590.30	589.85
C7	1	48	40	1.15	588.79	588.33



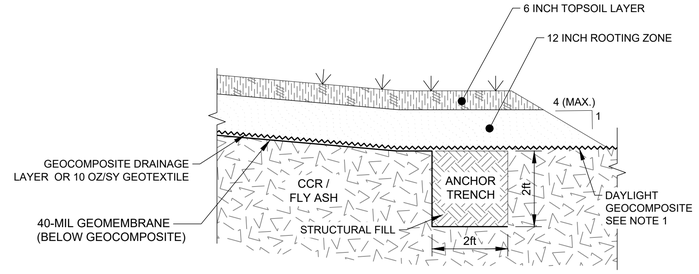
NOTES
1. ALTERNATIVE ROAD BASE AND SUBBASE MATERIAL MAY BE PROPOSED TO BE APPROVED BY OWNER. ROAD MAY CROWN AT CENTERLINE AS SHOWN ON THE PLANS
2. DEPTH OF STRUCTURAL FILL AS REQUIRED TO ACHIEVE MINIMUM ROAD THICKNESS.
3. GEOTEXTILE MAY BE MODIFIED AS APPROVED BY THE OWNER.
4. RIPRAP BEDDING MAY REPLACE ROOTING ZONE AS APPROVED BY THE OWNER.
5. MDOT RCP FLARED END SECTION FOR SINGLE CULVERTS OR STANDARD MDOT PRECAST HEAD WALL FOR MULTIPLE CULVERTS. END SECTION TO BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS AND APPROVED BY OWNER. ALTERNATIVE END SECTIONS MAY BE APPROVED BY OWNER.
6. DRAIN TILE AND GEOCOMPOSITE OUTLETS MAY BE ADDED AS APPROVED BY OWNER.

NOT TO SCALE 6/10 INTERIOR CULVERT CROSSING DETAIL - TYPICAL



NOTES
1. NO LINER PENETRATIONS ARE IDENTIFIED ON PLAN DRAWINGS, THIS DETAIL IS PROVIDED FOR USE BY OWNER IF REQUIRED FOR NEW INFRASTRUCTURE.
2. THIS DETAIL MAY BE USED FOR EXISTING TRANSMISSION LINE MONO-POLE STRUCTURES AS APPROVED BY OWNER.

NOT TO SCALE 7/10 LINER PENETRATION DETAIL - TYPICAL



NOTES
1. DRAIN TILE AND GEOCOMPOSITE OUTLETS MAY BE ADDED OR MODIFIED AS APPROVED BY OWNER

NOT TO SCALE 8/10 TRANSMISSION TOWER ANCHOR TRENCH DETAIL - TYPICAL

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MICHIGAN P.E. No.: 6201055778

Consumers Energy
J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

DETAILS - 3
DRY ASH LANDFILL CLOSURE PLAN

SCALE: AS SHOWN
JOB: 1773608.0003
SHEET 10
REV. 0

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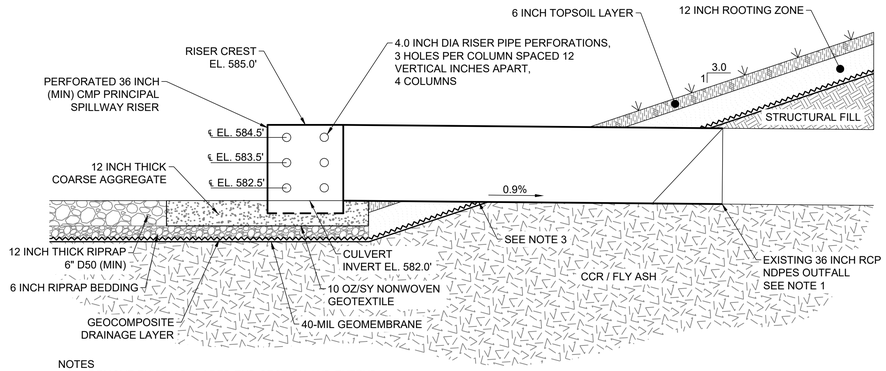

NOTES
1. REMOVE EXISTING FLARED END SECTION AND EXTEND EXISTING CULVERT APPROXIMATELY 15-FT.
2. ALTERNATIVE RISER PIPE MATERIAL MAY BE USED AS APPROVED BY OWNER.
3. EXTRUSION WELD GEOMEMBRANE TO RCP PIPE. ALTERNATIVE SEALS TO RCP MAY BE APPROVED BY OWNER.

NOT TO SCALE — 1/11 PROPOSED OUTFALL DETAIL

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MICHIGAN P.E. No.
6201055778

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J.C. WEADOCK GENERATING FACILITY
ESSEXVILLE, MI

DETAILS - 4

DRY ASH LANDFILL CLOSURE PLAN

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REV. 0

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APPENDIX B
CONSTRUCTION QUALITY ASSURANCE PLAN

CONSTRUCTION QUALITY ASSURANCE PLAN

J.C. WEADOCK GENERATING FACILITY

WEADOCK DISPOSAL AREA CONSTRUCTION QUALITY ASSURANCE PLAN

Essexville, Michigan

Submitted To: Consumers Energy Company
1945 W. Parnall Road
Jackson, MI 49201

Submitted By: Golder Associates Inc.
15851 South US 27, Suite 50
Lansing, Michigan 48906

November 2018 **1773608**

Golder Associates

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Appendix A Example CQA Forms

1.0 INTRODUCTION

1.1 Summary

The Construction Quality Assurance (CQA) program for the Consumers Energy Company (CEC) J.C. Weadock Generating Facility (JC Weadock) Coal Ash Disposal Area located in Essexville, Michigan is presented in the following paragraphs. This CQA Plan presents the methods to be followed during final cover construction necessary to confirm that the construction of the cover is in accordance with the final cover design and regulatory requirements.

1.2 Purpose and Scope

The purpose of the CQA program is to provide minimum requirements for construction observation, testing, and documentation activities to be performed during closure and to verify that the constructed final cover meets or exceeds design requirements and specifications contained in the approved Final Closure Plan and achieves regulatory and local requirements. The CQA Plan details sampling and testing programs to be carried out during the final cover construction. The primary goal of the CQA Plan is to provide a means of evaluating the quality of the constructed final cover so that the intent of the design is achieved.

1.3 Design Summary

In general, the closure of the ash disposal area includes the following major components:

- Initial site preparation and grading of the placed ash to final grades
- Preparation of the subgrade for placement of geomembrane
- Installation of a geomembrane cover system
- Overlay of the geomembrane with a geocomposite drainage layer
- Placement of cover soils consisting of a 12-inch rooting zone soil overlain by six inches of topsoil
- Construction of the stormwater conveyance system to remove stormwater from the cover area
- Final grading, seeding, mulching, and fertilizing to establish vegetation to protect the completed final cover system

2.0 RESPONSIBILITY AND AUTHORITY

2.1 Permitting Agencies

The Michigan Department of Environmental Quality (MDEQ) has the regulatory authority for approval or denial of the development and operational permits required for the landfill facility. Other agencies could be involved with construction and will be identified on a project-specific basis at the preconstruction meeting.

2.2 Facility Owner/Operator

CEC is responsible for the design, construction, and operation of the facility in compliance with the regulatory requirements.

2.3 Design Engineer

The Design Engineer (Engineer) has the responsibility of designing the final cover system to meet the permitted design and operational requirements of the MDEQ and CEC.

2.4 Construction Contractor

The Construction Contractor (Contractor) is responsible for construction of the final cover as indicated on the contract drawings and in the CQA Plan. The Contractor may implement their own quality control program for purposes of monitoring their related construction. The CQA program presented in this document provides the minimum standards for the acceptance of the work and the regulatory agencies.

2.5 Construction Quality Assurance Officer

The CQA Officer is a designated representative of CEC who is responsible for certificates of construction. The CQA Officer is a professional engineer registered in the state of Michigan with experience associated with the components of the layers of the landfill liner system. The CQA Officer is responsible for supervising all the inspection and testing quality assurance (QA) requirements of this section. The CQA Officer is also responsible for the preparation of a construction certification report following construction to document the completed observations, measurements, and testing. The report will include a certification statement signed by the CQA Officer that construction meets or exceeds design requirements and specifications contained in the approved Final Closure Plan and achieves regulatory and local requirements.

The specific responsibilities for administering the CQA program are the responsibility of the CQA Officer and will include the following at a minimum:

- Reviewing plans and specifications for clarity, completeness, and compliance with the approved Final Closure Plan and applicable regulations
- Educating and training QA personnel on requirements and procedures outlined in the CQA program
- Scheduling and coordinating QA activities

- Supervising field personnel
- Confirming that QA data are accurately recorded and maintained
- Verifying that raw QA data are properly recorded, reduced, summarized, and interpreted
- Providing associated organizations with reports on CQA activities and results
- Identifying non-conforming construction and verifying corrective measures

2.6 Construction Quality Assurance Technician(s)

The Construction Quality Assurance Technician(s) [CQAT(s)], under the direct supervision of the CQA Officer, will be present to perform observations and testing during the following construction activities:

- Elevation of the liner subgrade
- Structural fill placement and subgrade preparation
- Installation of the polyethylene geomembrane
- Installation of the geocomposite drainage layer
- Placement of one-foot-thick rooting zone and six inches of topsoil
- Installation of the culverts, ditches, and stilling basins
- Placement of road gravel
- Site restoration
- Documentation of tests, work activities, and material deliveries

The CQAT will document construction and CQA activities as described in Section 4.0 of this document.

3.0 MEETINGS

The meeting requirements for the CQA program include a preconstruction meeting, construction progress meetings, and special meetings. The meetings are to be documented by a designated secretary, and minutes will be transmitted to all parties.

3.1 Preconstruction Meeting

A preconstruction meeting will be held prior to the start of construction and will be attended by all principle parties (CEC, Contractor, CQA Officer) involved in the project. The MDEQ will be notified as soon as possible in advance of the preconstruction meeting in the event a representative wishes to attend. The purpose of the meeting is to:

- Exchange the following information: business addresses, phone numbers, and e-mail addresses of the Owner (CEC), Engineer, CQA Officer, and pertinent personnel for the Contractor
- Resolve any uncertainties following the award of the construction contract
- Review work scope
- Conduct a site walkthrough and inspection
- Discuss the Contractor's overall construction schedule and anticipated work hours
- Discuss project administration
- Review status of submittals required to be transmitted
- Discuss any appropriate design modifications or clarifications
- Discuss the Contractor's surface water and dust management plan
- Discuss the schedule and procedures of the geomembrane installation
- Discuss CEC's emergency notification and operating practices for emergency situations
- Review project methods, site security, and safety

3.2 Progress Meetings

A progress meeting will be held prior to the beginning of each major phase or on an "as needed" basis. The day of week and time of day will be determined and agreed upon by all parties prior to the meeting. The meeting will be conducted by CEC. The purpose of the meetings are to:

- Review coordination of work
- Review schedule
- Review the previous work activities and accomplishments
- Review the status of the Contractor's submittals
- Identify the Contractor's personnel and equipment assignments for upcoming work
- Discuss any existing or potential construction problems and their respective corrective actions
- Review nonconformance list

3.3 Special Meetings

Special meetings will be called at the discretion of CEC, Engineer, CQA Officer, or Contractor to resolve problems or other work-related issues.

4.0 CONSTRUCTION OBSERVATIONS

4.1 Daily Reports

The CQAT(s) collects samples and performs or observes the CQA testing required by the CQA Plan. A daily inspection report is prepared by each CQAT for each day they are onsite observing the construction and kept in a record book which is to be made available to CEC on a daily basis. The report will, at a minimum, contain the items specified in R299.4921(3) of the Part 115 Rules and generally may contain the following information:

- Date
- Type of observations
- Summary of weather conditions such as minimum and maximum temperatures, wind speed, and any precipitation
- Summary of any meetings held and attendees
- Equipment and personnel on the project
- Name and titles of Contractor supervisors and Quality Control personnel
- Summary of construction activities and locations
- Description of offsite materials received
- Calibration and recalibration of test equipment
- Description of procedures used
- Test locations, procedures, results, and test data sheets
- Summary of samples collected
- Record of repairs to the liner system
- Personnel involved in daily observations and sampling activities
- Signature of the technician
- Description of delays in construction activities
- Detailed description of any problems or nonconforming construction and resolution/alternatives for each situation
- Approximate quantities completed each day (approximate volume of fill placed, area of subgrade prepared, square footage of geosynthetics placed, etc.)
- Summary of failed testing and corrective actions completed
- Confirmation that all proper lifts or equipment are used to ensure the minimum contact pressure required at the liner
- Record of and field modifications made to the design or if hot or cold weather placement procedures for liner installation are in effect

4.2 Photographs

The CQAT will coordinate with CEC personnel to ensure sufficient photographs are taken to document construction problems, non-conforming work, and related repairs before and after the problem or non-conforming work is corrected.

Photographs approved by CEC security will be provided to the CQA Officer for inclusion in the Certification Report. At the end of the project, photographs will be retained by CEC.

4.3 Test Data Sheets

In general, the CQAT will record all field test data results on separate forms listed below:

- Field monitoring report
- Geosynthetic installation monitoring report
- Geomembrane trial seam log
- Certificate of soil surface acceptance
- Geosynthetic inventory control log
- Geosynthetic panel deployment log
- Geomembrane seam log
- Construction and repair log
- Geomembrane seam non-destructive test log
- Destructive test summary - field
- Destructive test summary – laboratory
- Field compaction summary

Independent consultants or laboratories engaged by the CQA Officer will submit their test results on forms acceptable to and approved by the CQA Officer.

4.4 Documentation and Record Storage

The daily records maintained during construction activities include but are not limited to the following:

- Daily observation reports
- Test data sheets
- Test data from independent consultants or laboratories (if any)

Daily records will be copied and forwarded to the CQA Officer on a daily basis.

5.0 EARTHWORK OBSERVATIONS AND TESTING

The following section summarizes the quality assurance plan proposed for testing and monitoring of the landfill final cover construction. The Contractor will provide testing results that document all imported soil provided for this project is from clean and uncontaminated sources. If the source of soil is an established commercial sand/aggregate pit, then a letter from the pit stating that the soil is virgin and non-contaminated will satisfy the requirement for testing.

The contractor will document the physical address, including latitude and longitude of each borrow source to depict the location and provide a brief narrative about the soil and intended use (e.g. structural fill, rooting zone, etc.). Physical properties of the structural fill soil will be established by determining the relationship between moisture and density, as established with laboratory test data as part of an initial design report on the borrow source by using either the modified Proctor test, ASTM D1557-91, or the standard Proctor test, ASTM D698-91. The Contractor will reevaluate the soil if the source changes or the material at the source changes in the physical properties. Alternate testing methods may be approved by CEC.

5.1 *Subgrade Testing*

The CQAT will perform testing of subgrade in accordance with this CQA Plan. Subgrade may be constructed of CCR materials or soils used as structural fill depending on the area of the landfill being constructed or the requirements of CEC.

CCR materials used as subgrade will be placed and tested as directed as in the Requirements for Placement and Testing of Historically Placed CCR Being Relocated. Structural fill used as subgrade will not be directly subject to the CCR relocation plan and testing procedures but will be addressed as included in this CQA Plan.

Structural fill is any subsoil free of wood, peat, stones larger than six inches, or other unsuitable material that may be compacted to form suitable subgrade. Material testing of the structural fill material will include determining the maximum dry density to be performed using the modified Proctor test (ASTM D 1557) or using the standard Proctor test (ASTM D 698) and determining the grain size distribution of the soil (ASTM D 422). Laboratory testing of structural fill will be completed at a rate of one sample per 10,000 cubic yards (cy) of in-place material. Field compaction testing will be performed in accordance with ASTM D 2922, “Density of Soil and Soil Aggregate In-Place by Nuclear Methods,” and ASTM D 3017, “Water Content of Soil and Rock In-Place by Nuclear Methods,” at a minimum rate of one test per 1,000 cy of in-place material. Subgrade fill is required to be compacted to a minimum of 90 percent of the modified Proctor or 95 percent of the standard Proctor maximum dry density in lifts not exceeding 12 inches. Alternate testing methods may be approved by CEC. Special modifications to the placement criteria will be made for areas of fill that may be below the natural water table. In those locations, granular fill may be placed until the fill is above the water level and then compaction or static loading will be allowed.

Once design liner grade is obtained and testing is completed, the subgrade will be smooth drum-rolled. Ruts or irregular surfaces, stones, debris, and any existing dense vegetation will be eliminated prior to placement of the geomembrane.

If tests indicate the work does not meet the specified requirements; the work will be removed, replaced, and retested or otherwise addressed. The top of subgrade will be documented by survey and compared to the design elevations.

5.2 Aggregate Materials

5.2.1 Road Aggregate

The CQAT will collect samples of the aggregate materials used as road aggregate for laboratory testing in accordance with the following specifications.

Grain size distribution testing of aggregate materials will be performed in accordance with ASTM D 422, "Particle Size Analysis of Soil," at a rate of one sample per 2,000 linear feet of road length or a minimum of three samples, whichever is greater. The aggregate materials will be clean, sound, tough, and durable with a particle size distribution in accordance with MDOT Class 21AA Road Aggregate.

If tests indicate the aggregate does not meet the specified requirements; the material will be removed, replaced, and retested. Alternate materials may be used as approved by the Engineer. The general final configuration will be documented in the certification report.

5.2.2 Pipe and Riprap Bedding Stone

The CQAT will collect samples of the aggregate materials used as riprap and pipe bedding stone for laboratory testing in accordance with the following specifications.

Grain size distribution testing of aggregate materials will be performed in accordance with ASTM D 422, "Particle Size Analysis of Soil," at a rate of one sample per 1,000 linear feet of pipe, one sample per 2,000 cy of material placed, or a minimum of three samples, whichever is greater. The aggregate materials will meet the gradation requirements of the tables below:

Table 5.1 - Riprap Bedding Material

Sieve Size	Percent Passing by Weight
1.5 inch	100%
1 inch	95 to 100%
1/2 inch	30 to 60%
No. 4	0 to 8%

Table 5.2 - Pipe Bedding Material

Sieve Size	Percent Passing by Weight
1/2 inch	100%
3/8 inch	90 to 100%
No. 8	0 to 5%

If tests indicate the aggregate does not meet the specified requirements; the material will be removed, replaced, and retested. Alternate materials may be used as approved by the Engineer. The general final configuration will be documented in the certification report.

5.2.3 Riprap

The CQAT will monitor the placement techniques of riprap to be in accordance with the technical specifications. The CQAT will also provide field measurements of the riprap to confirm minimum D50 sizes are in accordance with the contract drawings. Collection of riprap samples to be laboratory tested in accordance with ASTM D 422, "Particle Size Analysis of Soil," may be performed at the discretion of the CQA Officer or CEC.

5.3 Anchor Trenches

QA associated with monitoring and testing of anchor trenches will include the following:

- Anchor trench excavation will be monitored for proper depth and location.
- Geosynthetic panels extending into the anchor trench will be monitored for complete seaming into the anchor trench.
- Anchor trench backfill operations will be observed and documented.
- The depth of a typical anchor trench will be documented to conform to contract drawings.
- Backfill will be placed in thin lifts not to exceed one foot in loose thickness.
- Density tests will be performed at a minimum interval of one per 500 linear feet of anchor trench to be compacted to a minimum of 90 percent of the modified Proctor or 95 percent of the standard Proctor maximum dry density in lifts not exceeding 12 inches. The CQAT will increase testing interval if the Contractor changes backfill material, placement procedures, or compaction methods of backfill.
- The geosynthetic panel runout in the anchor trench will be within ± 0.3 foot, as shown on the contract drawings.

5.4 Rooting Zone

Rooting zone soils will be placed over geosynthetics within the landfill limits and, to a limited degree, over soils in staging areas for final restoration. Rooting zones may be various soil types but must be either SM, ML, SC, CL, or CH. Alternative materials may be approved by CEC. Since these soils are placed adjacent to the geosynthetics, there will be no stones larger than two inches, and they will be free of materials that could harm the geosynthetics.

The soil source will be approved by CEC and free of contaminants prior to hauling onsite. Material will be spread to the thickness shown by the plans with low ground pressure [not exceeding five pounds per square inch (psi)] by dozers and, to the degree possible, pushed up-slope to prevent tensioning of the geosynthetics. Limited placement of rooting zone soils downslope will be allowed pending submittal of a slope stability evaluation by the contractor in accordance with Section 6.7. Temporary haul roads for normal ground pressure vehicles will be a minimum of 36 inches thick.

During cover soil placement, the CQAT will observe the following:

- Placement procedures and equipment sizes
- Weather conditions to prevent placement of frozen material
- Removal of stones or other debris
- Confirmation that underlying geosynthetic drainage layer and geotextile, as appropriate, remain in place to cushion the geomembrane
- Control of rooting zone thickness over the landfill and in areas of hauling
- Evaluate degree of compaction by visual, qualitative means

The CQAT will perform the following testing prior to and during rooting zone placement:

- Collect sample for contaminant testing at the request of CEC from potential borrow sites
- Collect one sample per 10,000 cy of placed material and/or when the material source changes for grain size determination in accordance with ASTM D422
- Conduct thickness checks performed on a 200 foot grid
- All testing and observations will be documented in the daily report and with construction photographs in accordance with Section 4.2

5.5 Topsoil

The topsoil for the landfill will be the final six inches of the cover soil. This material may be the same as the rooting zone, but it must have at least 2.5 percent organic matter to support the establishment of vegetation and retain moisture. Testing of the topsoil for organic content will be in accordance with ASTM D2974.

The CQAT will observe the following during topsoil placement:

- Placement procedures and equipment sizes
- Weather conditions to prevent placement of frozen material
- Removal of stones or other debris
- Control of rooting zone thickness over the landfill and in areas of hauling
- Degree of compaction

The CQAT will perform the following testing prior to and during topsoil placement:

- Collect sample for contaminant testing at the request of CEC from potential borrow sites.
- Collect and test a minimum of one sample per 10,000 cy of material placed and/or when the material source changes for grain size determination in accordance with ASTM D422 and for organic content.
- Document all testing and observations in the daily report and with construction photographs in accordance with Section 4.2.

The maximum allowable difference from documented grades to design grades is +1.0/- 0.0 foot. If the documented top of topsoil differs from the design grades by more than +1.0/- 0.0 foot, the topsoil and/or rooting zone will be regraded and re-documented.

6.0 GEOMEMBRANE LINER OBSERVATIONS AND TESTING

The geomembrane is the synthetic barrier layer of the final cover system. The geomembrane systems will be linear low-density polyethylene (LLDPE) or high-density polyethylene (HDPE) of the thickness shown on the contract drawings. Textured geomembrane will be used as indicated by the plans.

6.1 Geomembrane Rolls and Panels

Geomembrane materials will be approved by the CQA Officer before being used in construction. Approval will be based on the review of material data provided by the manufacturer and the inspection for defects of material as it is delivered to the site. HDPE and LLDPE flexible membrane liners (FML) will be in accordance with Geosynthetic Research Institute (GRI) GM 13 & 17 standard, latest revision.

The CQA Officer will review Contractor submittals and monitor handling and deployment of the materials. These activities may include:

- Monitoring and documenting the unloading of trucks delivering geomembrane rolls to the site:
  - Name of the manufacturer and fabricator
  - Name and type of liner
  - Thickness of liner
  - Batch code
  - Date of fabrication
  - Physical dimensions of rolls or fabricated panels
  - Panel number
  - Location and method of storage at the site
- Monitoring the handling and onsite storage of geomembrane rolls
- Recording the manufacturing roll and batch number of geomembrane rolls delivered to the site
- Reviewing the manufacturer's quality control testing for conformance with latest revision of GRI GM 17 & GRI GM 13 and the required testing in Tables 6.1 and 6.2
- Fixing a code number to samples and recording the manufacturing numbers of the rolls from which samples are taken
- Labeling, packaging, and shipping samples to an offsite laboratory for conformance testing (if required)
- Interpreting laboratory test results in accordance with the specifications and accepting or rejecting delivered rolls based on results of offsite testing
- Observing and marking geomembrane as it is unrolled and deployed at the job site for uniformity, damage, and imperfections including holes, cracks, thin spots, tears, punctures, blisters, and foreign matter
- Reviewing documentation of the origin and identification of the raw materials used in the liner

- Reviewing copies of quality control certificates that are issued by the producer of the raw materials

Table 6.1 – Textured LLDPE Geomembrane Properties and Testing Frequencies

Properties	Test Method	Test Value 40 mils	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	16 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.939 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • break strength • break elongation	D 6693 Type IV	 60 lb/in. 250%	20,000 lb
Tear Resistance (min. ave.)	D 1004	22 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	44 lb	45,000 lb
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (6) (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	535% 35% 60%	per each formulation
UV Resistance (8) (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs (11)	D7238 D3895 D5885	N.R. *(9)* 35%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥14 mils, and lowest individual reading must be ≥12 mils; also see Note 2.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be based on 5 test specimens each direction.
- Yield elongation is calculated using a gage length of 1.3 inches
- Break elongation is calculated using a gage length of 2.0 inches

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3
(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.
(11) *Table contents from current GM 17. If GM 17 is modified, newest values may be used.*

Table 6.2 – Textured HDPE Geomembrane Properties and Testing Frequencies

Properties	Test Method	Test Value 40 mils	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.)	D 7466	16 mil	every 2nd roll *(1)*
Formulated Density (min. ave.)	D 1505/D 792	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	84 lb/in. 60 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	28 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	60 lb	45,000 lb
Stress Crack Resistance (*3*)	D 5397 (App.)	500 hr	Per GRI GM 10
Carbon Black Content (range)	D 4218 *(4)*	2.0-3.0 %	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (6) (c) Standard OIT — or — (d) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	per each formulation
UV Resistance (8) (c) Standard OIT (min. ave.) — or — (d) High Pressure OIT (min. ave.) - % retained after 1600 hrs (11)	D7238 D3895 D5885	N.R. *(9)* 50%	per each formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be based on 5 test specimens each direction.
- Yield elongation is calculated using a gage length of 1.3 inches
- Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(11) *Table contents from current GM 13. If GM 13 is modified, newest values may be used.*

6.2 Panel Placement

QA monitoring for panel placement includes:

- Obtaining a written acceptance of the subgrade by the geomembrane installer
- Evaluating and documenting weather conditions (e.g., temperature, wind) for geomembrane placement; and informing the CQAT if requirements for weather conditions are not met so the CQAT can decide whether or not to stop geomembrane placement
- Monitoring and documenting geomembrane placement as well as conditions of panels as placed
- Noting panel defects, tears, or other deformities
- Observing panel placement for proper overlap
- Measuring panel lengths
- Recording the approximate locations of installed panels and checking that the panels have been installed in accordance with the design plan
- Assigning each panel a unique panel number and identifying that panel with the manufacturer's roll number
- Recording panel numbers and approximate locations on a panel layout diagram
- Recording ambient air temperature (daily)

6.3 Geomembrane Field Seam Construction

Seam construction information includes:

- Seam Layout:
  - When possible, orient seams parallel to line of maximum slope, i.e., oriented along, not across, slope.
  - When possible, no horizontal seam will be less than 10 feet from toe of slope.
  - In general, maximize lengths of field panels and minimize number of field seams.
  - Align geomembrane panels to have nominal overlap of three inches for extrusion welding and four to six inches for fusion welding. Final overlap will be sufficient to allow strength tests to be performed on seam.
  - Seams will be wiped free of moisture and debris prior to seaming.
  - Where applicable, the panels will be shingled in a downslope fashion.
- Temporary Bonding:
  - Hot air device (Liester) will be used to temporarily bond geomembrane panels to be extrusion welded.
  - Do not damage geomembrane when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack geomembrane panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.
  - Do not use solvent or adhesive.

- Seaming Methods:
  - Approved processes for field seaming are extrusion welding and double-wedge fusion welding methods. Proposed alternate processes will be documented and submitted to CEC for approval. Alternate procedures will be used only after being approved in writing by CEC.
  - Seams will meet the requirements of GRI GM 19a, latest revision.
  - Use double-wedge fusion welding as primary method of seaming adjacent field panels:
    - For cross seam tees associated with fusion welding, a patch is required. Extrusion welding of cross seam tees will only be permitted with approval of CQAT.
    - When subgrade conditions dictate, use movable protective layer (e.g., extra piece of geomembrane) directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers. If protective layer is used, it will be removed after completion of seam.
  - Use extrusion welding as secondary method of seaming between adjacent panels and as primary method of welding for detail and repair work.
- Seaming Procedures:
  - General seaming procedures (ambient temperature between 32°F and 104°F) (Note that seaming outside of this temperature range may be allowed provided trial welds provide passing results and are approved by CEC):
    - Do not seam if dust is blowing because of excessive winds.
    - Align seams with fewest possible number of wrinkles and fishmouths.
    - Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris, or foreign material.
    - At beginning and end of each seam, Contractor will record start time of weld, date, welder initials, identification number of seaming unit, seaming unit temperature, and speed.
    - T-welding of cross seams will not be permitted unless approved by CQAT.
  - Cold weather seaming procedures (ambient temperature below 32°F) will meet the requirements of GM 9:
    - Sheet grinding may be performed before preheating, if applicable.
    - Trial seaming will be conducted under the same ambient temperature and preheating conditions as actual seams. New trial seams will be conducted if ambient temperature drops by more than 10°F from initial trial seam test conditions. New trial seams will be conducted upon completion of seams in progress during temperature drop.
    - CQAT or CEC will inspect the geomembrane surfaces for the presence of frost or residual moisture prior and during the welding procedure. If either is present, Installer will make provisions for removal and sufficient drying.
    - The CQAT will describe the nature and time of the execution of cold weather welding procedures in the certification report as a means of notification to MDEQ.
  - Warm weather procedures (ambient temperature above 104°F):
    - No seaming of geomembrane is permitted unless demonstrated to CQAT that geomembrane seam quality will not be compromised.

- At option of CQAT, additional destructive seam tests may be required for any suspect areas.

- Repair procedures:
  - Repair portions of geomembrane exhibiting flaw or failing destructive or nondestructive test.
  - Final decision as to repair procedure will be agreed upon between CEC, Contractor, and CQAT.
  - Acceptable repair procedures may include the following:

Patching: Piece of same geomembrane material welded into place. Use to repair large holes, tears, non-dispersed raw materials, and contamination by foreign matter.

Capping: Strip of same geomembrane material extrusion welded into place over inadequate seam. Use to repair large lengths of failed seams.

Removal and replacement: Remove bad seam and replace with strip of same geomembrane material welded into place. Use to repair large lengths of failed seams.

QA monitoring and testing to be conducted for seam construction includes:

- Monitoring trial test seams: Test seams will be made by each operator and seaming unit combination each day prior to commencing field seaming. These seams will be made on fragment pieces of geomembrane liner to observe that seaming conditions are adequate. Such test seams will be made at the beginning of each seaming period; at changes of equipment, equipment settings, or power supply interruption; at CQAT discretion; and at least once every five hours or as directed by the CQAT in accordance with temperature and weather conditions during continuous operation of each welding machine. Also, each seamer and seaming unit combination will make at least one test seam each day prior to commencing seaming operations. Requirements for test seams are stated below.

  The test seam sample will be at least three-feet (0.9 m) long by one-foot (0.3m) wide, or as agreed, with the seam centered lengthwise. Six adjoining specimens, one-inch (25 mm) wide each, will be die cut from the test seam sample. These specimens will be tested in the field with a tensiometer for both shear (three specimens) and peel (three specimens) for single-track fusion welds or extrusion welds. For dual-track fusion welds, the Contractor will test each track as if it were a single-track weld. Test seams will be tested by the Contractor under observation of the CQAT or designated representative of CEC. The specimens will not fail in the weld. No strain measurements need to be obtained in the field. A passing fusion or extrusion welded test seam will be achieved when the criteria shown in Table 1(a) and Table 2(a) of GRI GM 19a, pertaining to seam strength and the related properties of thermally bonded textured HDPE and LLDPE, are met. Values from Table 2(a), pertaining to LLDPE geomembrane thickness of 40 mils, are shown below in Table 6.3. Values from Table 1(a), pertaining to HDPE geomembrane thickness of 40 mils, are shown below in Table 6.4.

Table 6.3 – Seam Strength and Related Properties of Thermally Bonded Textured LLDPE Geomembranes

Geomembrane Nominal Thickness	40 mils
Hot Wedge Seams [1]	
Shear Strength, lb/in	60
Shear Elongation [2], %	50
Peel Strength, lb/in	50
Peel Separation, %	25
Extrusion Fillet Seams	
Shear Strength, lb/in	60
Shear Elongation, [2], %	50
Peel Strength, lb/in	44
Peel Separation, %	25

Notes:
Also for hot air and ultrasonic seaming methods.
Elongation measurements should be omitted for field testing.

Table 6.4 – Seam Strength and Related Properties of Thermally Bonded Textured HDPE Geomembranes

Geomembrane Nominal Thickness	40 mils
Hot Wedge Seams [1]	
Shear Strength, lb/in	80
Shear Elongation [2], %	50
Peel Strength, lb/in	60
Peel Separation, %	25
Extrusion Fillet Seams	
Shear Strength, lb/in	80
Shear Elongation, [2], %	50
Peel Strength, lb/in	52
Peel Separation, %	25

Notes:
Also for hot air and ultrasonic seaming methods.
Elongation measurements should be omitted for field testing.

If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Trial test seam failure is defined as failure of any one of the specimens tested in shear or peel. For double weld seams, both weld tracks will meet the test seam criteria.

- The CQAT will log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

- Non-destructive testing:
  - Production seams will be tested by the Contractor continuously using non-destructive techniques. The Contractor will perform all pressure and vacuum testing, and the non-destructive testing will be observed by the CQAT(s) or CQA Officer on a procedural basis. Requirements for non-destructive testing are as follows:
  - Extrusion weld seams:
    - The Contractor will maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams. The

system will be capable of applying a vacuum of at least 5 psi (35 kPa). The vacuum will be held for a minimum of 10 seconds for each section of seam.

- If bubbles are present indicating leakage, the area will be marked clearly for repair.
- If the vacuum test indicates leakage, the area will be patched or the entire seam will be capped.

- Double-wedge fusion weld seams:
  - The Contractor will maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system will be capable of applying a pressure of at least 30 psi (207 kPa) for not less than five minutes. The seam will be cut at the opposite end from the air pressure gauge to assure full continuity of the test.
  - Pressure loss tests will be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes," GRI Test Method GM 6. As outlined by the test method, the seam or portion thereof being tested will be pressurized to 30 psi and; following a two-minute pressurized stabilization period, pressure losses over a measurement period of five minutes will not exceed four psi for a 40-mil sheet.
  - The Contractor will demonstrate the required pressure over the entire length of the seam.
  - If pressure drops below the allowance, the test will be considered a failure and the following procedures will be implemented:
    1. Check to determine if there is excessive seepage around the inflation needle.
    2. Check both ends of the seam to ensure the flow channel is completely sealed off.
    3. Walk the length of the seam, and look and listen for air leaks.
    4. If these procedures fails to identify the leak, trim the seam overlap, and vacuum test the seam to locate the leak.
    5. Once the leak is identified, make the necessary repairs and retest the seam.

- Destructive testing: Destructive testing will be performed on at least one field-seamed sample per day per seaming crew and machine combination. The sampling and testing frequency will be at least one test every 500 linear feet (150 m) of production seam for fusion and extrusion welded seams. Minor repairs with less than 10 feet of seam length are not included in the extrusion weld seam total. If the weather conditions are such that the ambient air temperature is less than 32°F, the minimum frequency may be increased by CEC, CQAT, or CQA Officer. GRI Test Method GM 9, “Cold Weather Seaming of Geomembrane” will be utilized for seaming under 32°F. The locations will be selected by the CQAT or CQA Officer. Sufficient samples will be obtained by the Contractor to provide one sample to the archive, one sample to the CQAT or CQA Officer for laboratory testing (if required), and one sample to be retained by the Contractor for field testing. The Contractor will mark each sample with the name of the person welding, date, time, ambient air temperature, temperature of heating element, speed of seaming, and identification number of seaming unit. The test seam sample will be a minimum of three-feet (0.9 m) long by one-foot (0.3 m) wide with the seam centered lengthwise. Testing requirements are as indicated in GRI standard GM 19a, “Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers.” Final determination of sample sizes will be agreed upon at the pre-construction meeting.

- Seam destructive testing will be observed by the CQAT(s) or CQA Officer on a procedural basis. The Contractor will test samples in the field. All tests will be performed using a calibrated, motor-driven, strain-controlled tensionmeter approved by the CQA Officer.
  - Peel will be measured for one sample (five specimens). Peel tests will be evaluated for the criteria described in GRI GM 19a. For double track welders, peel tests (five specimens) will be evaluated for each track.
  - Shear will be measured for one sample (five specimens). Tests will be evaluated for the criteria described in GRI GM 19a.
- The CQAT(s) or CQA Officer will observe production seam field tests on a procedural basis and will provide samples to a third party laboratory certified by "Geosynthetic Accreditation Institute – Laboratory Accreditation Program" for laboratory testing for both peel and shear and evaluate test results in accordance with GRI GM 19a.
- The CQAT or CQA Officer will be responsible for the archive specimen and will assign a number to the archive sample and mark the sample with the number and will log the date, seam number, approximate location in the seam, and field test pass or fail description, if applicable.

6.4 Seam Repair

Damaged and sample coupon areas of geomembrane will be repaired by the Contractor by construction of a cap strip. No repairs will be made to seams by application of an extrusion bead to a seam edge previously welded by fusion or extrusion methods. Repaired areas will be tested for seam integrity. Damaged materials are the property of the Contractor and will be removed from the site. The following QA monitoring and testing will be implemented to monitor defect repairs:

- Destructive test failure procedures: When a sample fails destructive testing, Contractor has the following options:
  - Repair seam between any two passing destructive test locations.
  - Trace welding path to intermediate point (10 feet minimum from point of failed test in each direction) and take a small sample with a one-inch wide die for an additional field test at each location. If these additional samples pass test, then take a full size destructive sample for peel and shear testing in accordance with Section 6.3. If these samples pass tests, repair seam between these locations. If either sample fails, repeat process to establish a zone in which seam should be repaired.
  - Acceptable repaired seams will be bound by locations from which samples passing destructive tests have been taken. In cases exceeding 150 feet of repaired seam, the CQA Officer may have Contractor destructive test repair seam.
  - When sample fails, CQA Officer or CQAT may require additional testing of seams that were welded by same welder and/or welding apparatus during same time shift.
- Repair verification:
  - The CQAT will observe each repair on a procedural basis and will number and log each repair.
  - The CQAT will observe the repair testing on a procedural basis and will document non-destructive testing of each repair.
  - The CQAT will document passing non-destructive test results as adequate repairs.
  - Repairs more than 150-feet long may require destructive test sampling.

Failed destructive or non-destructive tests indicate that the repair will be redone and retested until passing test results.

6.5 Documentation and Reporting

Documentation and reporting methods will be implemented to systematically record results of onsite monitoring and testing. Reporting forms will be used for roll and panel placement, trial weld construction, panel seaming, non-destructive seam testing, and destructive seam testing. Unique identifying numbers will be assigned to each panel and seam and used to reference the panel and seam location and test results. Copies of example CQA forms are included in Appendix A.

Panel location and seam location diagrams will be kept showing the location of all panel and seams, repairs, and destructive sample test locations. These location diagrams will be updated on a daily basis and will be available for review.

Copies of test results for any offsite laboratory testing will be forwarded to the CQA Officer and CQAT. The laboratory test result documents will be maintained in a job file and submitted with the final certification report.

6.6 Stability

Prior to placement of cover soils on the geomembrane, interface friction testing will be performed and reviewed by a qualified geotechnical engineer as approved by CEC. If substantially the same material is being used as previously tested, CEC may elect to waive the testing. A stability analysis of the proposed cover placement methods will be performed prior to the use of new materials at the facility and submitted to CEC prior to construction. The calculations will reflect the actual test results for material in the field and equipment being proposed. The calculations will be provided to the MDEQ in the construction certification report.

Any equipment required to access final cover will maintain pressure below five psi at the geotextile. If larger equipment is required, access/haul roads may be needed to prevent damage to the geotextiles.

7.0 GEOCOMPOSITE DRAINAGE LAYER OBSERVATIONS AND TESTING

The following section defines the CQA program for installation of the geocomposite drainage layer in the final cover system. Geocomposite drainage layer materials consisting of a drainage net with geotextile heat bonded to the upper and lower sides will be placed over the geomembrane.

7.1 Geocomposite Drainage Layer Rolls and Panel

CQA monitoring for geocomposite drainage layer rolls and panels includes the following:

- Monitoring and documenting the unloading of geocomposite and geonet rolls delivered to the site
- Monitoring the handling and onsite storage of geocomposite and geonet rolls
- Recording the roll number of geocomposite and geonet rolls delivered to the site
- Reviewing manufacturer's quality control testing and certification for conformance with Tables 7.1, 7.2, and 7.3
- Obtaining samples and recording the manufacturer roll numbers from which samples are taken
- Reviewing manufacturer's certifications for conformance with the specifications
- Labeling, packaging, and shipping samples to an offsite laboratory for conformance testing (if required)
- Observing geocomposite and geonet as it is installed for uniformity, damage, and imperfections including holes, tears, thin spots, punctures, and foreign matter

Table 7.1 - Geocomposite Geotextile Properties (Prior to the Heat Bonding)

Property	Method	Value	Frequency
Mass per Unit Area	ASTM D 5261	10 ounces/square yard nominal	1 per 100,000 sq. ft.
Puncture Resistance	ASTM D 4833	90 lb. minimum	1 per 100,000 sq. ft.
Grab Tensile	ASTM D 4632	160 lb. minimum	1 per 100,000 sq. ft.
UV Resistance	ASTM D 4355	50 percent @ 500 hours	1 per formulation

Note: Alternative test methods must be approved by Engineer.

Table 7.2 - Geocomposite Geonet Properties (Prior to the Heat Bonding)

Property	Method	Value	Frequency (min)
Thickness	ASTM D 1777	200 mils minimum	1 per 100,000 sq. ft.
Mass per Unit Area	ASTM D 3776 (Option C)	0.16 lb./ft^2 minimum	1 per 100,000 sq. ft.
Density (Geonet)	ASTM D 1505	0.940 g/cc minimum	1 per 100,000 sq. ft.
Tensile Strength	ASTM D 5035	45 lb./in. minimum	1 per 100,000 sq. ft.
Modifications: Use 4-inch by 8-inch specimens and test at rate of 8-inch/minimum. Continue test until first strand completely separates. Report average of five tests in machine direction.			

Property	Method	Value	Frequency (min)
Carbon Black Content	ASTM D 1603	2.0 to 3.0 percent	1 per 100,000 sq. ft.
Transmissivity	ASTM D 4716	$8x10^{-3}$ m^2/sec. at 2,000 pounds per square foot confinement and gradient of 0.1	1 per 100,000 sq. ft.

Note: Alternative test methods must be approved by Engineer.

Table 7.3: Geocomposite Properties (After Heat Bonding)

Property	Method	Value	Frequency
Adhesion Peel Resistance	ASTM D 7005	1.0 lb./in.	1 per 100,000 sq. ft.
Transmissivity	ASTM D 4761	$6x10^{-4}$ m^2/sec. at 2000 pounds per square foot confinement and gradient of 0.1	1 per 100,000 sq. ft.

Note: Alternative test methods must be approved by Engineer.

7.2 Geocomposite and Geonet Seams and Overlaps

The CQAT will observe that geocomposite drainage layer and geonet overlaps and seams conform to the CQA Plan. Geonet seams and overlap on adjacent geocomposite/geonet roll edges will overlap a minimum of three inches, and overlap adjacent geonet roll will end a minimum of six inches. The geonet overlaps will be tied with plastic fasteners, and white or yellow tying devices will be used for easy inspection. Metallic devices will not be used. The upper geotextile will be continuously sewn or fusion seamed, and geotextile will overlap a minimum of three inches prior to seaming.

Heat-bonding of the geotextile to geocomposite is allowed provided there is a minimum overlap of four feet, the overlap is shingled downslope in the direction of soil placement, and there is no exposed drainage core directly against soil, either above or below, at any location. If necessary, heat bonding of additional geotextile to the composite's geotextile must be completed to prevent any exposed drainage core from being installed against soil as specified in Section 4.4 of GRI GN 2 and GRI GC 13.

7.3 Geocomposite and Geonet Repairs

The CQAT will observe that repairs to the geocomposite drainage layer and geonet conform to the CQA Plan. Geonet will be overlapped a minimum of three inches and tied into place when repairing at a spacing of every six inches along the perimeter of the patch. The geotextile will overlap the repaired geonet by a minimum of 12 inches and be heat bonded in place.

7.4 Geocomposite Slope Deployment

CQAT will observe that on slopes, the geocomposite is anchored securely and deployed downslope in a controlled manner to continually keep geocomposite in tension.

7.5 Geocomposite and Geonet Sampling

CQAT will include sampling of the geocomposite and geonet materials at a rate of one sample per five acres of installed material. Samples may be forwarded to a laboratory for testing at the CQA Officer's discretion. Otherwise, the samples will be archived. Extra samples of deployed material may be taken if the general material appearance is questioned by the CQA Officer or CEC.

7.6 Documentation and Reporting

Daily estimates of the amount of geocomposite and geonet placed and seamed will be kept. This information will be included in the daily reports. A record of geocomposite and geonet roll numbers delivered to the project site will be kept with a copy of the required manufacturer certifications.

8.0 CUSHION GEOTEXTILE

The following section defines the CQA program for installation of the geotextile cushion layer in the final cover system. Geotextile (10 oz/sy) for cushion will be for over the 40-mil geomembrane, at the toe of slope below the geocomposite drainage outlets.

8.1 Geotextile Rolls

Monitoring for geotextile cushion rolls includes the following:

- Monitoring the condition of the rolls following delivery and unloading
- Recording the roll number of rolls delivered to the site
- Reviewing manufacturer's quality control testing for conformance with the CQA Plan shown in Table 8.1
- Obtaining samples and recording the manufacturer roll numbers from which samples are taken
- Labeling, packaging, and shipping samples to an offsite laboratory for conformance testing (if required)
- Observing geotextile as it is installed for uniformity, damage, and imperfections including holes, tears, thin spots, punctures, and foreign matter

Table 8.1 - Geotextile Properties

Property	Test Method	Frequency	Maximum Value	Minimum Value
Mass per Unit Area, oz/yd^2	ASTM D 5261	90,000 ft^2	NA	10
Puncture Resistance, lb.	ASTM D 6241	90,000 ft^2	NA	700
Grab Tensile Strength, lb. (elong. percent)	ASTM D 4632	90,000 ft^2	NA (50%)	230 (50%)
Trapezoidal Tear Strength, lb.	ASTM D 4533	90,000 ft^2	NA	95
UV Resistance, percent	ASTM D 7238	90,000 ft^2	70%	70%

Note: Alternative test methods must be approved by the Engineer.

8.2 Geotextile Seams and Overlaps

The geotextile will be continuously sewn. Overlaps will be at least three to four inches or as required to perform the proper seaming. A double stitch seam will be used on all areas. Alternate seaming methods may be approved by CEC.

8.3 Geotextile Repairs

The geotextile will overlap the repair area by four to six inches to provide proper excess material to perform the sewing. On repairs smaller than six square feet, the geotextile may be repaired by overlapping the damaged area with new geotextile and heat bonding it into place.

8.4 Geotextile Sampling

CQA monitoring will include sampling of the geotextile at a rate of one sample per 90,000 square feet of delivered material. Samples may be forwarded to a laboratory for testing at the CQA Officer's discretion. Otherwise, the material will be archived. Extra samples of deployed material may be taken if the general material appearance is questioned by the CQA Officer or CEC.

8.5 Documentation and Reporting

Daily estimates of the amount of geotextile placed and seamed will be kept. This information will be included in the daily reports. A record of geotextile roll numbers delivered to the project site will be kept with a copy of the required manufacturer certifications.

9.0 SITE RESTORATION

The following section describes the CQA requirements for the site restoration such as final cover seeding, fertilizing, and mulching. Miscellaneous activities required for complete site restoration are included in this section such as road grading and waste management.

9.1 Erosion and Sediment Control

The CQAT will monitor the installation of erosion and sediment control features. This includes the documentation of temporary silt fencing, location of silt check dams, and temporary ditching. The CQAT will document the type and quantity of material installed.

On the final cover system where rolled erosion control mats are installed, the CQAT will record the location and quantity of material deployed.

9.2 Seeding, Fertilizer, and Mulch

The final cover topsoil will be prepared for seeding and mulching in accordance with typical Michigan Department of Transportation (MDOT) standards. Alternative seed mixtures may be proposed and approved by CEC. The CQAT will document material and equipment delivered to the site for the seeding operation. In general, the CQAT will record the following information:

- Seed types and quantities delivered to the site
- Type and quantity of fertilizer delivered
- Type and quantity of lime or other soil amendments
- Approximate area seeded and rate of seed application
- Approximate area fertilized or limed and rate of application
- Copies of soil nutrient test results from Contractor
- Type and quantity of mulch applied

9.3 Documentation

CQAT or CEC will document the limits of site restoration and dates of seeding as the work progresses. All installation procedures and types of equipment used for the work will be recorded. Photographs of typical procedures will be taken in accordance with Section 4.2. The data will be reported in the final documentation report.

While onsite, the CQAT will document any repairs to the erosion controls or areas that are reseeded. Calculations and/or confirmation will also be provided that demonstrate the seeding equipment does not exceed five psi at the liner.

10.0 SURFACE WATER MANAGEMENT

This section describes the requirements for the CQAT during construction of the stormwater features of the cap.

10.1 Diversion Berms

Diversion berms will be constructed as “tack on” berms on top of the final cover system composed of the rooting zone material and six inches of topsoil as shown on the contract drawings. The diversion berms will be lined with a synthetic erosion mat per manufacturer specifications approved by CEC. The CQAT will provide visual monitoring of the materials placement and construction of the diversion berms.

10.2 Perimeter Ditches

All perimeter ditches will be lined with the permitted final cover system. During construction, the CQAT will record the information described under the geomembrane, geocomposite, and geotextile sections for those portions of the ditch work.

10.3 Stilling Basins

Stilling basins will be constructed as shown on the closure plan. In general, the upgradient side of the basins will include 12-inch thick 6-inch D50 MDOT riprap underlain by six-inch riprap bedding or as shown on the closure plan. The piping to the stilling basin will be reinforced concrete pipe (RCP) material (or approved equivalent). Any required connection to the liner system will be detailed on the plans. The CQAT will provide visual monitoring of the material placement and construction along with verification of invert elevations, material placement, and required testing.

10.4 Culverts

The CQAT will document the location, size, grades, and material types for all culverts installed on the cover system. The culverts will be installed to meet appropriate ditch flow lines and invert elevations appropriately documented. The CQAT will record the procedures for laying the culverts, methods for outleting the drainage composite to the culverts, and placing the backfill.

10.5 Documentation

The final cover documentation report will provide a drawing that shows stormwater management features that were constructed. The report will contain information on methods for installation and the types of material used. Any repair or replacement will be documented.

11.0 CONSTRUCTION CERTIFICATION REPORT

11.1 Summary

A Construction Certification Report will be prepared under the direction of the CQA Officer in accordance with Rule 921 of Part 115. The report will contain, at a minimum, the following information:

- Daily field reports
- Detailed narrative describing the construction activities in chronological order
- Analysis and discussion of all QA testing performed with summaries of all test results
- All raw data and test reports performed during construction
- Detailed description and documentation of all material, equipment types, and specifications
- Discussion of any construction material or equipment which deviated from the engineering plan and reason for deviation
- Photographs documenting all aspects of construction
- Correspondence and documentation with MDEQ concerning rule exceptions or CQA changes
- Record drawings containing:
  - Existing site grades prior to construction
  - Liner system subgrade grades
  - Granular drainage layer thickness measurement locations
  - Pipe invert grades
  - Geomembrane panel layout diagram including seam locations and types, repair locations, destructive sample locations, and anchor trench location
  - Location of all field tests
  - Final site grades

Based on the review of the data and the CQA Officer's personal observations during construction, the CQA Officer will certify that the construction has been prepared and constructed in conformance with the engineering plans and specifications, the CQA Plan, and the requirements of applicable MDEQ rules.

12.0 REFERENCES

Geosynthetics Research Institute (GRI) GM 6 – Pressurized Air Channel Test for Dual Seamed Geomembranes.

GRI GM 9 - Cold Weather Seaming of Geomembranes.

GRI GN 2 and GC 13 - Joining and Attaching Geonets and Drainage Composites.

GRI GM 13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

GRI GM 17 - Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

GRI GM 19a - Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers.

Golder Associates Inc. D.E. Karn and J.C. Weadock Ash Disposal Area's Requirements for Placement and Testing of Historically Placed CCR's Being Relocated, Consumers Energy, November, 2016.

APPENDIX A

SAMPLE CQA FORMS

- Daily Field Form
- Geosynthetic Installation Monitoring Report
- Specification/Design Clarification Form
- Field Moisture/Density Test Record
- Geosynthetic Inventory Control Log
- Certificate of Acceptance of Soil Surface
- Geosynthetic Panel Deployment Log
- Geomembrane Trial Seam Log
- Geomembrane Seam Log
- Geomembrane Defect Log
- Geomembrane Repair Log
- Geomembrane Vacuum Test Log
- Geomembrane Seam Non-Destructive Test Log
- Geomembrane Seam Destructive Sample Log
- Failed Destructive Sample Tracking Log

DAILY FIELD FORM

PROJECT OVERVIEW		
Project Title:	**Project Number:**	**Date:**
Client:	**Site/Location:**	
GAI Personnel:	**Arrival/Departure Time:**	
Contractor(s):	**Contractor(s) Rep:**	

SITE CONDITIONS	
Weather (AM):	**Temperature:**
Weather (PM):	**Temperature:**
Precipitation:	**Wind:**

EQUIPMENT ON SITE

SUMMARY OF CONSTRUCTION
Construction:

Golder CQA ACTIVITIES AND TEST RESULTS
•

SUMMARY OF SURVEYOR'S ACTIVITIES
•

SUMMARY OF PROBLEMS AND RESOLUTIONS

SUMMARY OF MEETINGS/DISCUSSIONS HELD (ATTENDEES AND ISSUES)

SUMMARY OF INCIDENTS / ACCIDENTS / HEALTH AND SAFETY ISSUES

PHOTOGRAPHS

SUBMITTED BY Golder

CQA Officer: **Signature:**

GEOSYNTHETIC INSTALLATION MONITORING REPORT

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____ **CONTRACTOR REP:** _____

DATE: _____ **S M T W R F S**

GEOSYNTHETIC DEPLOYMENT:

TRIAL SEAMING:

SEAMING:

NON-DESTRUCTIVE TESTING:

DESTRUCTIVE TESTING:

GENERAL REMARKS:

SUBMITTED BY:

_____

SPECIFICATION / DESIGN CLARIFICATION FORM

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____

Form Number _____

Location / Reference of Clarification:

Clarification Made:

Approved by Designer:

Name Company Date

Approved by Owner:

Name Company Date

Received by the Golder Representative:

Name Date

Remarks:

Attachments:

GOLDER FORM: M3

(JANUARY 2005)

GOLDER ASSOCIATES INC.

FIELD MOISTURE / DENSITY TEST RECORD

NUCLEAR GAUGE METHOD

ASTM D 6938

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____ **DATE TESTED:** _____

TEST NUMBER								
TEST LOCATION	**N**							
	E							
ELEVATION								
DEPTH								
THICKNESS OF LIFT								
DENSITY COUNT								
MOISTURE COUNT								
WET DENSITY, pcf								
MOISTURE %								
DRY DENSITY, pcf								
MATERIAL DESCRIPTION								
MAX DRY DENSITY, pcf								
OPTIMUM MOISTURE, %								
% COMPACTION								
DIFF FROM O.M.C.								
PASS/FAIL (DENSITY)								
PASS/FAIL (MOISTURE)								

SPECIFICATIONS:

See Window Attached **% STANDARD / MODIFIED**

See Window Attached **% OF O.M.C.**

DAILY STANDARD COUNTS:

MOISTURE _____

DENSITY _____

TESTED BY: _____ **CHECKED BY:** _____ **DATE:** _____

GOLDER FORM S17-0699

(JANUARY 2005)

GOLDER ASSOCIATES INC.

GEOSYNTHETIC INVENTORY CONTROL LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____
OWNER: _____ **CONTRACTOR:** _____
LOCATION: _____

MATERIAL TYPE : GEOMEMBRANE GEONET GEOTEXTILE GCL OTHER _____
DATE OF ARRIVAL: _____ **DATE OF INVENTORY:** _____
MATERIAL MANUFACTURER: _____ **INVENTORY MONITOR:** _____
PRODUCT IDENTIFICATION: _____ **CONDITION IN TRUCK:** _____
TRUCK TYPE: _____ **UNLOADING METHOD:** _____

	ROLL NUMBER	BATCH OR LOT NO.	MATERIAL DIMENSIONS			QC CERT Y / N	CONF. SAMP. Y / N	OTHER _____	REMARKS
			LENGTH	WIDTH	THICKNESS OR WEIGHT				
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

Golder Form: G2
(January 2005)

REVIEWED BY: _____ **DATE:** _____

GOLDER ASSOCIATES INC.

CERTIFICATE OF ACCEPTANCE OF SOIL SURFACE

GEOSYNTHETIC INSTALLER

COMPANY _____ **LOCATION** _____ **PROJECT**

ADDRESS _____ **PROJECT OWNER** _____

_____

I, the Undersigned, the duly authorized representative of

_____

do hereby accept the area of soil surface bounded by

_____

and shall be responsible for maintaining its integrity and suitability in accordance with the project specifications from this date to the completion of the installation.

NAME	SIGNATURE	TITLE	DATE

CERTIFICATE OF ACCEPTANCE RECEIVED BY QA / QC MANAGER

NAME	SIGNATURE	TITLE	DATE

CERTIFICATE OF ACCEPTANCE RECEIVED BY OWNER

NAME	SIGNATURE	TITLE	DATE

GOLDER FORM: G4-0699

(January 2005)

GOLDER ASSOCIATES INC.

GEOSYNTHETIC PANEL DEPLOYMENT LOG

PROJECT NUMBER: ____________ **PROJECT TITLE:** ____________
OWNER: ____________ **CONTRACTOR:** ____________
LOCATION: ____________

GEOMEMBRANE: Secondary Primary Closure Other: ____________
SUBGRADE CONDITION: (Surface Compaction Protrusions Dessiccation Excessive Moisture)
REMARKS: ____________

TRANSPORT EQUIPMENT: ____________

PANEL #	ROLL NUMBER	DEPLY'D LENGTH	AMBIENT AIR TEMP	OBS'D OVERLAP	MONITOR	THICKNESS MEASUREMENTS		REMARKS
						LEAD	SIDE	
						/ / / /	/ / / /	
						/ / / /	/ / / /	
						/ / / /	/ / / /	
						/ / / /	/ / / /	
						/ / / /	/ / / /	
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						/ / / /	/ / / /	

REVIEWED BY: ______ **DATE:** ____________

Golder Form: G2-TSS
(January 2005)

GOLDER ASSOCIATES INC.

GEOMEMBRANE TRIAL SEAM LOG

PROJECT NUMBER: ______________________ **PROJECT TITLE:** ______________________
OWNER: ______________________ **CONTRACTOR:** ______________________
LOCATION: ______________________

[ ] **TF - # = FUSION** **DATE** ______________
[ ] **TX - # = EXTRUSION** **SHEET NUMBER** ______________

				TEMPERATURES				TEST RESULTS					
SAMPLE NUMBER	APPROX. TIME	WELDING MACHINE NUMBER	WELD TECH.	AMBIENT AIR TEMP.	PREHEAT OR MACHINE SPEED	EXTRUDER	NOZZLE OR WEDGE	INSIDE PEEL STRENGTH	OUTSIDE PEEL STRENGTH	SHEAR STRENGTH	PASS OR FAIL	MON.	REMARKS **
								/ /	/ /	/			
								/ /	/ /	/			
								/ /	/ /	/			
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								/ /	/ /	/			

NOTE: ADHESION FAILURE OF TRIAL SEAM SAMPLES SHALL BE NOTED IN THE REMARKS COLUMN

REVIEWED BY: __________ **DATE:** ______________

GEOMEMBRANE SEAM LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____
OWNER: _____ **CONTRACTOR:** _____
LOCATION: _____

PASSING TRIAL SEAMS

	NO.	TIME	TECH ID
☐ FUSION			
☐ EXTRUSION			

DESTRUCTIVE LENGTH CARRY-OVER FROM PREVIOUS LOG _____

DATE _____

MACHINE # _____

SHEET NUMBER _____

	SEAM NUMBER	SEAM SECTION* START POINT	SEAM SECTION* FINISH POINT	APPROX. START TIME	AMB. AIR TEMP.	WELD TECH.	PREHEAT OR MACH. SPEED	MACHINE TEMPERATURES DIGITAL SET WEDGE OR BARREL	MACHINE TEMPERATURES INDICATOR WEDGE OR NOZZLE	APPROX. LENGTH WELDED	LENGTH FROM PREVIOUS DESTR.	DESTR. NUMBER	MON.	REMARKS	** NON-DESTRUCTIVE TEST DATE	** NON-DESTRUCTIVE MON.
1	/	-						-	-							
2	/	-						-	-							
3	/	-						-	-							
4	/	-						-	-							
5	/	-						-	-							
6	/	-						-	-							
7	/	-						-	-							
8	/	-						-	-							
9	/	-						-	-							
10	/	-						-	-							
11	/	-						-	-							
12	/	-						-	-							
13	/	-						-	-							
14	/	-						-	-							
15	/	-						-	-							
16	/	-						-	-							
17	/	-						-	-							
18	/	-						-	-							
19	/	-						-	-							
20	/	-						-	-							
									DAILY TOTAL							

* REFERENCE SEAM ENDPOINTS FROM AN END OF SEAM (EOS), A REPAIR NUMBER, OR A POINT LOCATION ON THE SEAM.

DESTRUCTIVE LENGTH CARRY-OVER

** COLUMNS TO BE USED BY THE DATA REVIEWER ONLY

GOLDER FORM: G13-0699
(January 2005)

REVIEWED BY: _____ **DATE:** _____

GOLDER ASSOCIATES INC.

GEOMEMBRANE DEFECT LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____
OWNER: _____ **CONTRACTOR:** _____
LOCATION: _____

SHEET NUMBER _____

DEFECT CODE	DEFECT LOCATION: SEAM, PANEL OR REPAIR NO.	DEFECT LOCATION: DEFECT LOCATION DESCRIPTION	DEFECT TYPE	LOG DATE	MON.	REMARKS	** REPAIR DATE	** TEST DATE
A								
B								
C								
D								
E								
F								
G								
H								
I								
J								
K								
L								
M								
N								
P								
Q								
R								
S								
T								
V								
W								
X								
Y								
Z								

B - UNDISPERSED RESIN BEAD
BO - FUSION WELDER BURN
BS - BOOT/SKIRT FOR FML PENETRATION
CO - CHANGE OF OVERLAP
CR - CREASE
D - INSTALLATION DAMAGE
DS-# - DESTRUCTIVE TEST NUMBER
EXT - EXTENSION
FM - FISHMOUTH
FS - FAILED SEAM LENGTH
FTS - FIELD TEST STRIP
HT - HEAT TACK BURN
IO - INSUFFICIENT OVERLAY (UNDER SPEC.)
MD - MANUFACTURER/DELIVERY DAMAGE
SI - SOIL SURFACE IRREGULARITY
SL - SLAG ON TEXTURED SHEET
T - THREE PANEL INTERSECTION
VL - VACUUM TEST LEAK
WR - WRINKLE
WS - WELDER RESTART
OTHER _____

REVIEWED BY: _____ **DATE:** _____

** COLUMNS TO BE USED BY THE DATA REVIEWER ONLY.

GOLDER FORM: G18-0699
(January 2005)

GOLDER ASSOCIATES INC.

GEOMEMBRANE REPAIR LOG

PROJECT NUMBER _____ **PROJECT TITLE:** _____
OWNER: _____ **CONTRACTOR:** _____
LOCATION: _____

PASSING TRIAL SEAMS

NO.	TIME	TECH	NO.	TIME	TECH

MACHINE NUMBER: _____
DATE: _____
SHEET NO: _____

	DEFECT CODE	REPAIR DATE	APPRX. TIME	REPAIR TYPE	APPRX. DIM.	WELD TECH.	MON.	REMARKS
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
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16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

	DEFECT CODE	REPAIR DATE	APPRX. TIME	REPAIR TYPE	APPRX. DIM.	WELD TECH.	MON.	REMARKS
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
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54								
55								
56								
57								
58								
59								
60								

REPAIR TYPE: P - PATCH, C - CAP, RS - RECONSTRUCTED SEAM, G&W - GRIND WELD

REVIEWED BY: _____ **DATE** _____

GOLDER FORM: G19-tss

(January 2005)

GOLDER ASSOCIATES INC.

GEOMEMBRANE VACUUM TEST LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____

	REPAIRS						
	DEFECT CODE	TEST DATE	TECH ID	DEFECTS * *	OBS. TEST	MON.	REMARKS
1							
2							
3							
4							
5							
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7							
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9							
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11							
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36							
37							
38							
39							
40							
41							
42							
43							
44							
45							

	REPAIRS						
	DEFECT CODE	TEST DATE	TECH ID	DEFECTS * *	OBS. TEST	MON.	REMARKS
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
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89							
90							

* * RECORD QUANTITY OF LEAKS DETECTED AND REFERENCE NEW DEFECT CODE IN REMARKS.

GOLDER FORM: G17-tss

(January 2005)

REVIEWED BY: _____ **DATE** _____

GOLDER ASSOCIATES INC.

GEOMEMBRANE SEAM NON-DESTRUCTIVE TEST LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____

DATE: _____

SHEET NUMBER: _____

	SEAM NUMBER	SEAM SECTION * FROM	TO	VACUUM OR PRESSURE	TECH ID	TIME START	FINISH	PRESSURE INITIAL	FINAL	OBS. TEST	RESULTS PASS/ FAIL	SEAM COMPLETE NO	YES	MON.	REMARKS
1	/	-				:		:							
2	/	-				:		:							
3	/	-				:		:							
4	/	-				:		:							
5	/	-				:		:							
6	/	-				:		:							
7	/	-				:		:							
8	/	-				:		:							
9	/	-				:		:							
10	/	-				:		:							
11	/	-				:		:							
12	/	-				:		:							
13	/	-				:		:							
14	/	-				:		:							
15	/	-				:		:							
16	/	-				:		:							
17	/	-				:		:							
18	/	-				:		:							
19	/	-				:		:							
20	/	-				:		:							

*** REFERENCE SEAM ENDPOINTS FROM AND END OF SEAM (EOS), A REPAIR NUMBER,**
OR A POINT LOCATION ON THE SEAM (i e, REFERENCE POINT, DISTANCE, DIRECTION FROM REF. PT.)

GOLDER FORM: G16-tss
(January 2005)

REVIEWED BY: _____ **DATE:** _____

GOLDER ASSOCIATES INC.

GEOMEMBRANE SEAM DESTRUCTIVE SAMPLE LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____

OWNER: _____ **CONTRACTOR:** _____

LOCATION: _____

SHEET NUMBER _____

	DESTRUCTIVE		MACHINE NUMBER	DATE REMOVED	FIELD TEST RESULTS	MON.	DATE SHIPPED	LAB TEST STATUS (PASS/FAIL)	DATE OF NOTIFICATION	REMARKS
	SAMPLE NUMBER	SEAM NUMBER			PEEL SHEAR (PASS/FAIL)					
1		/		/ /	:		/ /		/ /	
2		/		/ /	:		/ /		/ /	
3		/		/ /	:		/ /		/ /	
4		/		/ /	:		/ /		/ /	
5		/		/ /	:		/ /		/ /	
6		/		/ /	:		/ /		/ /	
7		/		/ /	:		/ /		/ /	
8		/		/ /	:		/ /		/ /	
9		/		/ /	:		/ /		/ /	
10		/		/ /	:		/ /		/ /	
11		/		/ /	:		/ /		/ /	
12		/		/ /	:		/ /		/ /	
13		/		/ /	:		/ /		/ /	
14		/		/ /	:		/ /		/ /	
15		/		/ /	:		/ /		/ /	
16		/		/ /	:		/ /		/ /	
17		/		/ /	:		/ /		/ /	
18		/		/ /	:		/ /		/ /	
19		/		/ /	:		/ /		/ /	
20		/		/ /	:		/ /		/ /	
21		/		/ /	:		/ /		/ /	
22		/		/ /	:		/ /		/ /	

REVIEWED BY: _____ **DATE:** _____

GOLDER FORM: G20-0699

(JUNE 1999)

GOLDER ASSOCIATES INC.

FAILED DESTRUCTIVE SAMPLE TRACKING LOG

PROJECT NUMBER: _____ **PROJECT TITLE:** _____
OWNER: _____ **CONTRACTOR:** _____
LOCATION: _____

DATE _____ **DESTRUCTIVE NUMBER** _____ **PASSING SAMPLE IN DIRECTION P** _____
MONITOR _____ **MACHINE NUMBER** _____ **PASSING SAMPLE IN DIRECTION N** _____
SEAMER(S) ID _____

CHRONOLOGICAL SEAMING ORDER		
SEAM OR REPAIR NO.	SEAM DATE	START TIME
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		
_____ / _____ SEAMING SHEET # _____ LINE # _____		

START POINT	ILLUSTRATED RECORD OF DESTRUCTIVE SAMPLE TRACKING AND SEAM RECONSTRUCTION	FINISH POINT

----------> ----------> ----------> DIRECTION OF SEAMING ---------> ----------> ---------->

PANEL # / PANEL #

INITIAL DESTRUCTIVE NO. _____

FAIL

CONTINUED Y / N SHEET NO. _____

(P) PREVIOUS" DIRECTION

/ \ | | | | | | | | | | | | \ /

(N) "NEXT" DIRECTION

CONTINUED? Y / N SHEET NO. _____

NOTE: COMPLETE SEAMING ORDER INFORMATION FROM FIELD SEAMING LOGS. COMPLETE ILLUSTRATION SECTION FROM DIRECT OBSERVATION OF THE SEAMS. ILLUSTRATE FOLLOW-UP DESTRUCTIVE SAMPLES, CAPS AND/OR RECONSTRUCTED SEAMS AND REFERENCE REPAIR NUMBERS.

GOLDER FORM: G21-0699

(JUNE 1999)

REVIEWED BY: _____ **DATE:** _____

GOLDER ASSOCIATES INC.

APPENDIX C
HYDROLOGIC AND HYDRAULIC CALCULATIONS

Client CEC **Subject** Hydrologic Parameters

Project J.C. Weadock Dry Ash Landfill

Prepared By JSH **Date** 03/26/18

Reviewed By JDP **Date** 11/7/18

Approved By DML **Date** 11/13/18

HYDROLOGIC PARAMETERS

Objective

Determine hydrologic parameters (curve number, rainfall depth and rainfall distribution) and design criteria to be used to design and evaluate the stormwater management system for the Weadock Landfill (Landfill).

Design Criteria and Assumptions

1. Curve numbers were calculated using the Soil Conservation Service ("SCS") methodology.

2. Times of concentration were computed by HydroCAD using methodology developed by the SCS.

3. Rainfall depths are provided in Attachment 1. Depths for rainfall distributions are based on the Rainfall Frequency Atlas of the Midwest, Midwest Climate Center.

4. HydroCAD was used to calculate the peak flow and velocity into diversion berms, channels and culverts, and compute peak surface water discharge from the Landfill. Storage-Indication-Translation Method routing techniques were used to route surface water through the surface water management system. The antecedent moisture condition specifies the moisture level in the ground immediately prior to the storm. A value of "2" for normal conditions is used in the analyses.

5. The stormwater management system is designed to meet the following criteria:

    - Design all proposed diversion berms, stilling basins, channels, and culverts to manage run-off from the SCS Type II, 25-year, 24-hour storm event with a minimum of one-foot of freeboard.
    - Evaluate the NPDES Outfall 001H to confirm the ability to manage the peak flow of surface water from the 25-year 24-hour storm event with 1.0 ft of freeboard.
    - All proposed culverts were modeled with a mannings n value of 0.012 for concrete. Alternative culverts types may be used with equivalent or improved hydraulic performance.

6. The Type II, 100-year, 24-hour storm event was also modeled for the stormwater management system to determine the systems capability to contain this storm event. While the 100-year event is not required to be evaluated per Part 115, it was included to demonstrate the stormwater management's systems capacity.

Calculations

Curve Numbers

A Curve Number ("CN") was used for all of the intermediate and final cover drainage areas located onsite. A summary of curve numbers used throughout the calculations is provided in Table 1 shown below. The TR-55 Tables 2-2c, used to develop the curve number summary, is provided in Attachment 2.

Client CEC **Subject** Hydrologic Parameters

Project J.C. Weadock Dry Ash Landfill

Prepared By JSH **Date** 03/26/18

Reviewed By JDP **Date** 11/7/18

Approved By DML **Date** 11/13/18

TABLE 1- CURVE NUMBER SUMMARY

Study Area Cover Description	TR-55 Cover Type and Hydrologic Condition	Hydrologic Soil Group	Curve Number
Final Cover	Grassland In Good Condition	C	74

Rainfall Depth

Rainfall depths for storm events used in the analyses are provided in Attachment 1. The rainfall depths used in the analyses are summarized in Table 2, below.

Table 2- Summary of Rainfall Depths

Rainfall Event	Duration (hours)	Depth (inches)
SCS Type II 25-yr	24	4.29
SCS Type II 100-yr	24	5.99

Conclusions

CNs for the final cover conditions were determined using standard SCS methods. Rainfall depths for storm events are summarized in Table 2. These hydrologic parameters will be used to design the stormwater management system for the Landfill.