

STATE OF OHIO
DEPARTMENT OF NATURAL
RESOURCES

Division of Oil and Gas
Resources Management
WELL PERMIT

API WELL NUMBER
34-155-2-4075-00-00

OWNER NAME, ADDRESS

AMERICAN WATER MGMT SERV LLC
ONE AMERICAN WAY
WARREN

OH 44484 5555

DATE ISSUED

7/18/2013

PERMIT EXPIRES

7/18/2014

TELEPHONE NUMBER

(330) 856-8800

IS HEREBY GRANTED PERMISSION TO: Drill New Well

AND ABANDON WELL IF UNPRODUCTIVE

PURPOSE OF WELL: Water Injection - Disposal

COMPLETION DATE IF PERMIT TO PLUG:

DESIGNATION AND LOCATION:

LEASE NAME AWMS-2 (SWIW #22)
WELL NUMBER 2
COUNTY TRUMBULL
CIVIL TOWNSHIP WEATHERSFIELD
TRACT OR ALLOTMENT
SURFACE FOOTAGE LOCATION 674' SL & 2153' WL OF SECTION 9
TARGET FOOTAGE LOCATION

SURFACE NAD27

X: 2474652
Y: 561735
LAT: 41.1956633152072
LONG: -80.7751783109284

TARGET NAD27

TYPE OF TOOLS: Air Rotary/Fluid Rotary

PROPOSED TOTAL DEPTH 9100 FEET
GROUND LEVEL ELEVATION 909 FEET

GEOLOGICAL FORMATION(S):

KNOX DOLOMITE & MT. SIMON SANDSTONE

SPECIAL PERMIT CONDITIONS: Salt Water Injection Well (Class II) Construction and Operating Conditions

CASING PROGRAM (CASING MUST BE CENTRALIZED AND IS SUBJECT TO APPROVAL OF THE OIL AND GAS INSPECTOR):

20 " APPROX. 60 ' WITH CEMENT CIRCULATED TO SURFACE
13-3/8 " APPROX. 375 ' WITH CEMENT CIRCULATED TO SURFACE
9-5/8" CASING 7300' CEMENTED TO A MINIMUM OF 300' ABOVE INJECTION ZONE
4-1/2" TUBING SET ON A PACKER APPROX. 50' ABOVE INJECTION ZONE

This permit is NOT TRANSFERABLE. This permit, or an exact copy thereof, must be displayed in a conspicuous and easily accessible place at the well site before permitted activity commences and remain until the well is completed. Ample notification to inspector is necessary.

OIL AND GAS WELL INSPECTOR:

STEPHEN OCHS (330) 933-2090
THOMAS HILL - Supervisor (330) 283-3204
DISTRICT #: (330) 896-0616

INSPECTOR NOTIFICATION

The oil and gas inspector must be notified at least 24 hours prior to:

1. Commencement of site construction
2. Pit excavation and closure
3. Commencement of drilling, reopening, converting or plugback operations
4. Installation and cementing of all casing strings
5. BOP testing
6. Well stimulation
7. Plugging operations
8. Well pad construction

The oil and gas inspector must be notified immediately upon:

1. Discovery of defective well construction
2. Detection of any natural gas or H2S gas during drilling in urban areas
3. Discovery of defective well construction during well stimulation
4. Determination that a well is a lost hole
5. Determination that a well is a dry hole

FIRE AND EMERGENCY NUMBERS:

FIRE: () - 911
MEDICAL SERVICE () - 911

Richard J. Simmers

CHIEF, Division of Oil and Gas Resources
Management

STATE OF OHIO
DEPARTMENT OF NATURAL
RESOURCES

Division of Oil and Gas
Resources Management
WELL PERMIT

API WELL NUMBER

34-155-2-4075-00-00

AMERICAN WATER MGMT SERV LLC
ONE AMERICAN WAY
WARREN, OH 44484-5555

PERMIT CONDITIONS – CLASS II SALTWATER INJECTION WELL – DRILL NEW WELL

**RE: Permit # 4075, SWIW #22, AWMS No. 2, Weathersfield
Township, Trumbull County, Ohio**

Constructional conditions:

- 1. The 9-5/8" casing must be enclosed with Class A cement from the total depth to approximately 7000 feet (minimum of 300 feet above the top of the injection zone).**
- 2. Bow-string or rigid centralizers must be used to provide sufficient casing stand off and foster effective circulation of cement to isolate critical zones including aquifers, flow zones, voids, lost circulation zones, and hydrocarbon-bearing zones.**
- 3. No drilling into the Precambrian basement is allowed on Class II injection wells.**
- 4. American Water Management Services LLC shall run at minimum, a gamma ray, compensated density-neutron, and resistivity geophysical log. A copy of this geophysical log must be submitted to the UIC Section within 48 hours after the geophysical logging has been accomplished.**
- 5. Prior to setting the tubing and packer, American Water Management Services LLC shall run a radioactive tracer test or spinner survey to demonstrate that the injection fluids are going into the permitted injection zones. The Division recommends using the radioactive fluid versus the radioactive beads, if a tracer survey is to be accomplished. Copies of these logs shall be submitted to the Division within 48 hours after the geophysical logging has been accomplished.**
- 6. After completion of the well and setting of the tubing and packer, American Water Management Services LLC shall run two downhole digital pressure gauges to record original reservoir pressure and perform a pressure fall-off test. The pressure fall-off test method will be provided American Water Management Services LLC well in advance of the testing requirements.**
- 7. Injection tubing must be set on a packer at approximately 7250 feet. A 1/4", female, threaded fitting with a stop valve must be installed on the tubing and accessible at the surface.**
- 8. The annular space between the injection tubing and the 9-5/8" production casing must be filled with a fluid (e.g., freshwater with a corrosion inhibitor additive), pressure tested to at least 1680 psi, and**

monitored for at least 15 minutes with no more than a five percent decline in pressure. Additionally, the injection line must also be tested to 1680 psi for 15 minutes with no more than a five percent decline.

9. The UIC Section and the Mineral Resources Inspector must be notified at a minimum of 48 hours in advance of the time of cementing, placing and removing of casing, installation of the tubing and packer, testing of the casing, construction of the surface facilities, pressure testing of the injection line, and initial injection so that a representative of the Division can be present to witness the operations. The Division must also be notified in advance of any subsequent removal of the injection tubing or resetting the packer. A pressure test will also be required.
10. Surface facilities as proposed in the application are satisfactory and must be constructed under the supervision of a representative of the Division. A concrete pad with drain must be constructed so as to contain any spillage of saltwater during unloading from the trucks. Any proposed changes in the surface facilities must be submitted in writing and must have prior approval of the UIC Section.
11. **If an unloading pad is to be constructed, the underground concrete vault associated with the catch basin on the unloading pad shall be of one-piece construction and if the concrete vault has a detached lid, the lid must be exposed above the ground level. Additionally, the inside walls of the concrete vault shall be sealed with a salt-corrosion type material such as an asphalt-based coating to prevent deterioration of the vault from the brine water.**
12. A Well Construction Record (Form 8) must be submitted within 30 days after completion describing how the well was completed for injection operations. This report should include the amount and grade of tubing, type and depth of packer, treatment of the injection formation, testing of the system integrity, method used to monitor pressure in the annulus and injection tubing, and method used to monitor volumes of injected fluid.
13. **A Murphy Switch or other cut-off switch device must be in-line with the injection pump and set at the maximum allowable surface injection pressure of 1680 psi, so that the pump will automatically shut-down upon exceeding the maximum allowable surface injection pressure.**
14. **American Water Management Services LLC shall notify the Division in writing prior to the initiation of injection operations and injection operations shall not commence until the Division provides American Water Management Services LLC with written approval that authorizes injection. Operational conditions to the permit shall be issued with the written approval.**

Proof Sheet

APPL NUMBER	aPATT020309	URBANIZED AREA ?	<input type="checkbox"/>
OWNER NUMBER	8905	NAME	
OWNER NAME	AMERICAN WATER MGMT SERV LLC		
EXISTING WELL	0		
API PERMIT NO		DISPOSAL PLAN 1	ND
APPL TYPE	NW	DISPOSAL PLAN 2	
TYPE OF WELL	SWD	DISPOSAL PLAN 3	
VARIANCE REQUEST		DISPOSAL PLAN 4	
WELL NAME	AWMS-2	DISPOSAL PLAN 5	
WELL NUMBER	2 (SWWW-22)	MP Check #	0
PREV/PROPOSED TD	9100		
DRILL UNIT ACRES	101		
TYPE OF TOOL	RTAF	PROPOSED FORMATIONS	
WELL CLASS	SWWW	KNOX DOLOMITE & MT. SIMON SANDSTONE	
FIRE PHONE	() - 911		
MEDICAL PHONE	() - 911		
COUNTY CODE	155		
COUNTY NAME	TRUMBULL		
COAL (Y=-1/N=0)	-1		
CIVIL TOWNSHIP	WEATHERSFIELD	TARG CIVIL TWP	
SURF QUAD	WARREN	TARG QUAD	
Nad 27 SURF ORIG X	2474652	Nad 27 TARG ORIG X	
Nad 27 SURF ORIG Y	561734	Nad 27 TARG ORIG Y	
GROUND ELEVATION	909	TARG ELEV	0
SURF SEC	9	TARG SECTION	
SURF LOT		TARG LOT	
SURF QTR TWP		TARG QTR TWP	
SURF ALLOT		TARG ALLOT	
SURF TRACT		TARG TRACT	
SURF FRACTION		TARG FRACTION	

Proof Sheet

SURFACE FOOTAGE

674' SL & 2153' WL OF SECT 9

TARGET FOOTAGE

CASING PROGRAM

09	20	60'
09	13 3/8	375'
32	95/8	7300
40	4 1/2	50

SPECIAL CONDITIONS/COMMENTS

Class II Drilling and Construction Conclusions

COMPLETION DT

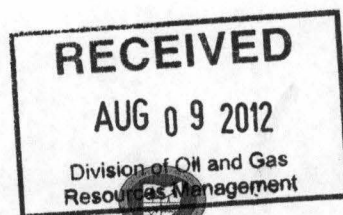
MINES APPROVAL

AFFIDAVIT APPROV

FINAL ENTRY DATE



Ohio Department of Natural Resources
Division of Mineral Resources Management
2045 Morse Rd. Bldg. H-3 - Columbus OH 43229-6693



Urbanized Area Permit Conditions

Application Number	SWIW #22	Permit Number		Inspection Date	07/30/12	Modification Date (if applicable)	
Company		American Water Management Services, LLC.		Lease Name/Well #		AWMS #2	
County		Trumbull		Township		Weathersfield	
Section/Lot		Section 9		Urban Area		City of Niles	
Inspected By		Stephen Ochs					
Accompanied By							

Directions to Location	From North Road and Main Street in Niles; 0.4 mile west on N Main Street; south side of the street
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ITEM	LEASE ROAD, WELL SITE CONSTRUCTION	Comments:
1	Tree/Brush Removal/Disposition	Some brush
2	Topsoil Removal/Stockpiles/Placement	Soil will be stockpiled on location
3	Erosion/Sediment Control (Silt Fence, Berms)	Silt fence used as needed
4	Drainage Controls (Diversion Ditches, Culverts, Waterways, Crossings)	N/A
5	Signage	As required by HB278
6	Apron/Culverts/Road Material	Existing access road
7	Pull Off Area	Well site
8	Parking	Well site
9	GPS - Access Road	N 41.19663 W 80.77358
10	GPS - Well Stake	N/A
11	GPS - Tank Battery	N/A

ITEM	DRILLING CONSIDERATIONS	Comments:
12	Noise Mitigation (Mufflers, Extra Frac Tanks, Tarps)	Appropriate muffler
13	Rig Type	Fluid rotary
14	Is a Blow-out Preventor required?	X Yes <input type="checkbox"/> No
	If No, explain:	
15	Equipment Placement/ Orientation (Rig/ Frac Tanks/ etc.)	Recommend the rig be placed North/South
16	Drilling Pits (Placement/Orientation)	Recommend the pits be placed West
17	Fencing (Pits/Entire Location)	Existing fence around entire location
18	Flood Plain	None
19	Mine Voids	None
20	Verify Water Wells Within 300'	None
21	Verify Structures Within 500'	One business (industrial) on same property
22	Verify Streams and Drainage	Mahoning River tributary approximately 1/2 mile to the West

ITEM	RESTORATION	
23	Pit Closure - (Standard/ Solidification/ Off-Site Disposal - state time frame)	Once total depth has been reached, the drilling equipment will be removed and pits will be solidified within 14 days.
24	Site Specific Time Frame For Restoration	All restoration will be completed within three months after drilling is commenced.
25	Erosion/Sediment Control	Maintain until preliminary restoration is completed
26	Drainage Control	N/A

ITEM	PRODUCTION	Comments:
27	Is the Access Road Gate required?	X Yes <input type="checkbox"/> No
	If No, explain:	
28	Landscaping/Screening (Wellhead, Tank Battery) (Waiver Attached if applicable)	Existing screening acceptable
29	Fencing (Wellhead, Tank Battery) (Waiver Attached if applicable)	Existing fence around entire location acceptable

WAIVERS	Comments:
Is the Company required to submit a waiver?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
If yes, submit the following waiver requests:	

Is the Company required to submit revised drawings?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
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THE FOLLOWING ITEMS HAVE BEEN CHANGED FROM THE ORIGINAL APPLICATION:

1011
\$1000.00

APPLICATION FOR A PERMIT (Form 1)
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL AND GAS RESOURCES MANAGEMENT
2045 Morse Road, Building H-3
COLUMBUS, OHIO 42229-6693
(614) 265-6633

SEE INSTRUCTIONS ON PAGE 2 (BACK)

2PA4020309

1. I, We (applicant) (address) <u>American Water Management Services LLC</u> One American Way, Warren, Ohio, 44484 Hereby apply this date <u>December 23</u> , 2011, for a permit to:		2. Owner #: <u>8905</u> Phone #: <u>330-856-8800</u>
<div style="display: flex; justify-content: space-between;"><div><input type="checkbox"/> Reissue (check appropriate blank) <input checked="" type="checkbox"/> Drill New Well <input type="checkbox"/> Drill Directionally <input type="checkbox"/> Drill Horizontally</div><div><input type="checkbox"/> Revised Location <input type="checkbox"/> Plug Back <input type="checkbox"/> Plug and Abandon <input type="checkbox"/> Orphan Well Program</div><div><input type="checkbox"/> Convert <input type="checkbox"/> Deepen <input type="checkbox"/> Reopen <input type="checkbox"/> Temporary Inactive</div></div>		
3. TYPE OF WELL: <div style="display: flex; justify-content: space-between;"><div><input type="checkbox"/> Oil & Gas <input type="checkbox"/> Stratigraphic test <input type="checkbox"/> Solution Mining * <input type="checkbox"/> Input/Injection</div><div><input type="checkbox"/> Annular Disposal <input type="checkbox"/> Gas Storage <input type="checkbox"/> Enhanced Recovery * <input type="checkbox"/> Water Supply</div><div><input checked="" type="checkbox"/> Saltwater Injection <input type="checkbox"/> Other (explain): _____ <small>* if check, select appropriate box below:</small> <input type="checkbox"/> Observation <input type="checkbox"/> Production/Extraction</div></div>		
4. MAIL PERMIT TO: American Water Management Services LLC c/o Mr. Steve Kilper One American Way Warren, Ohio 44484		20. TYPE OF TOOLS: <div style="display: flex; justify-content: space-between;"><div><input type="checkbox"/> Cable <input type="checkbox"/> Cable/Air Rotary <input type="checkbox"/> Cable/ Fluid Rotary <input type="checkbox"/> Cable/Air/Fluid Rotary</div><div><input type="checkbox"/> Air Rotary <input checked="" type="checkbox"/> Air/Fluid Rotary <input type="checkbox"/> Fluid Rotary <input type="checkbox"/> Service Rig</div></div>
5. COUNTY: <u>Trumbull</u> 6. CIVIL TOWNSHIP: <u>Weathersfield</u> 7. SECTION: <u>9</u> 8. LOT: <u>375</u> 9. FRACTION: _____ 10. QTR TWP: <u>AA</u> 11. TRACT/ALLOT: _____ 12. WELL #: <u>2</u> 13. LEASE NAME: <u>AWMS-2</u> 14. PROPOSED TOTAL DEPTH <u>9,100'</u> 15. PROPOSED GEOLOGIC FORMATION: <u>Knox Dolomite and the Mt. Simon Sandstone</u>		21. PROPOSED CASING PROGRAM: 20" Conductor minimum of 60'(if air); 13-3/8" surface casing minimum 4,400' (cement circulated to surface); 9-5/8" production casing minimum 7,300' (casing cement to 4,000'); 4-1/2" tubing set at 7,250'; "Blow out Preventor Required" Hazardous Conditions may be encountered; All due precautions should be taken.
16. DRILLING UNIT IN ACRES (must be same as acres indicated on plat): <u>101 Acres</u> 17. IF PERMITTED PREVIOUSLY: API #: _____ OWNER: _____ WELL #: _____ LEASE NAME: _____ TOTAL DEPTH: _____ GEOLOGICAL FORMATION: _____		22. FIRE AND MEDICAL DEPARTMENT TELEPHONE NUMBERS (closest to well site): Fire: <u>911</u> Medical: <u>911</u>
18. IF SURFACE RIGHTS ARE OWNED BY THE OHIO DEPARTMENT OF NATURAL RESOURCES Division Name: _____ Division Phone: _____		23. MEANS OF INGRESS & EGRESS: Township Road: <u>N Main Street</u> County Road: _____ Municipal Road: _____ State Highway: <u>169</u>
19. LANDOWNER ROYALTY INTEREST: Is There An Attached List? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Name: <u>Gearmar Properties, Inc.</u> Address: <u>PO Box 209, Portersville, PA 16051</u> Name: _____ Address: _____ Name: _____ Address: _____		24. IS THE WELL LOCATION OR THE PRODUCTION FACILITIES WITHIN AN URBANIZED AREA AS DEFINED BY 1509.01(Y)? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

RECEIVED

DEC 27 2011

I, the undersigned, being first duly sworn, depose and state under penalties of law, that I am authorized to make this application, that this application was prepared by me or under my supervision and direction, and that the facts stated herein are true, correct, and compete, to the best of my knowledge.

I, the undersigned, further depose and state that I am the person who has the right to drill on the tract or drilling unit and to drill into and produce from a pool and to appropriate the oil or gas that I produce therefrom either for myself or others as described in this application. And furthermore, I, the undersigned, being duly sworn, depose and state at this time that I am not liable for any final nonappealable order of a court for damage to streets, roads, highways, bridges, culverts, or drainage ways pursuant to Section 5577.12 of the Ohio Revised Code (ORC). I, the undersigned, further depose and state that all notices required by 1509.06 (A) (9) ORC for this application have been duly provided by me. If applying for a permit to plug and abandon a well, I hereby certify that the written notices, as required by Section 1509.13, ORC, have been given.

That I hereby agree to conform with all provisions of Chapter 1509, ORC, and chapter 1501, ORC, and all orders and conditions issued by the chief, division of Oil and Gas Resources management.

Signature of Owner/ Authorized Agent

Name (Type or Print)

Kenneth J. McMahon

Title President

If signed by Authorized Agent, a certificate of appointment of agent must be on file.

Sworn to and subscribed before me this the

23rd

day of

December

, 20

11

(Notary Public)

(Date Commission Expires)

DNR 5619 (Rev. 10/2011)



ANGELA K. MARIMPIETRI
Notary Public - State of Ohio
My Commission Expires 9/26/2015

RESTORATION PLAN (Form 4)

Ohio Department of Natural Resources

Division of Oil and Gas Resources Management, 2045 Morse Road, Bldg. H-3, Columbus OH 43229-6693

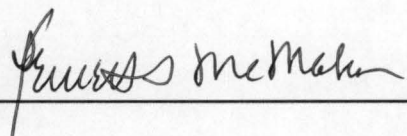
1. DATE OF APPLICATION: 23-Dec-11	3. API #:
2. OWNER NAME, ADDRESS, & TELEPHONE NO.: American Water Management Services LLC, One American Way, Warren, Ohio 44484, (330) 856-8800	4. WELL #: 2
	5. LEASE NAME: AWMS-2
	6. PROPERTY OWNER: Gearmar Properties, Inc.
	7. COUNTY: Trumbull
	8. CIVIL TOWNSHIP: Weathersfield
	9. SECTION: 9 10. LOT:
11. CURRENT LAND USE: <input type="checkbox"/> Cropland <input type="checkbox"/> Commercial <input type="checkbox"/> Pasture <input type="checkbox"/> Idle Land <input type="checkbox"/> Wetlands <input type="checkbox"/> Recreational <input type="checkbox"/> Residential <input checked="" type="checkbox"/> Industrial <input type="checkbox"/> Unreclaimed strip mine <input type="checkbox"/> Woodland: <input type="checkbox"/> Broadleaf <input type="checkbox"/> Needlelike	17. TYPE OF WELL: <input type="checkbox"/> Oil <input type="checkbox"/> Gas <input checked="" type="checkbox"/> Other
12. SLOPE GRADIENT & LENGTH DETERMINED FROM: <input type="checkbox"/> Ground Measurement <input checked="" type="checkbox"/> U.S. Geological Survey Topographical Maps <input type="checkbox"/> Other: (explain) _____	18. STEEPEST SLOPE GRADIENT CROSSING SITE: <input checked="" type="checkbox"/> 0 to 2% <input type="checkbox"/> 2.1 to 8% <input type="checkbox"/> 8.1 to 10% <input type="checkbox"/> 10.1 to 24% <input type="checkbox"/> greater than 24%
13. TYPE OF FALL VEGETAL COVER: <input checked="" type="checkbox"/> Little or no vegetal cover <input type="checkbox"/> Short grasses <input type="checkbox"/> Tall weeds or short brush (1 to 2 ft.) <input type="checkbox"/> Brush or bushes (2 to 6 ft.) <input type="checkbox"/> Agricultural crops <input type="checkbox"/> Trees with sparse low brush <input type="checkbox"/> Trees with dense low brush	19. LENGTH OF STEEPEST SLOPE CROSSING SITE: <input type="checkbox"/> 1 to 100 ft. <input type="checkbox"/> 101 to 200 ft. <input type="checkbox"/> 201 to 400 ft. <input checked="" type="checkbox"/> greater than 400 ft.
14. SOIL & RESOILING MATERIAL AT WELLSITE: <input type="checkbox"/> Stockpile and protect topsoil to be used when preparing seedbed <input type="checkbox"/> Use of soil additives (e.g., lime, fertilizer) <input checked="" type="checkbox"/> No resoiling planned <input type="checkbox"/> Proposed alternative _____	20. RESTORATION OF DRILLING PITS: ** <input checked="" type="checkbox"/> Haul drilling fluids and fill pits <input type="checkbox"/> Use steel circulating tanks <input type="checkbox"/> Proposed alternative _____
15. DISPOSAL PLAN FOR TREES AND TREE STUMPS: <input type="checkbox"/> No trees disturbed <input type="checkbox"/> Haul to landfill <input type="checkbox"/> Cut into firewood <input type="checkbox"/> Sell to lumber company <input checked="" type="checkbox"/> Bury with landowner's approval <input type="checkbox"/> Mulch small trees and branches, erosion control <input type="checkbox"/> Use for wildlife habitat with landowner approval <input type="checkbox"/> Proposed alternative _____	21. BACKFILLING AND GRADING AT SITE: <input type="checkbox"/> Construct diversions channeled to naturally established drainage systems <input type="checkbox"/> Construct terraces across slopes <input checked="" type="checkbox"/> Grade to approximate original contour <input type="checkbox"/> Grade to minimize erosion & control offsite runoff <input type="checkbox"/> Proposed alternative _____
16. SURFACE AND SUBSURFACE DRAINAGE FACILITIES: <input checked="" type="checkbox"/> No existing drainage facilities for removal of surface and/or subsurface water <input type="checkbox"/> Tile drainage system underlying land to be disturbed <input type="checkbox"/> Drain pipe(s) underlying land to be disturbed <input type="checkbox"/> Surface drainage facilities on land to be disturbed	22. VEGETATIVE COVER TO BE ESTABLISHED AT SITE: <input type="checkbox"/> Seeding plan <input type="checkbox"/> Sod <input type="checkbox"/> Agricultural crops <input type="checkbox"/> Trees and/or Bushes <input checked="" type="checkbox"/> Proposed alternative <u>restore to original cover</u>
	23. ADDITIONAL HOLES: <input checked="" type="checkbox"/> Rat/Mouse, if used, will be plugged
	24. PROPOSED OR CURRENT LENGTH OF ACCESS ROAD: <input type="checkbox"/> 100 ft. or less <input type="checkbox"/> 101 to 500 ft. <input checked="" type="checkbox"/> 501 to 1500 ft. <input type="checkbox"/> greater than 1500 ft.
	25. CURRENT LAND USE OF PATH OF ACCESS ROAD: <input type="checkbox"/> Cropland <input type="checkbox"/> Pasture <input type="checkbox"/> Commercial <input type="checkbox"/> Idle land <input type="checkbox"/> Wetlands <input type="checkbox"/> Recreational <input checked="" type="checkbox"/> Industrial <input type="checkbox"/> Residential <input type="checkbox"/> Unreclaimed strip mine <input type="checkbox"/> Woodland: <input type="checkbox"/> Broadleaf <input type="checkbox"/> Needlelike

**PITS MUST BE FILLED WITHIN TWO MONTHS AFTER COMMENCEMENT OF THE WELL AND WITHIN FOURTEEN DAYS AFTER COMMENCEMENT OF THE WELL IN AN URBANIZED AREA.

REQUIRED BY SECTION 1509.06 (A)(10), OHIO REVISED CODE -- FAILED TO SUBMIT MAY RESULT IN AN ASSESSMENT OF CRIMINAL FINES NOT LESS THAN \$100.00 NOR MORE THAN \$2,000.00 OR CIVIL PENALTIES NOT LESS THAN \$4,000.00.

26. SURFACING MATERIAL FOR ACCESS ROAD: <input checked="" type="checkbox"/> Gravel <input type="checkbox"/> Brick and/or tile waste <input checked="" type="checkbox"/> Slag <input type="checkbox"/> Crushed stone <input type="checkbox"/> No surfacing material to be used <input type="checkbox"/> Proposed alternative _____	29. STEEPEST SLOPE GRADIENT ON ACCESS ROAD: <input checked="" type="checkbox"/> 0 to 5% <input type="checkbox"/> 6 to 10% <input type="checkbox"/> greater than 10%
27. PATH OF ACCESS ROAD TO BE DETERMINED BY: <input type="checkbox"/> Landowner <input type="checkbox"/> Contractor <input checked="" type="checkbox"/> Existing access road <input checked="" type="checkbox"/> Operator	30. APPROXIMATE LENGTH OF STEEPEST SLOPE ON ROAD: <input type="checkbox"/> 0 to 100 ft. <input type="checkbox"/> 101 to 200 ft. <input type="checkbox"/> 201 to 400 ft. <input type="checkbox"/> greater than 400 ft.
28. GRADING AND EROSION CONTROL PRACTICE ON ROAD: <input checked="" type="checkbox"/> Diversions <input type="checkbox"/> Filter strips <input type="checkbox"/> Drains <input type="checkbox"/> Riprap <input type="checkbox"/> Open top culverts <input type="checkbox"/> Water breaks <input checked="" type="checkbox"/> Outsloping of road <input type="checkbox"/> Pipe culverts <input type="checkbox"/> Proposed alternative _____	31. HAS LANDOWNER RECEIVED A COPY OF THIS RESTORATION PLAN? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No

The undersigned hereby agrees to implement all restoration operations identified on this form, and conform to all provisions of Section 1509.072 of the Ohio Revised Code, and to all Orders and rules issued by the Chief, Division of Oil and Gas Resources Management.

Signature of Owner/Authorized Agent 

Name (Typed or Printed) Kenneth J. McMahon, President Date 12-23-11

RESTORATION PLAN MUST BE SUBMITTED TO THE DIVISION IN DUPLICATE.

RECEIVED
DEC 27 2011

Trumbull County, Weathersfield Twp.,
SWIW #22 AWMS SWIW #2

**Subsurface Construction
For Injection Well**

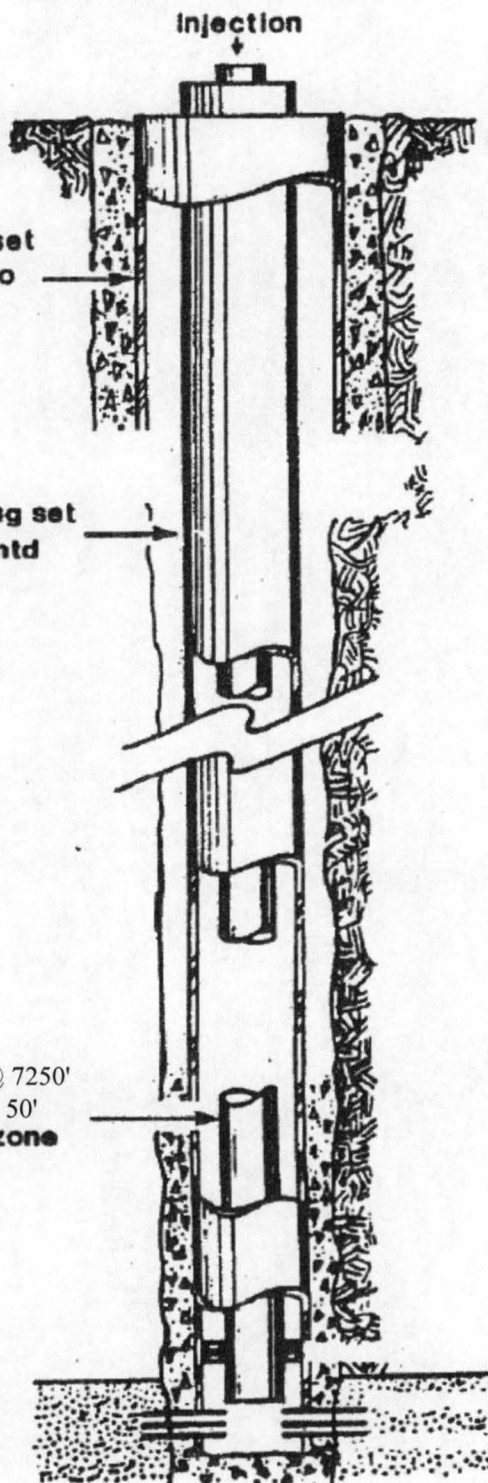
Maximum Injection Pressure: 1680 psi

20" Conductor csg set
at 60' and cmt to

13 3/8" Surf csg set
at 375' & cmtd to
surface

9 5/8" Prod csg set
at 7300' & cmtd
back to 4000'

4 1/2" Tubing set @ 7250'
at approx 50'
above injection zone



Knox/Mt. Simon
7300' - 9100'

Total Depth: 9100'

SUPPLEMENT TO APPLICATION
PERMIT FOR A SALTWATER INJECTION WELL (Form 210)

Ohio Department of Natural Resources, Division of Oil and Gas Resources Management
2045 Morse Road, Bldg H3
Columbus, OH 43229-6693

AREA OF REVIEW. An application for a saltwater injection well (SWIW) will be evaluated on the basis of an "area of review" surrounding the proposed well. The area of review for wells in which injection of greater than two hundred barrels per day is proposed shall be the area circumscribed by a circle with the center point at the location of the injection well and a radius of one-half mile. The area of review for wells in which a maximum injection of two hundred barrels per day or less is proposed shall be the area circumscribed by a circle with the center point at the location of the injection well and a radius of one-quarter mile.

31. PROPOSED INJECTION ZONE

Geologic Formation: Knox Dolomite and the Mt. Simon Sandstone
Injection Interval: From: 7,300 feet to 9,100 feet
Geologic description of injection zone: Dolomite and Sandstone

32. WELL CONSTRUCTION AND OPERATION

- A. Description of the proposed casing and cement program for new wells, or of the casing, cementing or sealing with prepared clay for existing wells to be converted.
Casing and Cement Program: See Attached Well Detail for AWMS No. 2. Casing sizes, types, set depths, cement quantities and cement tops are described.

- B. Proposed method for testing the casing:
See attached "Exhibit 1" Supplement to Application.

- C. Description of the proposed method for completion and operation of the injection well:
See attached "Exhibit 1" Supplement to Application.

- D. Description of the proposed unloading, surface storage, and spill containment facilities:
See "Exhibit 2" for diagrams and descriptions.

33. PROPOSED INJECTION VOLUMES

- A. Indicate the estimated amount of saltwater to be injected into the proposed injection well per day:
AVERAGE: 2,200 bbl/day MAXIMUM: 4,000 bbl/day
- B. Indicate the method to be used to measure the actual amount of saltwater injected into the well:
Electronic monitoring will be installed at the discharge of the injection pump. This volume along with the injection pressure at the pump, wellhead, and annular pressure will be monitored (see attached "Exhibit 1").

34. PROPOSED INJECTION PRESSURES

- A. Indicate the estimated pressure to be used for injection of saltwater into the proposed injection well:
AVERAGE: 1,050 psi MAXIMUM: 1,680 psi
- B. Indicate the method to be used to measure the actual daily injection pressure:
Pressure transducers and transmitters will be installed at the wellhead on the tubing and the tubing casing annulus. They will be continuously monitored and data stored electronically (see attached "Exhibit 1").

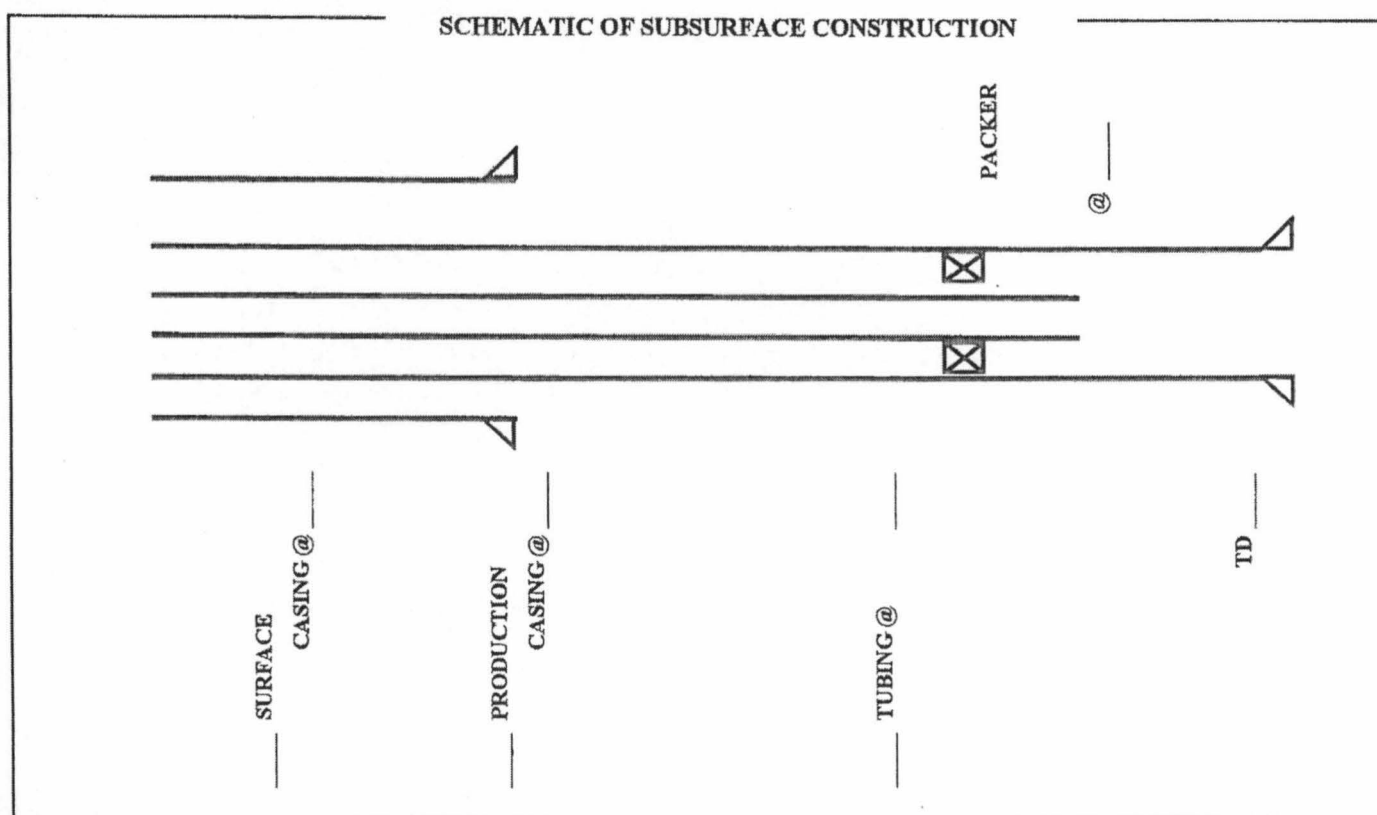
35. PROPOSED CORRECTIVE ACTION

Explain any corrective action proposed for wells penetrating the proposed injection formation or zone within the area of review:
At the time of this application, there are no known wells currently penetrating and/or producing from the proposed disposal formations within the area of review.

36. **MAP.** Each application for a permit shall be accompanied by a map or maps showing and containing the following information:

- A. The subject tract of land on which the proposed injection well is to be located.
- B. The location of the proposed injection well on the subject tract established by an Ohio registered surveyor showing the distances in feet from the proposed well site to the boundary lines on the subject tract;
- C. The geographic location of all wells, penetrating the formation proposed for injection regardless of status, within the area of review;
- D. All holders of the land owner's royalty interest of record, or holders of the severed oil and gas mineral estates of record in the subject tract;
- E. All owners or operators of wells producing from or injecting into the same formation proposed as the injection formation.

37. **SCHEMATIC DRAWING OF SUBSURFACE CONSTRUCTION.** Label the schematic drawing below indicating size and setting depth of surface casing, intermediate (if any) and production casings; amount of cement used, measured or calculated tops of cement; size and setting depth of tubing; type and setting depth of packer; geologic name of injection zone showing top and bottom of injection interval. If the proposed input well design is substantially different from the schematic below, attach on a separate sheet a schematic of your proposal labeled with the above information.



38. Public notice of an application for an enhanced recovery project is required by law. In addition, the applicant must submit, on an attached sheet, a list of the names and address of those persons required to receive personal notice in accordance with Rule 1501:9-5-05(E)(1), of the Ohio Administrative Code.

After submitting the application, and after a determination by the Division that it is complete as required by the rules of the Division, a legal notice must be published by the applicant in a newspaper of general circulation in the area of review. The legal notice must contain the information described in Rule 1501:9-5-05(E)(1) of the Ohio Administrative Code. A copy of the notice must be delivered to all owners or operators of wells within the area of review producing from or injecting into the same formation proposed as the injection formation. Proof of publication, publication date, and an oath as to the delivery to those entitled to receive personal notice under this method must be filed with the Division within thirty days after the Division determines that the application is complete.

In addition, notice of all applications for enhanced recovery projects will be published in the Division's Weekly Circular.

The undersigned hereby agrees to comply with all provisions for an enhanced recovery project as required by Chapter 1501:9-5 of the Ohio Administrative Code. In addition, the undersigned deposed and says that he shall conform to all provisions of Section 1509.072 of the Ohio Revised Code, and to all orders and rules issued by the Chief, Division of Mineral Resources Management.

Owner/ Authorized Agent (Type or Print) American Water Management Services, LLC; Kenneth J. McMahon

Signature of Owner/Authorized Agent

Kenneth J. McMahon

Title President

Permanent Address of Home Office One American Way, Warren, Ohio 44484

If signed by Authorized Agent, a certificate of appointment of agent must be on file with the Division.

Sworn to and subscribed before me this the

23rd day of December, 2011



ANGELA K. MARIMPIETRI
Notary Public - State of Ohio
My Commission Expires 9/24/2015

Angela K. Marimpietri
(Notary Public)
9/26/2015
(Date Commission Expires)

AWMS No. 2

Weathersfield Township

Trumbull County

Location: N 561766.2718/E 2443195.0238

Elevation: Approximately 908' MSL

EXHIBIT 1

SUPPLEMENT TO APPLICATION

PERMIT FOR SALTWATER INJECTION WELL (Form 210)

31) Proposed Injection Zone

Geologic Formation: Knox Dolomite and the Mt Simon

Injection Interval: 7,300' to 9,100'

Geologic Description: Dolomite and Sandstone

32) Well Construction and Operation

Casing and Cement Program: See the attached Well Detail. Casing sizes, types, set depth, cement quantities, and cement tops are described.

Proposed method for testing casing: The 9-5/8" casing will be pressure tested to 1,600 psi at the conclusion of the cementing process. Additionally, there will be a BOP test on the casing to 1,000 psi prior to drilling off the casing shoe into the open borehole. The 9-5/8" casing will be tested to 2,200 psi as a part of a mechanical integrity test. The test will be witnessed by an ODNR Inspector. The annular space between the 4-1/2" tubing and the 9-5/8" casing will be pressurized up to a minimum of 2,200 psi and monitored for a minimum of 30 minutes. A pressure chart and injectivity data will be submitted to the ODNR. The 4.5" injection string will also be equipped to receive a set mechanical plug to allow testing without disturbing the packer. The 4.5" injection string will also be pressurized up to a minimum of 2,200 psi and monitored for a minimum of 30 minutes. This pressure data will be included with the ODNR submittal. The pressure on the annular space will be continually monitored electronically once injection begins to assure the mechanical integrity of this annular space.

Description of the proposed method for completion and operation of the injection well: The well will be equipped with 9-5/8" casing set and cemented above the injection horizon. Approximately 1,800' of 8-1/2" open hole will exist below the 9-5/8" casing. This open hole interval will be acidified with a 15% HCL solution to enhance the porosity and permeability of the injection horizon. Injection into this horizon will be accomplished by pumping filtered and treated water down the 4-1/2" injection tubing into the disposal horizon. This tubing is isolated from the 9-5/8" casing by means of a mechanical packer set. The attached Well Detail illustrates the well configuration.

Description of proposed unloading, surface storage, and spill containment facilities: See figures and for diagrams and descriptions.

33) Proposed Injection Volumes

Indicate the estimated amount of saltwater to be injected into the proposed injection well per day.

Average: 2,200 bbl/day

Maximum: 4,000 bbl/day

Indicate the method to be used to measure the actual amount of saltwater injected into the well: Electronic measurement instrumentation will be installed at the discharge of the injection pump. This volume, along with the injection pressure at the pump, wellhead, and the annular pressure will be continually monitored and electronically recorded. Remote access to the data will be available. Fluids hauled into the facility will also be measured and monitored for comparison and reporting.

34) Proposed Injection Pressures

Indicate the estimated pressure to be used for injection of saltwater into the proposed injection well:

Average: 1,050 psi

Maximum: 1,680 psi

Indicate the method to be used to measure the actual daily injection pressure: Pressure transducers and transmitters will be installed at the wellhead on the injection tubing and the tubing casing annulus. They will be continuously monitored and electronically recorded. Controls will be installed on the pump to automatically shutdown the pump if an over pressure or under pressure condition exists.

35) Proposed Corrective Actions

At the time of this application, there are no known wells currently penetrating and/or producing from the proposed disposal formations within the area of review.

36) Map

See attached Exhibit 3.

37) Schematic Drawing of Subsurface Construction

See attached Well Detail

AWMS No. 2

Weathersfield Township

Trumbull County

Location: N 561766.2718/E 2443195.0238

Elevation: Approximately 908' MSL

EXHIBIT 2

SUPPLEMENT TO APPLICATION

PERMIT FOR SALTWATER INJECTION WELL (Form 210)

Description of the proposed unloading, surface storage, and spill containment facilities:

Water to be injected by this facility will be initially off-loaded into a lined and diked surface impoundment or alternatively directly into a storage tank. The water stored in the impoundment will then be transferred into a series of tanks within a diked and lined containment area. Figure 2 presents the general layout of the facility.

The storage impoundment will be 200' by 50' by 7.5' deep and have a capacity of approximately 8,900 bbl. The impoundment will be constructed with a double composite liner (compacted clay and two 40-mil geomembranes) impoundment with a geocomposite (double sided GSE Fabric Net with 200 mil net, or equivalent) as a drainage/monitoring layer. The liner system will include 12 inches of compacted low permeability clay. The geocomposite will serve as the leak detection layer and will outlet into a sump at the south end of the pond. The sump will drain via a 4" pipe into a manhole outside the impoundment for observation. Figure 3 presents details for the impoundment. The impoundment will be constructed in conformance with the Quality Assurance/Quality Control Plan presented in Attachment A.

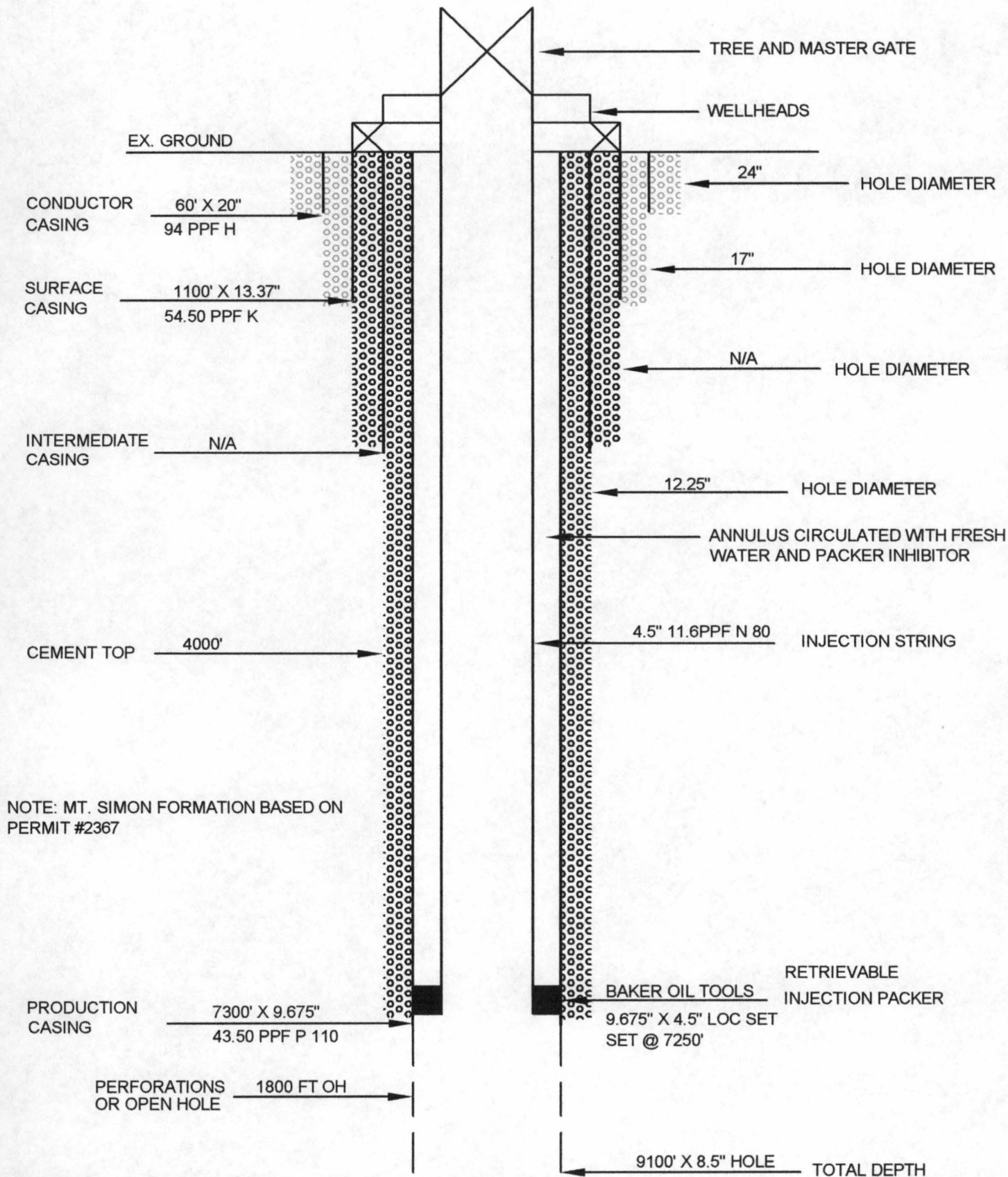
Tankage associated with the facility will total approximately 5000 bbl. The tankage will include a 200 bbl steel condensate tank, a 4,000 bbl (approximate) steel/glass lined primary storage tank, and two 400 bbl steel polished brine tanks. The tankage will be contained within a 124' by 84' by 4' deep diked containment area. Empty, this diked area has a capacity of approximately 5,800 bbl. Allowing for the displacement of the tanks within the diked area of 800 bbl, the diked capacity will equal 5,000 which equal the total facility tankage. The containment area will be constructed with a single liner (40-mil geomembrane) over 12 inches of low permeability compacted clay. Twelve inches of protective cover will be placed over the liner system. The cover material in the base of the diked area will consist of sand and gravel with topsoil to be used on the side slopes. A sump will be installed inside the diked area to remove precipitation that may enter this area. This water will be removed from the containment area via a sump pump and uploaded into the 400 bbl polished brine tanks. Figure 4 presents details for the unloading and containment area. The containment area will be constructed in conformance with the Quality Assurance/Quality Control Plan presented in Attachment A.

A concrete unloading pad, presented on Figure 4, will be constructed adjacent to the diked containment area. The pad will be built to allow trucks to pull in to an off-load valve that will be controlled by magnetic locks that require a swipe magnetic key to unlock (or similar secure

system). Brine from the trucks will initially be directed through an oil/water separator. The oil will be directed to the condensate tank and the raw brine directed to the impoundment or storage tank depending on suspended solids content and operational requirements. The pad will be sloped to a horizontal trench drain which will direct the spillage to a collection sump. The fluid collected in the sump will again be directed into the aforementioned oil/water separator and either directed to the condensate tank or the raw brine impoundment. Visual and audible alarms will be installed to notify the driver and operator of any pressure issues associated with the oil/water separator, and if the tank or impoundment are nearing capacities. Pressure and level controls will be wired to the offload valves. If an alarm condition occurs, the valves will automatically shut off.

The entire operation will be monitored round the clock both by operators at the facility and electronic monitoring. Video surveillance is also expected to be installed to provide additional monitoring.

J:\Projects\KUR003-INJECTION WELL\dwg\KUR003-FIG 1_MT SIMON SCH 2_122111.dwg - Dec 22, 2011 - 3:54pm - dbrookshire



AMERICAN WATER MANAGEMENT SERVICES, LLC

INJECTION WELL NO. AWMS-2 DETAIL
PROPOSED NILES INJECTION SITE

SCALE: NOT TO SCALE

DATE: 12-21-11

DWG: KUR003-FIG 2



NORTH POINT
ENGINEERING

6657 Frank Ave. N.W.
Suite 200
North Canton, Ohio 44720
330 - 494 - 8888
Fax 330 - 494 - 8889

**QUALITY ASSURANCE/QUALITY CONTROL
(QA/QC) PLAN**

GEOSYNTHETIC MATERIALS

AMERICAN WATER MANAGEMENT SERVICES, LLC
NILES INJECTION SITE
TRUMBULL COUNTY, OHIO

December 2011

Prepared by:

North Point Engineering
6657 Frank Ave. NW, Suite 200
North Canton, OH 44720
(330) 494-8888



**QUALITY ASSURANCE/QUALITY CONTROL PLAN
GEOSYNTHETIC MATERIALS
AMERICAN WATER MANAGEMENT SERVICES, LLC
NILES INJECTION SITE**

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2.0	Geomembranes
3.0	Geotextiles
4.0	Geocomposite Drainage Layers

SECTION 1.0

PERSONNEL AND QUALIFICATIONS

1.0 Overview

This construction QA/QC plan is intended to provide information regarding the methods, tests, and pass/fail criteria for construction of the geosynthetic lining system in the storage and containment system at the AWMS Niles Injection Site.

2.0 Qualifications of QA/QC Personnel

Individuals serving in the capacity of QA/QC personnel during site construction will have a degree in engineering or a related field or will have prior experience acceptable to the Owner in the performance of the specific task to be overseen. Accordingly, these personnel will be knowledgeable in the manufacturer's recommended field installation QA/QC procedures for any geosynthetic product that is placed in the construction area. Where appropriate, the personnel will have the proper certification and training in the operation of field-measuring equipment.

3.0 Definitions and Use of Terms

The following provides general information regarding specific terms, references, and units as used in the QA/QC Plan.

A. Definitions Relating to QA/QC

In the context of this QA/QC Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

1. Construction Quality Assurance (CQA): A planned and systematic pattern of means and actions employed to provide confidence that items or services meet contractual and regulatory requirements and will perform as specified in service.
2. Construction Quality Control (CQC): Those actions that provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements.

B. Use of Terms

In the context of this QA/QC Plan, the terms CQA and CQC are used as follows:

CQA refers to measures taken by the Owner to determine if the Contractors are in compliance with the design plans and specifications. CQC refers to measures taken by the Contractor to determine compliance with the requirements for materials and workmanship as stated in the contract drawings and specifications.

C. References to Standards

The QA/QC Plan includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS), and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF).

D. Units

Properties and dimensions given in the QA/QC Plan are expressed in U.S. units and may be followed by approximate equivalent values in SI units in parentheses. The values given in SI units are typically accurate within ten percent. In cases of conflict, the U.S. units govern.

4.0 Responsibility and Authority

The principal parties involved in the QA/QC of the geosynthetic lining system include the Owner, the Design Engineer, the QA/QC Consultant, the Geosynthetics CQA and CQC Testing Laboratory, the Earthwork Contractor, the Geosynthetics Manufacturer(s), and the Geosynthetics Installer(s). The general responsibilities and authorities of each of these parties are described in the following paragraphs. The responsibility and/or authority of a given party may be modified or expanded as dictated by specific project needs during Pre-Construction Meetings.

A. Owner

The Owner is responsible for coordinating the design and construction of the storage and containment system.

B. Project Manager

The Project Manager is the representative of the Owner and is responsible for coordinating schedules, meetings, and field activities. This responsibility includes communications to the Owner, QA/QC Consultant, Surveyor, Contractors, Manufacturers, and additional involved parties. The Project Manager has the authority to select and dismiss parties charged with construction activities. The Project Manager also has the authority to direct contractors hired by the Owner and to accept or reject their materials and workmanship.

C. Design Engineer

The Design Engineer is a firm or person, responsible for the preparation of the construction and contract documents necessary to construct the facility. The construction and contract documents are based on, and meet the minimum requirements of the permit documents which were approved by the appropriate regulatory agencies. Additional detail required for construction, accurate bidding, cost control, and contractual relationships and control are added by the Design Engineer.

D. QA/QC Consultant/Owner's Representative

The QA/QC Consultant/Owner's Representative is responsible for observing and documenting activities related to the permit documents and the QA/QC Plan. The QA/QC Consultant is represented by the on-site QA/QC monitoring personnel as appropriate. In general, the responsibilities and authorities of the QA/QC Consultant include:

- Complete understanding of the permit documents, design plans, and specifications in relation to all aspects of the QA/QC Plan.
- Scheduling, coordinating, and performing QA/QC activities;
- Performing independent on-site observation of the work in progress to assess compliance with the QA/QC Plan, permit documents, design plans, and technical specifications;
- Recognizing and reporting deviations from the QA/QC Plan, permit documents, design plans, and/or specifications to the Engineer and Project Manager.
- Secure documents which approve changes to the QA/QC Plan, permit documents, design plans, and/or specifications;
- Verifying that the QA/QC Consultant's test equipment meets testing and calibration requirements, and that tests are conducted according to standardized procedures defined in the QA/QC Plan;
- Recording and maintaining test data accurately;
- Identifying QA/QC-tested work that should be accepted, rejected, or further evaluated;
- Verifying that corrective measures are implemented;
- Documenting and reporting QA/QC activities;
- Collecting data needed for record documentation and
- Maintaining open lines of communications with other parties involved in the construction.

Certifications shall bear the seal of a Professional Engineer registered in the state of Ohio.

E. Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is responsible for performing the laboratory testing required by the QA/QC Plan to determine specific characteristics of the geosynthetics. The Geosynthetics CQA Laboratory is also responsible for providing adequate documentation of analytical results, test methods followed, and testing equipment used. Work of the Geosynthetics CQA Laboratory will be administered by the QA/QC Consultant. All results should be reported to the QA/QC Consultant.

F. Earthwork Contractor or "Contractor"

The Earthwork Contractor is responsible for moving earth to establish the proposed grades, preparation of the recompacted soil liner, and for the placement of the soil and granular materials composing the soils components of the storage and

containment system. The Earthwork Contractor may also be responsible for construction of sedimentation and erosion control facilities, anchor trenches for liner installation, and other support activities outside the storage and containment system. It is the responsibility of the Earthwork Contractor that the construction be performed using the procedures and equipment necessary to produce results in conformance with the contract documents.

The Earthwork Contractor may also be responsible for the placement of geotextile, geosynthetic reinforcement, and piping systems. In this capacity, the Earthwork Contractor is responsible for the quality of the materials and installation of the materials in conformance with the contract documents.

G. Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is responsible for the production of geosynthetics that meet the requirements of the contract documents. The Geosynthetics Manufacturer is also responsible for providing adequate documentation regarding the characteristics of the resin, the characteristics of the finished product, the testing performed to determine the characteristics, and the quality control measures taken during manufacturing.

The Geosynthetics Manufacturer(s) may be responsible for the safe transportation of the geosynthetics between the manufacturing plant and the site. The Geosynthetics Manufacturer is responsible for carefully loading and transporting geosynthetics and accepts full responsibility for damage to the geosynthetics that may occur during these operations.

H. Geosynthetics Installer

The Geosynthetics Installer(s) is responsible for unloading (as applicable), field handling, storing, placing, seaming, temporarily anchoring against wind, and other aspects of geosynthetics installation in accordance with the contract documents. The Geosynthetics Installer may also be responsible for the preparation and completion of anchor trenches.

Prior to mobilization on to the site, the Geosynthetics Installer is responsible for providing the installation schedule, a proposed panel layout drawing, standard details for geosynthetic seaming and pipe encasements, and a list of proposed field personnel and their qualifications. The Geosynthetics Installer is responsible for providing quality control documentation. Upon completion of the installation, the Geosynthetics Installer shall provide the geomembrane installation certification, the Manufacturer's warranty, and the installation warranty.

5.0 Project Meetings

To achieve a high degree of quality during installation, clear, open channels of communication are essential. The following meetings should be held when appropriate.

A. Pre-construction Meeting

Following the completion of the contract documents and selection of a QA/QC Consultant for the project, a Pre-construction Meeting shall be held. The meeting may be attended by the Project Manager, the QA/QC Consultant's Engineer, the QA/QC Consultant's Inspection personnel, the Geosynthetic Installer's Superintendent, the Earthwork Contractor's Superintendent, and other involved parties.

B. Daily Meetings

A daily meeting shall be held, as necessary, between the QA/QC Consultant, the Geosynthetic Installer, the Earthwork Contractor, the Project Manager, the Owner, and other involved parties. Those attending will discuss, plan, coordinate the work, and QA/QC activities to be completed that day.

C. Progress Meetings

Progress meetings shall be held as necessary. Attendees shall include the Project Manager, the QA/QC Consultant, the Geosynthetic Installer, the Earthwork Contractor, and other involved parties. Those attending will discuss current progress, planned activities for the next week, and new business or revisions to the work. The QA/QC Consultant will log problems, decisions, or questions arising at this meeting.

D. Problem or Work Deficiency Meeting

A special meeting shall be held when and if a problem or deficiency, which would impact the construction schedule, is present or likely to occur. At a minimum, the meeting shall be attended by the affected contractors, the Project Manager, and the QA/QC Consultant. The purpose of the meeting is to define and resolve the problem or work deficiency.

6.0 Qualifications of Key Personnel and Organizations

The following qualifications shall be required of the key personnel and organizations involved in the construction of the storage and containment system.

A. QA/QC Consultant

The QA/QC Consultant shall be pre-qualified and approved by the Owner. The QA/QC Consultant shall be a qualified engineering firm with experience in construction quality assurance and quality control, particularly on projects involving similar storage and containment systems. The QA/QC Consultant shall designate an Engineer who is a Professional Engineer registered in the state of the permitting site. The Engineer shall be solely responsible for the QA/QC personnel and their activities, as well as the preparation of a certification report to certify the project has

been constructed in accordance with the QA/QC Plan, permit documents, permit, design plans, and specifications. The QA/QC Consultant shall be capable of assigning technically qualified personnel to the project, including CQA Monitors, as needed. CQA monitors shall be specifically trained in quality assurance of geosynthetics, earthwork, concrete, etc.

B. Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory shall be pre-qualified by the Owner. The Geosynthetics CQA Laboratory shall be experienced in performing laboratory tests to determine geosynthetics characteristics as required by this QA/QC Plan. The Geosynthetics CQA Laboratory shall demonstrate that it follows the standard test methods listed in the QA/QC Plan and maintains the appropriate, calibrated equipment to perform the tests. The Geosynthetics CQA Laboratory shall also demonstrate to the QA/QC Consultant and Engineer that it adheres to a formal in-house quality control program and can provide the required analytical documentation and reports.

C. Earthwork Contractor

The Earthwork Contractor shall be pre-qualified and approved by the Owner. The Earthwork Contractor shall be capable of assigning the personnel and equipment required to perform the work within the schedule.

D. Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) shall be able to provide sufficient production capacity and experience to meet the demands of the project. In particular, the Geomembrane Manufacturer shall be pre-qualified and approved by the Owner. The qualifications required of the Geomembrane Manufacturer are presented in detail in specific section of the QA/QC Plan. The Manufacturers of the remaining forms of geosynthetics shall provide sufficient documentation of production capacity and experience to the satisfaction of the Owner.

E. Geosynthetics Installer

The Geosynthetics Installer(s) shall be trained and qualified to install geosynthetics. Prior to confirmation of contractual agreements, the Geomembrane Installer shall provide the Project Manager with the information demonstrating qualifications. The Installers of the remaining forms of geosynthetics shall provide sufficient documentation of installation capabilities and experience to the satisfaction of the Project Manager.

The Geomembrane Installer shall provide the Project Manager with a list of proposed seaming personnel and their professional qualifications. This certificate shall be reviewed by the Project Manager and the QA/QC Consultant. Proposed seaming personnel deemed insufficiently experienced shall not be accepted by the Project Manager or shall be required to pass a seaming test.

The Geomembrane Installer shall designate one representative as the Superintendent, who will represent the Installer on-site and at site meetings. The Superintendent shall be qualified by experience. The Superintendent shall be approved by the Project Manager.

In addition, the Geomembrane Installer shall designate a Master Seamer, who shall not be the Superintendent. The Master Seamer shall be present during all seaming operations and be experienced with extrusion welding, fusion welding, and welding in varying weather conditions.

SECTION 2.0 GEOMEMBRANES

Preface

The manufacture, shipment, and installation of polyethylene geomembrane shall be in accordance with this section of the QA/QC Plan and the design specifications.

General Manufacturer's installation specifications have been incorporated into the QA/QC Plan as appropriate. After a specific Geomembrane Manufacturer has been contracted, modifications may be made to this section of the QA/QC Plan to incorporate particular requirements of that Manufacturer. The modifications will be submitted for approval by the permitting agency prior to implementation.

The QA/QC Consultant shall document inventory, testing, and placement of geosynthetics.

The flexible membrane liner shall

- (a) Be, at a minimum, a 40-mil high density polyethylene (HDPE) or a 40-mil linear low density (LLDPE) geomembrane for the base liner system.
- (b) Be physically and chemically resistant to attack by waste, wastewater, or other materials that may come in contact with it using U.S. EPA Method 9090 or other documented data.
- (c) Be one of the following products:
 - a. GSE Lining Systems 40-mil dual sided textured and smooth HDPE or LLDPE geomembrane,
 - b. Agru America 40-mil dual sided textured and 40-mil smooth HDPE or LLDPE geomembrane.
 - c. PolyFlex, Inc 40-mil dual sided textured and 40-mil smooth HDPE or LLDPE geomembrane,
 - d. Alternate manufacturers that produce geomembrane products that meet or exceed the above noted manufacturers and the requirements of GRI GM 13 or GRI GM 17 (as applicable) will be considered.

1.0 Manufacture, Shipment, and Storage

The following addresses the activities associated with the manufacture of the geomembrane; the shipment, handling, and delivery of geomembrane to the site; conformance testing of delivered geomembrane; and the storage of the geomembrane prior to installation.

A. Manufacture of Polyethylene Geomembrane

The Geomembrane Manufacturer shall provide documentation that the material meets the requirements of the design specifications and that adequate quality control measures have been implemented during the manufacturing process.

1. Resin Quality

Prior to the shipment of polyethylene geomembrane material, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with the following information:

- The origin (Resin Supplier's name and resin production plant), identification (brand name, number), and production date of the resin;
- A copy of the quality control certificates issued by the Resin Supplier;
- Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls and extrudate rods and
- A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight).

At the Owner's discretion and cost, testing may be carried out on the resin by the Geosynthetics QA/QC Laboratory for purposes of verifying conformance. If the results of the Manufacturer and the Geosynthetics QA/QC Laboratory testing differ, the testing will be repeated by the Geosynthetics QA/QC Laboratory, and the Geomembrane Manufacturer will be permitted to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

2. Certification of Property Values

In addition to information regarding the raw material, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with the following prior to shipment of the geomembrane:

- A properties sheet certification including, at a minimum, guaranteed values for all properties specified in GRI GM 13.
- A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

3. Manufacturer Quality Control Certificates

Prior to shipment, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with quality control certificates for the geomembrane provided. The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer. The quality control certificate will include:

- Roll numbers and identification;
- Date of production; and
- Results of quality control tests.

The Manufacturer shall be required to perform the testing at the frequencies specified in GRI GM 13 requirements.

The QA/QC Consultant shall:

- Verify that the quality control certificates have been provided at the specified frequency for all rolls; and
- Review the quality control certificates and verify that the test methods and values are acceptable.

B. Shipment and Handling

Shipment of the geomembrane to the site is the responsibility of the Owner, Geomembrane Manufacturer, or Installer depending on the contract documents. Handling on-site is the responsibility of the Installer. Shipments will be accepted by the Owner only if delivered by flatbed trailer.

The QA/QC Consultant shall observe that:

- Handling equipment used on-site poses minimal risk of damage to the geomembrane; and
- The Geomembrane Installer's personnel handle the geomembranes with care. Upon delivery at the site, the Installer and the QA/QC Consultant shall conduct a surface observation of the exposed outer surface rolls for defects, damage, and labeling. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. All labels identifying rolls shall be weatherproof. The QA/QC Consultant will indicate to the Project Manager:
- Rolls, or portions thereof, that should be rejected and removed from the site because they have severe flaws;

- Rolls that have minor repairable flaws; and
- Rolls without proper identification.

Rolls without proper identification shall be rejected by the Project Manager.

- C. Conformance Testing of Geomembrane
Conformance testing is not specified for the Comp Dairy project.
- D. Storage
The Installer shall be responsible for the storage of the geomembrane on site. Storage space should protect the geomembrane from theft, vandalism, passage of vehicles, water, and weather. The QA/QC Consultant shall document that storage of the geomembrane provides adequate protection against dirt, vehicle impact, and other sources of damage.

2.0 Geomembrane Installation

The installation of the geomembrane involves three primary tasks; earthwork, placement of geomembrane field panels, and seaming the field panels.

- A. Earthwork
The earthwork supporting the geomembrane and anchoring it in place is crucial to the performance of the geomembrane. The Contractor shall inform the Construction Quality Assurance (CQA) Inspector when the surface on which the geomembrane will be installed is suitable for installation. Geomembrane placement may not commence until both the CQA Inspector and the Installer inspect the subgrade and agree that the area under consideration is acceptable.

It is the Installer's responsibility to protect the supporting soil after it has been accepted. After the supporting soil has been accepted by the Installer, it shall be the responsibility of the Installer and the QA/QC Consultant to indicate to the Project Manager any change in the supporting soil condition that may require repair work.

- B. Geomembrane Placement
The placement of field panels of geomembrane is the responsibility of the Installer and shall be performed in accordance with the approved layout and the following sections. The geomembrane shall be placed in direct and uniform contact with the underlying recompacted soil or barrier layer.

- 1. Panel Layout
If requested, prior to installation, the Geomembrane Installer shall provide to the Project Manager and the QA/QC Consultant, a drawing of the facility to be lined showing the proposed panel layout. The QA/QC Consultant shall review the panel layout drawing and verify it is consistent with the accepted state of practice and the QA/QC Plan. The panel layout drawing shall be approved by the QA/QC Consultant's Engineer (QA/QC Engineer).

Seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. Horizontal seams should be greater than 5 feet (1.5 m) from the toe of slopes, or areas of potential stress concentration, unless otherwise authorized.

2. Field Panel Identification

The QA/QC Consultant shall document that the Installer labels each field panel with an "identification code" (number and/or letter) consistent with the layout plan. This identification code shall be agreed upon by the Project Manager, Installer, and QA/QC Consultant. It is the responsibility of the Installer and the QA/QC Consultant to verify that each field panel placed can be tracked to the original roll number. The identification code will be marked at a location agreed upon by the Project Manager, Installer, and QA/QC Consultant at the Pre-Construction Meeting.

The QA/QC Consultant shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code will be used for all quality assurance records.

3. Location

The QA/QC Consultant shall verify that field panels are installed at the location indicated in the Installer's layout plan, as approved or modified.

4. Installation Schedule

Field panels shall be placed one at a time unless otherwise approved by the QA/QC Consultant, and the Project Manager. Each field panel shall be seamed after its placement in order to minimize the number of unseamed field panels exposed to weather.

It is usually beneficial to "shingle" overlaps in the downward direction to facilitate drainage in the event of precipitation. It is also beneficial to proceed in the direction of prevailing winds. Scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Installer shall be fully responsible for the decision made regarding placement procedures.

The QA/QC Consultant shall record the identification code, location, date of installation, time of installation, ambient temperature, sheet temperature, and thickness of each field panel.

The QA/QC Consultant shall evaluate field changes by the Installer which may have affected the original schedule proposed by the Installer and advise the Project Manager on the acceptability of that change.

5. Weather Conditions

Geomembrane placement shall not proceed when sheet temperature measured by placing a thermometer on the surface of the sheet is below 41°F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding. Deviations from the above temperature criteria shall only occur when authorized by the Project Manager and with the concurrence of the QA/QC Consultant. Geomembrane placement shall not be done during any precipitation, fog, snow, in an area of ponded water, or in the presence of excessive winds.

The QA/QC Consultant shall verify that the above conditions are fulfilled and shall inform the Project Manager if the conditions are not fulfilled.

6. Anchorage System

Anchor trenches shall be excavated by the Earthwork Contractor (unless otherwise specified) to the lines and widths shown on the plans prior to geomembrane placement. The QA/QC Consultant shall verify that anchor trenches have been constructed according to the plans.

Slightly rounded corners will be provided in trenches where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. Loose soil shall not underlie the geomembrane in the trenches. Seaming shall continue through the anchor trench.

7. Method of Placement

The following is the responsibility of the Geomembrane Installer; the QA/QC Consultant shall document that these conditions are satisfied:

- Equipment used does not damage the geomembrane by handling, traffic, excessive heat, leakage of liquids, or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;
- Geosynthetic material immediately underlying the geomembrane is clean and free of debris;
- Personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method and equipment used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags or rolls of geosynthetic materials, is recommended along the edges of panels to minimize the risk of wind flow under the panels); and
- Direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The QA/QC Consultant shall inform the Project Manager if the above conditions are not fulfilled.

8. Damage

The QA/QC Consultant shall visually observe each panel, after placement and prior to seaming, for damage. The QA/QC Consultant shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the QA/QC Consultant. Repairs shall be made according to procedures described in within this section. As a minimum, the QA/QC Consultant shall document that:

- The panel is placed in such a manner that it is unlikely to be further damaged;
- Any tears, punctures, holes, thin spots, etc. are either marked for repair or the panel is rejected.

The party responsible for damaging the geomembrane will be responsible for payment for all repairs or replacements.

C. Field Seaming

Field seaming shall be performed to allow no more than negligible amounts of leakage; the seaming material shall be physically and chemically resistant to chemical attack by the waste, wastewater, or other materials that may come in contact with the seams. Field seaming is the responsibility of the Installer and shall be performed in accordance with the following.

1. Requirements of Personnel

At the Pre-Construction Meeting, the Geomembrane Installer will provide the QA/QC Consultant with a list of proposed seaming personnel and their professional records. This document will be reviewed and approved by the Project Manager and QA/QC Consultant. Seaming personnel shall meet the requirements listed in Section 1.0 of this QA/QC Plan.

2. Seaming Equipment and Products

Approved processes for field seaming are extrusion seaming and fusion seaming. Proposed alternate processes shall be documented and submitted to the Owner for approval. Only seaming equipment which has been specifically approved by make and model shall be used. The Installer shall submit seaming equipment documentation to the Project Manager and the QA/QC Consultant for approval.

The following is the responsibility of the Installer; the QA/QC Consultant shall verify that these conditions are met:

- The Installer maintains on-site the number of spare operable seaming apparatus decided at the Pre-Construction Meeting;
- Equipment used for seaming is not likely to damage the geomembrane;
- The extruder is purged prior to beginning a seam until heat-degraded extrudate has been removed from the barrel;
- For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to seaming;
- The electric generator is placed on a flat smooth base and a rub sheet such that no damage occurs to the geomembrane; and
- A smooth insulating plate, scrub sheet or fabric is placed beneath the hot seaming apparatus after usage.

a. Extrusion Process

The extrusion seaming apparatus shall be equipped with gauges giving the relevant temperatures of the extrudate, nozzle, and preheat. The Installer shall provide documentation regarding the extrudate to the Project Manager and the QA/QC Consultant, and shall certify that the extrudate is compatible with the design specifications, and is comprised of resin which is compatible with geomembrane sheeting. The QA/QC Consultant shall log apparatus temperatures, ambient temperatures, extrudate temperatures, and sheet temperatures at appropriate intervals.

b. Fusion Process

The fusion-seaming apparatus must be automated vehicular mounted devices, equipped with gauges giving the applicable temperatures. Pressure settings shall be verified by the Installer prior to each seaming period. The QA/QC Consultant shall log ambient temperatures, sheet temperatures, seaming apparatus temperatures, speeds, and pressures.

3. Seam Preparation

The following is the responsibility of the Installer; the QA/QC Consultant shall verify that these conditions are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, oils, greases, debris of any kind, and foreign material. The material to be joined must be wiped with a clean cloth just prior to seaming;
- A rub sheet must be used to protect the liner while cutting any materials;
- If seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane;
- The abrading is not visible when welding is complete;
- Seams are aligned with the fewest possible number of wrinkles and "fishmouths"; and
- No metal objects that could potentially damage the liner are permitted for use on the lined area.

4. Weather Conditions for Seaming

The required weather conditions for seaming are as follows:

- The sheet temperatures shall be measured with the thermometer on the surface of the geomembrane sheet.
- Unless authorized in writing by the Project Manager, no seaming shall be attempted at a sheet temperature below 41° F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding.
- The geomembrane shall be dry and protected from wind.

If the Installer wishes to use methods which may allow seaming at sheet temperatures below 41°F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding, the Installer shall provide adverse weather welding procedures which shall be reviewed and approved by the QA/QC Consultant, and certify in writing that the installation crew has been trained to perform adverse weather welding. The installer shall also demonstrate through trial welding that the overall quality of the geomembrane is not adversely affected.

5. Overlapping and Temporary Bonding

The following shall be the responsibility of the Installer and verified by the QA/QC Consultant:

- As a general guidance, the panels of geomembrane have a finished overlap of a minimum of 3 inches (75 mm) for extrusion seaming and 4 inches (100 mm) for fusion seaming, but in any event sufficient overlap will be provided to allow peel tests to be performed on the seam;
- No solvent or adhesive is used unless the product is approved in writing by the Owner (samples will be submitted to the Owner for testing and evaluation); and
- The procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any spot seaming apparatus is controlled such that the geomembrane is not damaged).

The QA/QC Consultant shall log all appropriate temperatures and conditions, and shall log and report to the Project Manager any deviation.

6. Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate and that seam strength meets geomembrane manufacturer requirements. Such trial seams shall be made at the beginning of each seaming period, when a seaming apparatus is started, when operators change, and when a seaming apparatus is re-started. A passing trial seam shall be made for each seaming device and technician. A change in technician or machine on a previously passed trial seam warrants the welding of a new passing trial seam. A trial seam shall also be made in the event that the sheet temperature varies more than 18°F (10°C) since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. If seaming apparatus is turned off for any reason, a new passing trial seam must be completed for that specific seaming apparatus.

The Installer shall provide the tensiometer required for peel testing of trial seams in the field. Shear testing may be performed at the discretion of the QA/QC engineer. The tensiometer shall be automatic and shall have a direct digital readout. The tensiometer shall be calibrated at the site prior to use. The Installer shall provide the Project Manager with the calibration certification.

The trial seam sample shall be at least 5 feet (1.5 m) long by 1 foot (.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap will be as indicated in Subsection 2.C.5.

Three specimens, each 1 inch (25 mm) wide shall be cut from the trial seam sample by the Installer and tested in peel using a field tensiometer. For each fusion specimen, both tracks shall be tested. A passing welded seam is achieved in peel when the specimen meets the criteria specified in Table 2-1 at the end of this specification section. If shear testing is performed, it shall meet the requirements noted in Table 2-1.

If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

The QA/QC Consultant shall observe trial seam procedures. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the QA/QC Consultant, who will also log the date, hour, machine settings, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The remainder of the successful trial seam sample shall be archived by the owner until the Permitting Agency has approved the final documentation.

7. General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the Installer shall be as follows:

- For fusion seaming, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to help prevent any moisture build-up between the sheets to be seamed.
- If required, a firm substrate will be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- Wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut wrinkles will be seamed and any portion where the overlap is inadequate will then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.
- Seaming will extend to the outside edge of panels to be placed in the anchor trench.
- No field seaming shall take place without the Master Seamer being present.

The QA/QC Consultant shall verify that the above seaming procedures are followed, and shall inform the Project Manager if they are not.

8. Non-Destructive Seam Continuity Testing

The Installer shall non-destructively test field seams over their full length using a vacuum test unit (for extrusion seams only), air pressure test, or other approved method. The testing shall be carried out to the accepted standards of the industry. The purpose of non-destructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out on 100 percent of the seams as the seaming work progresses, not at the completion of all field seaming, unless otherwise approved by the Project Manager. The Installer shall complete any required repairs in accordance with Subsection 2.D.

a. Air Pressure Testing:

Unless otherwise specified, the general air pressure testing procedure used by the Installer shall be as follows:

- Seal both ends of the test channel with a heat gun or other acceptable clamping method.

- Insert a hollow needle with attached pressure gauge into the test channel.
 - Inflate the test channel to 30 to 35 psi, close valve, and observe initial pressure after approximate air temperature and pressure have stabilized. The initial pressure setting shall be between 30-35 psi.
 - Observe and record the test pressure 5 minutes after reading the initial test pressure. If pressure loss exceeds 3 psi, or if the pressure does not stabilize, locate the faulty area and repair.
 - At the conclusion of the pressure test, the end of the seam opposite the pressure gauge shall be cut to verify seam continuity. A decrease in a gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.
 - Remove needle or other approved pressure feed device and seal the resulting hole.
 - Test results will be recorded by the QA/QC Consultant.
- b. Non-Complying Air Pressure Test:
In the event of a non-complying air pressure test, the following procedure shall be followed:
- Check the seam end seals and retest the seams.
 - If the seam fails air pressure testing, the Installer may isolate the failing zone, air pressure test the seam outside the failing zone, then repair the failing zone by the methods listed below. Alternatively, the Installer may repair the entire seam by the methods listed below:
 - Cap-strip the suspect area;
 - When sufficient overlap exists (1 1/2 inch (38 mm)), heat tack the overlap and extrusion weld the entire seam; or
 - Further isolate the air pressure failure as agreed upon by the QA/QC Consultant and Project Manager.
 - Test the entire length of the repaired seam by vacuum testing.

- All sections shall be retested and repaired in accordance with Subsection 2D.
- c. Vacuum Testing
- Unless otherwise specified, the general vacuum testing procedure used by the Installer shall be as follows:
- Turn on the vacuum pump to reduce the vacuum box to approximately 5 psi (0.35 kg/cm³).
 - Apply a generous amount of liquid soap and water solution to the area to be tested.
 - Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.
 - Close the bleed valve and open the vacuum valve.
 - Ensure that a leak tight seal is created.
 - For a period of not less than 5 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
 - If no bubbles appear after 5 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inch (75 mm) overlap, and repeat the process.
- d. Non-Complying Vacuum Test
- In the event of a non-complying vacuum test, the following procedure shall be followed:
- Mark all areas where soap bubbles appear and repair the marked areas.
 - Retest repaired areas.
- e. QA/QC Responsibilities
- The QA/QC Consultant shall:
- Document all continuity testing;
 - Record location, date, test unit number, name of tester, and outcome of all testing; and,

- Inform the Installer and Project Manager of any required repairs.

When defects are located, the QA/QC Consultant shall:

- Observe the repair and retesting of the repair;
- Mark on the geomembrane that the repair has been made; and
- Document the results.

f. Non-Testable Areas

The Installer shall use the following procedures at locations where seams cannot be non-destructively tested:

- All such seams shall be cap-stripped with the same geomembrane material.
- If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the QA/QC Consultant and Installer for uniformity and completeness.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the QA/QC Consultant.

9. Destructive Testing

Destructive seam tests shall be performed at locations selected by the QA/QC Consultant. The purpose of these tests is to evaluate seam strength. Seam strength testing will be done as the seaming work progresses and not at the completion of all field seaming, unless otherwise approved by the Project Manager.

a. Location and Frequency

The QA/QC Consultant shall select locations where a destructive seam sample will be cut out for peel and shear strength testing. Those locations shall be established as follows:

- A frequency of one test location per 500 feet (150m) or less of seam length per seamer and seaming apparatus.
- Test locations will be determined during seaming at the QA/QC Consultant's discretion. Selection of such locations may be prompted by suspicion of contamination, offset seams, or any other potential cause of imperfect seaming.

The Installer will not be informed in advance of the locations where the seam samples will be taken.

b. Sampling Procedure

Samples shall be cut by the Installer as the seaming progresses in order to have passing test results before the geomembrane is covered by another material. The QA/QC Consultant shall:

- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly;
- Record the sample location on the layout drawing; and
- Record the reason for taking the sample at this location, if not taken due to statistical routine.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Subsection 2.D.2 of this Plan. The continuity of the new seams in the repaired area will be tested according to Subsection 2.C.8.

c. Size of Samples

At a given sampling location, samples shall be taken by the Installer. The sample shall be cut into three parts and distributed as follows:

- One portion to the QA/QC Consultant for archive storage, 12 inches x 12 inches (30 cm x 30 cm);
- One portion for peel and shear testing in the field, 12 inches x 18 inches (30 cm x 45 cm); and
- At the discretion of the QA/QC engineer and CQA Consultant, one portion for shipment to an independent testing laboratory, 12 inches x 12 inches (30 cm x 30 cm) assuming passing field testing results.

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

d. Field Testing

Ten (10) one-inch (25 mm) wide specimens shall be removed from the field sample and tested in the field with a tensiometer. Five (5) specimens shall be tested in peel and five (5) in shear; all specimens

shall meet the minimum strength requirements specified in Table 2-1 at the end of this specification section. A maximum of one non film tear bond (FTB) failure is acceptable, for each method, provided that strength requirements are met on that sample. If any field test specimen fails to pass, then the procedures outlined in Subsection 2.C.9.g will be followed.

The QA/QC Consultant shall witness field tests and mark all samples and portions with their number. The QA/QC Consultant shall also log the date and time, ambient temperature, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, and pass or fail description.

- e. Geosynthetics QA/QC Laboratory Testing (Discretionary)
At the discretion of the QA/QC engineer and CQA Consultant, the Destructive test samples shall be packaged and shipped, if necessary, by the QA/QC Consultant in a manner that will not damage the test sample. The Project Manager shall be responsible for storing the archive samples. Destructive seam sample testing shall be performed with a calibrated tensiometer.

Five (5) specimens will be tested in both peel and shear. A maximum of one non film tear bond (FTB) failure is acceptable, for each method, provided that strength requirements are met on that sample.

Written results of destructive testing of seam samples shall be made available to the QA/QC Consultant, Installer, and Project Manager within approximately 24 hours after samples are removed from the liner. The QA/QC Consultant shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager. If a sample fails, the procedures given in Subsection 2.C.9.g shall be followed.

- f. Installer's Laboratory Testing
If the Installer chooses to perform destructive testing on their portion of the seam samples, their test results shall be presented to the Project Manager and the QA/QC Consultant for review within approximately 24 hours after samples are removed from the liner.
- g. Destructive Test Failure
The following procedures shall apply whenever a seam sample fails destructive testing:
 - The Installer can reconstruct the seam between any two passed destructive seam test locations, or

- The Installer can trace the seaming path to an intermediate location (at least 10 ft (3 m) from the point of the failed test in each direction) and take a small sample for an additional field test at each location. If these samples pass destructive testing, then the seam is reconstructed between these locations (see Subsection 2.D.2 for repair procedures). If the additional testing fails, then the process shall be repeated to establish the zone to be reconstructed.

All acceptable seams must be bounded by two passing destructive tests. In cases exceeding 150 feet of reconstructed seam length, a sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined here must be repeated. The QA/QC Consultant shall document all actions taken in conjunction with destructive test failures.

D. Defects and Repairs

Seams and non-seam areas of the geomembrane shall be examined by the QA/QC Consultant for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The geomembrane surface shall be swept or washed by the Installer if the amount of dust or mud inhibits examination.

1. Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Subsection 2.C.8 as appropriate. Each location that fails the non-destructive testing shall be marked with an identification code by the QA/QC Consultant and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

2. Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive test, or non-destructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be approved by the Project Manager and QA/QC Consultant. The procedures available include:

- Patching

- Apply a new piece of geomembrane sheet over, and at least 6 inches (150 mm) beyond the limits of a defect. The patch shall be extrusion seamed to the underlying geomembrane. This method should be used to repair large holes, tears,

destructive test locations, undispersed raw materials, and contamination by foreign matter.

- Spot Seaming
 - Apply a "bead" of extrudate, maximum length of 6 inches (150 mm), over a defect. Spot seaming should be used only to repair dents, pinholes, pressure test air holes, or other minor, localized flaws.
- Capping
 - Apply a new strip of geomembrane over a faulty seam. The cap strip shall extend at least 6 inches (150 mm) beyond the limit of the seam and the edges will be extrusion seamed to the underlying geomembrane. This method should be used to repair lengths of extrusion or fusion seams.
- Welding Flap
 - Where an adequate flap exists, [(1-1/2 inches (38 mm))] extrusion weld the flap of a fusion seam. At the ends of this repair, the flap shall be cut to allow the extrusion weld to enclose the failed area.
- Replacement
 - The faulty seam is removed and replaced.

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired will be abraded no more than one hour prior to the repair;
- All surfaces must be clean and dry at the time of the repair;
- All seaming equipment used in repairing procedures must pass trial weld testing;
- The repair procedures, materials, and techniques will be approved in advance of the specific repair by the QA/QC Consultant and Installer; and
- Patches or caps will extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches will be rounded.

3. Verification of Repairs

Each repair shall be numbered and logged by the QA/QC Consultant and the Installer. Each repair shall be non-destructively tested using the methods described in Subsection 2.C.8 as appropriate. Repairs which pass the non-destructive test will be taken as an indication of an adequate repair. However, if the QA/QC Consultant suspects a repair to be questionable, although it passes non-destructive testing, a destructive test can be requested. Failed tests will require the repair to be redone and retested until a passing

test is achieved. The QA/QC Consultant shall observe non-destructive testing of repairs and shall record the date of the repair and test outcome.

4. Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the QA/QC Consultant shall observe the geomembrane wrinkles. The QA/QC Consultant will indicate to the Project Manager which wrinkles should be cut and resealed by the Installer. The seam thus produced will be tested like any other repair.

5. Backfilling of Anchor Trench

Anchor trenches will be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. Anchor trenches shall be backfilled and compacted as soon as possible. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The QA/QC Consultant shall observe the backfilling operation and advise the Project Manager of any problems.

6. Liner System Certification/Acceptance

The Installer and the Manufacturer shall retain ownership and responsibility for the geosynthetics in the facility until acceptance by the Owner. The liner system shall be accepted by the Owner when:

- The installation is finished;
- Verification of the adequacy of seams and repairs, including associated testing, is complete;
- Installer's representative furnishes the Project Manager with certification that the geomembrane was installed in accordance with the Manufacturer's recommendations as well as the design plans and specifications; and
- All documentation of installation is completed including the QA/QC Consultant's final report.

The QA/QC Consultant shall provide certification that installation was performed in accordance with this QA/QC Plan for the project except as noted to the Permit Engineer or Project Manager. If material availability allows, the QA/QC Consultant may collect a material sample for inclusion in the certification report.

7. Materials in Contact with the Geomembranes

The quality assurance procedures indicated in this Subsection are only intended to verify that the installation of these materials does not damage the

geomembrane. Additional quality assurance procedures provided in subsequent sections of this QA/QC Plan are necessary to verify that the systems built with these materials are constructed to perform as designed.

a. Geonet/Geocomposite/Geotextile/Aggregate Drainage Layer

The QA/QC Consultant shall verify that the geonet, geocomposite, geotextile, or aggregate drainage layer is installed in accordance with the procedures described in the appropriate sections of this QA/QC Plan. Extreme care shall be exercised so as not to damage the geomembrane during placement of any materials overlying the geomembrane.

b. Appurtenances

The Design Engineer shall provide design specifications for appurtenances to the Project Manager and the QA/QC Consultant. The QA/QC Consultant shall verify that:

- Installation of the geomembrane in appurtenance areas, and connection of geomembrane to appurtenances have been made according to design specifications;
- Extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and
- The geomembrane has not been visibly damaged while making connections to appurtenances.

The QA/QC Consultant will inform the Project Manager if the above conditions are not fulfilled.

TABLE 2-1**FIELD SEAM STRENGTH REQUIREMENTS****HDPE Geomembrane**

PROPERTY	TEST METHOD	VALUE (see note 1)	UNITS
1. Bonded Seam Shear Strength (see note 1)	ASTM D4437	80	ppi
2. Peel Adhesion (Fusion)	ASTM D4437	60	ppi
3. Peel Adhesion (Extrusion)	ASTM D4437	52	ppi

LLDPE Geomembrane

PROPERTY	TEST METHOD	VALUE (see note 1)	UNITS
1. Bonded Seam Shear Strength (see note 1)	ASTM D4437	60	ppi
2. Peel Adhesion (Fusion)	ASTM D4437	50	ppi
3. Peel Adhesion (Extrusion)	ASTM D4437	44	ppi

Notes:

1. Sample must fail in Film Tear Bond (FTB); PI < 25% (as applicable). If manufacturer standards are more restrictive, they shall supersede the specified values noted herein

SECTION 3.0 GEOTEXTILES

1.0 General/Manufacturer's Documentation

- A. Prior to delivery, the Geotextile Manufacturer shall provide documentation which demonstrates that the property values of the material meet project requirements. Delivered rolls of geotextile shall be appropriately labeled.
- B. The word "Geotextile" as used in this section refers to non-woven geotextile.
- C. Certification of Property Values
The Geotextile Manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geotextile to be supplied. The Geotextile Manufacturer shall also provide the Project Manager with a written certification signed by a responsible party that the geotextile actually delivered have properties which meet or exceed the guaranteed "minimum average roll values" properties.

The QA/QC Consultant shall examine the Manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Manufacturer's guaranteed minimum values and the design specifications. Deviations shall be reported to the Project Manager.

2.0 Materials

- A. Labeling
The Geotextile Manufacturer shall identify all rolls of geotextile. Each geotextile roll shall have a weatherproof label which contains the following:
 - Manufacturer's name;
 - Product identification;
 - Lot number;
 - Roll number;
 - Roll weight; and
 - Roll dimensions.

In addition, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile. Rolls without proper identification shall be rejected by the Project Manager. The QA/QC Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

3.0 Execution

A. Shipment and Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation, snow or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be wrapped in plastic sheets or otherwise protected. Wrappings protecting the geotextile rolls should be removed less than one hour prior to unrolling the geotextile. Geotextiles shall not be exposed to precipitation prior to being installed. Wet geotextiles are heavy which makes them difficult to deploy and can also effect liner welding when the geomembrane is adjacent to the geotextile. During cold weather, geotextiles must be protected from freezing.

The QA/QC Consultant shall observe rolls upon delivery and prior to installation, any deviation from the above requirements shall be reported to the Project Manager. Any damaged rolls shall be rejected and replaced at no cost to the Owner.

The Owner will only accept rolls delivered by flatbed trailer.

A. Installation and Handling

The Installer shall handle geotextiles in such a manner as to minimize damage and shall comply with the following:

1. After the wrapping has been removed, a geotextile shall not be exposed to sunlight for more than the time specified by the Geotextile Manufacturer.
2. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile panel in tension.
3. In the presence of wind, geotextiles shall be weighted with sandbags or the equivalent. Sandbags shall be installed during the placement and shall remain until replaced with the appropriate overlying material.
4. Sandbags shall be filled with the fine grained material and must be handled with care to prevent rupture.
5. Geotextiles shall be kept continually under tension to minimize the presence of wrinkles in the geotextile.
6. Geotextiles shall be cut using an approved geotextile cutter only (i.e., an upward cutting hook blade). If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
7. The Installer shall take necessary precautions to prevent damage to the underlying layers during placement of the geotextile.

8. During placement of geotextiles, care shall be taken not to entrap stones, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
9. After installation, the entire surface of the geotextile shall be examined, and harmful foreign objects, such as needles, shall be removed.

The QA/QC Consultant shall note any deviation and report it to the Project Manager.

C. Seams and Overlaps

Geotextiles shall be continuously sewn using thread, which is as chemically resistant and UV resistant as the geotextile. Thread shall be approved by the QA/QC Consultant and Owner. Spot sewing is not permitted, except for repairs, and thermal bonding shall not be permitted without the approval of the Project Manager. Geotextiles shall be overlapped a minimum of 6 inches (150 mm) prior to seaming. Horizontal seams on side slopes should be avoided. However, if horizontal seams are necessary, at least 100 feet shall be maintained between horizontal seams of adjacent panels. The Installer shall pay particular attention that no material is inadvertently inserted beneath the geotextile.

The QA/QC Consultant shall note any deviation and report it to the Project Manager.

D. Repair

Any holes or tears in the geotextile shall be repaired by the Installer as follows:

1. Holes in the geotextile shall be patched with geotextile of the same unit weight;
2. Sufficient overlap shall be provided to ensure a suitable seam can be produced, that will not come apart and, when used as a filter, will contain soil; and
3. Patches shall be sewn and not heat bonded unless otherwise approved by the QA/QC Consultant.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The QA/QC Consultant shall observe any repair, note any deviation with the above requirements and report them to the Project Manager.

E Placement of Materials on Geotextiles

The Installer shall place materials on the geotextile in the following manner:

1. Cause no damage to the geotextile and underlying geosynthetics;

2. Allow minimal slippage of the geotextile on underlying layers;
3. Equipment used for placing the overlying material shall not be driven directly on the geotextile;
4. A minimum thickness of 1 foot (30 cm) of soil must be maintained between a light, low ground pressure equipment and the geotextile;
5. A minimum thickness of 2 feet (61 cm) of soil must be maintained between rubber-tired vehicles and the geotextile unless approved by the Design Engineer and Owner; and,
6. In heavily trafficked areas such as access ramps, soil thickness shall be at least 3 feet (1 m).

Any deviation shall be noted by the QA/QC Consultant and reported to the Project Manager.

TABLE 3-1
NON-WOVEN GEOTEXTILE
MINIMUM AVERAGE ROLL VALUES

TESTED PROPERTY	MINIMUM SAMPLE FREQUENCY	ACCEPTANCE CRITERIA (minimum average roll values)
1. Mass/Unit Area	ASTM D5261	7.5 oz/sy
2. Grab Tensile Properties Tensile Strength Grab Elongation	ASTM D4632	220 lbs. 50%
3. Trapezoidal Tear Resistance	ASTM D4533	90 lbs
4. Apparent Opening Size	ASTM D4751	80 US Sieve
5. Puncture Resistance	ASTM D4833	120 lbs min
6. Mullen Burst Strength	ASTM D3786	320 lbs

SECTION 4.0 GEOCOMPOSITES

1.0 General

A. Description

The work covered in this section shall consist of furnishing the labor, materials, tools, equipment, and incidentals necessary to perform all work required to install geocomposite layer in the storage and containment system.

B. Definitions

1. Geosynthetic Quality Assurance Laboratory - the individual or firm responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetic Quality Assurance Laboratory must be independent from the Owner, Manufacturer, Resin Supplier, and Installer, and cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The Geosynthetic Quality Assurance Laboratory shall be selected by the Owner and approved by the QA/QC Consultant.
2. Installer - the individual or firm responsible for the unloading, field handling, inspection, sampling, storage, protection, placement, seaming, repair, and all other site aspects of the geonet and geocomposite installation.
3. Manufacturer - the individual or firm responsible for production of geonet, geotextile and/or geocomposite.
4. Resin Supplier - the individuals or firms who produce and deliver HDPE resin to the Manufacturer.

C. Manufacturing Quality Control

Testing shall be carried out by the Manufacturers and Resin Supplier to demonstrate that the raw material, geonet and geocomposite meet the product specification. The Manufacturers shall provide the following information:

1. Copies of the QC certificates issued by the Resin Supplier, including the origin, identification and production dates of the resin.
2. Copies of the QC certificates issued by the geotextile Manufacturer.
3. A list of guaranteed minimum average roll values for the geotextile used in the production of the geocomposite.
4. Copies of the QC certificates issued by the geonet and geocomposite Manufacturer.
5. A list of the guaranteed minimum physical properties for the geonet and geocomposite to be supplied.

D. Packing and Identification Requirements

Geocomposites shall be provided in rolls with relatively opaque and watertight wrappings. Each roll of geonet and geocomposite shall bear a label, which identifies the following:

1. Manufacturer's name
2. Product identification
3. Lot and/or roll number
4. Roll dimensions

2.0 Materials

A geosynthetic drainage net/geocomposite drainage layer used in lieu of a granular drainage layer shall meet the following requirements

A. Geocomposites shall consist of HDPE geonet with polyester nonwoven geotextiles heat bonded on both sides. The geonet and geotextile portions of the geocomposite shall meet the requirements set forth within all appropriate sections of this QA/QC Plan.

C. Conformance Testing (Discretionary)

At the discretion of the CQA Consultant, the Installer or Manufacturer may be directed to remove samples from the geocomposite rolls for conformance testing to supplement the quality control testing noted above. Testing by the Geosynthetic Quality Assurance Laboratory will be performed to insure conformance with both the design specifications and the list of guaranteed properties prior to installation.

3.0 Execution

A. Transportation, Handling and Inspection

Geocomposites shall be shipped in such a manner that they are protected from any damaging or deleterious conditions. All personnel shall handle the geocomposites in accordance with the Manufacturer's instructions and shall take all precautions necessary to prevent damaging the material at all times.

Shipments will only be accepted by the Owner if delivered by flatbed trailer.

Upon delivery of the material to the site, the Installer in the presence of the QA/QC Consultant shall conduct a visual inspection of the surface of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. All flaws in the materials shall be immediately brought to the attention of the Manufacturer, Owner and the trucking firm (the latter will only be notified if the damage is believed to have occurred during transportation). Rolls that have severe flaws shall be rejected. Rolls that, in the opinion of the QA/QC Consultant, have minor repairable flaws shall be repaired in

accordance with Sections 3.E.3 and 3.F.3. All flawed materials shall be stored in a separate location to insure that they are not inadvertently installed.

Any material damaged during shipment to the site shall be replaced by the Manufacturer at no cost to the Owner. Any material damaged by Installer's failure to properly handle, store and/or protect the material shall be replaced by the Installer at no cost to the Owner.

B. Storage

The Owner will provide a storage location for the material as close as possible to the area of deployment. Geonets shall be stored in their original, unopened, wrapped covers in a clean, dry area. Geonet materials will be unwrapped no more than one hour prior to installation and will not be exposed to ultraviolet light for more than 30 days.

Geocomposites shall also be stored in their original, unopened, wrapped covers such that they are protected from precipitation and ultraviolet light exposure and are free of dirt, dust or cuttings when they are installed. Geocomposite drainage materials shall be adequately pliable to allow for proper deployment.

D. Pre-Installation Inspection

Immediately prior to installation, the QA/QC Consultant shall verify that the geocomposites are free of dirt and dust. If the materials are judged to be dirty or dusty, they shall be cleaned by the Installer prior to installation.

E. Installation of Geocomposites

1. The Installer shall comply with the following:

- a. On slopes, the geocomposites shall be secured at the top of the slope as shown on the Drawings. The geocomposites shall then be rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension to minimize folds and wrinkles.
- b. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with other material.
- c. The Installer shall take all necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- d. During placement and joining of geocomposites, care shall be taken not to entrap stones, mud or dirt that could cause clogging of the drainage system and/or damage any adjacent geosynthetic materials.
- e. Geocomposites shall be cut with an approved cutter, i.e., hook blade. Care shall be taken to prevent damage to underlying materials.

2. Joining of Adjacent Geocomposites

As a minimum, the following requirements shall be met for joining of adjacent geocomposites.

- a. Adjacent rolls shall be overlapped such that the geotextile overlap is at least 4 inches and the geonet overlap is at least 4 inches.
- b. The geonet portion of adjacent geocomposite rolls shall be secured by tying as follows:
 - 1) Tying shall be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
 - 2) Unless otherwise authorized by the QA/QC Consultant, tying shall be every 5 feet along the slope and every 12 inches across the slope, at the top of slope and into the anchor trench (where applicable).
- c. The geotextile portion of the adjacent geocomposite rolls shall be seamed as follows:
 - 1) The bottom layers of geotextile shall be overlapped.
 - 2) On slopes steeper than 10 horizontal to 1 vertical, the top layers of geotextile shall be continuously sewn. The thread shall be a polymeric material with chemical resistance similar to the geotextile.
 - 3) On slopes shallower than 10 horizontal to 1 vertical, the top layers of geotextile can either be sewn as described above or thermally bonded.

Note: No horizontal seams shall be permitted on slopes steeper than 3 horizontal to 1 vertical.

3. Repairs

The damaged portion of the geocomposite will be inspected by the QA/QC Consultant. If the damaged area exceeds 3 feet by 3 feet, the roll will be cut, the damaged area removed, and a butt joint formed (where permitted) or the entire roll will be replaced. Unless otherwise approved by the QA/QC Consultant, the geocomposite will be repaired as follows if the damaged area is smaller than 3 feet by 3 feet:

- a. If the geonet is undamaged, a geotextile patch extending 12 inches beyond the edges of the damaged area shall be thermally bonded in place.
- b. If the geonet is damaged, the damaged geonet shall be removed. A section of geonet shall be cut to replace the removed geonet. The geonet patch shall be tied to the existing geonet using plastic fasteners secured at 6-inch intervals, with a staggered double row formation (i.e., the first row of fasteners shall be spaced at 12-inch intervals; the second set of fasteners shall be offset a maximum of 12 inches deep and spaced at 12-inch intervals, staggered in relation to the first row). A geotextile patch extending 12 inches beyond the edges of the damaged area shall be thermally bonded in place.

G. Placement of Cover Materials

The composite liner system must be protected from the intrusion of objects during construction and operation. The Earthwork Contractor shall place all cover materials in such a manner to ensure:

1. the geocomposite, underlying liner materials, and overlying geotextiles are not damaged.
2. there is minimal slippage of the geocomposite on underlying layers.
3. no excess tensile stresses develop in the geocomposite.

TABLE 4-1
GEOCOMPOSITE DRAINAGE MEDIA
MINIMUM AVERAGE ROLL VALUES

PROPERTY	TEST METHOD	VALUE	UNIT
GEOCOMPOSITE			
1. Ply Adhesion	ASTM D7005 or GRI GC7	1.0	lb/in
2. Transmissivity	ASTM D4716 (see note 1)	1.0E-04	m ² /sec
GEONET			
1. Density	ASTM D1505	0.94	g/cm ³
2. Thickness	ASTM D5199	200	mils
3. Carbon Black Content	ASTM D1603	2.0%	mils
4. Tensile Strength (MD)	ASTM D5035	45	lbs/in
GEOTEXTILE			
1. Nominal Weight	ASTM D5261	6.0	oz/sy
2. Grab Strength	ASTM 4632	170	lbs
3. Puncture Resistance	ASTM 4833	90	lbs
4. Flow Rate	ASTM D4491	110	gpm/sf
5. AOS	ASTM D4751	70	US Sieve

Notes:

1. Transmissivity test conditions: gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes.

MEMORANDUM OF LEASE

Made as of the 14th day of December, 2011, by and between GEARMAR PROPERTIES, INC., an Ohio corporation, as landlord ("Landlord") and AMERICAN WATER MANAGEMENT SERVICES, LLC, an Ohio limited liability company, as tenant ("Tenant").

WITNESSETH:

WHEREAS, as of the date hereof, Landlord and Tenant entered into a certain Lease Agreement (the "Lease"); and

WHEREAS, Landlord and Tenant desire to enter into this Memorandum of Lease to set forth certain terms and conditions of the Lease.

NOW THEREFORE, intending to be legally bound hereby, Landlord and Tenant set forth the following information with respect to the Lease:

1. Landlord: The name of the Landlord is GEARMAR PROPERTIES, INC.
2. Tenant: The name of the Tenant is AMERICAN WATER MANAGEMENT SERVICES, LLC.
3. Addresses: The addresses set forth in the Lease as addressed of the parties are:

LANDLORD: Gearmar Properties, Inc. _____
PO 209
Portersville, PA 16051

TENANT: One American Way
Warren Ohio , 44484

4. Date: The Lease is dated as of the December 14, 2011 (the "Effective Date").
5. Term Commencement: The term of the Lease commences on the Effective Date, and continues thereafter until the injection well(s) on the Leased Premises is legally closed.
6. Premises: Tenant has the exclusive right to operate one or more Class II salt water disposal wells on the property of Landlord described on Exhibit "A". Tenant shall have exclusive surface rights over only that portion of the Property as is described or depicted on Exhibit B as the Operations Areas, attached hereto and incorporated by reference herein plus the exclusive area for Rail Lines, Rail Access and Pipelines all as provided in the Lease (the "Leased Premises"), together with the non-exclusive easements and licenses granted to Lessee in the Lease including but not limited to Rail Lines, Siding and Switches, all road ways and other areas for ingress and egress and parking. The Leased Premises shall comprise approximately 5.2 acres for both Wells plus the exclusive area of the Rail Lines,

Rail Access and Pipelines.

WITNESS the due execution hereof.

WITNESSES:

William S. Duda
Dean Gendart

LANDLORD:

GEARMAR PROPERTIES, INC.

By: William E. Marsteller
Print Name: WILLIAM E MARSTELLER
Title: PRESIDENT

TENANT:

AMERICAN WATER MANAGEMENT
SERVICES, LLC.

Mark B. Colton

By: Kenneth J. McMahon
Print Name: Kenneth J. McMahon
Title: PRESIDENT

This instrument prepared by:
Jay M. Skolnick, Esq.
Nadler, Nadler & Burdman Co., LPA
20 Federal Plaza West, Suite 600
Youngstown, Ohio 44503

STATE OF OHIO)
) SS:
COUNTY OF Trumbull)

BEFORE ME, a Notary Public, in and for said County and State, personally appeared the above named ~~William E. Marshall~~ known to me to be the President, of GEARMAR PROPERTIES, INC. which executed the foregoing instrument, who acknowledged that he did sign said instrument for and on behalf of said corporation, being thereunto duly authorized by said corporation; that the same is his free act and deed and the free act and deed of said corporation.

IN TESTIMONY WHEREOF, I have hereunto set my hand and official seal at American Water Mng., this 14th day of December, 2011.

My Commission expires:

Nov. 20, 2013



JUDITH M. STYKA, NOTARY PUBLIC

State of Ohio

My Commission Expires November 20, 2013

Judith M. Styka
Notary Public

STATE OF OHIO)
) SS:
COUNTY OF Trumbull)

BEFORE ME, a Notary Public, in and for said County and State, personally appeared the above named ~~Kenneth J. Miller~~ known to me to be the President of AMERICAN WATGER MANAGEMENT SERVICES, LLC, the company which executed the foregoing instrument, who acknowledged that he did sign said instrument for and on behalf of said company, being thereunto duly authorized by said company; that the same is his free act and deed and the free act and deed of said company.

IN TESTIMONY WHEREOF, I have hereunto set my hand and official seal at American Water Mng., this 19th day of December, 2011.

My Commission expires:

Nov. 20, 2013



JUDITH M. STYKA, NOTARY PUBLIC

State of Ohio

My Commission Expires November 20, 2013

Judith M. Styka
Notary Public

Exhibit "A"

Parcel One:

Situated in the Township of Weathersfield, County of Trumbull and State of Ohio, and being known as Permanent Parcel No. 24-310900 by the Auditor of the County of Trumbull, State of Ohio, the same consisting of 22.8935 acres.

Parcel Two:

Situated in the Township of Weathersfield, County of Trumbull and State of Ohio, and being known as Permanent Parcel No. 24-311300 by the Auditor of the County of Trumbull, State of Ohio, the same consisting of 101.7372 acres.



American Water Management Services, LLC

One American Way • Warren, OH 44484-5555 • Phone: (330) 856-8800 • Fax: (330) 856-8480

December 23, 2011

Mr. Tom Tomastik, Geologist
Division of Mineral Resources Management
Ohio Department of Natural Resources
Fountain Square, 2045 Morse Road
Columbus, Ohio 43229-6693

RECEIVED

DEC 27 2011

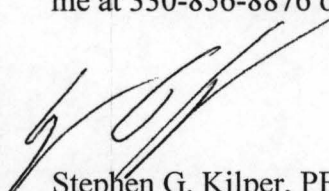
**Re: Submittal of Salt Water Injection Well Permit Application
AWMS No. 2 - Niles Injection Site
American Water Management Services, LLC - Owner Number 8905**

Dear Tom:

Enclosed please find the subject application for Salt Water Injection Well AWMS No. 2 proposed to be located in Section No. 9, Weathersfield Township, Trumbull County, Ohio, by American Water Management Services, LLC (AWMS). Concurrent with the submittal of this application, AWMS is submitting an application for a second salt water injection well, AWMS No. 1, at the same site. The two proposed injection wells will share above ground unloading, storage, treatment, and other necessary facilities.

The application includes the required forms, exhibits, figures, maps, affidavits, and other information that we believe is required, along with the application fee of \$1000.

Thank you for your time and assistance during our preparation of this application. Please contact me at 330-856-8876 or skilper@avalonholdings.com with any questions.


Stephen G. Kilper, PE
Vice President

SGK:akm\2247

cc: Ken McMahon, AWMS (w/encl)
Gearmar Industries (w/encl)
Dwight Williams, KU Resources

Application
Proposed Saltwater Injection Well AWMS No. 2
Niles Injection Site
Weathersfield Township, Trumbull County
American Water Management Services, LLC
December 23, 2011

Application Package Contents

- Application Fee (original only)
- Form 1 - Application for Permit
- Form 210 - Supplement to Application for Salt Water Injection
- Exhibits 1 and 2 to Form 210
- Well Construction Detail
- Saltwater Injection Well Affidavit
- Form 4 - Restoration Plan (duplicate)
- Figure 1 - Area of Review Map
- Figure 2 - Niles Injection Site Proposed Layout
- Figure 3 - Layout and Construction Details, Storage Impoundment
- Figure 4 – Layout and Construction Details, Unloading Pad and Storage Tank Containment
- Plat Map (original plus two copies)
- Geosynthetic Materials Quality Assurance/Quality Control Plan
- Memorandum of Lease

**QUALITY ASSURANCE/QUALITY CONTROL
(QA/QC) PLAN**

GEOSYNTHETIC MATERIALS

AMERICAN WATER MANAGEMENT SERVICES, LLC
NILES INJECTION SITE
TRUMBULL COUNTY, OHIO

December 2011

Prepared by:

North Point Engineering
6657 Frank Ave. NW, Suite 200
North Canton, OH 44720
(330) 494-8888



**QUALITY ASSURANCE/QUALITY CONTROL PLAN
GEOSYNTHETIC MATERIALS
AMERICAN WATER MANAGEMENT SERVICES, LLC
NILES INJECTION SITE**

TABLE OF CONTENTS

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1.0	Personnel and Qualifications
2.0	Geomembranes
3.0	Geotextiles
4.0	Geocomposite Drainage Layers

SECTION 1.0

PERSONNEL AND QUALIFICATIONS

1.0 Overview

This construction QA/QC plan is intended to provide information regarding the methods, tests, and pass/fail criteria for construction of the geosynthetic lining system in the storage and containment system at the AWMS Niles Injection Site.

2.0 Qualifications of QA/QC Personnel

Individuals serving in the capacity of QA/QC personnel during site construction will have a degree in engineering or a related field or will have prior experience acceptable to the Owner in the performance of the specific task to be overseen. Accordingly, these personnel will be knowledgeable in the manufacturer's recommended field installation QA/QC procedures for any geosynthetic product that is placed in the construction area. Where appropriate, the personnel will have the proper certification and training in the operation of field-measuring equipment.

3.0 Definitions and Use of Terms

The following provides general information regarding specific terms, references, and units as used in the QA/QC Plan.

A. Definitions Relating to QA/QC

In the context of this QA/QC Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

1. Construction Quality Assurance (CQA): A planned and systematic pattern of means and actions employed to provide confidence that items or services meet contractual and regulatory requirements and will perform as specified in service.
2. Construction Quality Control (CQC): Those actions that provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements.

B. Use of Terms

In the context of this QA/QC Plan, the terms CQA and CQC are used as follows:

CQA refers to measures taken by the Owner to determine if the Contractors are in compliance with the design plans and specifications. CQC refers to measures taken by the Contractor to determine compliance with the requirements for materials and workmanship as stated in the contract drawings and specifications.

C. References to Standards

The QA/QC Plan includes references to test procedures of the American Society for Testing and Materials (ASTM), the Federal Test Method Standards (FTMS), and the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF).

D. Units

Properties and dimensions given in the QA/QC Plan are expressed in U.S. units and may be followed by approximate equivalent values in SI units in parentheses. The values given in SI units are typically accurate within ten percent. In cases of conflict, the U.S. units govern.

4.0 Responsibility and Authority

The principal parties involved in the QA/QC of the geosynthetic lining system include the Owner, the Design Engineer, the QA/QC Consultant, the Geosynthetics CQA and CQC Testing Laboratory, the Earthwork Contractor, the Geosynthetics Manufacturer(s), and the Geosynthetics Installer(s). The general responsibilities and authorities of each of these parties are described in the following paragraphs. The responsibility and/or authority of a given party may be modified or expanded as dictated by specific project needs during Pre-Construction Meetings.

A. Owner

The Owner is responsible for coordinating the design and construction of the storage and containment system.

B. Project Manager

The Project Manager is the representative of the Owner and is responsible for coordinating schedules, meetings, and field activities. This responsibility includes communications to the Owner, QA/QC Consultant, Surveyor, Contractors, Manufacturers, and additional involved parties. The Project Manager has the authority to select and dismiss parties charged with construction activities. The Project Manager also has the authority to direct contractors hired by the Owner and to accept or reject their materials and workmanship.

C. Design Engineer

The Design Engineer is a firm or person, responsible for the preparation of the construction and contract documents necessary to construct the facility. The construction and contract documents are based on, and meet the minimum requirements of the permit documents which were approved by the appropriate regulatory agencies. Additional detail required for construction, accurate bidding, cost control, and contractual relationships and control are added by the Design Engineer.

D. QA/QC Consultant/Owner's Representative

The QA/QC Consultant/Owner's Representative is responsible for observing and documenting activities related to the permit documents and the QA/QC Plan. The QA/QC Consultant is represented by the on-site QA/QC monitoring personnel as appropriate. In general, the responsibilities and authorities of the QA/QC Consultant include:

- Complete understanding of the permit documents, design plans, and specifications in relation to all aspects of the QA/QC Plan.
- Scheduling, coordinating, and performing QA/QC activities;
- Performing independent on-site observation of the work in progress to assess compliance with the QA/QC Plan, permit documents, design plans, and technical specifications;
- Recognizing and reporting deviations from the QA/QC Plan, permit documents, design plans, and/or specifications to the Engineer and Project Manager.
- Secure documents which approve changes to the QA/QC Plan, permit documents, design plans, and/or specifications;
- Verifying that the QA/QC Consultant's test equipment meets testing and calibration requirements, and that tests are conducted according to standardized procedures defined in the QA/QC Plan;
- Recording and maintaining test data accurately;
- Identifying QA/QC-tested work that should be accepted, rejected, or further evaluated;
- Verifying that corrective measures are implemented;
- Documenting and reporting QA/QC activities;
- Collecting data needed for record documentation and
- Maintaining open lines of communications with other parties involved in the construction.

Certifications shall bear the seal of a Professional Engineer registered in the state of Ohio.

E. Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is responsible for performing the laboratory testing required by the QA/QC Plan to determine specific characteristics of the geosynthetics. The Geosynthetics CQA Laboratory is also responsible for providing adequate documentation of analytical results, test methods followed, and testing equipment used. Work of the Geosynthetics CQA Laboratory will be administered by the QA/QC Consultant. All results should be reported to the QA/QC Consultant.

F. Earthwork Contractor or "Contractor"

The Earthwork Contractor is responsible for moving earth to establish the proposed grades, preparation of the recompacted soil liner, and for the placement of the soil and granular materials composing the soils components of the storage and

containment system. The Earthwork Contractor may also be responsible for construction of sedimentation and erosion control facilities, anchor trenches for liner installation, and other support activities outside the storage and containment system. It is the responsibility of the Earthwork Contractor that the construction be performed using the procedures and equipment necessary to produce results in conformance with the contract documents.

The Earthwork Contractor may also be responsible for the placement of geotextile, geosynthetic reinforcement, and piping systems. In this capacity, the Earthwork Contractor is responsible for the quality of the materials and installation of the materials in conformance with the contract documents.

G. Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is responsible for the production of geosynthetics that meet the requirements of the contract documents. The Geosynthetics Manufacturer is also responsible for providing adequate documentation regarding the characteristics of the resin, the characteristics of the finished product, the testing performed to determine the characteristics, and the quality control measures taken during manufacturing.

The Geosynthetics Manufacturer(s) may be responsible for the safe transportation of the geosynthetics between the manufacturing plant and the site. The Geosynthetics Manufacturer is responsible for carefully loading and transporting geosynthetics and accepts full responsibility for damage to the geosynthetics that may occur during these operations.

H. Geosynthetics Installer

The Geosynthetics Installer(s) is responsible for unloading (as applicable), field handling, storing, placing, seaming, temporarily anchoring against wind, and other aspects of geosynthetics installation in accordance with the contract documents. The Geosynthetics Installer may also be responsible for the preparation and completion of anchor trenches.

Prior to mobilization on to the site, the Geosynthetics Installer is responsible for providing the installation schedule, a proposed panel layout drawing, standard details for geosynthetic seaming and pipe encasements, and a list of proposed field personnel and their qualifications. The Geosynthetics Installer is responsible for providing quality control documentation. Upon completion of the installation, the Geosynthetics Installer shall provide the geomembrane installation certification, the Manufacturer's warranty, and the installation warranty.

5.0 Project Meetings

To achieve a high degree of quality during installation, clear, open channels of communication are essential. The following meetings should be held when appropriate.

A. Pre-construction Meeting

Following the completion of the contract documents and selection of a QA/QC Consultant for the project, a Pre-construction Meeting shall be held. The meeting may be attended by the Project Manager, the QA/QC Consultant's Engineer, the QA/QC Consultant's Inspection personnel, the Geosynthetics Installer's Superintendent, the Earthwork Contractor's Superintendent, and other involved parties.

B. Daily Meetings

A daily meeting shall be held, as necessary, between the QA/QC Consultant, the Geosynthetic Installer, the Earthwork Contractor, the Project Manager, the Owner, and other involved parties. Those attending will discuss, plan, coordinate the work, and QA/QC activities to be completed that day.

C. Progress Meetings

Progress meetings shall be held as necessary. Attendees shall include the Project Manager, the QA/QC Consultant, the Geosynthetic Installer, the Earthwork Contractor, and other involved parties. Those attending will discuss current progress, planned activities for the next week, and new business or revisions to the work. The QA/QC Consultant will log problems, decisions, or questions arising at this meeting.

D. Problem or Work Deficiency Meeting

A special meeting shall be held when and if a problem or deficiency, which would impact the construction schedule, is present or likely to occur. At a minimum, the meeting shall be attended by the affected contractors, the Project Manager, and the QA/QC Consultant. The purpose of the meeting is to define and resolve the problem or work deficiency.

6.0 Qualifications of Key Personnel and Organizations

The following qualifications shall be required of the key personnel and organizations involved in the construction of the storage and containment system.

A. QA/QC Consultant

The QA/QC Consultant shall be pre-qualified and approved by the Owner. The QA/QC Consultant shall be a qualified engineering firm with experience in construction quality assurance and quality control, particularly on projects involving similar storage and containment systems. The QA/QC Consultant shall designate an Engineer who is a Professional Engineer registered in the state of the permitting site. The Engineer shall be solely responsible for the QA/QC personnel and their activities, as well as the preparation of a certification report to certify the project has

been constructed in accordance with the QA/QC Plan, permit documents, permit, design plans, and specifications. The QA/QC Consultant shall be capable of assigning technically qualified personnel to the project, including CQA Monitors, as needed. CQA monitors shall be specifically trained in quality assurance of geosynthetics, earthwork, concrete, etc.

B. Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory shall be pre-qualified by the Owner. The Geosynthetics CQA Laboratory shall be experienced in performing laboratory tests to determine geosynthetics characteristics as required by this QA/QC Plan. The Geosynthetics CQA Laboratory shall demonstrate that it follows the standard test methods listed in the QA/QC Plan and maintains the appropriate, calibrated equipment to perform the tests. The Geosynthetics CQA Laboratory shall also demonstrate to the QA/QC Consultant and Engineer that it adheres to a formal in-house quality control program and can provide the required analytical documentation and reports.

C. Earthwork Contractor

The Earthwork Contractor shall be pre-qualified and approved by the Owner. The Earthwork Contractor shall be capable of assigning the personnel and equipment required to perform the work within the schedule.

D. Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) shall be able to provide sufficient production capacity and experience to meet the demands of the project. In particular, the Geomembrane Manufacturer shall be pre-qualified and approved by the Owner. The qualifications required of the Geomembrane Manufacturer are presented in detail in specific section of the QA/QC Plan. The Manufacturers of the remaining forms of geosynthetics shall provide sufficient documentation of production capacity and experience to the satisfaction of the Owner.

E. Geosynthetics Installer

The Geosynthetics Installer(s) shall be trained and qualified to install geosynthetics. Prior to confirmation of contractual agreements, the Geomembrane Installer shall provide the Project Manager with the information demonstrating qualifications. The Installers of the remaining forms of geosynthetics shall provide sufficient documentation of installation capabilities and experience to the satisfaction of the Project Manager.

The Geomembrane Installer shall provide the Project Manager with a list of proposed seaming personnel and their professional qualifications. This certificate shall be reviewed by the Project Manager and the QA/QC Consultant. Proposed seaming personnel deemed insufficiently experienced shall not be accepted by the Project Manager or shall be required to pass a seaming test.

The Geomembrane Installer shall designate one representative as the Superintendent, who will represent the Installer on-site and at site meetings. The Superintendent shall be qualified by experience. The Superintendent shall be approved by the Project Manager.

In addition, the Geomembrane Installer shall designate a Master Seamer, who shall not be the Superintendent. The Master Seamer shall be present during all seaming operations and be experienced with extrusion welding, fusion welding, and welding in varying weather conditions.

SECTION 2.0 GEOMEMBRANES

Preface

The manufacture, shipment, and installation of polyethylene geomembrane shall be in accordance with this section of the QA/QC Plan and the design specifications.

General Manufacturer's installation specifications have been incorporated into the QA/QC Plan as appropriate. After a specific Geomembrane Manufacturer has been contracted, modifications may be made to this section of the QA/QC Plan to incorporate particular requirements of that Manufacturer. The modifications will be submitted for approval by the permitting agency prior to implementation.

The QA/QC Consultant shall document inventory, testing, and placement of geosynthetics.

The flexible membrane liner shall

- (a) Be, at a minimum, a 40-mil high density polyethylene (HDPE) or a 40-mil linear low density (LLDPE) geomembrane for the base liner system.
- (b) Be physically and chemically resistant to attack by waste, wastewater, or other materials that may come in contact with it using U.S. EPA Method 9090 or other documented data.
- (c) Be one of the following products:
 - a. GSE Lining Systems 40-mil dual sided textured and smooth HDPE or LLDPE geomembrane,
 - b. Agru America 40-mil dual sided textured and 40-mil smooth HDPE or LLDPE geomembrane.
 - c. PolyFlex, Inc 40-mil dual sided textured and 40-mil smooth HDPE or LLDPE geomembrane,
 - d. Alternate manufacturers that produce geomembrane products that meet or exceed the above noted manufacturers and the requirements of GRI GM 13 or GRI GM 17 (as applicable) will be considered.

1.0 Manufacture, Shipment, and Storage

The following addresses the activities associated with the manufacture of the geomembrane; the shipment, handling, and delivery of geomembrane to the site; conformance testing of delivered geomembrane; and the storage of the geomembrane prior to installation.

A. Manufacture of Polyethylene Geomembrane

The Geomembrane Manufacturer shall provide documentation that the material meets the requirements of the design specifications and that adequate quality control measures have been implemented during the manufacturing process.

1. Resin Quality

Prior to the shipment of polyethylene geomembrane material, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with the following information:

- The origin (Resin Supplier's name and resin production plant), identification (brand name, number), and production date of the resin;
- A copy of the quality control certificates issued by the Resin Supplier;
- Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls and extrudate rods and
- A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight).

At the Owner's discretion and cost, testing may be carried out on the resin by the Geosynthetics QA/QC Laboratory for purposes of verifying conformance. If the results of the Manufacturer and the Geosynthetics QA/QC Laboratory testing differ, the testing will be repeated by the Geosynthetics QA/QC Laboratory, and the Geomembrane Manufacturer will be permitted to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

2. Certification of Property Values

In addition to information regarding the raw material, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with the following prior to shipment of the geomembrane:

- A properties sheet certification including, at a minimum, guaranteed values for all properties specified in GRI GM 13.
- A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

3. Manufacturer Quality Control Certificates

Prior to shipment, the Geomembrane Manufacturer shall provide the Project Manager and the QA/QC Consultant with quality control certificates for the geomembrane provided. The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer. The quality control certificate will include:

- Roll numbers and identification;
- Date of production; and
- Results of quality control tests.

The Manufacturer shall be required to perform the testing at the frequencies specified in GRI GM 13 requirements.

The QA/QC Consultant shall:

- Verify that the quality control certificates have been provided at the specified frequency for all rolls; and
- Review the quality control certificates and verify that the test methods and values are acceptable.

B. Shipment and Handling

Shipment of the geomembrane to the site is the responsibility of the Owner, Geomembrane Manufacturer, or Installer depending on the contract documents. Handling on-site is the responsibility of the Installer. Shipments will be accepted by the Owner only if delivered by flatbed trailer.

The QA/QC Consultant shall observe that:

- Handling equipment used on-site poses minimal risk of damage to the geomembrane; and
- The Geomembrane Installer's personnel handle the geomembranes with care. Upon delivery at the site, the Installer and the QA/QC Consultant shall conduct a surface observation of the exposed outer surface rolls for defects, damage, and labeling. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected. All labels identifying rolls shall be weatherproof. The QA/QC Consultant will indicate to the Project Manager:
- Rolls, or portions thereof, that should be rejected and removed from the site because they have severe flaws;

- Rolls that have minor repairable flaws; and
- Rolls without proper identification.

Rolls without proper identification shall be rejected by the Project Manager.

- C. Conformance Testing of Geomembrane
Conformance testing is not specified for the Comp Dairy project.

- D. Storage
The Installer shall be responsible for the storage of the geomembrane on site. Storage space should protect the geomembrane from theft, vandalism, passage of vehicles, water, and weather. The QA/QC Consultant shall document that storage of the geomembrane provides adequate protection against dirt, vehicle impact, and other sources of damage.

2.0 Geomembrane Installation

The installation of the geomembrane involves three primary tasks; earthwork, placement of geomembrane field panels, and seaming the field panels.

- A. Earthwork
The earthwork supporting the geomembrane and anchoring it in place is crucial to the performance of the geomembrane. The Contractor shall inform the Construction Quality Assurance (CQA) Inspector when the surface on which the geomembrane will be installed is suitable for installation. Geomembrane placement may not commence until both the CQA Inspector and the Installer inspect the subgrade and agree that the area under consideration is acceptable.

It is the Installer's responsibility to protect the supporting soil after it has been accepted. After the supporting soil has been accepted by the Installer, it shall be the responsibility of the Installer and the QA/QC Consultant to indicate to the Project Manager any change in the supporting soil condition that may require repair work.

- B. Geomembrane Placement
The placement of field panels of geomembrane is the responsibility of the Installer and shall be performed in accordance with the approved layout and the following sections. The geomembrane shall be placed in direct and uniform contact with the underlying recompacted soil or barrier layer.

1. Panel Layout
If requested, prior to installation, the Geomembrane Installer shall provide to the Project Manager and the QA/QC Consultant, a drawing of the facility to be lined showing the proposed panel layout. The QA/QC Consultant shall review the panel layout drawing and verify it is consistent with the accepted state of practice and the QA/QC Plan. The panel layout drawing shall be approved by the QA/QC Consultant's Engineer (QA/QC Engineer).

Seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. Horizontal seams should be greater than 5 feet (1.5 m) from the toe of slopes, or areas of potential stress concentration, unless otherwise authorized.

2. Field Panel Identification

The QA/QC Consultant shall document that the Installer labels each field panel with an "identification code" (number and/or letter) consistent with the layout plan. This identification code shall be agreed upon by the Project Manager, Installer, and QA/QC Consultant. It is the responsibility of the Installer and the QA/QC Consultant to verify that each field panel placed can be tracked to the original roll number. The identification code will be marked at a location agreed upon by the Project Manager, Installer, and QA/QC Consultant at the Pre-Construction Meeting.

The QA/QC Consultant shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code will be used for all quality assurance records.

3. Location

The QA/QC Consultant shall verify that field panels are installed at the location indicated in the Installer's layout plan, as approved or modified.

4. Installation Schedule

Field panels shall be placed one at a time unless otherwise approved by the QA/QC Consultant, and the Project Manager. Each field panel shall be seamed after its placement in order to minimize the number of unseamed field panels exposed to weather.

It is usually beneficial to "shingle" overlaps in the downward direction to facilitate drainage in the event of precipitation. It is also beneficial to proceed in the direction of prevailing winds. Scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Installer shall be fully responsible for the decision made regarding placement procedures.

The QA/QC Consultant shall record the identification code, location, date of installation, time of installation, ambient temperature, sheet temperature, and thickness of each field panel.

The QA/QC Consultant shall evaluate field changes by the Installer which may have affected the original schedule proposed by the Installer and advise the Project Manager on the acceptability of that change.

5. Weather Conditions

Geomembrane placement shall not proceed when sheet temperature measured by placing a thermometer on the surface of the sheet is below 41°F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding. Deviations from the above temperature criteria shall only occur when authorized by the Project Manager and with the concurrence of the QA/QC Consultant. Geomembrane placement shall not be done during any precipitation, fog, snow, in an area of ponded water, or in the presence of excessive winds.

The QA/QC Consultant shall verify that the above conditions are fulfilled and shall inform the Project Manager if the conditions are not fulfilled.

6. Anchorage System

Anchor trenches shall be excavated by the Earthwork Contractor (unless otherwise specified) to the lines and widths shown on the plans prior to geomembrane placement. The QA/QC Consultant shall verify that anchor trenches have been constructed according to the plans.

Slightly rounded corners will be provided in trenches where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. Loose soil shall not underlie the geomembrane in the trenches. Seaming shall continue through the anchor trench.

7. Method of Placement

The following is the responsibility of the Geomembrane Installer; the QA/QC Consultant shall document that these conditions are satisfied:

- Equipment used does not damage the geomembrane by handling, traffic, excessive heat, leakage of liquids, or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;
- Geosynthetic material immediately underlying the geomembrane is clean and free of debris;
- Personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method and equipment used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags or rolls of geosynthetic materials, is recommended along the edges of panels to minimize the risk of wind flow under the panels); and
- Direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The QA/QC Consultant shall inform the Project Manager if the above conditions are not fulfilled.

8. Damage

The QA/QC Consultant shall visually observe each panel, after placement and prior to seaming, for damage. The QA/QC Consultant shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the QA/QC Consultant. Repairs shall be made according to procedures described in within this section. As a minimum, the QA/QC Consultant shall document that:

- The panel is placed in such a manner that it is unlikely to be further damaged;
- Any tears, punctures, holes, thin spots, etc. are either marked for repair or the panel is rejected.

The party responsible for damaging the geomembrane will be responsible for payment for all repairs or replacements.

C. Field Seaming

Field seaming shall be performed to allow no more than negligible amounts of leakage; the seaming material shall be physically and chemically resistant to chemical attack by the waste, wastewater, or other materials that may come in contact with the seams. Field seaming is the responsibility of the Installer and shall be performed in accordance with the following.

1. Requirements of Personnel

At the Pre-Construction Meeting, the Geomembrane Installer will provide the QA/QC Consultant with a list of proposed seaming personnel and their professional records. This document will be reviewed and approved by the Project Manager and QA/QC Consultant. Seaming personnel shall meet the requirements listed in Section 1.0 of this QA/QC Plan.

2. Seaming Equipment and Products

Approved processes for field seaming are extrusion seaming and fusion seaming. Proposed alternate processes shall be documented and submitted to the Owner for approval. Only seaming equipment which has been specifically approved by make and model shall be used. The Installer shall submit seaming equipment documentation to the Project Manager and the QA/QC Consultant for approval.

The following is the responsibility of the Installer; the QA/QC Consultant shall verify that these conditions are met:

- The Installer maintains on-site the number of spare operable seaming apparatus decided at the Pre-Construction Meeting;
- Equipment used for seaming is not likely to damage the geomembrane;
- The extruder is purged prior to beginning a seam until heat-degraded extrudate has been removed from the barrel;
- For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to seaming;
- The electric generator is placed on a flat smooth base and a rub sheet such that no damage occurs to the geomembrane; and
- A smooth insulating plate, scrub sheet or fabric is placed beneath the hot seaming apparatus after usage.

a. Extrusion Process

The extrusion seaming apparatus shall be equipped with gauges giving the relevant temperatures of the extrudate, nozzle, and preheat. The Installer shall provide documentation regarding the extrudate to the Project Manager and the QA/QC Consultant, and shall certify that the extrudate is compatible with the design specifications, and is comprised of resin which is compatible with geomembrane sheeting. The QA/QC Consultant shall log apparatus temperatures, ambient temperatures, extrudate temperatures, and sheet temperatures at appropriate intervals.

b. Fusion Process

The fusion-seaming apparatus must be automated vehicular mounted devices, equipped with gauges giving the applicable temperatures. Pressure settings shall be verified by the Installer prior to each seaming period. The QA/QC Consultant shall log ambient temperatures, sheet temperatures, seaming apparatus temperatures, speeds, and pressures.

3. Seam Preparation

The following is the responsibility of the Installer; the QA/QC Consultant shall verify that these conditions are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, oils, greases, debris of any kind, and foreign material. The material to be joined must be wiped with a clean cloth just prior to seaming;
- A rub sheet must be used to protect the liner while cutting any materials;
- If seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane;
- The abrading is not visible when welding is complete;
- Seams are aligned with the fewest possible number of wrinkles and "fishmouths"; and
- No metal objects that could potentially damage the liner are permitted for use on the lined area.

4. Weather Conditions for Seaming

The required weather conditions for seaming are as follows:

- The sheet temperatures shall be measured with the thermometer on the surface of the geomembrane sheet.
- Unless authorized in writing by the Project Manager, no seaming shall be attempted at a sheet temperature below 41° F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding.
- The geomembrane shall be dry and protected from wind.

If the Installer wishes to use methods which may allow seaming at sheet temperatures below 41°F (5°C) or above 104°F (40°C) for extrusion welding and 140°F (60°C) for fusion welding, the Installer shall provide adverse weather welding procedures which shall be reviewed and approved by the QA/QC Consultant, and certify in writing that the installation crew has been trained to perform adverse weather welding. The installer shall also demonstrate through trial welding that the overall quality of the geomembrane is not adversely affected.

5. Overlapping and Temporary Bonding

The following shall be the responsibility of the Installer and verified by the QA/QC Consultant:

- As a general guidance, the panels of geomembrane have a finished overlap of a minimum of 3 inches (75 mm) for extrusion seaming and 4 inches (100 mm) for fusion seaming, but in any event sufficient overlap will be provided to allow peel tests to be performed on the seam;
- No solvent or adhesive is used unless the product is approved in writing by the Owner (samples will be submitted to the Owner for testing and evaluation); and
- The procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any spot seaming apparatus is controlled such that the geomembrane is not damaged).

The QA/QC Consultant shall log all appropriate temperatures and conditions, and shall log and report to the Project Manager any deviation.

6. Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate and that seam strength meets geomembrane manufacturer requirements. Such trial seams shall be made at the beginning of each seaming period, when a seaming apparatus is started, when operators change, and when a seaming apparatus is re-started. A passing trial seam shall be made for each seaming device and technician. A change in technician or machine on a previously passed trial seam warrants the welding of a new passing trial seam. A trial seam shall also be made in the event that the sheet temperature varies more than 18°F (10°C) since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. If seaming apparatus is turned off for any reason, a new passing trial seam must be completed for that specific seaming apparatus.

The Installer shall provide the tensiometer required for peel testing of trial seams in the field. Shear testing may be performed at the discretion of the QA/QC engineer. The tensiometer shall be automatic and shall have a direct digital readout. The tensiometer shall be calibrated at the site prior to use. The Installer shall provide the Project Manager with the calibration certification.

The trial seam sample shall be at least 5 feet (1.5 m) long by 1 foot (.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap will be as indicated in Subsection 2.C.5.

Three specimens, each 1 inch (25 mm) wide shall be cut from the trial seam sample by the Installer and tested in peel using a field tensiometer. For each fusion specimen, both tracks shall be tested. A passing welded seam is achieved in peel when the specimen meets the criteria specified in Table 2-1 at the end of this specification section. If shear testing is performed, it shall meet the requirements noted in Table 2-1.

If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

The QA/QC Consultant shall observe trial seam procedures. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the QA/QC Consultant, who will also log the date, hour, machine settings, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The remainder of the successful trial seam sample shall be archived by the owner until the Permitting Agency has approved the final documentation.

7. General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the Installer shall be as follows:

- For fusion seaming, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to help prevent any moisture build-up between the sheets to be seamed.
- If required, a firm substrate will be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- Wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut wrinkles will be seamed and any portion where the overlap is inadequate will then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.
- Seaming will extend to the outside edge of panels to be placed in the anchor trench.
- No field seaming shall take place without the Master Seamer being present.

The QA/QC Consultant shall verify that the above seaming procedures are followed, and shall inform the Project Manager if they are not.

8. Non-Destructive Seam Continuity Testing

The Installer shall non-destructively test field seams over their full length using a vacuum test unit (for extrusion seams only), air pressure test, or other approved method. The testing shall be carried out to the accepted standards of the industry. The purpose of non-destructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out on 100 percent of the seams as the seaming work progresses, not at the completion of all field seaming, unless otherwise approved by the Project Manager. The Installer shall complete any required repairs in accordance with Subsection 2.D.

a. Air Pressure Testing:

Unless otherwise specified, the general air pressure testing procedure used by the Installer shall be as follows:

- Seal both ends of the test channel with a heat gun or other acceptable clamping method.

- Insert a hollow needle with attached pressure gauge into the test channel.
 - Inflate the test channel to 30 to 35 psi, close valve, and observe initial pressure after approximate air temperature and pressure have stabilized. The initial pressure setting shall be between 30-35 psi.
 - Observe and record the test pressure 5 minutes after reading the initial test pressure. If pressure loss exceeds 3 psi, or if the pressure does not stabilize, locate the faulty area and repair.
 - At the conclusion of the pressure test, the end of the seam opposite the pressure gauge shall be cut to verify seam continuity. A decrease in a gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.
 - Remove needle or other approved pressure feed device and seal the resulting hole.
 - Test results will be recorded by the QA/QC Consultant.
- b. Non-Complying Air Pressure Test:
In the event of a non-complying air pressure test, the following procedure shall be followed:
- Check the seam end seals and retest the seams.
 - If the seam fails air pressure testing, the Installer may isolate the failing zone, air pressure test the seam outside the failing zone, then repair the failing zone by the methods listed below. Alternatively, the Installer may repair the entire seam by the methods listed below:
 - Cap-strip the suspect area;
 - When sufficient overlap exists (1 1/2 inch (38 mm)), heat tack the overlap and extrusion weld the entire seam; or
 - Further isolate the air pressure failure as agreed upon by the QA/QC Consultant and Project Manager.
 - Test the entire length of the repaired seam by vacuum testing.

- All sections shall be retested and repaired in accordance with Subsection 2D.

c. Vacuum Testing

Unless otherwise specified, the general vacuum testing procedure used by the Installer shall be as follows:

- Turn on the vacuum pump to reduce the vacuum box to approximately 5 psi (0.35 kg/cm³).
- Apply a generous amount of liquid soap and water solution to the area to be tested.
- Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.
- Close the bleed valve and open the vacuum valve.
- Ensure that a leak tight seal is created.
- For a period of not less than 5 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- If no bubbles appear after 5 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inch (75 mm) overlap, and repeat the process.

d. Non-Complying Vacuum Test

In the event of a non-complying vacuum test, the following procedure shall be followed:

- Mark all areas where soap bubbles appear and repair the marked areas.
- Retest repaired areas.

e. QA/QC Responsibilities

The QA/QC Consultant shall:

- Document all continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and,

- Inform the Installer and Project Manager of any required repairs.

When defects are located, the QA/QC Consultant shall:

- Observe the repair and retesting of the repair;
- Mark on the geomembrane that the repair has been made; and
- Document the results.

f. Non-Testable Areas

The Installer shall use the following procedures at locations where seams cannot be non-destructively tested:

- All such seams shall be cap-stripped with the same geomembrane material.
- If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the QA/QC Consultant and Installer for uniformity and completeness.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the QA/QC Consultant.

9. Destructive Testing

Destructive seam tests shall be performed at locations selected by the QA/QC Consultant. The purpose of these tests is to evaluate seam strength. Seam strength testing will be done as the seaming work progresses and not at the completion of all field seaming, unless otherwise approved by the Project Manager.

a. Location and Frequency

The QA/QC Consultant shall select locations where a destructive seam sample will be cut out for peel and shear strength testing. Those locations shall be established as follows:

- A frequency of one test location per 500 feet (150m) or less of seam length per seamer and seaming apparatus.
- Test locations will be determined during seaming at the QA/QC Consultant's discretion. Selection of such locations may be prompted by suspicion of contamination, offset seams, or any other potential cause of imperfect seaming.

The Installer will not be informed in advance of the locations where the seam samples will be taken.

b. Sampling Procedure

Samples shall be cut by the Installer as the seaming progresses in order to have passing test results before the geomembrane is covered by another material. The QA/QC Consultant shall:

- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly;
- Record the sample location on the layout drawing; and
- Record the reason for taking the sample at this location, if not taken due to statistical routine.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Subsection 2.D.2 of this Plan. The continuity of the new seams in the repaired area will be tested according to Subsection 2.C.8.

c. Size of Samples

At a given sampling location, samples shall be taken by the Installer. The sample shall be cut into three parts and distributed as follows:

- One portion to the QA/QC Consultant for archive storage, 12 inches x 12 inches (30 cm x 30 cm);
- One portion for peel and shear testing in the field, 12 inches x 18 inches (30 cm x 45 cm); and
- At the discretion of the QA/QC engineer and CQA Consultant, one portion for shipment to an independent testing laboratory, 12 inches x 12 inches (30 cm x 30 cm) assuming passing field testing results.

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

d. Field Testing

Ten (10) one-inch (25 mm) wide specimens shall be removed from the field sample and tested in the field with a tensiometer. Five (5) specimens shall be tested in peel and five (5) in shear; all specimens

shall meet the minimum strength requirements specified in Table 2-1 at the end of this specification section. A maximum of one non film tear bond (FTB) failure is acceptable, for each method, provided that strength requirements are met on that sample. If any field test specimen fails to pass, then the procedures outlined in Subsection 2.C.9.g will be followed.

The QA/QC Consultant shall witness field tests and mark all samples and portions with their number. The QA/QC Consultant shall also log the date and time, ambient temperature, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, and pass or fail description.

- e. Geosynthetics QA/QC Laboratory Testing (Discretionary)
At the discretion of the QA/QC engineer and CQA Consultant, the Destructive test samples shall be packaged and shipped, if necessary, by the QA/QC Consultant in a manner that will not damage the test sample. The Project Manager shall be responsible for storing the archive samples. Destructive seam sample testing shall be performed with a calibrated tensiometer.

Five (5) specimens will be tested in both peel and shear. A maximum of one non film tear bond (FTB) failure is acceptable, for each method, provided that strength requirements are met on that sample.

Written results of destructive testing of seam samples shall be made available to the QA/QC Consultant, Installer, and Project Manager within approximately 24 hours after samples are removed from the liner. The QA/QC Consultant shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager. If a sample fails, the procedures given in Subsection 2.C.9.g shall be followed.

- f. Installer's Laboratory Testing
If the Installer chooses to perform destructive testing on their portion of the seam samples, their test results shall be presented to the Project Manager and the QA/QC Consultant for review within approximately 24 hours after samples are removed from the liner.
- g. Destructive Test Failure
The following procedures shall apply whenever a seam sample fails destructive testing:
 - The Installer can reconstruct the seam between any two passed destructive seam test locations, or

- The Installer can trace the seaming path to an intermediate location (at least 10 ft (3 m) from the point of the failed test in each direction) and take a small sample for an additional field test at each location. If these samples pass destructive testing, then the seam is reconstructed between these locations (see Subsection 2.D.2 for repair procedures). If the additional testing fails, then the process shall be repeated to establish the zone to be reconstructed.

All acceptable seams must be bounded by two passing destructive tests. In cases exceeding 150 feet of reconstructed seam length, a sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined here must be repeated. The QA/QC Consultant shall document all actions taken in conjunction with destructive test failures.

D. Defects and Repairs

Seams and non-seam areas of the geomembrane shall be examined by the QA/QC Consultant for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The geomembrane surface shall be swept or washed by the Installer if the amount of dust or mud inhibits examination.

1. Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Subsection 2.C.8 as appropriate. Each location that fails the non-destructive testing shall be marked with an identification code by the QA/QC Consultant and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

2. Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive test, or non-destructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be approved by the Project Manager and QA/QC Consultant. The procedures available include:

• Patching

- Apply a new piece of geomembrane sheet over, and at least 6 inches (150 mm) beyond the limits of a defect. The patch shall be extrusion seamed to the underlying geomembrane. This method should be used to repair large holes, tears,

destructive test locations, undispersed raw materials, and contamination by foreign matter.

- Spot Seaming
 - Apply a "bead" of extrudate, maximum length of 6 inches (150 mm), over a defect. Spot seaming should be used only to repair dents, pinholes, pressure test air holes, or other minor, localized flaws.
- Capping
 - Apply a new strip of geomembrane over a faulty seam. The cap strip shall extend at least 6 inches (150 mm) beyond the limit of the seam and the edges will be extrusion seamed to the underlying geomembrane. This method should be used to repair lengths of extrusion or fusion seams.
- Welding Flap
 - Where an adequate flap exists, [(1-1/2 inches (38 mm))] extrusion weld the flap of a fusion seam. At the ends of this repair, the flap shall be cut to allow the extrusion weld to enclose the failed area.
- Replacement
 - The faulty seam is removed and replaced.

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired will be abraded no more than one hour prior to the repair;
- All surfaces must be clean and dry at the time of the repair;
- All seaming equipment used in repairing procedures must pass trial weld testing;
- The repair procedures, materials, and techniques will be approved in advance of the specific repair by the QA/QC Consultant and Installer; and
- Patches or caps will extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches will be rounded.

3. Verification of Repairs

Each repair shall be numbered and logged by the QA/QC Consultant and the Installer. Each repair shall be non-destructively tested using the methods described in Subsection 2.C.8 as appropriate. Repairs which pass the non-destructive test will be taken as an indication of an adequate repair. However, if the QA/QC Consultant suspects a repair to be questionable, although it passes non-destructive testing, a destructive test can be requested. Failed tests will require the repair to be redone and retested until a passing

test is achieved. The QA/QC Consultant shall observe non-destructive testing of repairs and shall record the date of the repair and test outcome.

4. Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the QA/QC Consultant shall observe the geomembrane wrinkles. The QA/QC Consultant will indicate to the Project Manager which wrinkles should be cut and resealed by the Installer. The seam thus produced will be tested like any other repair.

5. Backfilling of Anchor Trench

Anchor trenches will be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. Anchor trenches shall be backfilled and compacted as soon as possible. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The QA/QC Consultant shall observe the backfilling operation and advise the Project Manager of any problems.

6. Liner System Certification/Acceptance

The Installer and the Manufacturer shall retain ownership and responsibility for the geosynthetics in the facility until acceptance by the Owner. The liner system shall be accepted by the Owner when:

- The installation is finished;
- Verification of the adequacy of seams and repairs, including associated testing, is complete;
- Installer's representative furnishes the Project Manager with certification that the geomembrane was installed in accordance with the Manufacturer's recommendations as well as the design plans and specifications; and
- All documentation of installation is completed including the QA/QC Consultant's final report.

The QA/QC Consultant shall provide certification that installation was performed in accordance with this QA/QC Plan for the project except as noted to the Permit Engineer or Project Manager. If material availability allows, the QA/QC Consultant may collect a material sample for inclusion in the certification report.

7. Materials in Contact with the Geomembranes

The quality assurance procedures indicated in this Subsection are only intended to verify that the installation of these materials does not damage the

geomembrane. Additional quality assurance procedures provided in subsequent sections of this QA/QC Plan are necessary to verify that the systems built with these materials are constructed to perform as designed.

a. Geonet/Geocomposite/Geotextile/Aggregate Drainage Layer

The QA/QC Consultant shall verify that the geonet, geocomposite, geotextile, or aggregate drainage layer is installed in accordance with the procedures described in the appropriate sections of this QA/QC Plan. Extreme care shall be exercised so as not to damage the geomembrane during placement of any materials overlying the geomembrane.

b. Appurtenances

The Design Engineer shall provide design specifications for appurtenances to the Project Manager and the QA/QC Consultant. The QA/QC Consultant shall verify that:

- Installation of the geomembrane in appurtenance areas, and connection of geomembrane to appurtenances have been made according to design specifications;
- Extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and
- The geomembrane has not been visibly damaged while making connections to appurtenances.

The QA/QC Consultant will inform the Project Manager if the above conditions are not fulfilled.

TABLE 2-1**FIELD SEAM STRENGTH REQUIREMENTS****HDPE Geomembrane**

PROPERTY	TEST METHOD	VALUE (see note 1)	UNITS
1. Bonded Seam Shear Strength (see note 1)	ASTM D4437	80	ppi
2. Peel Adhesion (Fusion)	ASTM D4437	60	ppi
3. Peel Adhesion (Extrusion)	ASTM D4437	52	ppi

LLDPE Geomembrane

PROPERTY	TEST METHOD	VALUE (see note 1)	UNITS
1. Bonded Seam Shear Strength (see note 1)	ASTM D4437	60	ppi
2. Peel Adhesion (Fusion)	ASTM D4437	50	ppi
3. Peel Adhesion (Extrusion)	ASTM D4437	44	ppi

Notes:

1. Sample must fail in Film Tear Bond (FTB); PI < 25% (as applicable). If manufacturer standards are more restrictive, they shall supersede the specified values noted herein

SECTION 3.0 GEOTEXTILES

1.0 General/Manufacturer's Documentation

- A. Prior to delivery, the Geotextile Manufacturer shall provide documentation which demonstrates that the property values of the material meet project requirements. Delivered rolls of geotextile shall be appropriately labeled.
- B. The word "Geotextile" as used in this section refers to non-woven geotextile.
- C. Certification of Property Values
The Geotextile Manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geotextile to be supplied. The Geotextile Manufacturer shall also provide the Project Manager with a written certification signed by a responsible party that the geotextile actually delivered have properties which meet or exceed the guaranteed "minimum average roll values" properties.

The QA/QC Consultant shall examine the Manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Manufacturer's guaranteed minimum values and the design specifications. Deviations shall be reported to the Project Manager.

2.0 Materials

- A. Labeling
The Geotextile Manufacturer shall identify all rolls of geotextile. Each geotextile roll shall have a weatherproof label which contains the following:
 - Manufacturer's name;
 - Product identification;
 - Lot number;
 - Roll number;
 - Roll weight; and
 - Roll dimensions.

In addition, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile. Rolls without proper identification shall be rejected by the Project Manager. The QA/QC Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

3.0 Execution

A. Shipment and Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation, snow or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be wrapped in plastic sheets or otherwise protected. Wrappings protecting the geotextile rolls should be removed less than one hour prior to unrolling the geotextile. Geotextiles shall not be exposed to precipitation prior to being installed. Wet geotextiles are heavy which makes them difficult to deploy and can also effect liner welding when the geomembrane is adjacent to the geotextile. During cold weather, geotextiles must be protected from freezing.

The QA/QC Consultant shall observe rolls upon delivery and prior to installation, any deviation from the above requirements shall be reported to the Project Manager. Any damaged rolls shall be rejected and replaced at no cost to the Owner.

The Owner will only accept rolls delivered by flatbed trailer.

A. Installation and Handling

The Installer shall handle geotextiles in such a manner as to minimize damage and shall comply with the following:

1. After the wrapping has been removed, a geotextile shall not be exposed to sunlight for more than the time specified by the Geotextile Manufacturer.
2. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile panel in tension.
3. In the presence of wind, geotextiles shall be weighted with sandbags or the equivalent. Sandbags shall be installed during the placement and shall remain until replaced with the appropriate overlying material.
4. Sandbags shall be filled with the fine grained material and must be handled with care to prevent rupture.
5. Geotextiles shall be kept continually under tension to minimize the presence of wrinkles in the geotextile.
6. Geotextiles shall be cut using an approved geotextile cutter only (i.e., an upward cutting hook blade). If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
7. The Installer shall take necessary precautions to prevent damage to the underlying layers during placement of the geotextile.

8. During placement of geotextiles, care shall be taken not to entrap stones, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
9. After installation, the entire surface of the geotextile shall be examined, and harmful foreign objects, such as needles, shall be removed.

The QA/QC Consultant shall note any deviation and report it to the Project Manager.

C. Seams and Overlaps

Geotextiles shall be continuously sewn using thread, which is as chemically resistant and UV resistant as the geotextile. Thread shall be approved by the QA/QC Consultant and Owner. Spot sewing is not permitted, except for repairs, and thermal bonding shall not be permitted without the approval of the Project Manager. Geotextiles shall be overlapped a minimum of 6 inches (150 mm) prior to seaming. Horizontal seams on side slopes should be avoided. However, if horizontal seams are necessary, at least 100 feet shall be maintained between horizontal seams of adjacent panels. The Installer shall pay particular attention that no material is inadvertently inserted beneath the geotextile.

The QA/QC Consultant shall note any deviation and report it to the Project Manager.

D. Repair

Any holes or tears in the geotextile shall be repaired by the Installer as follows:

1. Holes in the geotextile shall be patched with geotextile of the same unit weight;
2. Sufficient overlap shall be provided to ensure a suitable seam can be produced, that will not come apart and, when used as a filter, will contain soil; and
3. Patches shall be sewn and not heat bonded unless otherwise approved by the QA/QC Consultant.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The QA/QC Consultant shall observe any repair, note any deviation with the above requirements and report them to the Project Manager.

E. Placement of Materials on Geotextiles

The Installer shall place materials on the geotextile in the following manner:

1. Cause no damage to the geotextile and underlying geosynthetics;

2. Allow minimal slippage of the geotextile on underlying layers;
3. Equipment used for placing the overlying material shall not be driven directly on the geotextile;
4. A minimum thickness of 1 foot (30 cm) of soil must be maintained between a light, low ground pressure equipment and the geotextile;
5. A minimum thickness of 2 feet (61 cm) of soil must be maintained between rubber-tired vehicles and the geotextile unless approved by the Design Engineer and Owner; and,
6. In heavily trafficked areas such as access ramps, soil thickness shall be at least 3 feet (1 m).

Any deviation shall be noted by the QA/QC Consultant and reported to the Project Manager.

TABLE 3-1
NON-WOVEN GEOTEXTILE
MINIMUM AVERAGE ROLL VALUES

TESTED PROPERTY	MINIMUM SAMPLE FREQUENCY	ACCEPTANCE CRITERIA (minimum average roll values)
1. Mass/Unit Area	ASTM D5261	7.5 oz/sy
2. Grab Tensile Properties Tensile Strength Grab Elongation	ASTM D4632	220 lbs. 50%
3. Trapezoidal Tear Resistance	ASTM D4533	90 lbs
4. Apparent Opening Size	ASTM D4751	80 US Sieve
5. Puncture Resistance	ASTM D4833	120 lbs min
6. Mullen Burst Strength	ASTM D3786	320 lbs

SECTION 4.0 GEOCOMPOSITES

1.0 General

A. Description

The work covered in this section shall consist of furnishing the labor, materials, tools, equipment, and incidentals necessary to perform all work required to install geocomposite layer in the storage and containment system.

B. Definitions

1. Geosynthetic Quality Assurance Laboratory - the individual or firm responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetic Quality Assurance Laboratory must be independent from the Owner, Manufacturer, Resin Supplier, and Installer, and cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The Geosynthetic Quality Assurance Laboratory shall be selected by the Owner and approved by the QA/QC Consultant.
2. Installer - the individual or firm responsible for the unloading, field handling, inspection, sampling, storage, protection, placement, seaming, repair, and all other site aspects of the geonet and geocomposite installation.
3. Manufacturer - the individual or firm responsible for production of geonet, geotextile and/or geocomposite.
4. Resin Supplier - the individuals or firms who produce and deliver HDPE resin to the Manufacturer.

C. Manufacturing Quality Control

Testing shall be carried out by the Manufacturers and Resin Supplier to demonstrate that the raw material, geonet and geocomposite meet the product specification. The Manufacturers shall provide the following information:

1. Copies of the QC certificates issued by the Resin Supplier, including the origin, identification and production dates of the resin.
2. Copies of the QC certificates issued by the geotextile Manufacturer.
3. A list of guaranteed minimum average roll values for the geotextile used in the production of the geocomposite.
4. Copies of the QC certificates issued by the geonet and geocomposite Manufacturer.
5. A list of the guaranteed minimum physical properties for the geonet and geocomposite to be supplied.

D. Packing and Identification Requirements

Geocomposites shall be provided in rolls with relatively opaque and watertight wrappings. Each roll of geonet and geocomposite shall bear a label, which identifies the following:

1. Manufacturer's name
2. Product identification
3. Lot and/or roll number
4. Roll dimensions

2.0 Materials

A geosynthetic drainage net/geocomposite drainage layer used in lieu of a granular drainage layer shall meet the following requirements

A. Geocomposites shall consist of HDPE geonet with polyester nonwoven geotextiles heat bonded on both sides. The geonet and geotextile portions of the geocomposite shall meet the requirements set forth within all appropriate sections of this QA/QC Plan.

C. Conformance Testing (Discretionary)

At the discretion of the CQA Consultant, the Installer or Manufacturer may be directed to remove samples from the geocomposite rolls for conformance testing to supplement the quality control testing noted above. Testing by the Geosynthetic Quality Assurance Laboratory will be performed to insure conformance with both the design specifications and the list of guaranteed properties prior to installation.

3.0 Execution

A. Transportation, Handling and Inspection

Geocomposites shall be shipped in such a manner that they are protected from any damaging or deleterious conditions. All personnel shall handle the geocomposites in accordance with the Manufacturer's instructions and shall take all precautions necessary to prevent damaging the material at all times.

Shipments will only be accepted by the Owner if delivered by flatbed trailer.

Upon delivery of the material to the site, the Installer in the presence of the QA/QC Consultant shall conduct a visual inspection of the surface of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. All flaws in the materials shall be immediately brought to the attention of the Manufacturer, Owner and the trucking firm (the latter will only be notified if the damage is believed to have occurred during transportation). Rolls that have severe flaws shall be rejected. Rolls that, in the opinion of the QA/QC Consultant, have minor repairable flaws shall be repaired in

accordance with Sections 3.E.3 and 3.F.3. All flawed materials shall be stored in a separate location to insure that they are not inadvertently installed.

Any material damaged during shipment to the site shall be replaced by the Manufacturer at no cost to the Owner. Any material damaged by Installer's failure to properly handle, store and/or protect the material shall be replaced by the Installer at no cost to the Owner.

B. Storage

The Owner will provide a storage location for the material as close as possible to the area of deployment. Geonets shall be stored in their original, unopened, wrapped covers in a clean, dry area. Geonet materials will be unwrapped no more than one hour prior to installation and will not be exposed to ultraviolet light for more than 30 days.

Geocomposites shall also be stored in their original, unopened, wrapped covers such that they are protected from precipitation and ultraviolet light exposure and are free of dirt, dust or cuttings when they are installed. Geocomposite drainage materials shall be adequately pliable to allow for proper deployment.

D. Pre-Installation Inspection

Immediately prior to installation, the QA/QC Consultant shall verify that the geocomposites are free of dirt and dust. If the materials are judged to be dirty or dusty, they shall be cleaned by the Installer prior to installation.

E. Installation of Geocomposites

1. The Installer shall comply with the following:

- a. On slopes, the geocomposites shall be secured at the top of the slope as shown on the Drawings. The geocomposites shall then be rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension to minimize folds and wrinkles.
- b. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with other material.
- c. The Installer shall take all necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- d. During placement and joining of geocomposites, care shall be taken not to entrap stones, mud or dirt that could cause clogging of the drainage system and/or damage any adjacent geosynthetic materials.
- e. Geocomposites shall be cut with an approved cutter, i.e., hook blade. Care shall be taken to prevent damage to underlying materials.

2. Joining of Adjacent Geocomposites

As a minimum, the following requirements shall be met for joining of adjacent geocomposites.

- a. Adjacent rolls shall be overlapped such that the geotextile overlap is at least 4 inches and the geonet overlap is at least 4 inches.
- b. The geonet portion of adjacent geocomposite rolls shall be secured by tying as follows:
 - 1) Tying shall be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
 - 2) Unless otherwise authorized by the QA/QC Consultant, tying shall be every 5 feet along the slope and every 12 inches across the slope, at the top of slope and into the anchor trench (where applicable).
- c. The geotextile portion of the adjacent geocomposite rolls shall be seamed as follows:
 - 1) The bottom layers of geotextile shall be overlapped.
 - 2) On slopes steeper than 10 horizontal to 1 vertical, the top layers of geotextile shall be continuously sewn. The thread shall be a polymeric material with chemical resistance similar to the geotextile.
 - 3) On slopes shallower than 10 horizontal to 1 vertical, the top layers of geotextile can either be sewn as described above or thermally bonded.

Note: No horizontal seams shall be permitted on slopes steeper than 3 horizontal to 1 vertical.

3. Repairs

The damaged portion of the geocomposite will be inspected by the QA/QC Consultant. If the damaged area exceeds 3 feet by 3 feet, the roll will be cut, the damaged area removed, and a butt joint formed (where permitted) or the entire roll will be replaced. Unless otherwise approved by the QA/QC Consultant, the geocomposite will be repaired as follows if the damaged area is smaller than 3 feet by 3 feet:

- a. If the geonet is undamaged, a geotextile patch extending 12 inches beyond the edges of the damaged area shall be thermally bonded in place.
- b. If the geonet is damaged, the damaged geonet shall be removed. A section of geonet shall be cut to replace the removed geonet. The geonet patch shall be tied to the existing geonet using plastic fasteners secured at 6-inch intervals, with a staggered double row formation (i.e., the first row of fasteners shall be spaced at 12-inch intervals; the second set of fasteners shall be offset a maximum of 12 inches deep and spaced at 12-inch intervals, staggered in relation to the first row). A geotextile patch extending 12 inches beyond the edges of the damaged area shall be thermally bonded in place.

G. Placement of Cover Materials

The composite liner system must be protected from the intrusion of objects during construction and operation. The Earthwork Contractor shall place all cover materials in such a manner to ensure:

1. the geocomposite, underlying liner materials, and overlying geotextiles are not damaged.
2. there is minimal slippage of the geocomposite on underlying layers.
3. no excess tensile stresses develop in the geocomposite.

TABLE 4-1
GEOCOMPOSITE DRAINAGE MEDIA
MINIMUM AVERAGE ROLL VALUES

PROPERTY	TEST METHOD	VALUE	UNIT
GEOCOMPOSITE			
1. Ply Adhesion	ASTM D7005 or GRI GC7	1.0	lb/in
2. Transmissivity	ASTM D4716 (see note 1)	1.0E-04	m ² /sec
GEONET			
1. Density	ASTM D1505	0.94	g/cm ³
2. Thickness	ASTM D5199	200	mils
3. Carbon Black Content	ASTM D1603	2.0%	mils
4. Tensile Strength (MD)	ASTM D5035	45	lbs/in
GEOTEXTILE			
1. Nominal Weight	ASTM D5261	6.0	oz/sy
2. Grab Strength	ASTM 4632	170	lbs
3. Puncture Resistance	ASTM 4833	90	lbs
4. Flow Rate	ASTM D4491	110	gpm/sf
5. AOS	ASTM D4751	70	US Sieve

Notes:

1. Transmissivity test conditions: gradient of 0.1, normal load of 10,000 psf, water at 70°F between steel plates for 15 minutes.

MEMORANDUM OF LEASE

Made as of the 14th day of December, 2011, by and between GEARMAR PROPERTIES, INC., an Ohio corporation, as landlord ("Landlord") and AMERICAN WATER MANAGEMENT SERVICES, LLC, an Ohio limited liability company, as tenant ("Tenant").

WITNESSETH:

WHEREAS, as of the date hereof, Landlord and Tenant entered into a certain Lease Agreement (the "Lease"); and

WHEREAS, Landlord and Tenant desire to enter into this Memorandum of Lease to set forth certain terms and conditions of the Lease.

NOW THEREFORE, intending to be legally bound hereby, Landlord and Tenant set forth the following information with respect to the Lease:

1. Landlord: The name of the Landlord is GEARMAR PROPERTIES, INC.
2. Tenant: The name of the Tenant is AMERICAN WATER MANAGEMENT SERVICES, LLC.
3. Addresses: The addresses set forth in the Lease as addressed of the parties are:

LANDLORD: Gearmar Properties, Inc. _____
PO 209
Portersville, PA 16051

TENANT: One American Way
Warren Ohio , 44484

4. Date: The Lease is dated as of the December 14, 2011 (the "Effective Date").
5. Term Commencement: The term of the Lease commences on the Effective Date, and continues thereafter until the injection well(s) on the Leased Premises is legally closed.
6. Premises: Tenant has the exclusive right to operate one or more Class II salt water disposal wells on the property of Landlord described on Exhibit "A". Tenant shall have exclusive surface rights over only that portion of the Property as is described or depicted on Exhibit B as the Operations Areas, attached hereto and incorporated by reference herein plus the exclusive area for Rail Lines, Rail Access and Pipelines all as provided in the Lease (the "Leased Premises"), together with the non-exclusive easements and licenses granted to Lessee in the Lease including but not limited to Rail Lines, Siding and Switches, all road ways and other areas for ingress and egress and parking. The Leased Premises shall comprise approximately 5.2 acres for both Wells plus the exclusive area of the Rail Lines,

Rail Access and Pipelines.

WITNESS the due execution hereof.

WITNESSES:

William S. Decker
Dean Gearhart

LANDLORD:

GEARMAR PROPERTIES, INC.

By: William E. Marsteller
Print Name: WILLIAM E. MARSTELLER
Title: PRESIDENT

TENANT:

AMERICAN WATER MANAGEMENT
SERVICES, LLC.

By: Kenneth J. McMahon
Print Name: Kenneth J. McMahon
Title: PRESIDENT

This instrument prepared by:
Jay M. Skolnick, Esq.
Nadler, Nadler & Burdman Co., LPA
20 Federal Plaza West, Suite 600
Youngstown, Ohio 44503

STATE OF OHIO)
) SS:
COUNTY OF Trumbull)

BEFORE ME, a Notary Public, in and for said County and State, personally appeared the above named William E. Marshall known to me to be the President, of GEARMAR PROPERTIES, INC. which executed the foregoing instrument, who acknowledged that he did sign said instrument for and on behalf of said corporation, being thereunto duly authorized by said corporation; that the same is his free act and deed and the free act and deed of said corporation.

IN TESTIMONY WHEREOF, I have hereunto set my hand and official seal at American Water Mng., this 19th day of December, 2011.

My Commission expires:

Nov. 20, 2013



JUDITH M. STYKA, NOTARY PUBLIC
State of Ohio
My Commission Expires November 20, 2013

Judith M. Styka
Notary Public

STATE OF OHIO)
) SS:
COUNTY OF Trumbull)

BEFORE ME, a Notary Public, in and for said County and State, personally appeared the above named Kenneth J. Miller known to me to be the President of AMERICAN WATGER MANAGEMENT SERVICES, LLC, the company which executed the foregoing instrument, who acknowledged that he did sign said instrument for and on behalf of said company, being thereunto duly authorized by said company; that the same is his free act and deed and the free act and deed of said company.

IN TESTIMONY WHEREOF, I have hereunto set my hand and official seal at American Water Mng., this 19th day of December, 2011.

My Commission expires:

Nov. 20, 2013



JUDITH M. STYKA, NOTARY PUBLIC
State of Ohio
My Commission Expires November 20, 2013

Judith M. Styka
Notary Public

Exhibit "A"

Parcel One:

Situated in the Township of Weathersfield, County of Trumbull and State of Ohio, and being known as Permanent Parcel No. 24-310900 by the Auditor of the County of Trumbull, State of Ohio, the same consisting of 22.8935 acres.

Parcel Two:

Situated in the Township of Weathersfield, County of Trumbull and State of Ohio, and being known as Permanent Parcel No. 24-311300 by the Auditor of the County of Trumbull, State of Ohio, the same consisting of 101.7372 acres.