



01630595

State of Colorado
Oil and Gas Conservation Commission

1120 Lincoln Street, Suite 801, Denver, Colorado 80203 (303)894-2100 Fax:(303)894-2109



FOR OGCC USE ONLY

EARTHEN PIT REPORT/PERMIT

This form is to be used for both reporting and permitting pits. Rule 903 describes when a Permit with prior approval, or a Report within 30 days, is required for pits. Submit required attachments and forms.

Complete the
Attachment Checklist

Oper OGCC

Detailed Site Plan	✓	
Topo Map w/ Pit Location	✓	
Water Analysis (Form 25)		
Source Wells (Form 26)		
Pit Design/Plan & Cross Sec	✓	
Design Calculations	✓	
Sensitive Area Determ.	✓	
Mud Program		
Form 2A		

FORM SUBMITTED FOR:

 Pit Report Pit Permit

OGCC Operator Number: 19160
Name of Operator: ConocoPhillips Company
Address: 743 Horizon Court, Suite 101
City: Grand Junction State: CO Zip: 81506

Contact Name and Telephone:
Justin B. Lovato
No: 970.263.3123
Fax: 970.263.3124

API Number (of associated well): 05-045-15495 OGCC Facility ID (of other associated facility): SGU CP01B-27 M23 49

Pit Location (QtrQtr, Sec, Twp, Rng, Meridian): SWSW, Section 23, TWP 4S, R95W, UTE 6 PM

Latitude: 39.68056 Longitude: -108.142845 County: Garfield

Pit Use: Production Drilling (Attach mud program) Special Purpose (Describe Use):Pit Type: Lined Unlined Surface Discharge Permit: Yes NoOffsite disposal of pit contents: Injection Commercial Pit/Facility Name: M23 Pit/Facility No: M23

Attach Form 26 to identify Source Wells and Form 25 to provide Produced Water Analysis results.

Existing Site Conditions

Is the location in a "Sensitive Area?" Yes No Attach data used for determination.

Distance (in feet) to nearest surface water: 216 feet ground water: > 20 feet water wells: > 2

LAND USE (or attach copy of Form 2A if previously submitted for associated well) Select one which best describes land use:

Crop Land: Irrigated Dry Land Improved Pasture Hay Meadow CRPNon-Crop Land: Rangeland Timber Recreational Other (describe):Subdivided: Industrial Commercial Residential

SOILS (or attach copy of Form 2A if previously submitted for associated well)

Soil map units from USNRCS survey: Sheet No: N/A (WSS) Soil Complex/Series No: 38 and 61

Soils Series Name: Irigul-Starman channery loams Horizon thickness (in inches): A: 0-6 ; B: 6-17 ; C: 17-21

Soils Series Name: Rhone loam Horizon thickness (in inches): A: 0-8 ; B: 8-28 ; C: 28-52

Attach detailed site plan and topo map with pit location.

Pit Design and Construction

Size of pit (feet): Length: 267 Width: 95 Depth: 17

Calculated pit volume (bbls): 33,543 Daily inflow rate (bbls/day): Variable

Daily disposal rates (attach calculations): Evaporation: minimal bbls/day Percolation: N/A bbls/day

Type of liner material: Reinforced Polyethylene Thickness: 36 mil top layer/ 24 mil bottom layer

Attach description of proposed design and construction (include sketches and calculations).

Method of treatment of produced water prior to discharge into pit (separator, heater treater, other): Separator

Is pit fenced? Yes No Is pit netted? Yes No

I hereby certify that the statements made in this form are, to the best of my knowledge, true, correct, and complete.

Print Name: Justin B. Lovato Signed:

Title: Regulatory Specialist Date: November 10, 2008

OGCC Approved: Title: EPS - NW Area Date: 11/13/09

CONDITIONS OF APPROVAL, IF ANY:

FACILITY NUMBER: 414395

JAK



Revision Date: 11/10/08

Other Structural and Non-structural

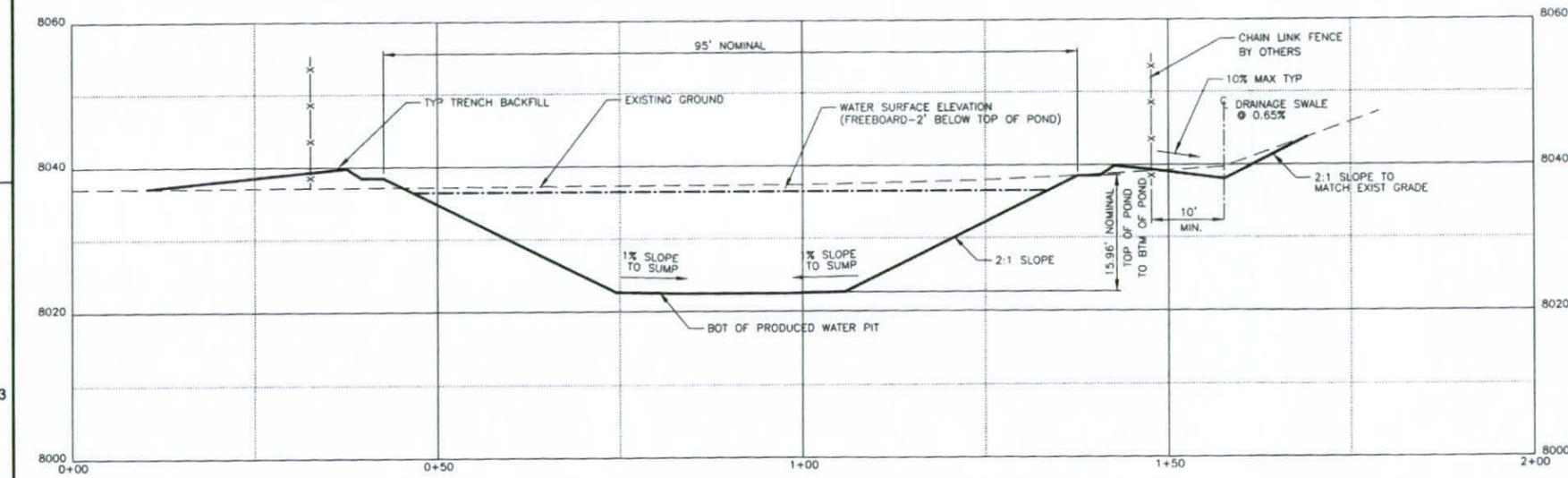
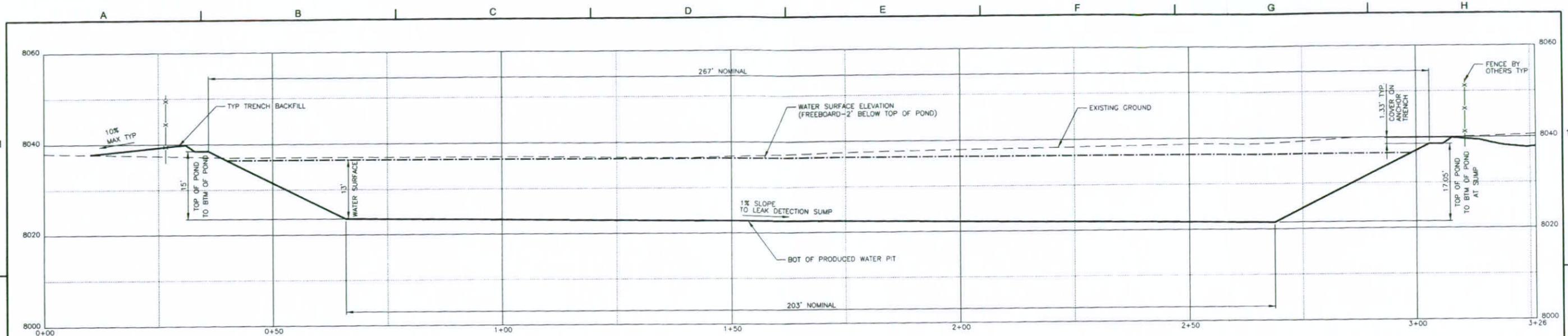
-  Guardshack
-  County Line
-  Lease Boundary
-  Streams
-  CP-M23-496

Comments:



0 120 240 480 720 960 feet





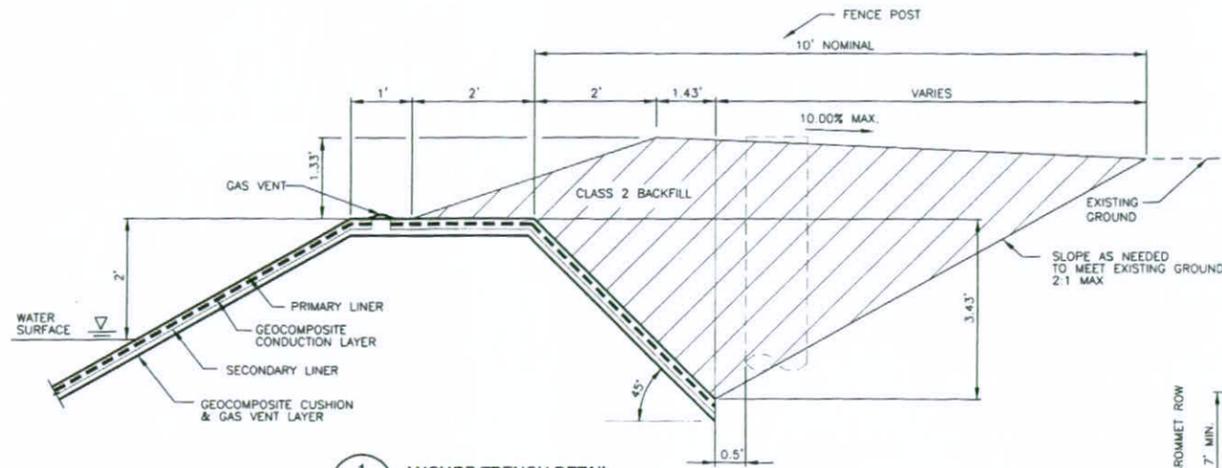
SECTION 'B-B'

- NOTES:
1. PRIOR TO ANY EXCAVATION WORK ON A PAD THAT HAS PIPELINES, THE PIPELINE SHALL BE PREPPED FOR CONSTRUCTION. PIPELINES SHALL BE LOCKED-OUT/TAGGED-OUT, PURGED, WATER TESTED AND OPEN TO ATMOSPHERE.
 2. ONE-CALL SHALL BE MADE IN ACCORDANCE WITH CO STATE LAW. AFTER ALL PIPES HAVE BEEN HORIZONTALLY LOCATED, DEPTH OF PIPES MUST BE DETERMINED WHEN PIPELINES ARE WITHIN TWO FEET OF EXCAVATION. THIS SHALL BE DONE BY DIGGING 6' DOWN ON EITHER SIDE OF THE PIPE AND SLOUGHING OFF THE MATERIAL BY HAND TO LOCATE THE PIPE. WHERE SPACE IS CONFINED, POT-HOLING SHALL BE USED TO LOCATE THE PIPE.
 3. FENCING, GATES AND BIRD NETTING TO BE DESIGNED AND LOCATED BY OTHERS. FENCING SHOWN ON PLAN IS FOR INFORMATION ONLY.
 4. WORK THIS DRAWING WITH GRADING PLAN M23-CE-103 AND SECTIONS & DETAILS M23-CE-303.

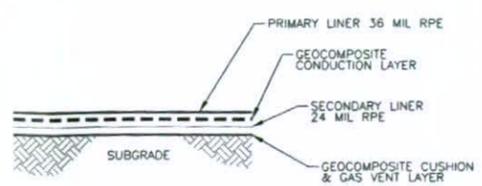


Know what's below.
Call before you dig.

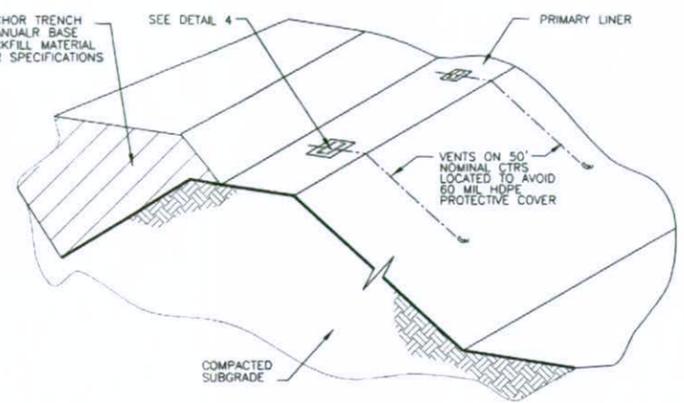
REFERENCE DRAWINGS		REVISIONS		REVISIONS		SCALE: 1"=10' DATE: 11/04/08 CLIENT: ConocoPhillips DESIGNED: M. LAMBERT DRAWN: E. CURTIS LOCATION: Parachute, CO CHECKED: [Signature] APPROVED: [Signature] SE Samuel Engineering, Inc. We Provide Solutions 8450 E. CRESCENT PARKWAY GREENWOOD VILLAGE, CO 80111 Phone: 303.714.4840 Fax: 303.714.4800		TITLE: M-23 PRODUCED WATER PIT DESIGN SECTIONS AND DETAILS, SHEET 1 OF 2 PROJECT NO.: 8053-07 DRAWING NUMBER: M23-CE-302	
NO.	DESCRIPTION	DATE	BY	NO.	DESCRIPTION	DATE	BY	REV	DESCRIPTION
0	ISSUED FOR PERMIT AND CONSTRUCTION	11/05/08	MCL	0					
A	ISSUED FOR CLIENT REVIEW	11/04/08	MCL						



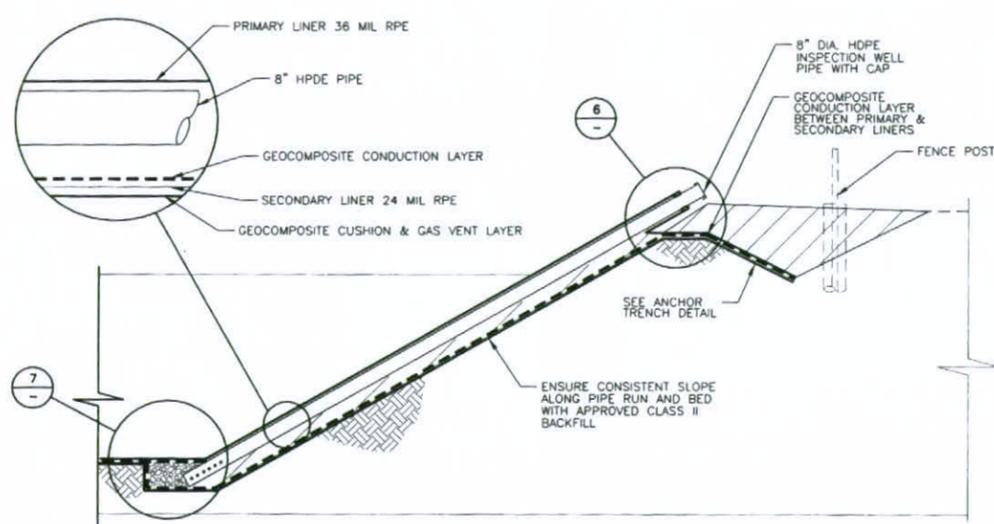
1 ANCHOR TRENCH DETAIL
- N.T.S.



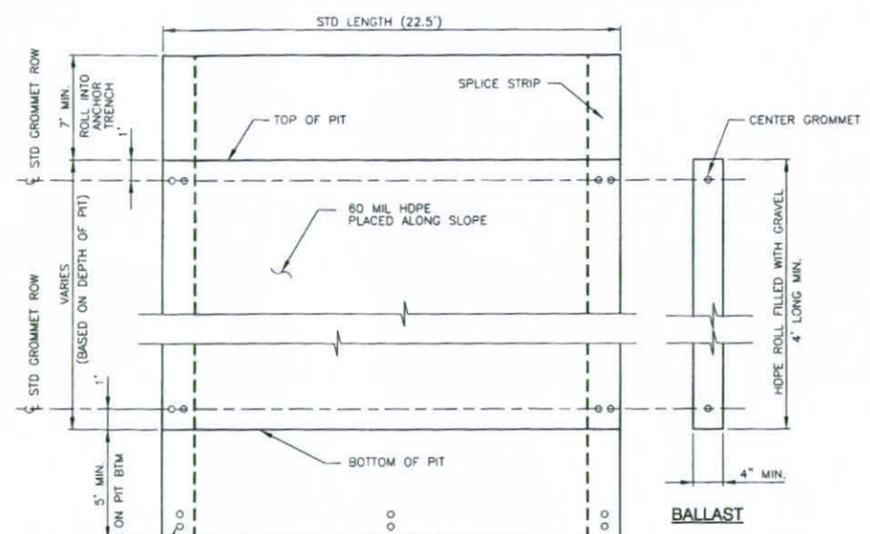
2 TYPICAL POND LINING SYSTEM DETAIL
- N.T.S.



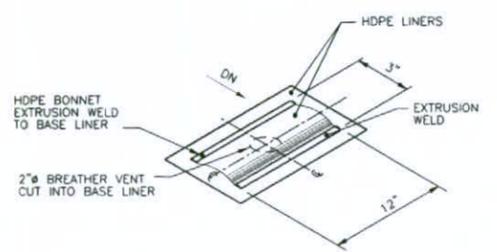
3 GAS VENT LOCATION DETAIL
- N.T.S.



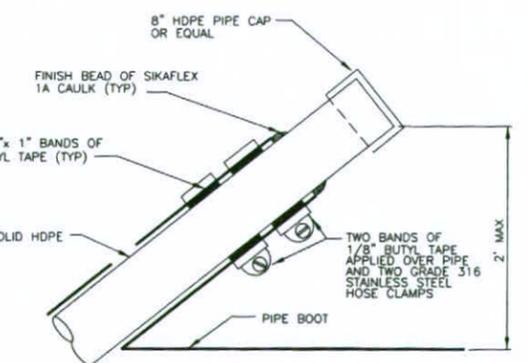
5 LEAK DETECTION WELL DETAIL WITH PIPE RESTING ON SLOPE GRADE
- N.T.S.



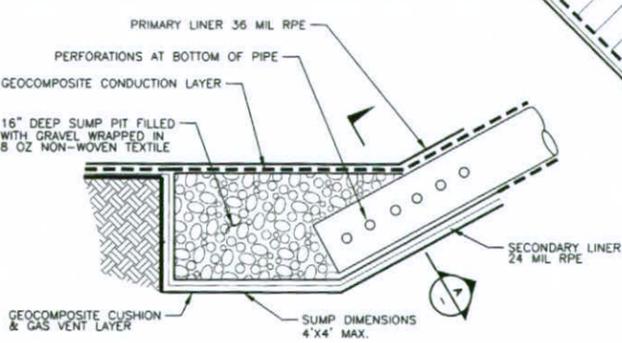
8 60 MIL FLAP (LINER PROTECTION)
- N.T.S.



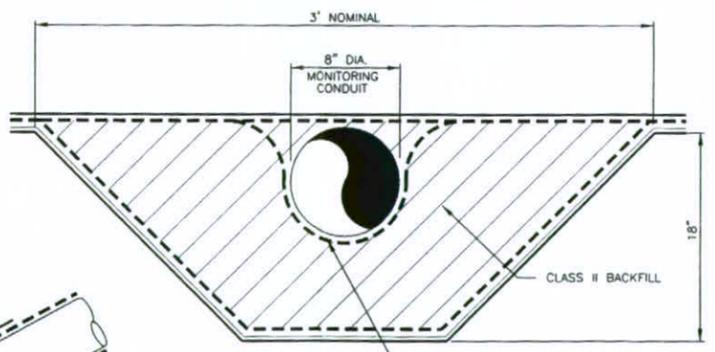
4 AIR/GAS VENT DETAIL
- N.T.S.



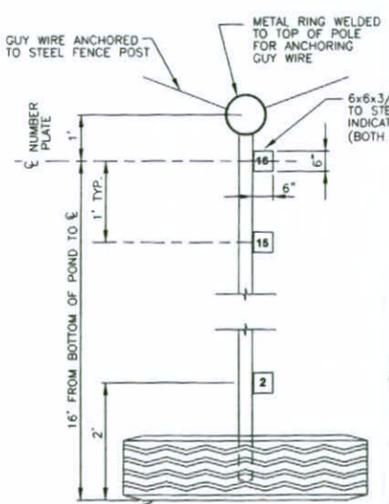
6 PIPE BOOT SEALING DETAIL
- N.T.S.



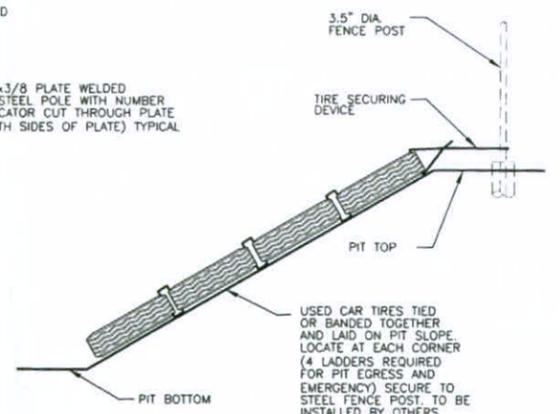
7 SUMP PIT FILLED WITH GRAVEL
- N.T.S.



A SECTION
- N.T.S.



9 STAFF GAGE DETAIL
- N.T.S. (TYPICAL)



10 TIRE LADDER
- N.T.S. (TYPICAL)

NO.	DESCRIPTION	DATE	BY	NO.	DESCRIPTION	DATE	BY
0	ISSUED FOR PERMIT AND CONSTRUCTION	11/09/08	MCL				
A	ISSUED FOR CLIENT REVIEW	11/09/08	MCL				

NO.	DESCRIPTION	DATE	BY

CLIENT	PROJECT MANAGER	PROJECT ENGINEER	CHECK
ConocoPhillips			

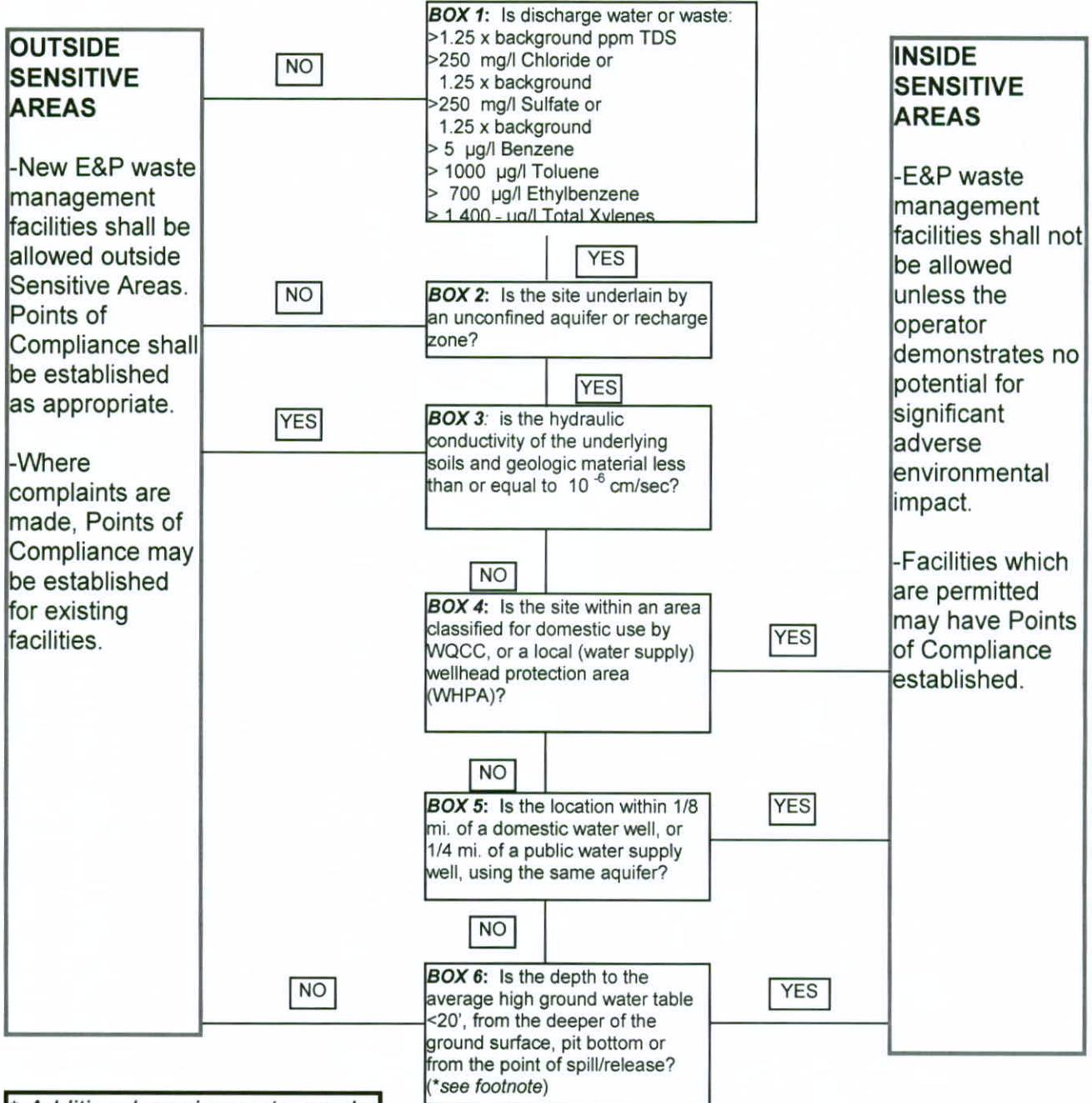
SCALE	DATE	CLIENT	TITLE	PROJECT NO.
N.T.S.	10/21/08	ConocoPhillips	M-23 PRODUCED WATER PIT DESIGN SECTIONS AND DETAILS, SHEET 2 OF 2	8053-07

DESIGNED BY	CHECKED BY	APPROVED BY	LOCATION	DATE
M. LAMBERT	E. TRUJILLO		Parachute, CO	10/21/08

COMPANY	PHONE	FAX
Samuel Engineering, Inc.	303.714.4800	303.714.4800

REFERENCE DRAWINGS	REVISIONS	REVISIONS

**Figure 901-1
SENSITIVE AREA DETERMINATION
Decision Tree**



** Additional requirements may be imposed by the Director in accordance with Rule 901.c.*

PERFORMANCE SPECIFICATION

SPECIFICATION 02530

GEOSYNTHETICS INSTALLATION AND TESTING

FOR

ConocoPhillips

M-23 Produced Water Pit Geosynthetic Lining System
SE Project 8053-07

Orig./Lead Eng.: Melissa C Lambert Date 11/7/08
 Project Engineer Approval: Melissa C Lambert Date 11/7/08
 Project Manager Approval: JTM Date 11/7/08
 Client Approval: _____ Date _____

Rev. No.	By	Revisions	Approval	Date
0	JM	ISSUED FOR PERMIT AND CONSTRUCTION	JTM	11/7/08

1.0 GENERAL

- A. This specification establishes the quality of materials and workmanship and defines how quality is measured for geosynthetic materials to be manufactured and installed for the N-07 Drill Pad as part of the Piceance Basin Project on the Roan Plateau, Garfield County CO.
- B. The word "Owner", as used here, shall mean Conoco Phillips.
- C. Measurement shall be made of the total surface area in square feet covered by the geosynthetic. Final quantities will be based on as-built conditions. Allowance will be made for geosynthetic in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor.

2.0 ABBREVIATIONS

ASTM.....	American Society for Testing Materials
HDPE.....	High Density Polyethylene
LLDPE.....	Linear Low Density Polyethylene
RPE.....	Reinforced Polyethylene
LDS.....	Leak Detection System

3.0 CODES AND STANDARDS

ASTM D751 (2006)	Standard Test Methods for Coated Fabrics
ASTM D413 98(2007)	Standard Test Methods for Rubber Property—Adhesion to Flexible Substrate
ASTM D 1004 (2007)	Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1203 (1994; R 2003)	Volatile Loss from Plastics Using Activated Carbon Methods
ASTM D 1204 (2007)	Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 1505 (2003)	Density of Plastics by the Density-Gradient Technique
ASTM D 1603 (2006)	Carbon Black Content in Olefin Plastics

ASTM D 1790 (2002)	Brittleness Temperature of Plastic Sheeting by Impact
ASTM D 3895 (2007)	Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D 4218 (1996; R 2001)	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D 4354 (1999; R 2004)	Sampling of Geosynthetics for Testing
ASTM D 4355 (2007)	Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491 (1999a; R 2004e1)	Water Permeability of Geotextiles by Permittivity
ASTM D 4533 (2004)	Trapezoid Tearing Strength of Geotextiles
ASTM D 4595 (2005)	Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632 (1991; R 2003)	Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716 (2004)	Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D 4751 (2004)	Determining Apparent Opening Size of a Geotextile
ASTM D 4759 (2002)	Determining the Specification Conformance of Geosynthetics
ASTM D 4833 (2000e1)	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873 (2002)	Identification, Storage, and Handling of Geosynthetic Rolls and Samples
ASTM D 5035 (2006)	Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5199 (2001; R 2006)	Measuring Nominal Thickness of Geosynthetics
ASTM D 5261 (1992; R 2003)	Measuring Mass Per Unit Area of Geotextiles
ASTM D 5262 (2007)	Evaluating the Unconfined Tension Creep Behavior of Geosynthetics

ASTM D 5321 (2002)	Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D 5397 (2007)	Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D 5596 (2003)	Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D 5721 (1995; R 2002)	Air-Oven Aging of Polyolefin Geomembranes
ASTM D 5885 (2006)	Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D 5994 (1998; R 2003)	Measuring Core Thickness of Textured Geomembrane
ASTM D 6497 (2002)	Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D 792 (2000)	Density and Specific Gravity (Relative Density) of Plastics by Displacement
GSI GRI GC7 (1997)	Determination of Adhesion and Bond Strength of Geocomposites
GSI GRI GM7 (1995)	Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM9 (1995)	Cold Weather Seaming of Geomembranes
GSI GRI GM11 (1997)	Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device

4.0 SUBMITTALS

- A. Shop Drawings
 - 1. Geomembrane panel layout and penetration detail drawings.
- B. As-Built Drawings
 - 1. Final as-built drawings of geomembrane installation.
- C. Product Data

1. Tests, Inspections, and Verifications – Manufacturer's and fabricator's QC manuals.
2. Field Seaming – Installer's QC manual.
3. Qualifications
 - a. Manufacturer's, and fabricator's qualification statements, including resumes of key personnel involved in the project.
 - b. Installer's, QC inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in the project.
 - c. The submittal from the QC laboratory shall include verification that the laboratory is accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.
4. Samples – Geomembrane QA and QC samples.
5. Test Reports
 - a. Materials – Manufacturer's certified raw and sheet material test reports and a copy of the QC certificates.
 - b. Surface Preparation – Certification from the QC inspector and installer of the acceptability of the surface on which the geomembrane is to be placed, immediately prior to geomembrane placement.
 - c. Non-Destructive Field Seam Continuity Testing – QC inspector certified test results on all field seams.
 - d. Destructive Field Seam Testing – Installer and certified QC laboratory test results on all destructively tested field seams.
 - e. Destructive Seam Test Repairs – QC inspector certified test results on all repaired seams.
 - f. Interface Friction Testing - Certified laboratory interface friction test results including description of equipment and test method.
 - g. Tests – Certified QC test results.

5.0 QUALIFICATIONS

- A. Manufacturer – Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects and a minimum total area of 10 million square feet.

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- B. Fabricator – The fabricator is responsible for seaming geomembrane sheets into panels. Fabricator shall have fabricated the proposed geomembrane panels for at least 5 completed projects and a total area of 2 million square feet.
- C. Installer – The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects, for a minimum total area of 2 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.
- D. QC Technician – The QC inspector is the person or corporation hired by the Owner, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.
- E. QC Laboratory – The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

6.0 MATERIALS

A. Geocomposite

1. Geocomposite Manufacturer's Quality Control

- a. The geocomposite material to be used for lining the pond shall be a double sided geotextile-geonet geocomposite. The bottom geocomposite layer is to act as cushion and gas vent and the top one as a leak detection layer.
- b. The polymer used to manufacture the geonet core of the geocomposite shall be polyethylene which is clean and free of any foreign contaminants.
- c. Re grind material, which consists of edge trimmings and other scraps, may be used to manufacture the geonet; however, post consumer recycled material shall not be used.
- d. The drainage core of the geocomposite shall be manufactured by

extruding three sets of polyethylene strands to form a triaxial void maintaining structure consisting of a thick vertical rib with diagonally placed top and bottom ribs. The geonet shall meet the property requirements listed in Table 1.

- e. The geotextile of the geocomposite shall be high UV resistant, continuous filament which is a needle punched, nonwoven polypropylene geotextile. The strength retained after 500 hours of UV exposure shall be at least 95% per ASTM G154. The filter and cushioning properties of the geotextile shall meet the property requirements listed in Tables 2 and 3.

2. Geocomposite Material Properties.

The Geocomposite Layer shall conform to the following material properties:

Table 1: Required Geocomposite Material Properties

Tested Property	Test method	Frequency	Minimum Average Roll Value		
			6 oz/yd ²	8 oz/yd ²	10 oz/yd ²
Geocomposite			6 oz/yd²	8 oz/yd²	10 oz/yd²
Product Code			F42060060S	F42080080S	F42100100S
Transmissivity ^(a) , gal/min/ft (m ² /sec)	ASTM D 4716-00	1/540,000 ft ²	0.48 (1 x 10 ⁻⁴)	0.48 (1 x 10 ⁻⁴)	0.43 (9 x 10 ⁻⁵)
Ply Adhesion, lb/in (g/cm)	GRI GC-7	1/50,000 ft ²	1.0 (178)	1.0 (178)	1.0 (178)
Roll Width, ft (m)			14.5 (4.4)	14.5 (4.4)	14.5 (4.4)
Roll Length, ft (m)			230 (70.1)	200 (60.9)	190 (58.0)
Roll Area, ft ² (m ²)			3,335 (310)	2,900 (269)	2,755 (256)
Geonet core^(b)					
Transmissivity ^(a) , gal/min/ft (m ² /sec)	ASTM D 4716-00		9.66 (2 x 10 ⁻³)	9.66 (2 x 10 ⁻³)	9.66 (2 x 10 ⁻³)
Thickness, mil (mm)	ASTM D 5199	1/50,000 ft ²	200 (5)	200 (5)	200 (5)
Density, g/cm ³	ASTM D 1505	1/50,000 ft ²	0.94	0.94	0.94
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft ²	45 (7.9)	45 (7.9)	45 (7.9)
Carbon Black Content, %	ASTM D 1603	1/50,000 ft ²	2.0	2.0	2.0
Geonet core^(b,c)					
Mass per Unit Area, oz/yd ² (g/m ²)	ASTM D 5261	1/90,000 ft ²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft ²	170 (755)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft ²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft ²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, (sec ⁻¹)	ASTM D 4491	1/540,000 ft ²	1.5	1.5	1.2
Flow Rate, gpm/ft ² (lpm/m ²)	ASTM D 4491	1/540,000 ft ²	110 (4,480)	110 (4,480)	85 (3,460)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	Once per formulation	70	70	70

NOTES:

(a) Gradient of 0.1, normal load of 10,000 psf, water at 70 degrees F between steel plates for 15 minutes..

(b) Component properties prior to lamination.

(c) Several geotextiles are available and may be supplied by GSE or other approved equivalent.

(d) These are MARV values that are based on the cumulative results of specimens tested and determined by GSE. AOS in mm is maximum average roll value.

B. Geomembranes (24 mil Primary and 36 mil Secondary RPE)

1. Geosynthetics Manufacturer's Quality Control

- a. The geomembrane liner shall be a four layer reinforced laminate containing no adhesives.
- b. The outer layers of the RPE shall consist of a high strength polyethylene film and shall be resistant to ultraviolet rays in exposed applications.
- c. The manufacturer of the liner shall take random samples of the liner material from each fabricated roll during manufacturing. Samples shall be tested by methods specified within this Section, or applicable ASTM standards, for thickness, strength, tear resistance, low temperature impact density and dimensional stability. Each roll of material shall be clearly identified and correlated to the test results provided.
- d. The geomembrane manufacturer shall confirm in writing, that the geosynthetics to be furnished will be free of defects in materials and workmanship at the time of sale, and against deterioration due to the effects of ozone, ultraviolet or other normal weathering on a pro-rata basis. The geomembrane manufacturer shall furnish a sample warranty during the submittal process for review and approval prior to shipment. In addition, the manufacturer shall provide a minimum warranty against material failure of 15 years in case of the 24 mil RPE and for a minimum of 20 years for the 36 mil RPE.

2. RPE Material Properties

The material provided as Reinforced Polyethylene (RPE) liner shall conform to the following standards or approved equivalent:

Table 2: Required Primary Geomembrane Properties

Properties	Test Method	30 mil		36 mil		45 mil	
		Min. Roll Avg.	Typical Roll Avg.	Min. Roll Avg.	Typical Roll Avg.	Min. Roll Avg.	Typical Roll Avg.
Appearance		Black/Black		Black/Black		Black/Black	
Thickness	ASTM D 5199	27 mil	30 mil	32 mil	36 mil	40 mil	45 mil
Weight Lbs Per MSF (oz/yd ²)	ASTM D 5261	126 lbs (18.14)	140 lbs (20.16)	151 lbs (21.74)	168 lbs (24.19)	189 lbs (27.21)	210 lbs (30.24)
Construction		**Extrusion laminated with encapsulated tri-directional scrim reinforcement					
Ply Adhesions	ASTM D 413	16 lbs	20 lbs	19 lbs	24 lbs	25 lbs	31 lbs
1" Tensile Strength	ASTM D 7003	88 lbf MD 63 lbf DD	110 lbf MD 79 lbf DD	90 lbf MD 70 lbf DD	113 lbf MD 87 lbf DD	110 lbf MD 84 lbf DD	138 lbf MD 105 lbf DD
1" Tensile Elongation @ Break % (Film)	ASTM D 7003	550 lbf MD	750 lbf MD	550 lbf MD	750 lbf MD	550 lbf MD	750 lbf MD

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Break)		550 lbf DD	750 lbf DD	550 lbf DD	750 lbf DD	550 lbf DD	750 lbf DD
1" Tensile Elongation Peak % (Scrim Break)	ASTM D 7003	20 lbf MD 20 lbf DD	33 lbf MD 33 lbf DD	20 lbf MD 20 lbf DD	30 lbf MD 31 lbf DD	20 lbf MD 20 lbf DD	36 lbf MD 36 lbf DD
Tongue Tear Strength	ASTM D 5884	75 lbf MD 75 lbf DD	97 lbf MD 90 lbf DD	75 lbf MD 75 lbf DD	104 lbf MD 92 lbf DD	100 lbf MD 100 lbf DD	117 lbf MD 118 lbf DD
Grab Tensile	ASTM D 7004	180 lbf MD 180 lbf DD	218 lbf MD 210 lbf DD	180 lbf MD 180 lbf DD	222 lbf MD 223 lbf DD	220 lbf MD 220 lbf DD	257 lbf MD 258 lbf DD
Trapezoid Tear	ASTM D 4533	120 lbf MD 120 lbf DD	146 lbf MD 141 lbf DD	130 lbf MD 130 lbf DD	189 lbf MD 172 lbf DD	160 lbf MD 160 lbf DD	193 lbf MD 191 lbf DD
* Dimensional Stability	ASTM D 1204	<1	<0.5	<1	<0.5	<1	<0.5
Puncture Resistance	ASTM D 4833	50 lbf	64 lbf	65 lbf	83 lbf	80 lbf	99 lbf
Maximum Use Temperature		180 °F					
Minimum Use Temperature		-70 °F					

NOTES:

Minimum Roll Averages are set to take into account product variability in addition to testing variability between laboratories.
MD stands for machine Direction and DD for Diagonal Direction.

*Dimensional stability maximum value

**30 mil, 36 mil, & 45 mil are a four layer reinforced laminate containing no adhesives. The outer layers consist of a high strength polyethylene film manufactured using virgin grade resins and stabilizers for UV resistance in exposed applications. 30 mil, 36 mil, & 45 mil are reinforced with a 1300 denier (minimum) tri-directional scrim reinforcement.

Table 3: Required Secondary Geomembrane Properties

Properties	Test Method	24 mil	
Grab Tensile	ASTM D 751/NSF	Warp 258 lb, 1160 N	Weft 250 lb, 1114 N
Tongue Tear – Large Scale	ASTM D 5884-01	Warp 140 lb, 621 N	Weft 149 lb, 663 N
Trapezoidal Tear	ASTM D 4533-04	Warp 200 lb, 890 N	Weft 130 lb, 578 N
Mullen Burst	ASTM D 3786-01	370 psi, 2553 kPa	370 psi, 2553 kPa
Hydrostatic Resistance	ASTM D 751-00	208 psi, 1438 kPa	208 psi, 1438 kPa
Puncture Resistance	ASTM D 4833-00	76 lb, 339 N	76 lb, 339 N
Carbon Black Content	ASTM D 4218-96	3.71%	3.71%
Volatile Loss	ASTM D 1203-94	0.07%	0.07%
Dimensional Stability	ASTM D 1204-02	Warp -1.40 %	Weft -1.34 %
Low Temperature Flex	ASTM D 2136-94	Warp Pass @ -40°	Weft Pass @ -40°
Accelerated UV Weathering	ASTM G151-00 ASTM G154-04	>95% strength retention after 2000 hrs exposure @ 0.77 W/m ² /nm, or 1200 hours exposure @ 1.35 W/m ² /nm.	

NOTES:

Q.U.V. (A-340 Lamps): 8 hrs UV @ 60° C; 4 hrs condensation @ 50 C°; Construction: Reinforcing polyester scrim between LLDPE barrier layers; Colour: Black and other colors available after consultation; Weight: 16 oz/yd² (542 g/m²) ±5%; Thickness: Nominal 24 mils 0.024" (0.61mm)

These values are typical data and are not intended as limiting specifications. All cut edges where scrim is exposed must be sealed using PE welding rod. Warp = machine direction; Weft = cross machine direction

C. Leak Detection System Geotextile and Gravel

1. A minimum 4-ft long by 4-ft wide by 16-inch deep pit fill with gravel and wrapped with an 8-oz non-woven geotextile fabric shall be placed at the low point of the pond and at the bottom end of the leak detection well. The geotextile shall serve as separation and filtration. The geotextile shall conform to the following standards or approved equivalent:

Table 4: Required Geotextile Properties

Property	Test method	Units	Value
Mechanical			
Grab Tensile Strength (MARV)	ASTM D 4632	lb	205
Grab Elongation (MARV)	ASTM D 4632	%	50
Puncture Strength (MARV)	ASTM D 4833	lb	110
Mullen Burst (MARV)	ASTM D 3786	psi	350
Trapezoidal Tear (MARV)	ASTM D 4533	lb	85
Hydraulic			
Apparent Opening Size (AOS) (MaxMARV)	ASTM D 4751	US Sieve	80
Permittivity (MARV)	ASTM D 4491	sec ⁻¹	1.5
Permeability	ASTM D 4491	cm/sec	0.30
Water Flow Rate	ASTM D 4491	gpm/ft ²	110
Physical			
Mass per Unit Area	ASTM D 5261	oz/yd ²	6.5
Thickness	ASTM D 5199	mils	70
Endurance			
UV Resistance	ASTM D 4355	% Retained @ 50 0hours	70
Standard Packaging			
Roll Width	Measured	feet	15
Roll Length	Measured	feet	360
Roll Area	Calculated	yd ²	600

NOTES:

The property values listed are effective 2/01/2004 and are subject to change without notice.

Values reported in weaker principle direction.

All values listed are minimum average roll values (MARV) unless otherwise noted, calculated as the typical minus two standard deviations.

Statistically it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported. MaxMARV represents typical plus two standard deviations.

Underlined styles meet and/or exceed the American Associate of State Highway Transportation Officials (AASHTO) M288 specifications.

7.0 INSTALLATION

A. Geocomposite

1. Prior to deployment of the geocomposite, the geosynthetics contractor shall inspect, certify, and accept, the subgrade on which the liner is to be placed to ensure

conformance with the specifications. Surfaces not in compliance with the specifications shall be rectified by the earthwork Contractor.

2. The geocomposite layer shall be handled in such a manner as to ensure that it is not damaged in any way. On slopes, the material shall be anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the material under tension.
3. In the presence of wind, the leading edge of the material shall be weighted with sandbags or ballasts until the final cover is placed.
4. Care shall be taken to assure that any underlying layers are not damaged during placement. Low ground pressure machines such as ATVs are recommended to facilitate deployment over the geosynthetic layers. Low ground pressure machines shall be used when carrying a driver weighing approximately 150 lbs.
5. The bottom geocomposite layer is to act as cushion and gas vent and the top one as a leak detection layer. The bottom layer is to be placed along the slope of the bottom of the pit so it conforms to the shape of the pit bottom or as directed by the field engineer.

B. Geomembrane (Primary and Secondary RPE)

1. Prior to deployment of geomembrane, the geosynthetics contractor shall inspect, certify and accept, all surfaces on which the liner is to be placed to ensure conformance with the specifications. Surfaces not in compliance with the specifications shall be rectified by the geosynthetics contractor.
2. The amount of geomembrane liner deployed without final quality control and final repairs being completed shall not exceed 100,000 square feet. In addition, no seams shall be left unwelded and no openings in the liner shall be left at the end of a shift unless approved by the field engineer. The liner shall be placed over the prepared surface using methods and procedures that ensure a minimum of handling. The geosynthetics contractor shall provide adequate temporary anchoring devices to prevent damage due to wind.
3. Handling and storage of liner material shall be in accordance with the manufacturer's printed instructions. All persons walking or working on the geomembrane shall wear soft-sole shoes.
4. The liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. All necessary precautions, including provisions for installing extra material, shall be taken to avoid trampolining of liner which will remain exposed (i.e., pad, pond corners and solution channels).
5. Horizontal field seams on slopes should be kept to a minimum. Seams shall be made by lapping the uphill material over the downhill material with sufficient

overlap. A minimum of five feet is to be allowed from the toe of the slope to any horizontal seam on flat areas.

6. Installation shall be performed under the direction of a superintendent who has installed a minimum of 10,000,000 square feet of HDPE or LLDPE flexible lining material. The superintendent shall be provided by the geosynthetics contractor and shall be in charge of the installation.
7. Extreme care shall be taken by the geosynthetics contractor in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to approved procedures, and all sheeting shall be welded together by thermal methods.

C. Geotextile

1. Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel. If approved, sewn seams may be used instead of overlapped seams.
2. The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.
3. Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Owner
4. Geotextile shall not be covered prior to inspection and approval by the Engineering Inspector. Cover soil shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Engineering Inspector. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the geotextile. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 8.0. Equipment

placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

8.0 FIELD INSPECTION AND TESTING

A. Geocomposite

1. Each component of the geocomposite (geotextile(s) and geonet) shall be secured or seamed to the like component at overlaps.
2. Adjacent edges of geonet along the length of the geocomposite, shall be overlapped 2-3 inches or as approved by the Engineer based on the site specific conditions, placed with the edges of each geonet butted against each other. These overlaps shall be joined by tying the geonet cores together with white or yellow cable ties or plastic fasteners. These ties shall be spaced at a maximum of every 10 feet along the roll length.

B. Geomembrane (Primary and Secondary RPE)

1. A maximum effort shall be made to install a perfect liner. This means that all seams completed in the field patches, and extrusions shall be inspected, tested, and recorded.
2. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the lining material in order to ensure that the integrity of the weld is not affected by changes in weather conditions.
3. No "fish mouth" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and extrusion welded. Welds on completion of the work shall be tightly bonded. Any membrane area showing distress due to excessive scuffing or puncture from any cause shall be replaced or repaired.
4. The geosynthetics contractor shall take into account that rapid weather changes are very possible, resulting in delays in construction of field seams. Joining of panels and repairs will only be permitted under weather conditions allowing such work within the warranty limits imposed by the manufacturer.
5. A quality-control technician shall inspect each seam, marking his initials and the date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with approved repair procedures.
6. The field installation testing program shall consist of periodic visual observations, continuity, and strength tests. These inspections and tests are to be made routinely and are automatic regardless of other types of testing

required. The program shall include:

a. Visual Observations

- To perform visual check field seams for squeeze out, footprint, melt and overlap.
- Machines to be checked for cleanliness.
- Any area of the seam or panel showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

b. Non Destructive Testing

A 48 inch (1.2 m) sample should be taken from each factory seam welding unit used in this work at the beginning of every work shift an every four hours of production thereafter. Samples shall be nondestructive, not requiring patching of fabricated panels. Test specimens shall be cut at quarter points from each 48 inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 modified method and peel adhesion will be tested in accordance with ASTM D413, Machine Method, Type A. A log shall be maintained showing the date, time, panel number and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the RPE material and/or seams as appropriate. The fabricator shall provide the test results to the owner or engineer upon request. The results of the leak test shall be marked at the location and shall be recorded by the geosynthetics contractor. If the test fails, the location of the leak shall be found and repaired or the entire seam shall be repaired and retested.

c. Strength Testing

1. For trial welds, the following procedure is to be used:

- Trial welds shall be completed under the same conditions and using the same materials, pre-seaming, and seaming techniques as used to fabricate field seams. The trial weld samples shall be a minimum of 3 feet long by 1 foot wide, marked with the date, technician's name, ambient temperature, and welding machine number and temperature. Coupons from the test weld shall be tested for peel and bonded seam strength using a calibrated tensiometer, as well as thickness, in accordance either the applicable ASTM or

NSF 54 standards as appropriate. If failing results occur, the welding machine shall be repaired or replaced and retested.

- The minimum frequency for obtaining trial weld samples from each of the welding machines in operation is the following:
 - Prior to the beginning of seaming operations.
 - After every four hours of seaming operations.
 - After repairs have been made to seaming equipment.
 - By each technician using the seaming equipment.
 - As required by the Owner.

d. Destructive Testing

1. For destructive testing of field seams the following procedure is to be used:

- Destructive samples may be obtained from field seams or repaired areas by cutting perpendicular to the seams. The sample should be approximately 2 feet long by 1 foot wide. This sample shall be cut into two samples of 1 foot by 1 foot and labeled with the welder's identification, date, and location. One of the samples will be retained by the Owner and one of the samples will be tested by the Geosynthetics Contractor, using a calibrated tensiometer, in accordance with the applicable ASTM or NSF 54 standards as appropriate.
- The frequency for obtaining destructive test samples shall not be less than one sample per 750 feet of field seam. Coupons from the destructive sample shall be tested for peel and bonded strength as well as thickness, in accordance with the applicable ASTM standards. If one or more of the coupons fails, the sample will be considered a failure. As far as practicable, samples should be taken from above the water level in the pond or from the anchor trench to minimize repair within the water bearing surface.
- In the event of a failing test result, additional samples, on either side of the failure, shall be tested to isolate the portion of the seam which needs to be repaired, and the failed portion of the weld shall be "capped". Alternatively, the entire seam

can be rewelded and retested.

C. Hydrotesting of Completed Pit

1. After installation of the uppermost liner and prior to operating the pit, the synthetic liner system shall be tested by filing the pit with at least four (4) feet of fresh water, measured from the base of the pit (not to exceed the two (2) foot freeboard requirement). The engineer's representative shall monitor the pit for a period of seventy-two (72) hours prior to draining the pit and commencing operations.
2. Any leakage through the liner shall be noted over the test period as measured at least twice daily using a gauge mounted within the pit or by measuring the distance from the water to a fixed point down the slope of the pit. A visual inspection of the Leak Detection System pipe shall be taken at each measurement. Measurements shall be taken and recorded by the engineer's representative. See attached form for recording the hydrotesting data.
3. Evaporation losses or precipitation gains will be accounted for from an evaporation pan (12 square foot surface area and 8 to 12 inches deep) or similar device installed in close proximity to the pit.
4. If leakage occurs, the pit shall be drained, inspected and repaired; and the pit shall be refilled and retested as described above. Operations shall not commence until a successful hydrotest is performed and no leaks observed.
5. Hydrotest monitoring results must be maintained by the operator for the life of the pit and provided to COGCC upon request.
6. Operations must be suspended within twenty-four (24) hours if leaks in the liner are observed. The leaks are to be repaired and hydrotests repeated as described above.

END OF SECTION 02530

SAMUEL ENGINEERING, INC
ConocoPhillips
B-16 Produced Water Pit
Pit Liner Hydrostatic Test

Reading	Date And Actual Time	Weather Conditions	Precipitation Since Last Reading	Gauge Reading	Evaporation Pan Reading	Water In Leak Detection System	Pass/Fail
Initial							
Comments							
12 Hour							
Comments							
24 Hour							
Comments							
36 Hour							
Comments							
48 Hour							
Comments							
60 Hour							
Comments							
72 Hour (End)							
Comments							
Test Performed by _____ Signature _____ Print Name _____ Contractor _____ Signature _____ Print Name _____							

PERFORMANCE SPECIFICATION
SPECIFICATION 02517
EARTHWORK AND LEAK DETECTION WELL
FOR
ConocoPhillips
M-23 Produced Water Pit Geosynthetic Lining System
SE Project 8053-07

Orig./Lead Eng.: *Malissa C Lambert* Date 11/7/08
 Project Engineer Approval: *Malissa C Lambert* Date 11/7/08
 Project Manager Approval: *J. M.* Date 11/7/08
 Client Approval: _____ Date _____

Rev. No.	By	Revisions	Approval	Date
0	JM	ISSUED FOR PERMIT AND CONSTRUCTION	JTM	11/7/08

1.0 GENERAL

- A. Related specifications: 02530 GEOSYNTHETICS INSTALLATION AND TESTING.
- B. These technical specifications establish the quality of materials and workmanship and define how quality is measured for earthwork, hard material subgrade, and leak detection wells. They apply to lined containment pond areas. It also establishes the quality of materials and workmanship for furnishing, delivering, installing and constructing hard material subgrade and standard leak detection wells for double-lined systems.
- C. The word "Owner," as used here shall mean ConocoPhillips.

2.0 ABBREVIATIONS

- A. The abbreviation below shall mean:
 - AASHTO..... American Association of State Highway and Transportation Officials
 - ASTM..... American Society for Testing Materials

3.0 CODES AND STANDARDS

- A. Unless otherwise specified or shown on drawings, the following codes and standards shall apply to the extent indicated herein:
 - ASTM D422..... Standard Method of Test for Particle-Size/Analysis of Soils
 - ASTM D2487.... Standard Test Methods for Classification of Soils for Engineering Purposes
 - ASTM D2488.... Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
 - ASTM D3740.... Evaluation of Agencies engaged in Testing and/or Inspection of Soil and Rock as used in Engineering Designing Construction

4.0 MATERIALS

- A. Hard materials will be encountered in 100 percent of the excavation from the existing surface.
- B. Material for subgrade will consist of the naturally occurring shale rock, shaped to the lines and grades on the Design Drawings. The naturally occurring shale rock

shall be broken into pieces with excavation equipment. The side slopes and bottom of the excavation shall be shaped with aggregate less than 2 inches in diameter in a manner that is smooth and does not allow for protrusion of rocks from the planar surface of the side slopes and the bottom of the pit.

- C. Drill cuttings mixed with fly ash and wood chips or drill cuttings alone may be used to provide a smooth finish to the subgrade for placement of the geosynthetic liner materials including geocomposites. Such cuttings must have passed the testing required by COGCC in Table 910-1.
- D. Materials will consist of the geocomposites and geomembranes used in the pond liner system. The leak detection well shall consist of 8-in diameter HDPE pipe perforated at the bottom end as shown on the design drawings. The 8-in HDPE shall be sealed from the primary liner with a pipe boot. An 8-in cap will be provided above grade as shown on the design drawings. Refer to 02530 GEOSYNTHETICS INSTALLATION for more information on geocomposites and geomembranes.
- E. A minimum 4-ft x 4-ft x 16-in deep sump pit filled with gravel and wrapped with 8-oz non-woven geotextile fabric shall be placed at the low point of the pond and at the bottom end of the leak detection well. Refer to 02530 GEOSYNTHETICS INSTALLATION for more information on geotextile.
- F. Class 2 Backfill is defined as all soils and rock excavated at the site with a diameter of less than 2 inch maximum dimension. Suitable equipment or approved procedures shall be provided to ensure the maximum dimension is not exceeded.

5.0 QUALITY ASSURANCE

- A. Quality assurance during preparation of hard material subgrade shall be performed by an agent of the sealing engineer. Inspections during filed construction shall be visual and the subgrade shall be approved by the certifying engineer prior to placement of the liner system.
- B. The owner shall engage a third party independent Engineering firm for quality control.
- C. Inspections during filed construction shall be visual and the subgrade shall be approved by the certifying engineer prior to placement of the leak detection well and related liners. The leak detection well shall be approved by the certifying engineer prior to backfill of the well.

6.0 PROJECT SITE CONDITIONS

- A. Data on indicated subsurface conditions are made available for the convenience of the earthwork contractor and are not intended as representations or warranties of continuity of such conditions.
- B. Protect existing benchmarks and monuments and other reference points; if disturbed or destroyed, replace as directed by Owner.
- C. Erect and maintain such safeguards as required by construction operations, codes or existing conditions, for the safety of persons or property and to protect the same from damage, injury or loss.
- D. Provide for diversion of surface drainage during the period of earthwork, keeping excavations free of water during entire process of work, regardless of cause, source or nature of the water.

7.0 SURVEY

- A. The Owner will establish the control point(s) to be utilized by the Contractor. The Contractor shall be responsible for all construction surveying to control the work.
- B. Cross-sections of the original surface and the as-built condition will be taken as directed.
- C. Prior to installation of any geosynthetic liners, Contractor shall verify with grading level that the pit side slopes are 2:1 maximum, the bottom of the pit slopes as designed for the leak detection system, and the pit depth and general layout is per the design drawings.
- D. All survey work will be subject to checking by the Owner or Owner's representative.

8.0 CLEARING AND GRUBBING

- A. Existing pit will be drained and the existing liner system removed prior to construction.
- B. Existing fencing will be removed prior to the start of work to allow for proper re-shaping of the existing pit.
- C. Fluids, solids, and existing liners removed from the existing pit shall be disposed of at the waste locations identified and approved by Owner.
- D. Clearing and grubbing shall be performed as required.

- E. Clearing will consist of the removal and disposal of all brush, grass, rubbish, and other obstructions resting on the surface of the original ground. Unless otherwise indicated, clearing shall be performed within the limits of and ten feet outside of the pits.

9.0 DUST PALLIATIVE

- A. Apply water or chemical for the control of airborne dust originating as a result of earthwork operations in accordance with applicable ordinances and regulations. Chemicals if utilized are to be approved in advance of use by field.

10.0 EXCAVATION

- A. Classification of all excavated materials shall be included in the following:
 - 1. Common and Rippable Excavation shall consist of all materials that can be excavated without blasting. Rippable excavation shall consist of all materials that can be effectively loosened or broken down by ripping in a single pass with a late model tractor-mounted hydraulic ripper equipped with one digging point of standard manufacturer's design adequately sized for use with and propelled by a crawler-type tractor rated equal to or better than a D-9 Caterpillar flywheel horsepower, operating in low gear. Additionally, all boulders or detached pieces of solid rock less than 2 cubic yards in volume will be classified as Common and Rippable Excavation.
 - 2. Rock Excavation - For the purpose of classification of excavation, rock is defined as sound and solid masses, layers, or ledges of mineral matter in place and of such hardness and texture that it cannot be effectively loosened or broken down by a hydraulic ripper specified above. Testing to determine compliance with this classification shall be made when requested. All boulders or detached masses of solid rock larger than 2 cubic yards in volume will be classified as rock.
- B. Suitable excavated materials conforming to the requirements of Section 4.0 shall be utilized in backfills. Unsuitable material within the limits of excavation shall be removed and disposed of as waste. Unsuitable material is defined as material that is greater than 2 inches in diameter, organic materials and debris of any kind, or any material that is protruding from the planar surface of the bottom of the pit, side slopes of the pit, and within the anchor trench. Unsuitable or excess excavated material shall be disposed of at Owner's designated waste locations.
- C. The method of excavation shall not weaken surrounding areas or damage structures or parts thereof that are completed or under construction. Existing structures and utilities adjacent to excavations shall be protected and supported to prevent displacement.

- D. Excavations shall conform within the tolerances specified to the lines, grades, sections and elevations shown on Design Drawings.
- E. Except as otherwise shown, grading tolerances shall be zero to minus 4 inches for horizontal and sloped planes of excavation in earth and zero to minus 6 inches for horizontal and sloped planes excavation in rock.
- F. Over-excavated areas within the pit area shall be restored with properly compacted drill cuttings to the elevations shown on Design Drawings. Compaction equipment shall be suitable for the size and depth of the holes being filled.
- G. If any areas outside of the pit area are over-excavated in rock, the over-excavation shall be restored by backfilling spaces under and adjacent to footings, foundations or other bearing portions of structures with concrete having a 28-day compressive strength of 2000 psi. Restoration of over-excavated areas in rock and soil shall provide uniform bearing values at least equivalent to that previously given by the excavation prior to the over-excavation.
- H. Areas being excavated and areas to be backfilled shall be maintained in a clean condition free from debris.
- I. Compaction shall be "Ordinary compaction" without field testing but shall require close observation to ensure that the materials are being densified and that no soft or loose spots remain. Loose lifts shall be no more than six inches in thickness prior to compaction. Care must be taken to ensure that tracks compact evenly and do not 'bridge' between hard points leaving uncompacted material between. Tracked equipment exerts fairly low ground pressures but may be suitable for this project if closely observed. For reference the following equipment exerts pressure on the soil.
 - i. D8 Tractor with standard track and dozer Ground pressure is 1884 pounds per square foot (13.1 psi).
 - ii. 345 D Hydraulic excavator with 36" track Ground pressure is 1163 pounds per square foot (8.1 psi).

11.0 PIPE TRENCH EXCAVATION

- A. The pipeline route for the leak detection system shall be over excavated and backfilled with Class 2 backfill or approved drill cuttings so that the pipe rests in bedding material, as indicated on the Design Drawings. The bottom and sides of the trench shall be finished as smooth as the pit subgrade with similar surface treatment. The pipe will be onsite and used to test the slope of the trench to ensure a uniform slope to the top. No bends will be allowed in the pipe.

- B. The 8 oz non-woven textile liner shall wrap around the outside of the gravel sump. The bottom geocomposite cushion and 24 mil RPE liners shall deform into the trench beneath the 8 oz non-woven textile liner. The geocomposite conduction liner shall continue over the top of the pit until the reaching the pipe and shall also be positioned underneath the pipe, as indicated on the Design Drawings. Ensure that the primary geomembrane liner is not significantly deformed over the pipe. Backfill around the pipe with clean drill cuttings.
- C. The leak detection sump shall be excavated so as to provide the cover, bedding depth and minimum width of 4 feet as shown on the drawings.
- D. The bottom of the pit shall be graded to drain to the leak detection system sump as indicated on the Design Drawings.
- E. The method of excavation shall not weaken surrounding areas or damage structures or parts thereof that are completed or under construction.
- F. All excavation shall conform within the tolerances specified to the lines, grades, sections and elevations shown on drawings and shall be shaped on the bottom to the bedding details shown to provide uniform bearing and support of each pipe section for the entire length.
- G. In all excavation requiring blasting, care shall be taken to minimize overbreak. Material outside the authorized cross section, which has been shattered or loosened by blasting, shall be removed.
- H. Precautions shall be taken so as not to excavate below the depths indicated on the drawings. Where excessive or unauthorized excavation occurs, backfill the depth to the proper grade with compacted sand and or pea gravel or other suitable material.
- I. Except as otherwise shown, grading tolerances shall be plus zero to minus 4 inches for rippable rock excavation.
- J. Remove excavated material not required or suitable for backfill from the excavation area and dispose of it at an onsite, designated location.

12.0 PIT SURFACE TREATMENT

A. Benching of Sloped Surfaces

Pit side slopes will be no steeper than 2 to 1 (horizontal to vertical) as indicated on Design Drawings. Tolerance for side slopes will be 2 inches in a 4 foot length of straight edge provided the transitions are smooth curves.

B. Surface Preparation:

Existing rippable hard material on the exposed surface of the pit bottom and side slopes shall be reduced in size to a maximum of 2 inches in diameter. Ensure that there are no rock protrusions above the planar surface of the pit bottom, side walls, and anchor trench. Reduction of this rock shall be done with the most appropriate means and methods available, such as tracking over the rock with the dozer, the use of ripper attachments on excavators, and/or the use of compaction equipment. Large or very hard materials which are resistant to crushing with available equipment may require removal or reduction with special equipment.

C. Filling Holes, Depressions and Cavities

Depressions and other cavities shall be filled in with clean drill cutting to the elevations of the pit bottom and side slopes indicated on the Design Drawings. Crushed rock less than 2 inches in diameter may also be used to fill in holes, depressions, and cavities. Compaction equipment shall be suitable for the size and depth of the holes being filled.

13.0 ANCHOR TRENCHES

- A. Geosynthetic runout and anchor trench shall be constructed to the dimensions as indicated on Design Drawings. The subgrade surface of the anchor trench runout shall be of the same material as the side slope of the pit and will be smooth for placement of the liner system. Subgrade will be approved by the onsite engineer prior to placement of geosynthetics.
- B. Class 2 Backfill as defined in Section 4.0 shall be used to backfill over the geosynthetic runout and in the anchor trench. Class 2 Backfill shall be used on top of the geosynthetic runout to a minimum depth of 12 inches and will match existing depth and grade as indicated on Design Drawings.
- C. Backfill within anchor trench and over geosynthetic runout shall be placed in 6-inch lifts and wheel or bucket compacted with onsite equipment. Tolerance for final grade over runout and anchor trench shall be minus zero to plus 2 inches. Compaction efforts will be observed and approved by the onsite engineer to ensure sufficient compaction in required lifts.

14.0 STOCKPILING

- A. As part of earthwork operations, stockpiling of excavated or borrowed material may be required.
- B. Different classes of material shall be stockpiled separately if required by Owner.
- C. Stockpiles and waste material shall be placed in such a manner to provide natural drainage and a stable embankment as approved by Owner.

- D. Stockpiles shall be constructed with maximum height not exceeding 40 feet.
- E. Location of stockpiles to be determined by Owner.

15.0 RESHAPING AND GRADING EXISTING IMPROVEMENTS

- A. Prior to commencing finish grading, existing improvements shall be checked for their compliance with rough grading requirements shown on design drawings and restored to original lines, grade and cross section if required.
- B. Clean and reshape previously constructed ditches of sedimentation and debris to original lines, grade and cross section.
- C. Clean all previously constructed culverts of sedimentation and debris.

16.0 FINISH GRADING TOLERANCES

- A. The finish grade tolerance for the rippable rock shall be plus zero and minus 4 inches to the lines and grades as indicated on the Design Drawings.
- B. Areas not within the allowable tolerances shall be corrected by breaking, scarifying, placing additional material, remixing, and reshaping to the specifications herein.

17.0 CLEANUP

- A. Leave area in a clean and neat condition. Grade all disturbed surfaces to prevent standing surface water.

END OF SECTION 02515

ATTACHMENT 1

GEOSYTHETIC COMPRESSION LOADING TEST RESULTS



August 4, 2008

Mr. John Heap
Colorado Lining Intl.
1062 Singing Hills Rd.
Parker, CO 80138-4653
(303) 841-2022
jheap@coloradolining.com

Re: Results of Compression Loading Testing (TRI Log 2308-47-03)

Dear Mr. Heap,

TRI/Environmental, Inc. (TRI) is pleased to present this final report for the requested compression testing in support of the Roan Plateau shale project. The testing was performed to determine the out-of-plane deformation resistance of a 60 mil HDPE smooth geomembrane and a 36 mil RPE geomembrane to compressive loading within a liner system. All sample materials and testing activities were managed under TRI log number E2308-47-03.

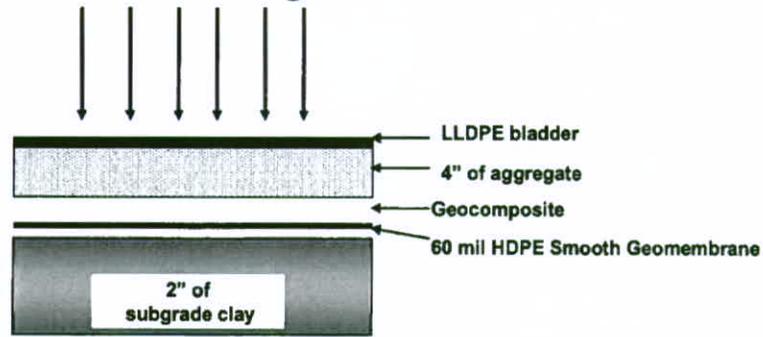
Technical Approach

The compression testing was performed in general accordance with ASTM D 5514, *Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics*. The test vessel measured 30" in diameter facilitating a 24" diameter test area. The test vessel is composed of a top and bottom half with an intermediate center section measuring 4" in height. The bottom of the test vessel was filled with a compacted clay liner substrate, which the geomembranes were placed over. Four different liner configurations were evaluated. Test configurations are depicted in the test configuration section. Each liner configuration was separated from the loading system via a 40 mil LLDPE geomembrane bladder.

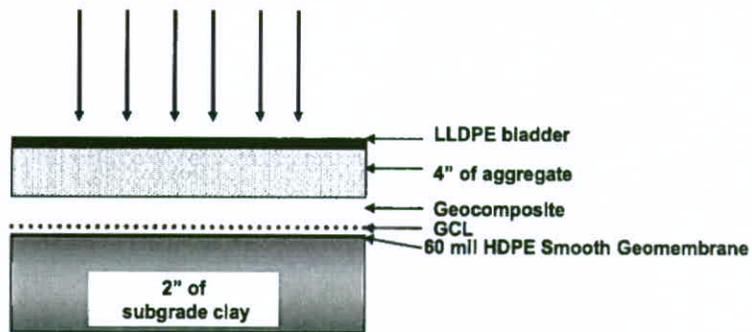
After securing the top test chamber, air was introduced above the bladder to provide normal compressive stress through the bladder and onto the liner system. A normal compressive stress was applied at 1 psi per minute until a static load of 20.8 psi was achieved. This load was allowed to remain static for 1 hour.



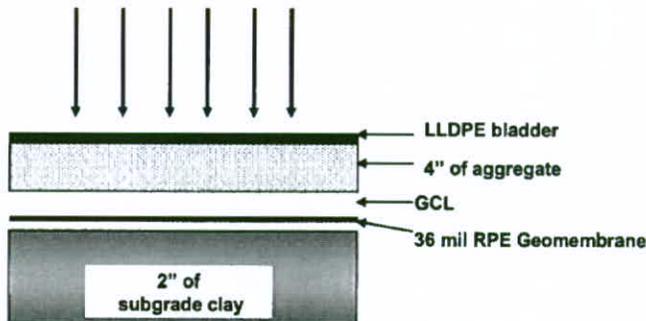
Test Configurations:



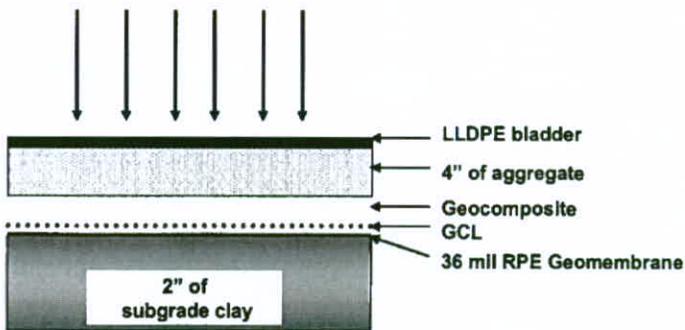
Test No. 1



Test No. 2



Test No. 3



Test No. 4



Post Test Inspection: After dismantling, the 60 mil smooth and 36 mil RPE geomembranes were inspected for out-of-plane deformations, punctures, and abrasions. Pictures showing equipment, system layers and post test exposure are also included. No visible punctures of the geomembrane were found.

Test No.	Observations
1	No measurable deformations, no punctures or notable marks
2	No measurable deformations, no punctures or notable marks
3	Three barely visible deformations noted, no punctures or notable marks
4	No measurable deformations, no punctures or notable marks

Conclusion

TRI trusts that this report sufficiently documents the testing described herein. TRI is pleased to be of service to Colorado Lining. Please contact me if you have any questions or require any additional information.

Sincerely,

A handwritten signature in black ink, appearing to read 'John M. Allen'. The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

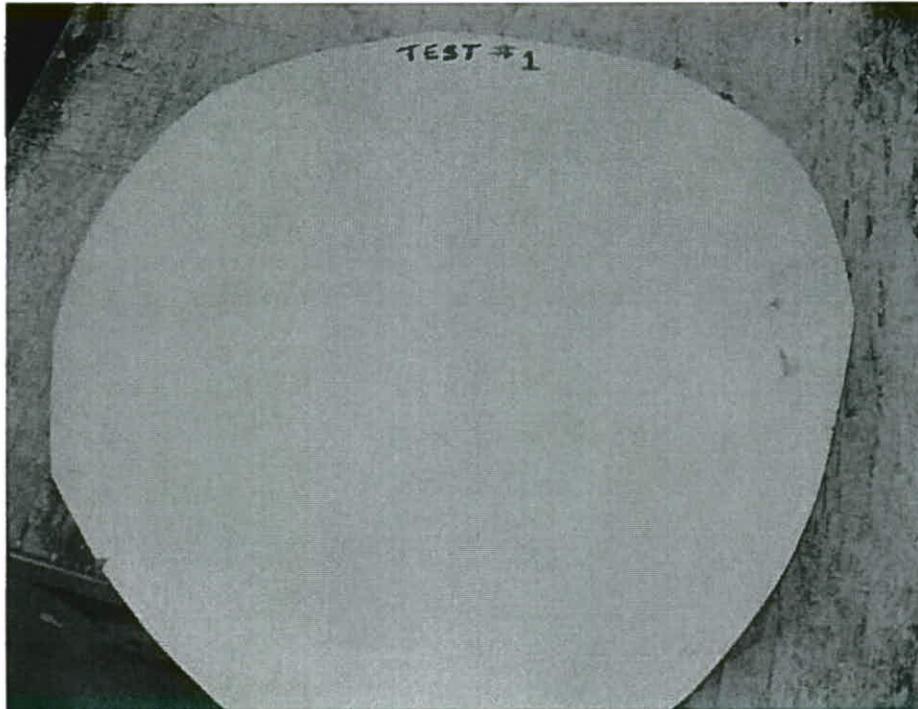
John M. Allen
Director
Geosynthetics Services
www.GeosyntheticTesting.com



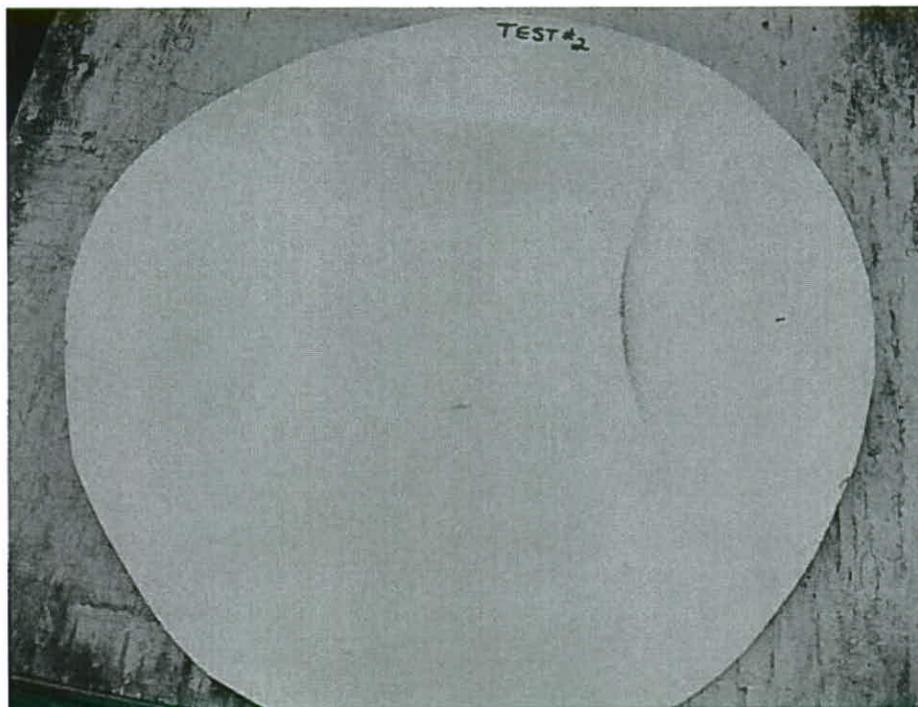
Test Cell



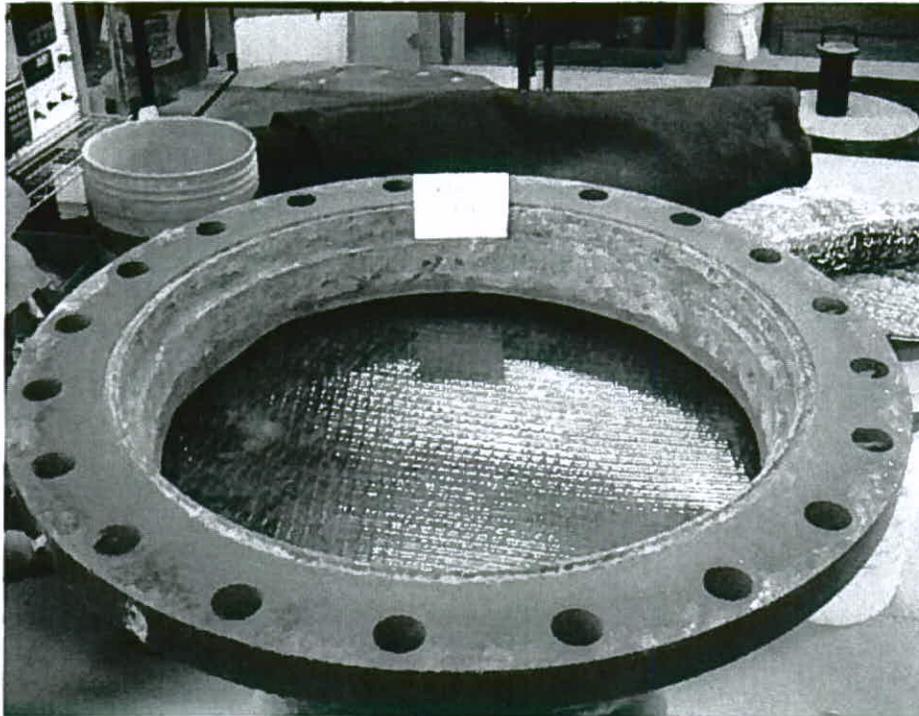
Example of the Roan Plateau shale placed over geosynthetic liner system



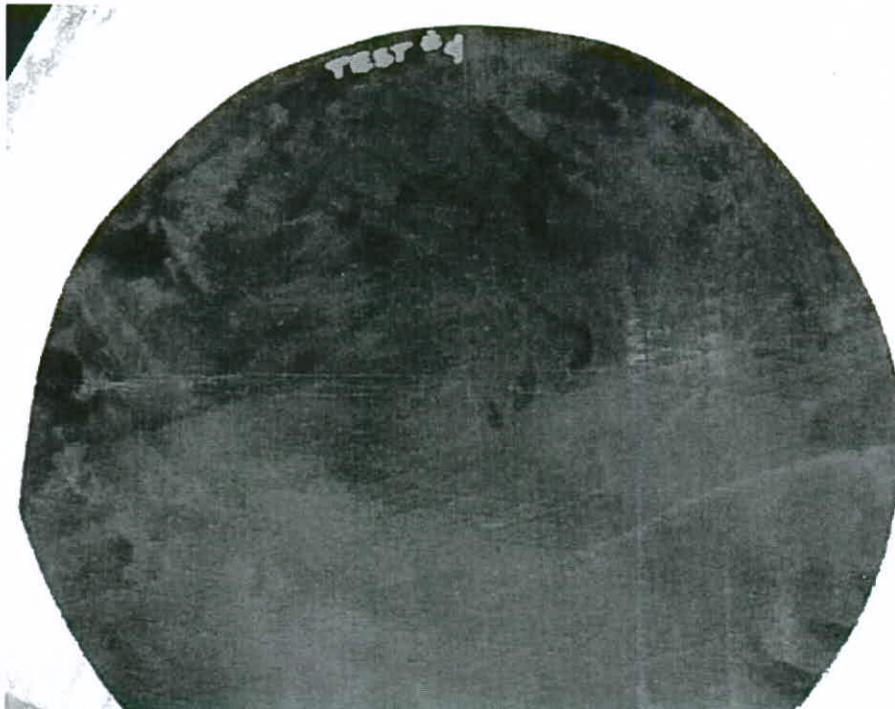
Test No. 1 geomembrane post exposure



Test No. 2 geomembrane post exposure



Test No. 3 geomembrane post exposure



Test No. 4 geomembrane post exposure