



TECHNICAL INFORMATION PAGE



FOR OGCC USE ONLY

1. OGCC Operator Number: <u>96850</u>	API Number: <u>05-045-06700</u>
2. Name of Operator: <u>Williams Production RMT</u>	OGCC Facility ID # <u>334734</u>
3. Well/Facility Name: _____	Well/Facility Number: <u>GV 88-1</u>
4. Location (QtrQtr, Sec, Twp, Rng, Meridian): <u>NWSE S1 T7S R95W 6th PM</u>	

This form is to be completed whenever a Sundry Notice is submitted requiring detailed report of work to be performed or completed. This form shall be transmitted within 30 days of work completed as a "subsequent" report and must accompany Form 4, page 1.

5. **DESCRIBE PROPOSED OR COMPLETED OPERATIONS**

This sundry notice Form 4 is submitted for COGCC's approval of the new pit dimensions and to install new liner and leak detection system.

During the course of liner system upgrade activity at the GV 88-1 completion pit, a historical release was discovered and reported to COGCC on 11/10/11. Release #2221268. After the excavation of contaminated material, the pit wall and bottom were prepared for the liner system upgrades (see remediation summary Form 27, submitted to COGCC on 12/9/2011, for details).

Attached are the following documents:

- Plats with the new pit dimensions and volume
- Earthen Pit Construction and Synthetic Lining Plans and Specifications - the liner system will be upgraded from the COGCC Form 15 permitted 45 mil polyethylene liner to the following specifications (see attached report for details):
 - 60 mil HDPE liner
 - 200 mil Hypernet Geonet Drain Mat
 - 40 mil HDPE liner
 - BentoLiner NSL geosynthetic bentonite liner
 - Leak detection system

GV 88-1

Earthen Pit Construction and Synthetic Lining Plans and Specifications



Prepared for:

Williams Production RMT
1058 County Road 215
Parachute, Colorado 81635



Date: May 2010

Prepared By:

Fox Engineering Solutions

670 Canyon Creek Drive
Grand Junction, CO 81507
Ph: (970) 250-5505 / Fax: (626) 784-0667
Email: coloradofox@bresnan.net

Table of Contents

Table of Contents.....	Page 2
Special Provisions.....	Page 3
Section 1010 Scope of Work.....	Page 4
Section 1300 Construction Sequence	Page 4
Section 1400 Construction Observation Notification.....	Page 4
Section 2200 Excavation / Embankment.....	Page 5
Section 2260 Synthetic Lining, Underlayment & Leak Detection Systems.....	Page 9
Section 2280 Hydrostatic Testing.....	Page 10

Figures

- Figure 1 - USGS Quadrangle Location Map
- Figure 2 - Plan View Survey Plat
- Figure 3 - Cross Section Plat
- Figure 4 - Anchor Trench Details
- Figure 5 – Liner and Leak Detention System

Appendices

- Appendix A – Liner Manufacture’s Installation Guidelines

Special Provisions

These plans and specifications have been compiled to comply with production, drilling, multi-well and centralized E&P waste management earthen pit regulations and policies of the Colorado Oil and Gas Conservation Commission (COGCC), Colorado Department of Natural Resources. Specifically included are the 900 Series Rules adopted in 2009; COGCC policy entitled "Notice to Operators Drilling Wells Within ¼ Mile of the Rim of the Roan Plateau in Garfield County, Pit Design, Construction and Monitoring Requirements", dated June 12, 2008; and COGCC email correspondence entitled "New Pit Requirements in the Piceance Basin", dated September 8, 2008. The specifications detail pit construction; and liner material, details and installation practices which are to be followed and employed by Williams Production RMT Company and their contractors.

Under current COGCC rules and policies, all earthen pits constructed on fill material and/or requiring the construction of embankments above natural or pre-construction grades will require design and certification by a registered professional engineer. Documented inspections, construction observation, compaction testing and hydrostatic monitoring may be performed by the professional engineer or their designee as outlined in the specifications. Within the scope of the work, the contractor(s) shall provide a minimum of 48 hours notice to the engineers for critical construction observations, testing and inspections.

A specific earthen pit location map on a USGS base map, site survey plats, and cross sections are provided in the figures as part of the plans and specifications. Synthetic liner system specification details and drawings are also included in this plan set. If required by the COGCC, a leak detection system shall be installed as specified per the drawings. Changes to the plan set may be made by the professional engineer as warranted to ensure compliance with COGCC regulations and policies. Changes will be conveyed to the contractor in the form of a Notice of Change correspondence.

No work shall commence by the contractor until a Notice to Proceed has been issued by Williams Production RMT Company. The contractor shall be responsible for locating all underground utilities as prescribed by Colorado law. All work shall be conducted within the limits of disturbance, unless approved by the Williams or professional engineer. Earthen pits shall be constructed within the boundary locations shown on the site survey plats and to the depths and side slopes noted, unless otherwise changed by the professional engineer. No changes to the plans and specifications will be permitted by the contractor without the approval of the professional engineer or their designee.

Williams Production RMT Company shall be responsible for providing as-built drawings, if any, including earthen pit plan and cross sections to the professional engineer. The as-built drawings and changes to the specifications shall be noted by the professional engineer as part of their certification and final construction report.

SECTION 1010 - SCOPE OF WORK

The primary work items to be performed under these plans and specifications involves the construction of earthen pits and installation of a synthetic lining systems regulated by the Colorado Oil and Gas Conservation Commission. Portions of well pad construction shall be included within this scope of work for pits influencing well pad cut and/or fill areas. The contractor shall be responsible for verifying and/or obtaining all field measurements necessary for liner sizing and fit. Pits shall not be constructed on known intermittent or perennial springs, seeps, or other surface water features. If groundwater is encountered during pit construction activities, the contract shall immediately cease construction and notify the Owner and the professional engineer. The water source may be mitigated and/or pit relocated at the direction of the Owner and/or professional engineer.

SECTION 1300 - CONSTRUCTION SEQUENCE

The Contractor will follow the general pit construction sequence outlined. Changes to the sequences may be made by the professional engineer as warranted by field or other conditions.

- 1.) Stake pit boundaries and edge of disturbed area including bank above freeboard and anchor trench for liner. Ensure that the edge of all pits maintain a minimum 10 feet setback from the edge well pad boundaries or fill slopes.
- 2.) Excavate the pit bottom and pit slopes per the plan set. Scarify soil in bottom and sides.
- 3.) Excavate pit top perimeter and anchor trench per the plan set.
- 4.) Compact pit bottom and slopes as specified.
- 5.) Compact pit top perimeter and anchor trenches as specified.
- 6.) Install underlayment; leak detection system, if required; and liner system as specified.
- 7.) Backfill and compact anchor trenches as specified.

SECTION 1400 - CONSTRUCTION OBSERVATION NOTIFICATION

The project professional engineer shall provide the Owner with a list of construction observations for each pit that must be witnessed or observed by the professional engineer or their designee. These observations may include, but are not limited to;

1. Construction of fills/embankments.
2. Subgrade completion of pit excavation and liner anchor trench.
3. Placement of underlayment; leak detection system, if required; and liners.
4. Embankment/fill compaction testing by the professional engineer.

The Owner or contractor shall provide the professional engineer with a 48-hour advance notice of the construction events requiring their presence.

The Owner shall provide the professional engineer with a set of surveyed as-built pit plan view and cross sections indicating natural and post construction grades. A copy of the hydrostatic test, if applicable, shall also be provided.

SECTION 2200 - EXCAVATION / EMBANKMENT

PART I - GENERAL

DESCRIPTION OF WORK

The primary work defined by this Section will be all excavation, embankment, and earthwork associated with the project including but not limited to the production pits, reserve pits, and cuttings pits. Well pad construction shall be included in this Section for pits constructed on or in well pad cut/fill areas.

RELATED WORK SPECIFIED ELSEWHERE

Section 2260 –Synthetic Lining and Underlayment System

SITE INFORMATION

The Contractor will be held to have examined the site(s), and to have detected the conditions under which the work is to be done. The drawings show the physical dimensions and general topography of the site, but do not show the extent of all obstructions and subsurface conditions. The Contractor, at his option and without additional cost to the Owner, may take borings and other exploratory actions to determine conditions of the site and to provide for the construction specified herein.

MEASUREMENTS AND LEVELS

Verify all drawing measurements and levels in relation to existing elevations, grades and adjacent structures, and determine conditions and requirements for excavations, fill, and protection of the premises. Carefully and accurately lay out all lines and grades of the new construction as indicated on the plans before proceeding with any work.

PROTECTION

Shoring - If applicable, provide and maintain all sheeting, shoring and bracing required to retain earth banks properly, protect adjoining grades and structures from caving, sliding, erosion, or other damage, all according to applicable codes and current OSHA requirements. Remove shoring and related items as excavations are backfilled unless approval has been requested in writing and granted by the Owner to leave in place.

Drainage - Maintain excavations and construction site free from water throughout work. Drain surface water or seepage by gravity, sumps, or temporary pumps and discharge lines as necessary for this purpose, complying with the Owner's Storm Water Management Plan. Use drainage methods that will prevent softening of foundation bottoms, undercutting of footings, or other conditions detrimental to proper construction procedures. Contractor shall keep an erosion control plan and best management practices consistent with the Owner's Storm Water Management Plan.

Utilities - Protect from damage existing utility lines and piping shown on drawings or locations of which are made known to the Contractor prior to work, and utility lines constructed during construction operations of the project. Before commencing work, the Contractor shall obtain necessary information concerning location, type, and extent of existing utilities on the site and adjacent properties. The

Contractor shall contact the Utility Notification Center of Colorado at phone (800) 922-1987 and have all utilities located prior to commencing construction activities. Notify the Owner and utility company immediately in the event of damage to utility lines. The Contractor will repair damages to utilities at no additional cost to the Owner.

PART II - PRODUCTS

A. **Embankment (Fill)** - Embankment, shall consist of approved material acquired from excavations, hauled and placed in embankments in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the drawings or as established in the field by the Owner. All embankment material shall be approved by the geotechnical engineer prior to placement. When the source of the embankment material is not designated on the drawings, approval of the source will be contingent on the material having a resistance value necessary for the construction in which it is used. Only approved materials shall be used in the construction of embankments.

B. **Suitable Materials for Structural Fill and Backfill** - On-site soil material obtained from excavation and free of debris, roots, organic or frozen materials, and stones or rubble with a maximum dimension smaller than 12 inches and less than 25% courser than 3/4-inches are acceptable. Imported material will be nonexpansive soil, or may be pit-run or bank-run sand and gravel capable of being compacted as specified hereafter. All fill and backfill material must be approved by the geotechnical engineer before fill or backfill work is started.

C. **Unsuitable Materials** - Expansive materials or materials that contain debris, roots, organic or frozen materials, stone, or concrete having a maximum dimension larger than 12 inches, or materials determined by the geotechnical engineer as unsuitable for providing stable slopes, fill, backfill, foundation or subgrade material for structures or pavements. Material that is unsuitable due to excess moisture content will not be classified as unsuitable if it can be dried by manipulation, aeration, or blending with other materials satisfactorily as determined by the geotechnical engineer.

PART III - EXECUTION

A. **Excavation: General** - Excavation includes removal and disposition of all materials excavated, despite the nature of materials encountered. Excavations shall be finished to a smooth and uniform surface. Variation from the subgrade plane shall not be more than .25 ft. in soil nor more than .08 ft. above or .50 ft. below in rock. Excavation operations shall be conducted so that material outside the limits of construction shall not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed. Place suitable excavated materials in fill areas within the limits of work or stockpile as directed by the Owner. Report to the Owner any unsuitable materials or unforeseen obstructions encountered during excavation for proper disposition. Materials shall not be wasted without permission of the Owner.

Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 ft. below subgrade, within the limits of construction and the excavation backfilled with material designated on the drawings or approved. When rock has been excavated greater than 0.5 ft. below subgrade, within the limits for construction, the excavation shall be backfilled within at least 0.5 ft. below subgrade with material shown on the drawings or as approved. Rock excavation shall not be considered or paid for as extra work.

B. **Embankments/Fills** - Construct all embankments to the lines and grades shown on the drawings. Immediately before placing fill material, scarify the entire area upon which fill is to be placed to a depth of 12-inches. Remove all frozen material, roots, debris, large stones, or other objectionable materials.

Place approved excavated or imported fill material in successive horizontal layers of 8-inch loose depth for full width of cross section, bring to optimum moisture content for compaction, and compact each layer to the required density. If required compaction cannot be obtained with the existing material, the area will be over-excavated to a depth of 18 inches and filled and compacted with suitable material.

Where fills are placed on natural slopes, within the influence of water pits, as determined by the professional engineer, benches shall be cut into the native material of not less than 42 inches. Material shall be replaced in 10 inch lifts, brought to proper moisture content, (within 1 % below and 3% above) and compacted to not less than 95% of maximum dry density as determined by the professional engineer.

As determined by the professional engineer, a toe drain shall be installed along the toe of the pad slope. Toe key location shall be determined by the professional engineer at the time of construction. Drain shall be encased in free draining aggregate of at least 3 cubic feet per linear foot of drain. Aggregate and pipe shall be wrapped with pipe filter wrap. Drain pipe shall day light as directed by the professional engineer.

Constructed embankments shall be finished to a smooth and uniform surface. Variation from the subgrade plane shall not be more than 0.25 ft. Free running water shall be drained from embankment materials prior to placement. When embankments are to be constructed against existing embankment or hillsides, constructed slopes that are steeper than 4:1 shall be brought up in layers keyed and benched into the existing materials. Where embankments encroach on stream channels or lakes, the largest available rock produced by excavation operations shall be placed at the toes of slopes to protect the embankments against erosion. The professional engineer reserves the right to modify the angle of slope on embankments during the construction process.

C. Pit Bottom Soils – Pit bottom is to be entirely in cut slopes from native and undisturbed material. Pit shall be scarified to a depth of 12” below nominal bottom elevation, and shall be disked or bladed until it is free from large clasts, brought to the proper moisture content (within 1% below to 3% above optimum) and compacted to not less than 95% of maximum dry density as determined in accordance with ASTM D696 standard Proctor. If soft/yielding subgrade conditions are encountered, stabilization may be required as determined by the professional engineer.

Where pit bottoms or portions of pit bottom must be constructed on fill materials, the professional engineer shall examine and approve the fill material; provide over-excavation, benching, compaction and testing requirements; and provide construction observation as necessary.

D. Pit Slope and Bank Soils – Pit slopes and bank or perimeter areas may be constructed from approved fill materials. These materials include, but are not limited to, reworked cuttings, native cut and imported materials. Pit slopes and areas on the top of bank shall be disked or rolled with a sheep’s foot or similar equipment until they are free from any protruding sharp clasts larger than 6 inches and with no clasts protruding more than 3 inches above the plane of the slope or bank. If soft/yielding subgrade conditions are encountered, stabilization may be required as determined by the professional engineer.

E. Anchor Trench Soils – An anchor trench shall be excavated as shown and the slopes of the trench shall be disked, raked and/or bladed until it is free from large clods and sharp clasts. Anchor trench backfill material shall be disked, raked, and/or bladed until it is free from clods or clasts over 6 inches diameter, and stockpiled until needed.

F. Anchor Trench Backfill – After installation of synthetic liner system as specified in this plan set, the edge of the liner is to be anchored as shown and covered with anchor trench backfill material as noted. Backfill is to be brought to proper moisture content (within 2% above or below optimum), and compacted

to not less than 95% of maximum dry density as determined in accordance with ASTM D698 – standard Proctor or as specified by the professional engineer.

G. Compaction - Perform all compaction with approved equipment well suited to location and material being compacted. Use heavy vibratory rollers for fill work and where heavy equipment is appropriate. In areas where a small amount of fill is necessary, a hand-operated compactor (whacker), will be required. Compact all site fills and embankments to 95% of standard Proctor density for all soil types unless directed otherwise by the professional engineer.

END OF SECTION

SECTION 2260 –SYNTHETIC LINING AND UNDERLAYMENT SYSTEM**PART I - GENERAL**Description of Work

This section covers the synthetic pit lining system and leak detection system, if required, and includes installation; liner and underlayment materials; anchor trench details, leak detection system; per manufacturer's installation guidelines, and warranty.

RELATED WORK SPECIFIED ELSEWHERE

Section 2200 – Excavation / Embankment

PART II - PRODUCTS

A. Polyethylene Liners – The liner material shall the mil thickness as indicated on the drawings and shall be high density polyethylene, black in color, denoted as GSE Smooth GeoMembrane as manufactured by GSE Lining Technology, Inc., or approved equal. The liner shall be manufactured from virgin resin specifically compounded for use as a hydraulic containment member.

B. Geosynthetic Clay Liner – shall be a factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needle punching, denoted as BentoLiner NSL Bentonite Lliner as manufactured by GSE Lining Technology, Inc., or approved equal.

C. Drain Rock Collection Wrap - shall be a porous woven synthetic fabric denoted as Mirafi N160 as manufactured by TenCate Geosynthetics or approved equal.

D. HyperNet – interstitial water conveyance material shall be 200 mil HyperNet Geonet drain mat as manufactured by GSE Lining Technology, Inc. or approved equal.

E. Perforated Drain and Riser Pipe shall be 4 inch diameter PVC meeting ASTM D 3034 & D 2729, or approved equal.

F. Leak Detection Collection Rock – shall be washed rounded ¾" to 1.5 inch diameter rock.

PART III - EXECUTION

A. Layout - The lining system shall be sized and fitted to the as-built constructed pit excavation as detailed in Section 2200 and per the manufacturer's installation guidelines contained in Appendix A of this plan set. Where practical, all liner seams shall be factory welded.

B. HyperNet Geonet - The geonet shall be installed per the configuration shown in Figure 4. The area to be lined shall be graded evenly and be free of loose or sharp protruding material from the pit floor, slopes or top bank. The geonet shall be installed per the manufacturer's installation guidelines.

GeoNet overlap shall be attached with 50 lbs. plastic zip ties as per the manufacturer's guidelines included in Appendix A or as specified by the professional engineer.

C. HDPE Liners – The liners shall be installed per the configuration shown in Figure 4 and per the manufacturer's guidelines included in Appendix A. The liners are to be laid perpendicular to the slope of the pit in contact with the underlayment and/or liner. If the liner is not entirely factory-seamed, field seams are to be staggered a minimum of 12 inches from underlayment or other liner seams. The contractor shall implement seaming or welding safeguards to ensure the no tears or burns affect the underlayment or adjacent liner materials. Field seams shall be observed by the professional engineer and tested per the manufacturer's guidelines.

D. Geosynthetic Clay Liners - The liners shall be installed per the configuration shown in Figure 4 and per the manufacturer's guidelines included in Appendix A with the exception of overlap distance. For this project, the clay liners shall overlap a minimum of 12 inches.

D. Leak Detection System – install per the drawings as required by the COGCC or Williams Production RMT Company. Carefully place drain rock and pipe to prevent damage to liner system.

END OF SECTION

SECTION 2280 –HYDROSTATIC TESTING

PART I - GENERAL

Description of Work

This section covers the hydrostatic integrity testing of the pit lining system and test reporting for pits geographically delineated in the COGCC's policy entitled "Notice to Operators Drilling Wells Within ¼ Mile of the Rim of the Roan Plateau in Garfield County, Pit Design, Construction and Monitoring Requirements", dated June 12, 2008; and COGCC email correspondence entitled "New Pit Requirements in the Piceance Basin", dated September 8, 2008.

PART II - PRODUCTS

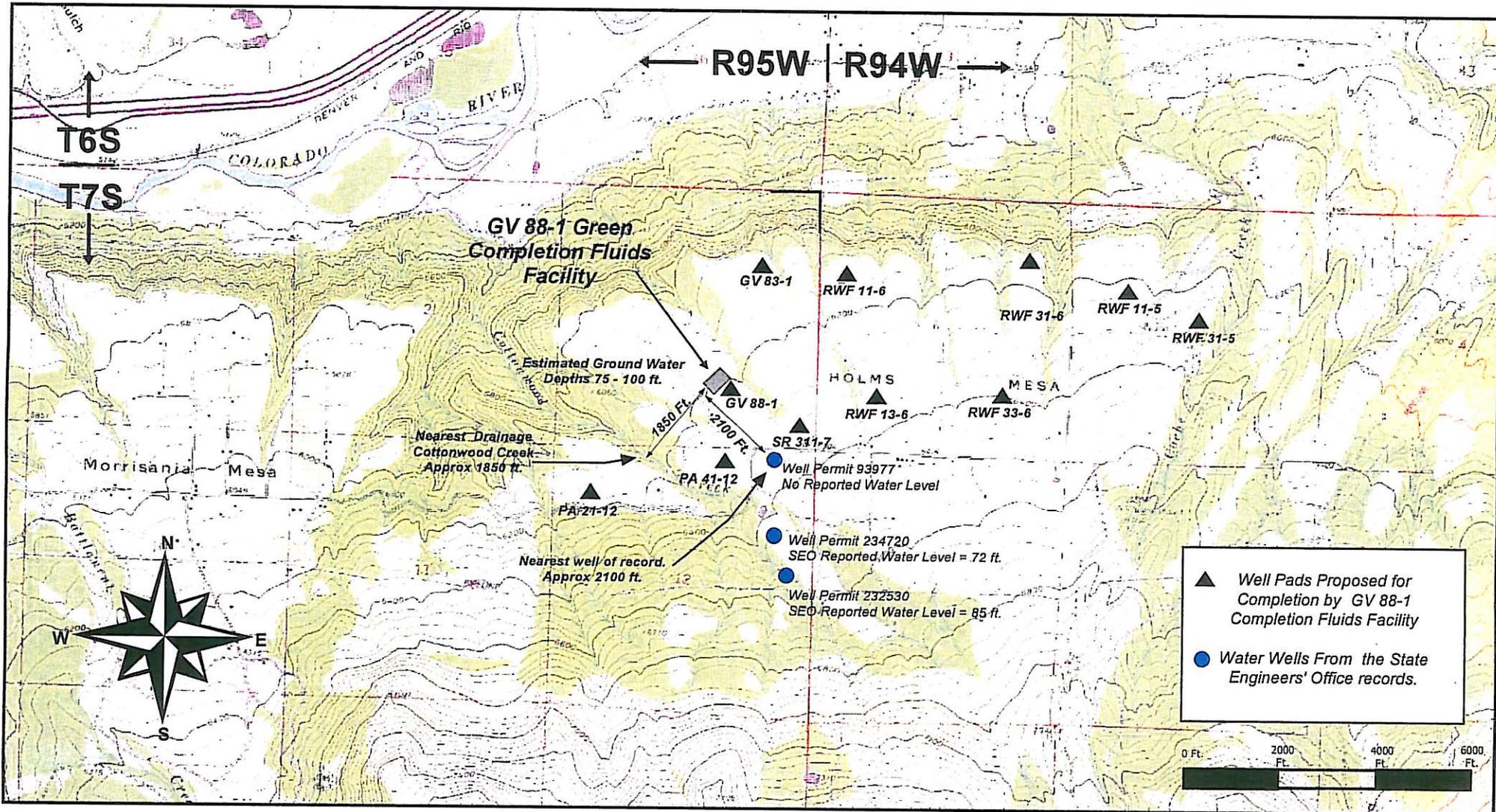
- A. Fresh Water – Untreated fresh water obtained from a legal water source and approved by the professional engineer shall be utilized for the hydrostatic integrity testing. Produced water may be used for the test subject to approval by the owner and the COGCC.

PART III - EXECUTION

- A. Hydrotesting – After complete installation of the liner system and prior to starting pit operations, the pit shall be filled with at least 4 feet, or 8 ft if required, of fresh or produced water, measured from the base of the pit and not to encroach into the 2 ft. freeboard. The owner or contractor shall monitor the pit for leaks for a period of 72 hours prior to draining the pit and commencing operations. Hydrostatic testing results shall be maintained by the Owner for the life of the pit and provide to the Colorado Oil and Gas Conservation Commission upon request.

Figure 1

**Williams Production RMT
COGCC Form 15 - Surface Water Impoundment
GV 88 - 1 Completion Fluids Facility Site Map**

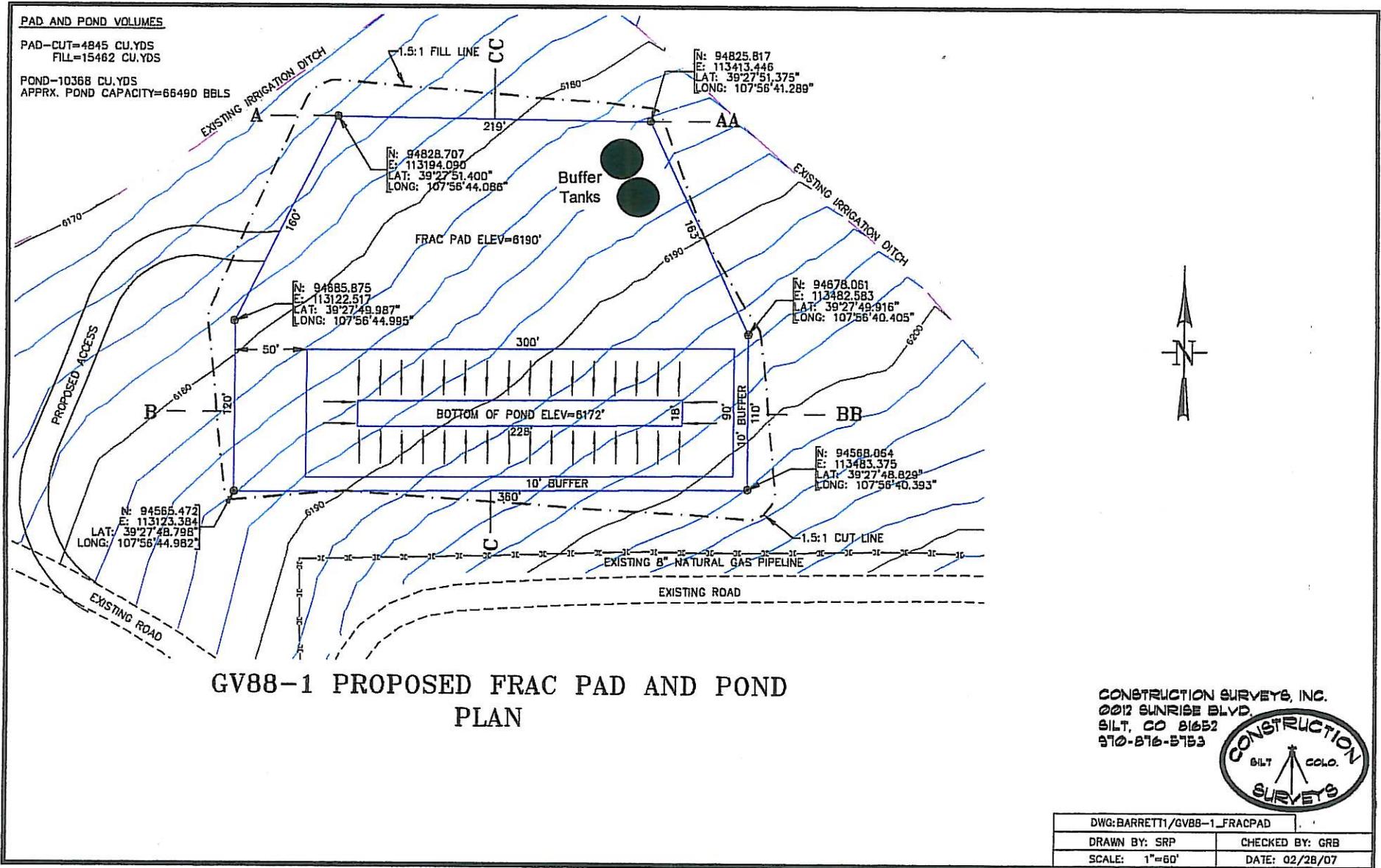


*USGS Quadrangle base map - Battlement Mesa, Co.

Prepared by: Fox Engineering Solutions, LLC
January 21, 2008

Figure 2

SITE PLAN

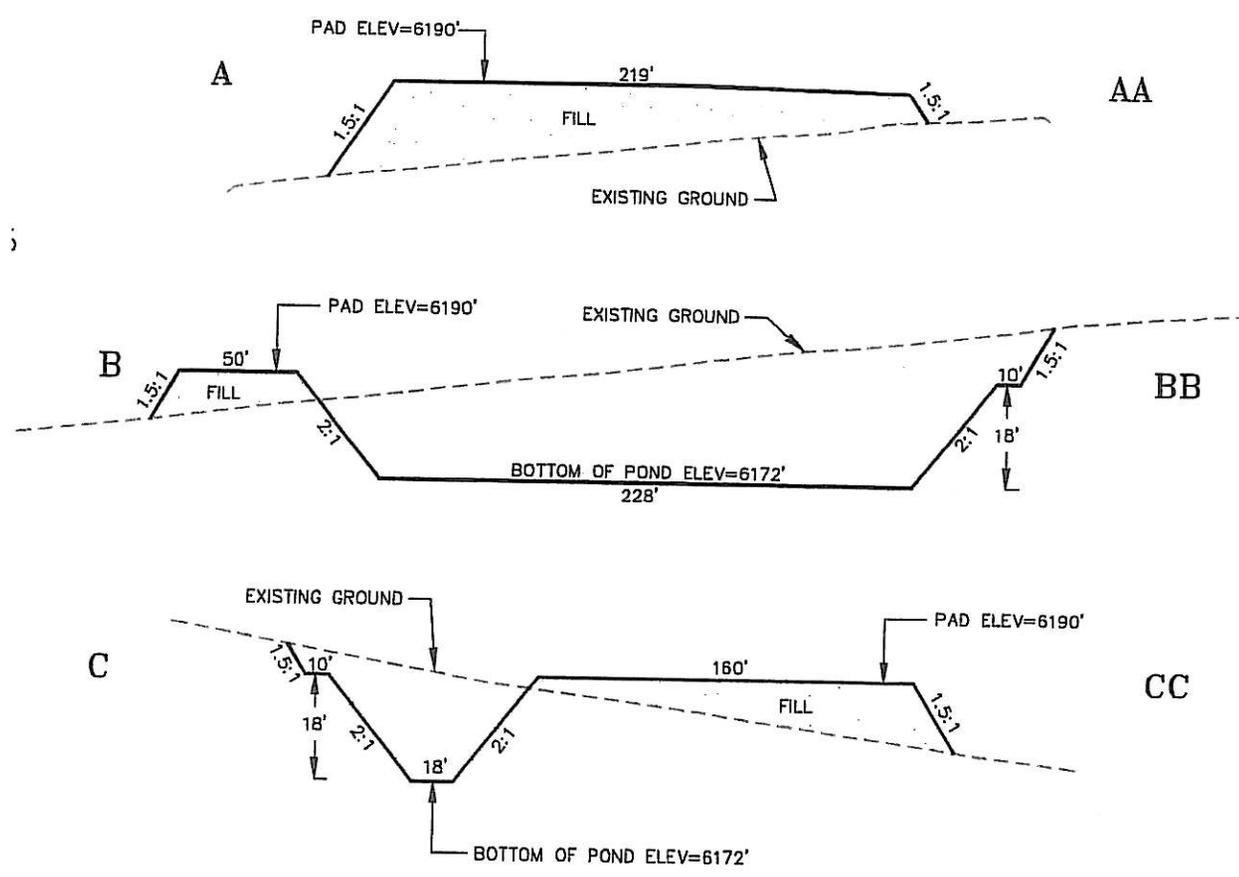


GV88-1 PROPOSED FRAC PAD AND POND PLAN

CONSTRUCTION SURVEYS, INC.
 2012 SUNRISE BLVD.
 SILT, CO 81652
 970-876-5753

DWG: BARRETT1/GV88-1_FRACPAD	
DRAWN BY: SRP	CHECKED BY: GRB
SCALE: 1"=60'	DATE: 02/28/07

Figure 3



SCALE: HORZ 1"=50', VERT 1"=20'

**GV88-1 PROPOSED FRAC PAD AND POND
X-SECTIONS**

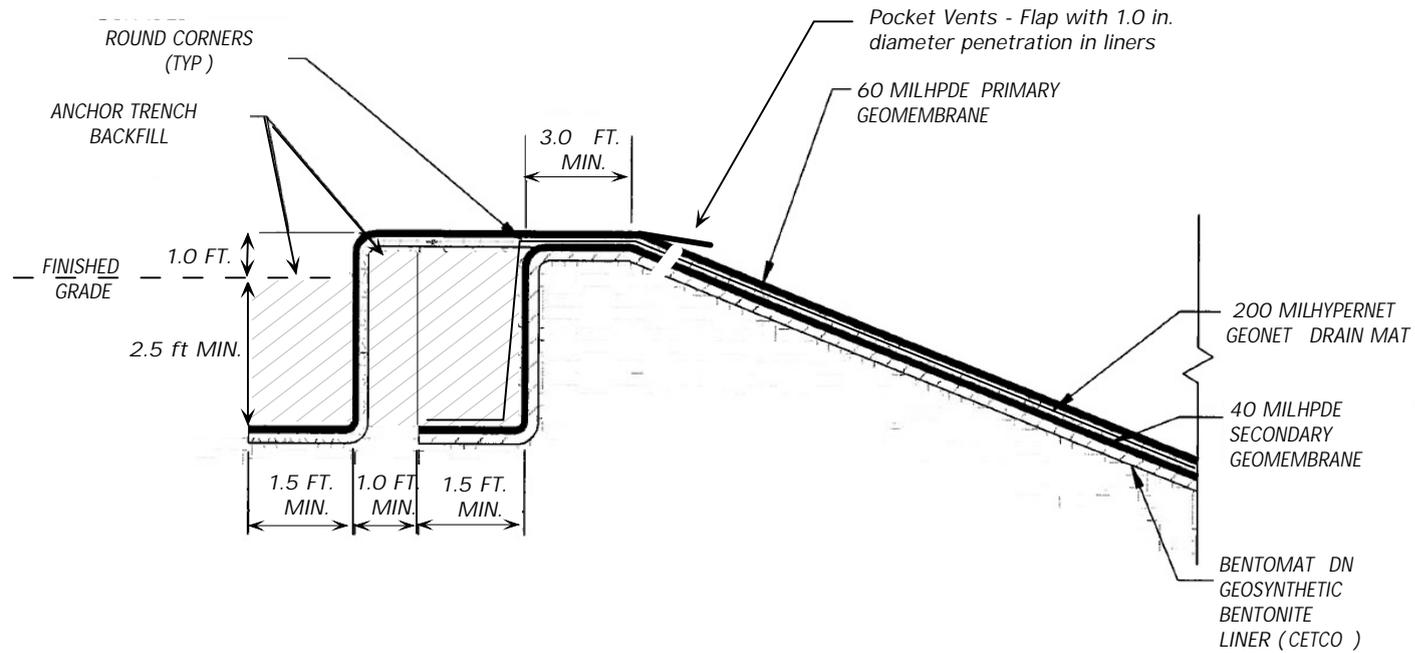
CONSTRUCTION SURVEYS, INC.
 2012 SUNRISE BLVD.
 SALT, CO 81652
 970-876-5753



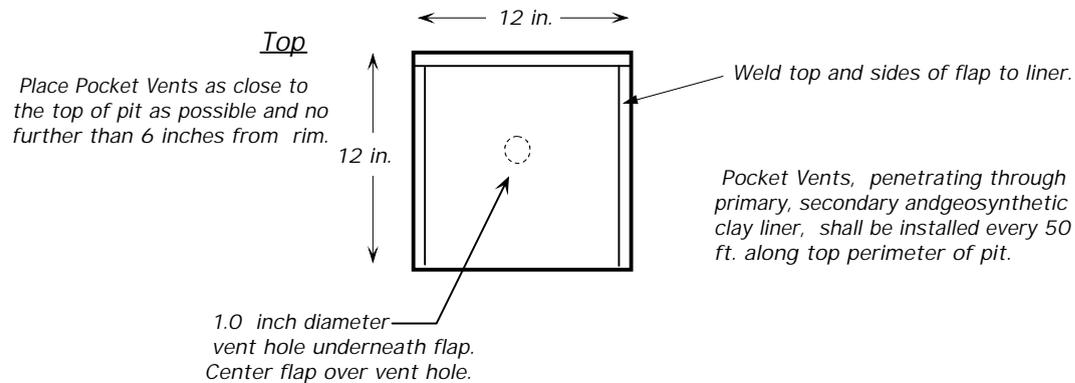
DWG: BARRETT1/GV88-1_FRACPAD	
DRAWN BY: SRP	CHECKED BY: GRB
SCALE: AS SHOWN	DATE: 02/28/07

Figure 4

Anchor Trench Details*



Pocket Vent Flap



* Subject to modification by liner manufacturer's installation instructions

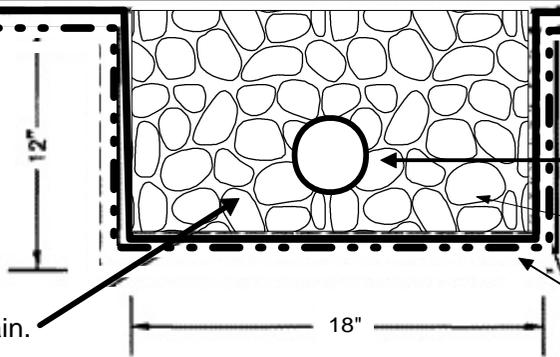
Figure 5

Liner & Leak Detection System Details

Pit Liner System:

- * 60 mil HDPE Liner)
- * 200 mil Hypernet Geonet Drain Mat
- * 40 mil HDPE Liner
- * BentoLiner NSL Geosynthetic Bentonite Liner

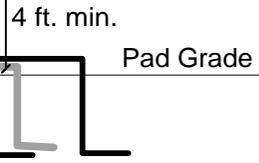
Place pipe 2" above bottom of collection drain.
Slope pipe toward deep end of pit.



- 4" Perforated PVC meeting ASTM D 3034 & D 2729.
- 3/4" - 1.5" rounded drain rock.
- Wrap collection drain rock in Mirafi Woven Fabric 160N or equal

Monitoring Stand Pipe with 4" PVC
Removeable Threaded Cap to be
located at deep end of pit. Place
steel fence posts for protection.

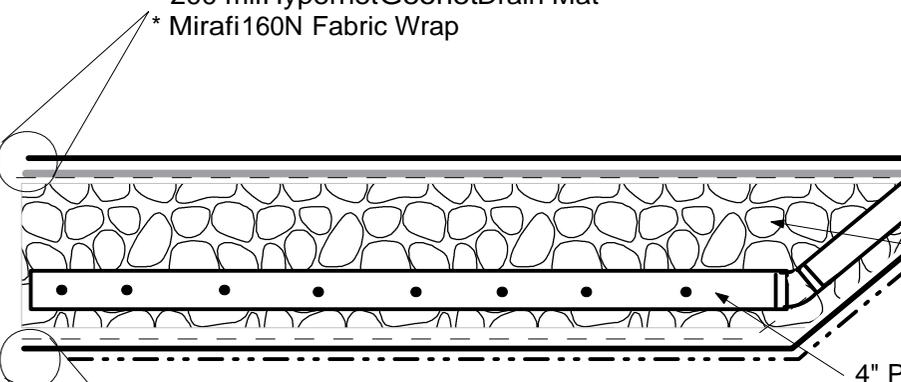
Install Pocket Vents per manufacturer's
recommendations every 50 liner feet along
perimeter at top of liner. Vent to perforate
both HDPE liners and clay liner.*



- * 60 mil HDPE Liner
- * 200 mil Hypernet Geonet Drain Mat
- * Mirafi 160N Fabric Wrap

Slope: As specified
in plan set.

See anchor trench detail.



- 4" PVC meeting ASTM D 3034 & D 2729.
- 3/4" - 1.5" round drain rock.
(No crushed gravel allowed.)
- 4" Perforated PVC meeting ASTM D 3034 & D 2729.

- * Mirafi 160N Fabric Wrap
- * 40 mil HDPE Liner
- * BentoLiner NSL Geosynthetic Bentonite Liner

* Install HPDE / Bentonite Liners;
Hypernet and Vent Pockets
per manufacturer's instructions except
where noted in the written specifications.

Exhibit A

Installation Quality Assurance Manual



Geomembrane Products





Table of Contents

1.0 Introduction..... 1

2.0 Standard Test Methods..... 1

3.0 Material Delivery..... 1

4.0 Earthwork..... 2

5.0 Panel Placement..... 2

6.0 Trial Welds..... 3

7.0 Geomembrane Field Seaming..... 5

8.0 Field Destructive Testing..... 6

9.0 Non-Destructive Testing..... 7

10.0 Defects & Repairs..... 8

11.0 Repair Procedures..... 8

12.0 As-Built Drawings..... 9

Appendix A: Inventory Check List Form..... 10

Appendix B: Subgrade Surface Acceptance Form..... 11

Appendix C: Panel Placement Log Form..... 12

Appendix D: HDPE & LLDPE Seam Strength Properties..... 13

Appendix E: Trial Weld Log Form..... 14

Appendix F: Seam Log Form..... 15

Appendix G: Destructive Test Log Form..... 16

Appendix H: Repair Log - Vacuum Test Form..... 17

Appendix I: Non-Destructive Log - Air Test Form..... 18

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1.0 INTRODUCTION

This manual provides an overview of the GSE Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the geomembrane products installed will perform for its intended purpose. In addition, all installation work will be performed in strict accordance per the customer's specifications. Please read the procedures below completely before you begin. If you need further clarification, contact the GSE Installation Department for assistance. Remember safety first and use safe practices always on every project.

2.0 STANDARD TEST METHODS

ASTM D 6392: Standard Test Methods For Determining The Integrity Of Non-Reinforced Geomembrane Seams Produced Using Thermo Fusion Methods

ASTM D 5820: Standard Practice For Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

ASTM D 5641: Standard Practice For Geomembrane Seam Evaluation By Vacuum Chamber

ASTM D 6497: Standard Guide For Mechanical Attachment of Geomembrane to Penetrations or Structures

ASTM D 7240: Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)

GRI Standard GM13: Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

GRI Standard GM14: Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes

GRI Standard GM17: Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

GRI Standard GM19: Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

3.0 MATERIAL DELIVERY

- A. Upon arrival on site, the GSE QA personnel will inventory all materials on the job site.
- B. Roll numbers of geomembrane will be logged on the Inventory Check List (Appendix A) and cross-referenced with the Bill of Lading for materials supplied by GSE.
- C. Copies of the Inventory Check List and signed Bill of Lading should be sent to the GSE's corporate headquarters while the QA personnel retains the original copies.



- D. Any visible damage to roll materials should be noted on the roll and Inventory Check List.

4.0 EARTHWORK

- A. The general contractor is responsible for preparing and maintaining the subgrade. The subgrade should be prepared and maintained per the job specifications.
- B. The GSE site manager shall be responsible for assuring that the subgrade surface has been properly prepared for deployment of geosynthetics. After each day's deployment the Subgrade Surface Acceptance form (Appendix B) will be signed by all parties.

5.0 PANEL PLACEMENT

- A. Each panel will be assigned a number as described below.
 - 1. When there is one layer, panels may be designated with only a number, i.e... 1, 2, 3, 4 etc.
 - 2. When two or more layers are required, use a letter and number, i.e....
 - Primary Liner P1, P2, P3, P4 etc...
 - Secondary Liner S1, S2, S3, S4 etc...
 - Tertiary Liner T1, T2, T3, T4 etc...
- B. This numbering system should be used whenever possible. Agreement to a panel numbering system should be made at the pre-construction meeting. However, it is essential that GSE and the owner representative and third party QA inspector agree.
- C. Panel numbers shall be written in large block letters in the center of each deployed panel. The roll number, date of deployment and length (gross) should be noted below the panel number. All notes should be made, so that they are easily visible from a distance. On long panels it is beneficial to write information on both ends.
- D. Panel numbers shall be logged on the GSE Panel Placement Log (Appendix C) along with the roll number and other information necessary to complete the form.
- E. If there is a partial roll left after deployment, it is important to write the last four digits of the roll number in several locations on the roll along with the estimated length for future identification.
- F. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:
 - 1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage. GSE Conductive should be installed with Conductive layer facing down.
 - 2. Place temporary ballast, such as sandbags, on geomembrane that will not damage the geomembrane and to prevent wind uplift.
 - 3. Personnel walking on geomembrane shall not engage in activities or wear shoes that could

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damage it. Smoking is not permitted on the geomembrane.

4. Do not allow heavy vehicular traffic directly on geomembrane. Rubber tired and tracked ATV's and equipment are acceptable if contact pressure is less than 8 psi.
 - a. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.
 - b. Prior to driving on any geomembrane layer, please check for sharp edges, embedded rocks, or other foreign objects that may protrude in the tires and tracks.
 - c. Path driven on geomembranes shall be as straight as possible with no sharp turns, sudden stops or quick starts.
 - d. Areas where driving occurs shall be continuously and thoroughly inspected throughout the deployment process by the contractor and the third party CQA.

6.0 TRIAL WELDS

- A. Seaming apparatus shall be allowed to warm up a minimum of 10 minutes before performing trial welds.
- B. Each seaming apparatus along with GSE welding technician will pass a trial weld prior to use. Trial welds to be performed in the morning and afternoon, as a minimum, as well as whenever there is a power shutdown.
- C. Fusion or wedge welds will always be performed or conducted on samples at least 6.0 ft long. Extrusion welds will be done on samples at least 3.0 ft long.

Note: Always perform trial welds in the same conditions that exist on the job. Run the trial welds on the ground, not the installed liner. Do not use a wind break unless you are using one on the job.

- D. Operating temperatures should be monitored while welding. The welding technician should verify that the equipment is capable of maintaining temperature while welding.
- E. Sampling Procedure
 1. Cut five 1.0 in wide specimens from the trial weld sample. Specimens will always be cut using a 1.0 in die cutter, so the peel values may be used for qualitative analysis.
 2. When cutting coupons from the trial weld samples, the inside and outside tracks on the coupon should be identified to assist in troubleshooting problems in case the weld fails. The outside track will be defined as the track, which would be peeled if pulling the overlap exposed in a typical installation, or the seam that is closest to the edge of the top sheet. The inside track is the seam closest to the edge of the bottom sheet.

F. Cutter

1. Only cut one sample at a time to avoid damaging the die cutter.
2. Samples should be free of sand and grit prior to cutting sample.
3. Inspect the die edge weekly for nicks, dents or signs of dullness. Dullness of the cutting edge may damage the units.
4. Remove die when edge has been dulled and lightly reshape it with a medium hand file. When wear is excessive return it for a replacement die.
5. When the cutting board becomes deeply scored and/or interferes with coupon cutting it should be replaced.
6. To adjust the depth of the die cut into the cutting board, after replacing the cutting board or sharpening the die, 0.015 in washer shims can be added or removed between the cutting ram and the ram extension. Only add shims when cutting is difficult due to lack of depth of cut.

G. Trial Weld Testing

1. Allow coupons to cool prior to testing. Avoid separating the coupons while hot as failure of the sheet may be initiated and false readings indicated.
2. In extreme heat the coupons may need to be cooled, using water or an insulated cooler prior to peel testing. Lab conditions specify 70 degrees (plus or minus 4 degrees) Fahrenheit. Coupon temperatures greater than 70 degrees may result in lowered strengths.
3. Visually inspect the coupons for squeeze-out, footprint, pressure and general appearance.
4. Each of the five coupons will be tested in peel on the field tensiometer at a separation rate of 2 in per minute (for HDPE). Shear tests, in addition to the peel tests, will be performed.

H. Pass/Fail Criteria

1. Criteria for passing trial welds will be as follows:
 - a. Seam must exhibit film tear bond (FTB). Trial welds should have no incursion into the weld.
 - b. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min).
 - c. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min).
 - d. Both tracks of fusion welded samples must pass for the trial weld to be considered acceptable. If any of the five coupons fail due to seam incursion (no FTB) or low strength values, the trial weld must be performed again.

- e. The GSE QA personnel will give approval to proceed with welding after observing and recording all trial welds.
2. All trial weld data will be logged on the GSE Trial Weld Log (Appendix E).
3. When logging fusion welded peel values on the GSE Trial Weld Log indicate the values for the outside track first, followed by the inside track.
4. Speed and temperature settings will be recorded for each machine trial weld as appropriate.

7.0 GEOMEMBRANE FIELD SEAMING

- A. The seam number takes the identity of the panels on each side. The seam between panels 1 & 2 becomes seam 1/2.
- B. Welding technicians will record their initials, machine number, date and time at the start of every seam and on the GSE Seam Log (Appendix F). The technician should also periodically mark temperatures along the seam and at the end of the seam.
- C. Approved processes for field seaming and repairing are fusion welding and extrusion welding. All welding equipment shall have accurate temperature monitoring devices installed and working to ensure proper measurement.
- D. Fusion welding shall be used for seaming panels together and is not used for patching or detail work. The GSE site manager shall verify that:
 1. The equipment used is functioning properly.
 2. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.
- E. Extrusion welding shall be used primarily for repairs, patching and special detail fabricating and may be used for seaming. The GSE site manager shall verify that:
 1. Equipment used is functioning properly.
 2. Welding personnel are purging the extrusion welders of heat degraded extrudate prior to actual use.
 3. All work is performed on clean surfaces and done in a professional manner. No seaming will be performed in adverse weather conditions.
- F. For seam preparation, the welding technician shall verify that:
 1. Prior to seaming, the seaming area is free of moisture, dust, dirt, sand or debris of any nature.
 2. The seam is overlapped properly for fusion welding.
 3. The seam is overlapped or extended beyond damaged areas at least 4.0 in when extrusion welding.



4. The seam is properly heat tacked and abraded prior to extrusion welding.
 5. Seams are welded with fewest number of unmatched wrinkles or "fishmouths".
- G. No seaming will be performed in ambient air temperatures or adverse weather conditions that would jeopardize the integrity of the liner installation.

8.0 FIELD DESTRUCTIVE TESTING

- A. Destructive seam tests shall be performed to evaluate bonded seam strength. The frequency of sample removal shall be one sample per 500 ft of seam, unless site specifications differ. Location of the destructive samples will be selected and marked by the QA technician or third party QA inspector. Field testing should take place as soon as possible after seam is completed.
- B. Samples should be labeled in numerical order, i.e. DS-1, DS-2 etc....This should carry thru any layer and or multiple ponds, do not start numbering from 1 again. The size of samples and distribution should be approximately 12 in x 39 in (Size may vary depending on job requirements) and distributed as follows:
1. 12 in x 12 in piece given to QA technician for field testing.
 2. 12 in x 12 in piece sent to the GSE's corporate headquarters for testing, if required.
 3. 12 in x 12 in piece given to third party for independent testing or to archive.

NOTE: All samples will be labeled showing test number, seam number, machine number, job number, date welded and welding tech number.

- C. The sample given to the QA technician in the field shall have ten coupons cut and be tested with a tensiometer adjusted to a pull rate as shown below. The strength of four out of five specimens should meet or exceed the values below, and the fifth specimen must meet or exceed 80% of the value below.
1. Seam must exhibit film tear bond (FTB). Welds should have $\leq 25\%$ incursion into the weld.
 2. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 1 for HDPE smooth or textured sheet (@ 2 in/min).
 3. Peel and shear values shall meet or exceed the values as listed in Appendix D, Table 2 for LLDPE smooth or textured sheet (@ 20 in/min).
- D. All weld destructive test data will be logged on the GSE Destructive Test Log (Appendix G).
- E. When logging fusion welded peel values on the GSE Destructive Test Log, indicate the values for the outside track first, followed by the inside track.
- F. Test results will be noted in the GSE Destructive Test Log as Pass (P) or Fail (F).

- G. If a test fails, additional samples will be cut, approximately 10 ft on each side of the failed test, and retested. These will be labeled A (After) & B (Before). This procedure will repeat itself until a sample passes. Then the area of failed seam between the two tests that pass will be capped or reconstructed.

9.0 NON-DESTRUCTIVE TESTING

- A. GSE shall non-destructively test all seams their full length using an air pressure or vacuum test. The purpose of this test is to check the continuity of the seam.
- B. For air pressure testing, the following procedures are applicable to those seams welded with a double seam fusion welder.
1. The equipment used shall consist of an air tank or pump capable of producing a minimum 35 psi and a sharp needle with a pressure gauge attached to insert into the air chamber.
 2. Seal both ends of the seam by heating and squeezing them together. Insert the needle with the gauge into the air channel. Pressurize the air channel to 30 psi. Note time test starts and wait a minimum of 5 minutes to check. If pressure after five minutes has dropped less than 2 psi then the test is successful (Thickness of material may cause variance).
 3. Cut opposite seam end and listen for pressure release to verify full seam has been tested.
 4. If the test fails, follow these procedures.
 - a. While channel is under pressure walk the length of the seam listening for a leak.
 - b. While channel is under pressure apply a soapy solution to the seam edge and look for bubbles formed by air escaping.
 - c. Re-test the seam in smaller increments until the leak is found.
 5. Once the leak is found using one of the procedures above, cut out the area and retest the portions of the seams between the leak areas per 4a to 4b above. Continue this procedure until all sections of the seam pass the pressure test.
 6. Repair the leak with a patch and vacuum test.
- C. For vacuum testing, the following procedures are applicable to those seams welded with an extrusion welder.
1. The equipment used shall consist of a vacuum pumping device, a vacuum box and a foaming agent in solution.
 2. Wet a section with the foaming agent, place vacuum box over wetted area. Evacuate air from the vacuum box to a pressure suitable to affect a seal between the box and geomembrane. Observe the seam through the viewing window for the presence of soap bubbles emitting from the seam.
 3. If no bubbles are observed, move box to the next area for testing. If bubbles are observed, mark the area of the leak for repair per section 11.0 and re-test per section 9.0.



Note: If vacuum testing fusion welded seams, the overlap flap must be cut off to perform the tests

4. All non-destructive tests will be noted in the GSE Non-Destructive Logs (Appendixes H-I).
- D. For spark testing GSE Conductive geomembranes, ASTM D 7240 will be the procedure, unless otherwise instructed by the engineer client.

10.0 DEFECTS & REPAIRS

- A. All seams and non-seam areas of the geomembrane lining system shall be examined for defects.
- B. Identification of the defect should be made using the following procedures:
 1. For any defect in the seam or sheet that is an actual breach (hole) in the liner, installation personnel shall circle the defect and mark with the letter P along side the circle. The letter P indicates a patch is required.
 2. For any defect that is not an actual hole, installation personnel shall circle the defect indicating that the repair method may be only an extruded bead and that a patch is not required.
 3. Each suspect area that has been identified as repair shall be repaired in accordance with section 11.0 and in the non-destructively testing per section 9.0. After all work is completed, the GSE site manager will conduct a final walk-through to confirm all repairs have been completed and debris removed. Only after this final evaluation by the GSE site manager, the owner, and the agent shall any material be placed over the installed liner.

11.0 REPAIR PROCEDURES

- A. Any portion of the geomembrane lining system exhibiting a defect that has been marked for repair may be repaired with any one or combination of the following procedures:
 1. Patching - used to repair holes, tears, undispersed raw materials in the sheet.
 2. Grind and Reweld - used to repair small sections of extrusion welded seams.
 3. Spot Welding - Used to repair small minor, localized flaws.
 4. Flap Welding - Used to extrusion weld the flap of a fusion weld in lieu of a full cap.
 5. Capping - Used to repair failed seams.
- B. The following conditions shall apply to the above methods:
 1. Surfaces of the geomembrane which are to be repaired shall be prepared according to this section.
 2. All surfaces must be clean and dry at the time of the repair.
 3. All seaming equipment used in repairing procedures shall be qualified.

DA-GS-102/2018

4. All patches and caps shall extend at least 4 in beyond the edge of the defect, and all patches must have rounded corners.
 5. All cut out holes in liner must have rounded corners of 3.0 in minimum radius.
- C. Patches should be labeled in numerical order, i.e. RP-1, RP-2, etc... This should carry through any layer and/or multiple ponds, and do not start with the number 1 again.

12.0 AS-BUILT DRAWINGS

As-built drawings are available per these items:

- A. As-built drawings will be provided at the completion of the project.
- B. AutoCad as-built drawings will be provided in either a printed version or by email in a PDF file.
- C. As-built drawings will include geomembrane panels and panel numbers with the last four digits of the roll number.
- D. Panel numbers and the full roll numbers will correspond with the GSE Panel Placement Log.
- E. All destructive testing and repair locations will be placed on the as-built drawings.

If you require further information, please contact the GSE Installation Department directly.



Appendix B: Subgrade Surface Acceptance

Subgrade Surface Acceptance

Date: _____

Project: _____ Site Manager: _____

Project #: _____

Location: _____ Partial: _____ Final: _____

This document only applies to the acceptability of surface conditions for installation of geosynthetic products. GSE does not accept responsibility for compaction, elevation or moisture content, nor for the surface maintenance during deployment. Structural integrity of the subgrade and maintenance of these conditions are the responsibility of the owner or earthwork contractor.

For GSE Lining Technology, LLC: _____ For Owner / Contractor _____

Acceptance Number: _____ Area Accepted: _____ s.f. Total Area Accepted to date: _____ s.f.

Appendix D: HDPE & LLDPE Seam Strength Properties

Table 1. HDPE Seam Strength Properties

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	81	65	52
60	121	98	78
80	162	130	104
100	203	162	130

Table 2. LLDPE Seam Strength Properties

Material (Mil)	Shear Strength (PPI)	Fusion Peel (PPI)	Extrusion Peel (PPI)
40	60	50	48
60	90	75	72
80	120	100	96
100	150	125	120



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Installation Quality Assurance Manual



GSE BentoLiner Fabric Encased Geosynthetic Clay Liner Products





Table of Contents

1.0	Introduction	1
2.0	Unloading Procedures.....	1
3.0	Storage.....	2
4.0	Subgrade Preparation.....	2
5.0	Deployment.....	3
6.0	Overlaps & Seams.....	3
7.0	Attachment Details.....	3
8.0	Anchoring.....	4
9.0	Repairs	4
10.0	Inspection	4
11.0	Cover Material	4
12.0	Hydration & Activation.....	5



1.0 INTRODUCTION

This manual provides an overview of the GSE Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the GSE BentoLiner GCL products installed will best perform for its intended purpose. In addition, all installation work will be performed in strict accordance per the customer's specifications. Please read the procedures below completely before you begin. If you need further clarification, contact the GSE Installation Department for assistance or please refer to ASTM D 6102, Standard Guide for Installation of Geosynthetic Clay Liners and ASTM D 5888, Standard Guide for Storage and Handling of Geosynthetic Clay Liners. Remember safety first and use safe practices always on every project.

2.0 UNLOADING PROCEDURES

As with all lifting or unloading operations, appropriate equipment and experienced personnel should be employed along with proper safe handling methods. The party responsible for unloading the GSE BentoLiner should contact GSE prior to shipment to determine the correct unloading methods and equipment if different from the pre-approved and specified methods as described below.

Lifting GCL rolls can typically be accomplished with by using a 2.5 in - 3.0 in (63 mm - 75 mm) outside diameter (O.D.) steel pipe (preferably solid), with a wall thickness capable of providing sufficient beam strength to support the weight of the roll, which average less than 3,000 lb (1,364 kg) and the length is approximately 18 ft (5.5 m). This core pipe is inserted through the hollow center of the GCL cardboard core. Heavy-duty slings or chains, which are approximately 10 ft (3.1 m) long, each are attached to each end of the pipe, which are then fastened to a I-beam spreader bar or a GSE approved alternative. Care should be taken to ensure that lifting chains or straps do not rub, chafe, or otherwise damage the GCL. A crane, backhoe, front-end loader or another suitable piece of construction equipment can then lift the entire assembly.

An all-terrain, extendable boom forklift, such as a Lull or Caterpillar Telehandler, can be fitted with a special, solid steel "carpet pole" or stinger, typically 14.0 ft (4.3 m) in length having an outside diameter of no more than 3.38 in (8.6 mm). The carpet pole can be inserted into the hollow cardboard core of the GCL roll.

The roll should not be fully suspended until the pole extends through the entire length of the core tube or you run the risk that the core may break creating additional handling and unloading difficulties

A properly structured and supported pole can be used to unload GCL rolls onsite. As an alternative, straps that are appropriately rated can be used as a GSE approved lifting method to unload GCL rolls. Lifting straps are supplied on every roll. Each GCL roll label contains roll weight information that should be consulted in determining appropriate lifting equipment and factors of safety.

The CQA inspector or owner's representative should verify that only appropriate handling equipment is utilized, i.e. equipment that does not pose any danger to personnel or undue risk of damage or deformation to the liner material.

All roll numbers should be recorded during the unloading operations and compared to shipping papers to ensure receipt of only project compliant materials. Furthermore, rolls should be visually inspected for damage and suspect rolls marked, recorded, and set aside for further investigation by CQA personnel.

3.0 STORAGE

While stored GCL needs to be kept dry and away from potential flooding or high storm runoff. On the job site storage methods include; storing the rolls tarped on pallets; storing the rolls under roof in a clean, dry protected area; and storing the rolls on a flat, dry, stable surface suitably covered with protective waterproof tarps. Rolls can be stacked as long as it is done in a manner that prevents them from rolling, shifting, or spontaneously moving. Maximum roll height should be determined by CQA personnel, but never more than can be safely managed considering site conditions, equipment and personnel.

Stored rolls should be tarped and remain in their original, unopened plastic shipping sleeves to prevent damage and undue prehydration prior to installation. Any rolls that come in contact with water should be examined by CQA or an owner's representative prior to installation. Prehydrated or physically damaged rolls should be set aside for further examination to determine the plausibility of repair or need to replace.

4.0 SUBGRADE PREPARATION

The surface upon which the GSE BentoLiner is installed should be smooth and free of wheel ruts, debris, roots, sticks, and rocks larger than 1.0 in (25 mm). Site specific compaction requirements should be followed in accordance with the project plans and specifications. At a minimum, the site should be smooth rolled the level of compaction such that installation equipment and other construction vehicles traffic does not cause rutting greater than 1.0 in (25 mm) deep. Furthermore, all protrusions extending more than 0.5 in (12 mm) from the subgrade shall be removed, crushed, or pushed into the subgrade.

In applications where the product is the sole barrier, subgrade surfaces consisting of gravel or granular soils may not be acceptable due to their large void content. For these applications, the subgrade shall be greater than 80% fines and contain no particles larger than 1 in (25 mm). In all high head, water containment applications, i.e. maximum water depth greater than 1 ft (30.5 cm), GSE recommends the use of a coated or laminated GCL such as GSE BentoLiner CNSL.

Immediately prior to deployment of the GCL, the subgrade shall be final compacted to fill in any remaining voids or desiccation cracks and to ensure that no sharp irregularities or abrupt elevation changes exist greater than 1.0 in (25 mm). The surfaces to be lined shall be maintained in this condition and free of standing water. GCL can be deployed on a frozen subgrade, if the subgrade would meet all the conditions as previously outlined if unfrozen.

The subgrade surface and preparation should be inspected and certified by the CQA inspector prior to GSE BentoLiner placement. Upon approval by the CQA inspector, it is the geosynthetic installer's responsibility to communicate to the engineer of any changes in the condition of the subgrade that might render it out of compliance, with any of the requirements of the project specification or ASTM

Standard D 6102.

5.0 DEPLOYMENT

As rolls are selected for deployment, the labels should be removed and recorded by the installer, along with any other pertinent information. The rolls should only be transported from the storage area using approved lifting equipment as described in section 2.0. The roll is supported during deployment, so that the fabric designated as the upper surface faces out, away from the installation vehicle. The free end of the roll can then be secured, while the vehicle supporting the roll slowly backs away, deploying the GCL as it moves. Alternatively, the free end can be manually pulled across an area to be lined by the installation crew while the equipment simply suspends the roll. Equipment traveling directly on GCL for deployment of overlying geosynthetics should be limited to lightweight ATVs maximum bearing capacity of 8.0 psi (34.5 kPa) or equivalent.

Successive panels are overlapped according to project specifications and/or within the overlap lines stenciled on the upper surface of each panel. Wherever possible, installation of GSE BentoLiner should begin at high elevation and proceed to low elevation. This allows any precipitation to accumulate and drain quickly without adversely affecting the GCL. The edges of exposed GCL should be weighted down with sandbags or equivalent ballast to prevent uplift in the event of substantially strong winds.

Only as much GSE BentoLiner as can be fully covered by the end of the day should be deployed or such amount that can be covered in a reasonably short time in the event of heavy precipitation. When GCL is being installed under a geomembrane, the leading edge should be folded back under the membrane at the end of the construction day. Temporary ballasting, such as sandbags, to prevent uplift and the infiltration of runoff water should secure the leading edge of the membrane.

GSE BentoLiner panels should be installed in a relaxed condition, free of wrinkles and folds. When fitting the product into small areas or around construction details, use a sharp utility or hook blade knife to cut the liner to the appropriate dimensions. Adjacent panels should overlap at the edges as described in section 6.0 below.

6.0 OVERLAPS & SEAMS

Unless specified differently adjacent lengthwise (longitudinal) seams should be overlapped a minimum of 6.0 in (150 mm). Granular bentonite should be used to augment all overlapped seams. Loose granular bentonite is placed between adjoining panels into the overlap area at a rate of 0.25 lb per linear foot (350 g per linear meter) of seam. Widthwise overlaps at the butt ends of rolls should be a minimum 12.0 in (300 mm). Seams should be shingled in a down slope direction, so that water flows across the seam from upslope sheet to the down slope sheet.

When the liner is cut to fit in small areas, i.e. into corners or around structures, adjacent panels should overlap a minimum of 1.0 ft (300 mm), adding abundant loose granular bentonite into the overlapped areas.

7.0 ATTACHMENT DETAILS

The product should be installed around penetrations, structures, pipes, structures and other appurte-

nances according to the contract drawings. GSE BentoLiner may be secured to appurtenances by use of a stainless steel batten or clamps, mechanical fasteners, or other appropriate device if necessary to minimizing movement. The use of additional granular bentonite or bentonite paste is recommended to maximize the seal around structures or protuberances.

8.0 ANCHORING

GSE BentoLiner is typically anchored in a trench around the perimeter of the lined area, which provides the required pullout resistance. In most cases, GCL can be anchored in the same trench as any adjacent geosynthetic liner components (if used). Dimensions and locations of the trench should be provided in the project drawings. Alternately, the material may be anchored by deploying additional run out of material, a minimum of 3.0 ft (1.0 m), past the slope crest and toe. Typically GCL should not be deployed in tension. The force holding the GCL in place should be provided by friction between the GCL and adjacent materials.

Steps should be taken to ensure that precipitation does not accumulate in the trench prior to backfilling. The GCL should only cover the front face and bottom of the anchor trench. The trench should be back filled and properly compacted prior to placing cover soil on the slopes.

9.0 REPAIRS

In the event an area of GSE BentoLiner becomes damaged, torn, or punctured during installation, the affected area should be repaired. On relatively level surfaces, the damaged area should be covered with a separate piece of GSE BentoLiner extending at least 12.0 in (300 mm) beyond the damaged area in every direction. Granular bentonite should be used to augment the patch overlays as is required for all other seams. Patches on side slopes can be temporarily secured with construction adhesive such as Liquid Nails or tape.

Areas that are exposed to standing water or excess precipitation with resulting bentonite hydration, typically as defined as greater than 30% moisture, prior to soil covering, should be examined for bentonite displacement and damage by subsequent activities. If it is determined that the GCL has been hydrated and damaged, the GCL should be covered with new material over the affected area or removed and replaced. All GSE BentoLiner material exposed to hydrocarbon fuels, chemicals, pesticides, non-compatible leachates, or other harmful liquids during the installation should be removed and replaced with non-affected material.

10.0 INSPECTION

Prior to soil covering the panels, penetrations and any other details should be visually inspected to ensure full coverage and proper orientation. Once the installed GSE BentoLiner material has been approved the next layer of geosynthetics or soil covering may be applied.

11.0 COVER MATERIAL

Only the amount of GSE BentoLiner GCL that can be anchored, inspected, and covered the same day should be installed. In cases where the GSE BentoLiner GCL is the sole hydraulic barrier, the GCL should be covered with the specified thickness of cover soil (a minimum 1.0 ft (300 mm)) immediately

following deployment. Where GSE BentoLiner GCL is used in conjunction with other membrane components, it should be covered with the geomembrane after placement, as soon as possible to protect it from the climatic elements.

When a geomembrane is being installed over the GCL, the leading edge of the GSE BentoLiner should be folded back under the geomembrane so that the geomembrane extends beyond the GCL a minimum of 2.0 ft (600 mm). The leading edge of the membrane should subsequently be weighted with sand bags or suitable ballast to safeguard against wind uplift and to prevent runoff water from undermining the liner.

When GSE BentoLiner is used with no overlying geomembrane, the soil cover should be placed within 2.5 ft (800 mm) of the leading edge of the GCL. The leading edge can then be covered with plastic sheeting that is folded under the exposed edge approximately 12.0 in (300 mm). Sand bags or suitable ballast should be placed on the liner to hold the plastic in place and to partially confine the GCL. The next morning the ballast and the plastic can be removed and subsequent rolls of GCL placed as described in section 5.0.

Cover soil placed directly on GCL should have a gradation to not damage or puncture the GCL. Cover soil should be free of all rocks greater than 0.75 in (18 mm) diameter, sharp or angular objects, sticks, roots or debris. Appropriate placement methods should be used at all times to protect the GCL. Compatibility of GSE BentoLiner GCL with the soil should be verified. Cover material should be pushed across the seams from top to bottom to prevent the cover material from lodging between the overlapped panel seams.

12.0 HYDRATION & ACTIVATION

In applications where the product is used as the sole hydraulic barrier, such as secondary containment, the GCL must first be hydrated with fresh water. Non-aqueous chemicals will not activate the bentonite. Therefore, bentonite hydration via rainwater or sprinkler and irrigation is necessary. When hydrated, the GSE BentoLiner is an excellent barrier to hydrocarbon fuels, fertilizers, and other such chemicals.

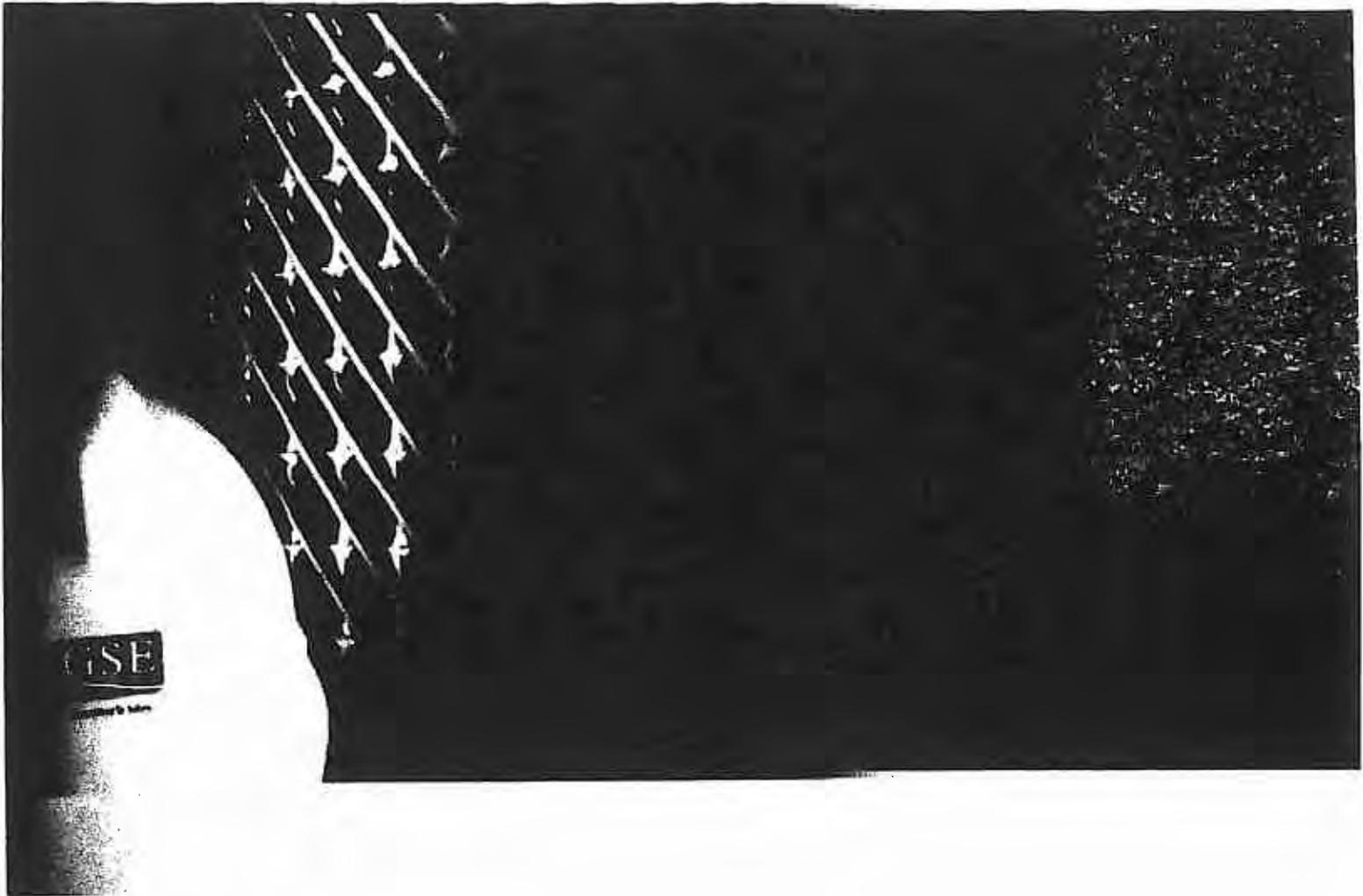
Only after the cover material has been placed should the GSE BentoLiner be allowed to hydrate. Once hydration has occurred no vehicles should be allowed to traffic the area directly above the GCL, unless minimum 1.0 ft (300 mm) separation exists between the GCL and the vehicle to adequately distribute the vehicle load. This should be increased to a minimum of 2.0 ft (600 mm) in high traffic areas such as roadways.

Periodic inspection of the liner to ensure proper coverage and adequate moisture content is recommended when GSE BentoLiner is used alone under a minimum 1.0 ft (300 mm) depth of cover soil. In arid regions, it may be necessary to irrigate the containment area, at a predetermined interval and/or a laminated or coated GCL used and deployed with the plastic component up in order to minimize desiccation and wet – dry cycling.



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Installation Quality Assurance Manual



Geonet & Geocomposite Products





Table of Contents

1.0	Introduction.....	1
2.0	Roll Packaging.....	1
3.0	Material Delivery.....	1
4.0	Unloading & Storage Procedures.....	1
5.0	Subgrade Preparation.....	1
6.0	Deployment.....	1
7.0	Overlaps & Seams	2
8.0	Cover Soil Placement	2
	Appendix A: Inventory Check List Form.....	3
	Appendix B: Certificate of Acceptance Form.....	4

1.0 INTRODUCTION

This manual provides an overview of the GSE Installation Quality Assurance procedures consistent with industry accepted practices to ensure that the geonet and geocomposite products installed will best perform for its intended purpose. In addition, all installation work will be performed in strict accordance per the customer's specifications. Please read the procedures below completely before you begin. If you need further clarification, contact the GSE Installation Department for assistance. Remember safety first and use safe practices always on every project.

2.0 ROLL PACKAGING

GSE geocomposite rolls shall be shipped from the factory in an opaque protective covering to prevent damage and UV degradation. However, GSE geonets do not need to be further protected from UV degradation during shipping or storage.

3.0 MATERIAL DELIVERY

- A. Upon arrival on site, QA personnel will inventory all materials on-site.
- B. Roll numbers of the geonet or geocomposite will be logged on the Inventory Check List (Appendix A) and cross-referenced with the Bill of Lading.
- C. Copies of the Inventory Check List and signed Bill of Lading should be sent to GSE corporate headquarters while the on-site QA personnel retains the original copies.
- D. Any visible damage to roll materials should be noted on the roll and Inventory Check List.

4.0 UNLOADING & STORAGE PROCEDURES

- A. Rolls of material shall be unloaded with equipment that will not damage the geonet or geocomposite.
- B. Fabric-straps, spreader bars, stinger bars, or other approved equipment shall be used for handling rolls of geonet and geocomposite.
- C. Materials should be stored in a flat, dry and well drained area.
- D. The surface shall be free of sharp rocks or other objects that could damage the materials.

5.0 SUBGRADE PREPARATION

The subgrade shall be free of sharp rocks or other objects that could otherwise cause damage to the materials.

6.0 DEPLOYMENT

Geonet and geocomposite shall be handled in a careful manner to ensure that it is not damaged in anyway.

- A. 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.

- B. In the presence of wind, the leading edge of the material shall be weighted with temporary ballasting, such as sandbags until the final cover is placed.
- C. Care shall be taken to assure that any underlying layers are not damaged during placement. Low ground pressure machines, such as ATV's to facilitate deployment over the geosynthetic layers is allowed. Low ground pressure machines are machines with a ground pressure less than 8 psi when carrying a driver weighing approximately 150 lbs.
- D. Care shall be taken to avoid entrapment of stones, mud and other materials during placement operations.

7.0 OVERLAPS & SEAMS

- A. The recommended geonet overlap in the machine direction is 3.0 in to 5.0 in. The recommended overlap in the transverse direction is 6.0 in to 12.0 in.
- B. On slopes the ends of the materials shall be shingled down in the direction of the slope.
- C. A plastic cable tie should be placed once per every five linear feet in the machine direction and once per every linear foot in the transverse direction.
- D. If the product is a geocomposite, the geotextile on the bottom shall be overlapped and the geotextile on top shall be overlapped, sewn or heat bonded. The exact seaming method or overlap is typically specified in project construction documents.

8.0 COVER SOIL PLACEMENT

- A. Prior to placement of cover soil, a Certificate of Acceptance (Appendix B) must be signed by a responsible party and an installer's representative.
- B. Any cover material, such as soil, that is placed over the drainage material shall be placed with care to assure the material is not damaged.
- C. Care shall be taken to minimize any movement of the geonet or geocomposite and to assure that no tensile stress is induced in the material.
- D. Cover soils deployed over the geonet or geocomposite should be free of all sharp objects, sharp rocks and sticks.
- E. Wide track equipment should be used to distribute cover soil over the geocomposite.
- F. A minimum of 12.0 in of cover soil is required to separate the equipment from the geocomposite to prevent damage.



Appendix B: Certificate of Acceptance

GSE Lining Technology, LLC
19103 Gundle Road
Houston Texas 77073
800-435-2008
281-443-8564
281-875-6010 Fax

Job No.: _____
Project: _____
Client: _____
Bill To: _____

Job Description: _____
% Complete of Total Job: _____

Certificate of Acceptance

Material	Estimated Square Feet	Final Quantity/Description

I, the undersigned, duly representative of:
Do hereby take over and accept the work described above from the date hereof and confirm to the best of my knowledge the work has been completed in accordance with specifications and the terms and conditions of the contract.

Name	Signature	Title	Date
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Certificate accepted by GSE Lining Technology, LLC Representative.

Name	Signature	Title	Date
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01/15/11 10:00 AM



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