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Volume 3, Part 1 of 3: Engineering Design and Calculations

STATE OF NEW MEXICO
DIRECTOR OF OIL CONSERVATION DIVISION

IN THE MATTER OF THE APPLICATION OF DNCS PROPERTIES, LLC FOR A SURFACE WASTE MANAGEMENT FACILITY PERMIT

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

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VOLUME III: ENGINEERING DESIGN AND CALCULATIONS

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APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

1.0 INTRODUCTION

DNCS Environmental Solutions (DNCS Facility) is a proposed Surface Waste Management Facility for oil field waste processing and disposal services. The proposed DNCS Facility is subject to regulation under the New Mexico Oil and Gas Rules, specifically 19.15.36 NMAC, administered by the Oil Conservation Division (OCD). The Facility has been designed in compliance with 19.15.36 NMAC, and will be constructed and operated in compliance with a Surface Waste Management Facility Permit issued by the OCD. The Facility is owned by, and will be constructed and operated by, DNCS Properties, LLC.

1.1 Description

The DNCS site is comprised of a 562-acre ± tract of land located south of NM 529 in portions of Section 31, Township 17 South, Range 33 East; and in the northern half of Section 6, Township 18 South, Range 33 East, Lea County, NM. A portion of the 562-acre tract is a drainage feature that will be excluded from development. The drainage feature includes a 500-ft setback and totals 67 acres ±. The DNCS Facility will include two main components; a liquid oil field waste Processing Area (177 acres ±), and an oil field waste Landfill (318 acres ±); therefore the DNCS Facility comprises 495 acres ±. Oil field wastes are anticipated to be delivered to the DNCS Facility from oil and gas exploration and production operations in southeastern NM and west Texas. The Site Development Plan provided in the **Permit Plans, Sheet 3**, identifies the locations of the Processing Area and Landfill facilities.

2.0 DESIGN CRITERIA

This Section, "Engineering Design" is provided as a summary of the engineering design elements for the DNCS Landfill and Processing Facility. The Engineering Design has been developed in accordance with the Oil and Gas Rules. More specifically, 19.15.36.17.A

NMAC requires an "Engineering Design Plan" for evaporation, storage, treatment and skimmer ponds. In addition, the construction standards for these facilities are also addressed in compliance with 19.15.36.17.B NMAC. Engineering requirements specific to landfills as referenced in 19.15.36.14.C-F NMAC, including landfill design standards, liner specifications, requirements for the soil component of composite liners, and the leachate collection and removal system are addressed herein. The Engineering Design also addresses the requirements of 19.15.36.13.M NMAC pertaining to the control of run-on and runoff from the 25-year, 24 hour design storm (**Volume III.4** and **Permit Plans, Attachment III.1.A**).

Compliance with the design standards is demonstrated on the **Permit Plans** listed in **Table III.1.1**, which are sealed by Mr. I. Keith Gordon, P.E., of Gordon Environmental, Inc., a New Mexico Professional Engineer with extensive experience in geotechnical engineering and waste containment design employing geosynthetics. The **Permit Plans** are provided for reference in **Attachment III.1.A** as 11 x 17 inch (in.) plots and are also submitted as "D" size sealed plots (i.e., 24 x 36 in.) as part of this Application for Permit.

Table III.1.1
List of Permit Plans
DNCS Environmental Solutions

Sheet No.	Title
1.	Cover Sheet and Drawing Index
2.	Existing Site Conditions
3.	Site Development Plan
4.	Landfill Base Grading Plan
5.	Landfill Final Grading Plan
6.	Landfill Cross Sections
7.	Landfill Completion Drainage Plan
8.	Liner System and Cover Details
9.	Leachate Collection System Details
10.	Stormwater Drainage Details
11.	Processing Area Layout
12.	Evaporation Pond Details
13.	Evaporation Pond and Stabilization/Solidification Area Cross Sections
14.	Processing Area Cross Sections

3.0 LANDFILL DESIGN STANDARDS

The proposed DNCS Landfill will be located within "eastern tract" (318 acres ±) as shown on the **Permit Plans, Sheet 3** (**Attachment III.1.A**). The DNCS Landfill disposal footprint will be approximately 234 acres ± in size with a depth from the top of the 15-foot (ft) perimeter berm to the base grades of approximately 20 ft on the east end and 50 ft on the west end. The base grades of the Landfill are in excess of 100 ft from groundwater. The Landfill consists of nine independent units (Units 1 through 9), each having an independent leachate collection system, cleanout riser, and collection sump located at the west end (**Permit Plans, Sheet 4**).

3.1 Liner System

A double liner and leak detection system design is proposed for the DNCS Landfill. An alternate liner system is being proposed that meets the requirements of 19.15.36.14.C NMAC demonstrated as equivalent in the United States Environmental Protection Agency (USEPA) Hydrologic Evaluation of Landfill Performance (HELP) Model (**Volume III.4)** and has a demonstrated track record for long-term waste containment performance. The liner system consists of, from top to bottom:

- 24-in. protective soil/leachate drainage layer (on-site soils with permeability $\geq 5.2 \times 10^{-4}$ cm/sec)
- 60-mil HDPE primary liner
- 200-mil HDPE geonet leak detection layer
- 60-mil HDPE secondary liner
- Geosynthetic Clay Liner (GCL)
- 6-in. soil compacted subgrade

The liner system is designed to meet the performance requirement of no more than one foot of leachate on the primary liner as required in 19.15.36.14.F NMAC and demonstrated in the HELP Model (**Volume III.4**).

HDPE material is proposed for the leachate collection layer, leak detection layer and liners as HDPE has proven to be the preferred material for waste containment facilities due to its durability and resistance to degradation by waste constituents. **Volume III.6** provides documentation regarding HDPE material compatibility in compliance with

19.15.36.14.D.(2)(a) NMAC.

3.2 Leachate Collection and Leak Detection System

The leachate collection system designed for the Landfill consists of an alternate 2-ft protective soil/leachate collection layer consisting of "SM" soil material with a permeability of $\geq 5.2 \times 10^{-4}$ centimeters per second (cm/sec). The leak detection system layer will incorporate a 200-mil geonet specifically prescribed for this application (**Permit Plans)**. With a design transmissivity of 1×10^{-3} square meters per second (m^2/sec), the geonet will provide fluid flow potential superior to the prescriptive soil leak detection layer of 2 ft of pervious soils (19.15.36.14.C.(3) NMAC and 19.15.36.14.C.(5) NMAC). This fact has been demonstrated in the HELP Model (**Volume III.4**).

The leachate collection layer slopes at 2.8% to a 6-in. diameter standard dimension ratio (SDR) 11 high density polyethylene (HDPE or Sch 80 PVC) perforated leachate collection pipe to the center of the units and is directed at a 2% slope to the leachate collection sumps on the west end of the Landfill (**Permit Plans, Sheet 4**). The leak detection geonet slopes at 2.8% to the center of the units and is directed at a 2% slope to each of the nine leak detection sumps located on the west end of the Landfill (**Permit Plans, Sheet 4**). Each of the sumps is approximately 2 ft deep and contains ¾-in. to 2.0-in. diameter pre-qualified select aggregate installed on and wrapped in a geotextile cushion placed over the HDPE liners. Classification criteria for the aggregate are specified in the Liner Construction Quality Assurance (CQA) Plan (**Volume II.7**), which state that it not be angular (i.e., sharp edges which could damage the liners) or calcareous (which could degrade over time).

The fluids collected in the leachate collection and leak detection sumps will be monitored and collected by separate 12-in. diameter sidewall riser pipes, that do not penetrate the liners, in compliance with 19.15.36.14.C.(10) NMAC. The piping is demonstrated to resist degradation by the waste constituents as documented in the Geosynthetic Application and Compatibility Documentation (**Volume III.6**).

The leachate collection system pipe will consist of a minimum 6-in. diameter perforated SDR 11 HDPE. The leachate collection and leak detection sump riser pipes will consist of a 12-in. diameter, SDR 11 HDPE; and will be perforated or slotted for the bottom 2 ft depth within the sump (i.e., 8 ft length at 4:1 slope). HDPE piping has shown superior characteristics for waste containment applications vs. the Schedule (SCH) 80 polyvinylchloride (PVC) specified in the Oil and Gas Rules; and has a greater wall thickness as shown on **Tables III.1.2** and **III.1.3**. The piping is demonstrated to resist degradation by the waste constituents as documented in the Geosynthetic Application and Compatibility Documentation (**Volume III.6**).

TABLE III.1.2
Comparison of 6-in. Diameter PVC and HDPE Leachate Collection Pipe
DNCS Environmental Solutions

Characteristic	6-in. Diameter Leachate Collection Pipe	
	Schedule 80	SDR 11 HDPE
Dimension Ratio	15.3	11.0
Method of Joining	Gasketed/Glued	Welded
Manning's Number (n)	0.009	0.010
Outside Diameter (in.)	6.625[1]	6.625[2]
Min. Wall Thickness (in.)	0.432[1]	0.602[2]
Tensile Strength (psi)	5,000	5,000
Modulus of Elasticity (psi)	400,000	130,000
Flexural Strength (psi)	14,450	135,000

Notes:
*[1]Handbook of PVC Pipe, pg. 340 (**Attachment III.1.G**)*
*[2]PolyPipe, A-4 (**Attachment III.1.G**)*

TABLE III.1.3
Comparison of 12-in. Diameter PVC and HDPE Sump Riser Pipe
DNCS Environmental Solutions

Characteristic	12-in. Diameter Leachate and Leak Detection Riser Pipes	
	Schedule 80	**SDR 11 HDPE**
Dimension Ratio	18.6	11.0
Method of Joining	Gasketed/Glued	Welded
Manning's Number (n)	0.009	0.010
Outside Diameter (in)	12.75[1]	12.75[2]
Min. Wall Thickness (in.)	0.687[1]	1.159[2]
Tensile Strength (psi)	5,000	5,000
Modulus of Elasticity (psi)	400,000	130,000
Flexural Strength (psi)	14,450	135,000

Notes:
*[1]Handbook of PVC Pipe, pg. 340 (**Attachment III.1.G**)*
*[2]PolyPipe, A-4 (**Attachment III.1.G**)*

The details in the **Permit Plans**, **Sheet 10** reflect the deployment of SDR 11 HDPE piping for the leachate collection pipe and leak detection sump riser pipes. HDPE flat stock or four layers of geonet will be placed beneath the beveled edge of the perforated risers in the sumps to prevent potential liner damage (**Permit Plans**). Solid-wall HDPE piping will extend from above the sumps to the permanent wellheads shown on the **Permit Plans**.

The entire leachate collection system will be covered by 2 ft of protective soil with a hydraulic conductivity greater than or equal to $\geq 5.2 \times 10^{-4}$ cm/sec. The HELP Model, provided in **Volume III.4**, confirms that the design meets the requirements of 19.15.36.14.F NMAC.

The leachate collection system and protective soil cover on the top of the liner system in the Landfill will protect the floor and sidewall liner by providing ballast and blocking sunlight (i.e., UV rays), with the upper sections of sidewall liner secured by the anchor trench as depicted on the **Permit Plans**.

3.3 Landfill Final Cover System

The final cover for the top of the Landfill will utilize the prescriptive final cover (defined by 19.15.36.14 (C) (8) NMAC) and consists of the following layers:

- 12-in. soil erosion layer
- 12-in. protection layer
- 12-in. drainage layer (w/saturated hydraulic conductivity $\geq 1 \times 10^{-2}$ cm/sec)
- 60-mil HDPE liner
- 12-in. foundation layer
- Oil Field Waste and soil compacted to 80% Standard Proctor

The sideslopes will utilize an alternative cover system consisting of the following:

- 12-in. erosion layer
- 24-in. infiltration layer
- Oil Field Waste and soil compacted to 80% Standard Proctor

On-site soils will be used to construct the final cover, and the cap will be placed as the Landfill reaches final grades. The Landfill will have 4:1 design sideslopes with drainage benches spaced at a vertical distance of approximately 30-ft; and a top slope of 5%. The final cover (sideslope) was modeled using the HELP Model (**Volume III.4**), and results indicate that percolation through the cover will not exceed that of the bottom liner as required in 19.15.36.14.C.(9) NMAC.

4.0 LANDFILL CONSTRUCTION

Construction of the Landfill will be accomplished by constructing individual cells within the units. Detailed Construction Plans and Technical Specifications will be prepared for the proposed DNCS Landfill cells and submitted to several pre-qualified Liner Installation Contractors for quotes. The cell excavation, construction, floor grading/compaction, and geosynthetics installation will be subject to the rigorous CQA standards specified in the Liner CQA Plan (**Volume II.7**).

OCD will be provided a major milestone schedule in advance of construction; and will be notified via e-mail or phone at least 3 working days prior to the installation of the primary liner. An Engineering Certification Report, sealed by a Professional Engineer with expertise in geotechnical engineering, will be submitted to OCD documenting compliance of completed construction with the Permit, regulatory requirements, industry standards, and the plans and specification.

The Engineering Design, as demonstrated by the Volumetric Calculations (**Volume III.2**) deliberately provides a "sustainable" configuration that does not require the import of off-site soils. The materials equation provides an excess of soils excavated (i.e., cut) and fill for the cover and perimeter berms. The in-situ and on-site fill soil will be pre-qualified in accordance with the CQA Plan (**Volume II.7**). At least one Standard Proctor Density test will be conducted in the laboratory for each 5,000 cubic yards of subgrade soils, fill material or a change in subgrade material. These tests will be the basis for field density measurements during construction (i.e., 90% standard Proctor dry density) conducted at a minimum frequency of 4 tests/acre/lift.

Fill for the berms will be placed in horizontal compacted lifts that do not exceed 12-in. in thickness. The subgrade surface will be inspected to confirm the absence of any deleterious materials, abrupt changes in slope, evidence of erosion, etc. The compliance of the completed subgrade construction will be confirmed prior to secondary liner installation, and documented in the Engineering Certification Report.

The 60-mil HDPE secondary liner will be installed for the proposed Cells in direct contact with the prepared and certified subgrade liner in accordance with the CQA Plan (**Volume II.7**). Installation of the geonet; geotextile, aggregate and riser pipes in the sumps will follow. The installation of all soil and geosynthetic components will meet or exceed the requirements of 19.15.36.14.C NMAC, as detailed in the CQA Plan. Finally, the primary liner will be constructed, and liner/leak detection/leachate collection system elements (i.e., secondary, geonet, primary) will be secured in the common anchor trench at the top of the Landfill sideslope**.** The anchor trench will be carefully backfilled with select on-site soils

compacted to 90% of standard Proctor dry density by mechanical and/or hand-tamping devices as required by the CQA Plan. Documentation will be provided in the Engineering Certification Report submitted to OCD upon completion of construction.

5.0 POND DESIGN STANDARDS

The designs for the Ponds are identical, except that Pond elevations are different depending on their site location (**Permit Plans, Sheets 12** and **13; Attachment III.1.A**). Each pond is approximately 420 ft east-west by 200 ft north-south as measured at the top of the surrounding berms, for a footprint of 2.0 ± acres each. The floor of the ponds is designed with a 2% slope to facilitate drainage in the leak detection system to the two sumps in each basin situated on the interior sidewall.

Because the berms have a uniform top elevation, the 2% floor slope creates a pond depth that ranges from a maximum of 12 ft to a minimum of just less than 8 ft. The maximum water depth occurs at the sump locations and does not exceed 8.5 ft. Maintaining a high water elevation of 3,966 ft in the Phase I Ponds; 3,965.5 ft in the Phase III Ponds; and 3,965 ft in the Phase IV Ponds; will provide a freeboard in excess of 3.5 ft in each pond. This is more than adequate to meet the 3 ft minimum freeboard standard; while also accommodating the minimal impact potential of rainfall or wave action (**Volume III.12**). The resultant capacity of each pond is approximately 9.5 acre-ft, not including freeboard, below the maximum 10 acre-ft volume prescribed by 19.15.36.17.B(12) NMAC.

Section 5.0 (Pond Construction) below and the CQA Plan (**Volume II.7**) provide documentation on the installation of berms, soil subgrade, and geosynthetics. Exceeding the standards specified in 19.15.36.17.B(4) NMAC, both the exterior and interior sidewalls of all of the Ponds have design slopes of 3:1. The top platform of the berms surrounding the Ponds has a minimum design width of 10 ft, which is more than adequate for the 2 ft anchor trench shown on the **Permit Plans**; and to accommodate pipe risers.

5.1 Liner System

A double liner and leak detection system design is proposed for each pond. An alternate liner system is being proposed that meets the requirements of 19.15.36.17.B(9) NMAC and has a demonstrated track record for long-term waste containment performance. The pond liner system consists of, from top to bottom:

- 60-mil HDPE primary liner
- 200-mil HDPE geonet leak detection layer
- 60-mil HDPE secondary liner
- GCL under the leak detection sumps
- 6-in. compacted soil subgrade

HDPE material is proposed for the liners and leak detection layer as HDPE has proven to be the preferred material for waste containment facilities due to its durability and resistance to degradation by waste constituents. **Volume III.6** provides documentation regarding HDPE material compatibility in compliance with 19.15.36.17.B(3) NMAC

5.2 Leak Detection System

The leak detection system layer designed for the ponds consists of a 200-mil geonet specifically prescribed for these applications (**Permit Plans**). With a design transmissivity of 1×10^{-3} m^2/sec, the geonet will provide fluid flow potential superior to the prescriptive leak detection layer of 2 ft of pervious soils (19.15.36.17.B(9) NMAC).

The underlying 60-mil HDPE secondary liner, the 200-mil geonet leak detection layer, and the overlaying 60-mil HDPE primary liner, will slope at 2% to the 2 leak detection sumps located in each pond (**Permit Plans**). Fluids collected in the leak detection layer, which encompasses the entire footprint for each pond, are directed with the 2% slope to the leak detection sumps. Each of the sumps will be approximately 2 ft deep, as measured from the secondary liner to the primary liner. The sumps will contain ¾-in. to 2.0-in. diameter pre-qualified select aggregate installed on a geotextile cushion placed over the secondary liner. Classification criteria for the aggregate are specified in the CQA Plan (**Volume II.7**), which state that it not be angular (i.e., sharp edges which could damage the liners) or calcareous (which could degrade over time).

The fluids collected in the leak detection sumps will be monitored and removed through a 6-in. diameter, SDR 11 HDPE sidewall riser pipes that do not penetrate the liners. The leak detection sump riser pipes will be perforated or slotted for the bottom 2 ft depth within the sump (i.e., 6 ft length at 3:1 slope). HDPE piping has shown superior characteristics for waste containment applications vs. the SCH 80 PVC specified in the Oil and Gas Rules; and has a greater wall thickness as shown on **Table III.1.4**. The piping is demonstrated to resist degradation by the waste constituents as documented in **Volume III.6**.

TABLE III.1.4
Comparison of 6-in. Diameter PVC and HDPE Sump Riser Pipe
DNCS Environmental Solutions

Characteristic	6-in. Diameter Leak Detection Riser Pipes	
	Schedule 80	SDR 11 HDPE
Dimension Ratio	15.3	11.0
Method of Joining	Gasketed/Glued	Welded
Manning's Number (n)	0.009	0.010
Outside Diameter (in.)	6.625[1]	6.625[2]
Min. Wall Thickness (in.)	0.432[1]	0.602[2]
Tensile Strength (psi)	5,000	5,000
Modulus of Elasticity (psi)	400,000	130,000
Flexural Strength (psi)	14,450	135,000

Notes:
[1]*Handbook of PVC Pipe, pg. 340 (**Attachment III.1.G**)*
[2]*PolyPipe, A-4 (**Attachment III.1.G**)*

The details in the **Permit Plans** reflect the deployment of SDR 11 HDPE piping for the leak detection sump riser pipes. HDPE flat stock or four layers of geonet will be placed beneath the beveled edge of the perforated risers in the sumps to prevent potential liner damage (**Permit Plans**). Solid-wall HDPE piping will extend from above the sumps to the permanent wellheads shown on **Permit Plans**. The sidewall liners and leak detection geonet will be secured by the anchor trench as depicted on the **Permit Plans.**

6.0 POND CONSTRUCTION

Detailed Construction Plans and Technical Specifications will be prepared for the proposed Ponds, and submitted to several pre-qualified Liner Installation Contractors for quotes. The berm construction, floor grading/compaction, and geosynthetics installation will be subject to the rigorous CQA standards specified in **Volume II.7**.

OCD will be provided a major milestone schedule in advance of construction; and notified via email or phone at least 3 working days prior to the installation of the primary liner in compliance with 19.15.36.17.B(10) NMAC. An Engineering Certification Report, sealed by a Professional Engineer with expertise in geotechnical engineering, will be submitted to OCD documenting compliance of completed construction with the Permit, regulatory requirements, industry standards, and the plans and specification.

The Engineering Design presented on the **Permit Plans** (**Attachment III.1.A**) deliberately provides a "sustainable" configuration that does not require import of off-site soils. The materials equation provides a balance between soils excavation (i.e., pond) and fill for the sidewalls. The in-situ and on-site fill soil will be pre-qualified in accordance with the CQA Plan (**Volume II.7**). At least one standard Proctor dry density test will be conducted in the laboratory for each pond footprint, 5,000 cubic yards (cy) of fill material for berms, or change in subgrade material. These tests will be the basis for field density measurements during construction (i.e., 90% standard Proctor dry density) conducted at a minimum frequency of 4 tests/acre/lift.

Fill for the berms will be placed in horizontal compacted lifts that do not exceed 12 in. in thickness. The subgrade surface will be inspected to confirm the absence of any deleterious materials, abrupt changes in slope, evidence of erosion, etc. The compliance of the completed subgrade construction shall be confirmed prior to secondary liner installation, and documented in the Engineering Certification Report.

The double liner and leak detection system design, planned for the ponds, consists of proven technology with a demonstrated track record of long-term waste containment performance. The secondary liner proposed for the ponds, consists of a smooth 60-mil HDPE

geomembrane placed in direct contact with a prepared and compacted soil subgrade, certified in accordance with the CQA Plan (**Volume II.7**). The same HDPE material will be used for the primary liner and the geonet for the leak detection layer. HDPE has proven to be the preferred material for waste containment facilities due to its durability and resistance to attack by waste constituents.

Volume III.6 provides documentation regarding liner and leak detection material compatibility in compliance with 19.15.36.17.B(3) NMAC. An additional layer of 60-mil HDPE (22.5 ft x 40 ft ±) will be welded above the primary Pond liner where active wastewater discharge will occur (**Permit Plans**). This will protect the Pond liner from excessive hydrostatic force or mechanical damage. External discharge lines and leak detection system discharge lines will not penetrate the liner. The CQA Plan (**Volume II.7**) provides the most current technical specifications for the geosynthetics.

Fluid in the Ponds will protect the floor and lower sidewall liner by providing ballast and deflecting sunlight (i.e., UV rays). The upper sections of pond sidewall liner will be secured by the anchor trench. The anchor trench will be carefully backfilled with select on-site soils compacted to 90% of standard Proctor dry density by mechanical and/or hand-tamping devices (per the CQA Plan). Documentation will be provided in the Engineering Certification Report submitted to OCD upon completion of construction.

Although the freeboard zone of the pond sidewall liner will be exposed to the elements, recent research indicates that exposed HDPE in similar environments has a functional longevity in excess of 25 years (**Attachment III.1.B**). GEI has inspected several similar water storage ponds in New Mexico and has found exposed geomembrane liners to be functionally intact after over 25 years.

7.0 POND OPERATION

Detailed plans for the operation of the Ponds are prescribed in the Operations, Maintenance, and Inspection Plan (**Volume II.1**). Essentially, it is anticipated that some fluids will accumulate in the leak detection sumps as a result of condensation, construction water, etc. As described in **Volume II.1**, the leak detection sumps will be monitored at least monthly for

the presence of fluids, which may be extracted and tested when the level in the sump(s) exceeds 24 in. A reduced monitoring frequency may be proposed to OCD dependent upon historical results. The design of the Ponds allows for isolation of potential leaks into isolated drainage basins, facilitating necessary evaluation or repair by allowing each pond to be emptied.

8.0 PROCESS AREA TANK CONTAINMENT

As proposed in this Application, produced water receiving tanks, produced water settling tanks, and the crude oil receiving tanks depicted in **Attachment III.1.C** and oil sales tanks as depicted in **Attachment III.1.D** will be installed in the excavated tank farm as shown on the **Permit Plans**. Detailed operations of the tanks are described in the Operations, Maintenance, and Inspection Plan (**Volume II.1**), and a schematic of the process area is provided in **Attachment III.1.E**. The tanks will be constructed with an underlying, continuous, system which is designed to capture any fluids within the watershed of the tank farm.

The secondary containment liner in the tank area is a 30-mil polyester liner (XR-5 8130 Reinforced Geomembrane). The use of the XR-5 8130 Reinforced Geomembrane in the tank area is primarily based on the chemical compatibility and puncture resistance of the material compared to either PVC or HDPE material. The chemical resistance of the XR-5 material exceeds the chemical compatibility of either PVC or HDPE to hydrocarbon products (see Chemical Resistance Chart, Page 13, "Technical Data and Specifications for XR-5", **Attachment III.1.H**). Since PVC material has marginal chemical resistance in a hydrocarbon environment, physical properties of the XR-5 geomembrane (**Attachment III.1.H**) are compared to 60-mil HDPE geomembrane (**Attachment III.1.I**) as shown in **Table III.1.5**:

TABLE III.1.5
Physical Properties: XR-5 8130 Reinforced Geomembrane
and 60-mil HDPE Geomembrane
DNCS Environmental Solutions

Property	XR-5 8130	60-mil HDPE
Thickness	30-mil	60-mil
Tear Strength	40 lbs	42 lbs
Puncture Resistance	275 lbs	108 lbs
Break Strength	400 lbs/in.	228 lbs/in.
Break Elongation	25%	700%
Hydrostatic Resistance	800 psi	> 450 psi
Hydraulic Conductivity	1×10^{-12} cm/sec	2×10^{-13} cm/sec
Seam Properties		
Shear Strength	500 lbs	120 lbs/in.
Peel Strength	40 lbs/2 in.	91 lbs/in.

The necessary storage capacity for the interconnected tank/containment system will be sufficiently managed by the proposed lined volume of the Ponds. In the unlikely event of a total failure of all affected storage units, the contents of the tanks will flow into the ponds, which have a lined storage capacity of 884,400 barrels (bbl) ± (excluding freeboard). When the freeboard is included, the storage capacity of the ponds is over 1,714,600 bbl, which results in a net surplus of over 830,200 bbl. The entire volume of the proposed receiving tanks will be 70,000 bbl, providing a net excess capacity of over 760,200 bbl. Thus, the Ponds will hold the entire volume of the receiving/settling tanks within the required permanent freeboard of 3 ft.

The maximum proposed number of interconnected tanks is five 1,000 bbl tanks for a total of 5,000 bbl. Allowing for an additional 30% capacity will require a minimum of 6,500 bbl of bermed capacity in the tank farm. The containment area is conservatively sized to surround the entire tank farm, which results in a holding capacity of 13,100 bbl, and is 12,100 bbl greater than the capacity of the largest tank (1,000 bbl) and 6,600 bbl greater than the combined connected tank volume, including a 30% factor of safety within the containment area. Therefore the containment area surrounding the receiving/settling tanks is more than sufficient. Included in this Section is a spreadsheet (**Attachment III.1.F**), that identifies all of the proposed tanks and Evaporation Ponds in this Application.

9.0 STABILIZATION AND SOLIDIFICATION AREA

The design for the stabilization and solidification (S&S) area relies on many of the Pond design characteristics, except that the S&S area is designed to allow dump trucks and tanker trucks delivering materials that require stabilization and/or solidification to discharge directly into the S&S area from a concrete unloading pad. (**Attachment III.1.A**). The S&S area covers approximately 5-acres and measures 660 ft east-west by 330 ft north-south at the top of the surrounding berms. The floor of this area is designed with a 2% slope to facilitate drainage on the liner and in the leak detection system to collect in a sump situated along the east sidewall of the area.

Because the three perimeter berms have a uniform top elevation, the 2% floor slope creates a pond depth that ranges from a minimum of 5 ft at the unloading pad to a maximum of 20 ft at the sump along the eastern perimeter berm. The bottom liner slope allows for a 5-ft-thick protective and operational cover on the liner. This slope also provides operation capacity for the S&S function proposed for this area while providing the capacity to meet the 3 ft minimum freeboard standard and accommodating the minimal impact potential of rainfall. The resultant capacity of the S&S area is approximately 5.6 acre-ft, not including freeboard, well below the maximum 10 acre-ft volume prescribed by 19.15.36.17.B(12) NMAC.

Section 5.0 (Pond Construction) and the CQA Plan (**Volume II.7**) provide documentation on the installation of berms, soil subgrade, and geosynthetics. Exceeding the standards specified in 19.15.36.17.B(4) NMAC, both the exterior and interior sidewalls of S&S area have design slopes of 3:1. The top platform of the berms surrounding the S&S area has a minimum design width of 10 ft, which is more than adequate for the 2 ft anchor trench.

9.1 Liner System

As with the Ponds, the S&S area is designed with a double liner and leak detection system proposing the same alternate liner system that meets the requirements of 19.15.36.17.B(9) NMAC and has a demonstrated track record for long-term waste containment performance. The S&S Area liner system consists of, from top to bottom:

- 5 ft protective soil and operational layer
- 60-mil HDPE primary liner
- 200-mil HDPE geonet leak detection layer
- 60-mil HDPE secondary liner
- GCL under the leak detection sumps
- 6-in. compacted soil subgrade

HDPE material is proposed for the liners and leak detection layer as HDPE has proven to be the preferred material for waste containment facilities due to its durability and resistance to attack by waste constituents. **Volume III.6** provides documentation regarding HDPE material compatibility in compliance with 19.15.36.17.B(3) NMAC

9.2 Leak Detection System

The leak detection system layer designed for the S&S area consists of a 200-mil geonet specifically prescribed for these applications. With a design transmissivity of 1×10^{-3} m^2/sec, the geonet will provide fluid flow potential superior to the prescriptive leak detection layer of 2 ft of pervious soils (19.15.36.17.B(9) NMAC).

The underlying 60-mil HDPE secondary liner, the 200-mil geonet leak detection layer, and the overlaying 60-mil HDPE primary liner, will slope at 2% to the leak detection sump located on the eastern berm of the S&S area. Fluids collected in the leak detection layer, which encompasses the entire footprint of the S&S area, are directed with the 2% slope to the leak detection sump. This sump will be approximately 2 ft deep, as measured from the secondary liner to the primary liner. The sump will contain ¾-in. to 2.0-in. diameter pre-qualified select aggregate installed on a geotextile cushion placed over the secondary liner. Classification criteria for the aggregate are specified in the CQA Plan (**Volume II.7**), which state that it not be angular (i.e., sharp edges which could damage the liners) or calcareous (which could degrade over time).

The fluids collected in the leak detection sump will be monitored and removed through a 12-in. diameter, SDR 11 HDPE sidewall riser pipe that does not penetrate the liners. The leak detection sump riser pipe will be perforated or slotted for the bottom 2 ft depth within the

sump (i.e., 6 ft length at 3:1 slope). HDPE piping has shown superior characteristics for waste containment applications vs. the SCH 80 PVC specified in the OCD standards; and has a greater wall thickness as shown on **Table III.1.4**. The piping is demonstrated to resist degradation by the waste constituents as documented in **Volume III.6**. The details in the **Permit Plans** reflect the deployment of SDR 11 HDPE piping for the leak detection sump riser pipe.

HDPE flat stock or four layers of geonet will be placed beneath the beveled edge of the perforated riser in the sump to prevent potential liner damage. Solid-wall HDPE piping will extend from above the sump to the permanent wellhead shown on the **Permit Plans**. The sidewall liners and leak detection geonet will be secured by the anchor trench as depicted on the **Permit Plans**.

9.3 Stabilization & Solidification Area Construction

Detailed Construction Plans and Technical Specifications will be prepared for the proposed S&S area, and submitted to several pre-qualified Liner Installation Contractors for quotes. The berm construction, floor grading/compaction, and geosynthetics installation will be subject to the rigorous CQA standards specified in **Volume II.7**.

OCD will be provided a major milestone schedule in advance of construction; and notified via email or phone at least 3 working days prior to the installation of the primary liner in compliance with 19.15.36.17.B(10) NMAC. An Engineering Certification Report, sealed by a Professional Engineer with expertise in geotechnical engineering, will be submitted to OCD documenting compliance of completed construction with the Permit, regulatory requirements, industry standards, and the plans and specification.

The Engineering Design presented on the **Permit Plans** (**Attachment III.1.A**) deliberately provides a "sustainable" configuration that does not require import of off-site soils. The materials equation provides a balance between soils excavation (i.e., S&S area) and fill for the sidewalls. The in-situ and on-site fill soil will be pre-qualified in accordance with the CQA Plan (**Volume II.7**). At least one standard Proctor dry density test will be conducted in the laboratory for the S&S area footprint, 5,000 cubic yard (cy) of fill material for berms, or

change in subgrade material. These tests will be the basis for field density measurements during construction (i.e., 90% standard Proctor dry density) conducted at a minimum frequency of 4 tests/acre/lift.

Fill for the berms will be placed in horizontal compacted lifts that do not exceed 12 in. in thickness. The subgrade surface will be inspected to confirm the absence of any deleterious materials, abrupt changes in slope, evidence of erosion, etc. The compliance of the completed subgrade construction shall be confirmed prior to secondary liner installation, and documented in the Engineering Certification Report.

The double liner and leak detection system design planned for the S&S area consists of proven technology with a demonstrated track record of long-term waste containment performance. The secondary liner proposed for the area, consists of a smooth 60-mil HDPE geomembrane placed in direct contact with a prepared and compacted soil subgrade, certified in accordance with the CQA Plan (**Volume II.7**). The same HDPE material will be used for the primary liner and the geonet for the leak detection layer. HDPE has proven to be the preferred material for waste containment facilities due to its durability and resistance to attack by waste constituents. **Volume III.6** provides documentation regarding liner and leak detection material compatibility in compliance with 19.15.36.17.B(3) NMAC. Leak detection system discharge lines will not penetrate the liner. The CQA Plan (**Volume II.7**) provides the most current technical specifications for the geosynthetics.

Protective cover in the S&S area will protect the floor and lower sidewall liner by providing ballast and deflecting sunlight (i.e., UV rays). The upper sections of S&S area sidewall liner will be secured by the anchor trench (**Permit Plans**). The anchor trench will be carefully backfilled with select on-site soils compacted to 90% of standard Proctor dry density by mechanical and/or hand-tamping devices (per the CQA Plan). Documentation will be provided in the Engineering Certification Report submitted to OCD upon completion of construction.

Although the freeboard zone of the S&S area sidewall liner will be exposed to the elements, recent research indicates that exposed HDPE in similar environments has a functional

longevity in excess of 25 years (**Attachment III.1.B**). GEI has inspected similar applications in New Mexico and has found exposed geomembrane liners to be functionally intact after over 25 years.

9.4 Stabilization and Solidification Area Operation

Detailed plans for the operation of the S&S area are prescribed in the Operations, Maintenance, and Inspection Plan (**Volume II.1**). To ensure compliance with the capacity limits imposed on the operation of this area, volumes in and out of this area will be tracked to document the volume in processing at any time. Equipment operating within the S&S area may be equipped with Global Positioning System (GPS) equipment (see **Attachment III.1.J** for information on the Computer Aided Earthmoving System provided by Caterpillar) to monitor the location of the equipment relative to the liner system. This system may be implemented to maintain adequate separation of equipment and the liner system during the stabilization and solidification operation. Material that has completed the S&S operation will be relocated to the Landfill for disposal. Solidification material will be excavated from borrow sources within the solid waste management facility.

10. FACILITY DRAINAGE DESIGN

The **Permit Plans**, **Attachment III.1.A,** show the stormwater management systems that will be employed to manage both run-on and runoff for the DNCS Landfill and Processing Facilities. The design event, pursuant to 19.15.36.13.M NMAC (i.e., 25-year, 24 hour storm) will be managed by a series of drainageways that surround the proposed Ponds, Processes, and Landfill and capture stormwater from other on-site areas.

Stormwater detention basins are planned for installation as shown on the **Permit Plans**; and the Stormwater Management Plan is included in **Volume III.3** that demonstrates the efficacy of the proposed system.

The berms surrounding the Landfill and processing area have a maximum exterior slope of 3:1, and an average height of less than 10 ft, minimizing the potential for soil erosion. The drainageways and detention basins will be regularly inspected and cleaned out, as necessary.

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.A

PERMIT PLANS

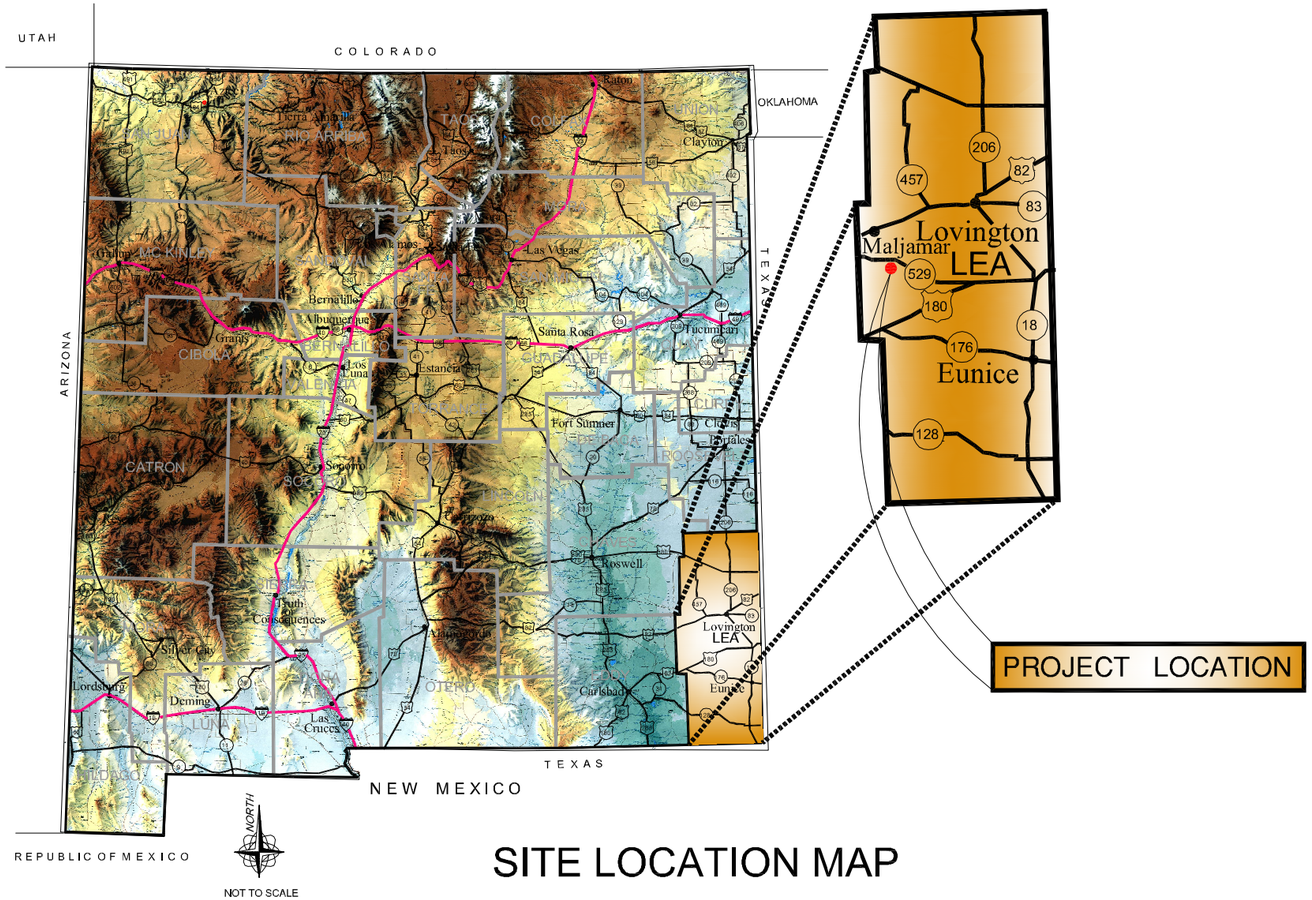
Sheet No.	Title
1.	Cover Sheet and Drawing Index
2.	Existing Site Conditions
3.	Site Development Plan
4.	Landfill Base Grading Plan
5.	Landfill Final Grading Plan
6.	Landfill Cross Sections
7.	Landfill Completion Drainage Plan
8.	Liner System and Cover Details
9.	Leachate Collection System Details
10.	Stormwater Drainage Details
11.	Processing Area Layout
12.	Evaporation Pond Details
13.	Evaporation Pond and Stabilization/Solidification Area Cross Sections
14.	Processing Area Cross Sections

PERMIT PLANS

FOR

DNCS ENVIRONMENTAL SOLUTIONS

LEA COUNTY, NEW MEXICO



SITE LOCATION MAP

NOT TO SCALE

SHEET	TITLE
01 COVER.DWG	1 COVER SHEET AND DRAWING INDEX
02 EXIST.DWG	2 EXISTING SITE CONDITIONS
03 SITE DEV.DWG	3 SITE DEVELOPMENT PLAN
04 BASE GRADES.DWG	4 LANDFILL BASE GRADING PLAN
05 FINAL GRADING.DWG	5 LANDFILL FINAL GRADING PLAN
06 X-SECTIONS.DWG	6 LANDFILL CROSS SECTIONS
07 DRAINAGE PLAN.DWG	7 LANDFILL COMPLETION DRAINAGE PLAN
08 LINER DET.DWG	8 LINER SYSTEM AND COVER DETAILS
09 LEACHATE DET.DWG	9 LEACHATE COLLECTION SYSTEM DETAILS
10 STORMWATER DET.DWG	10 STORMWATER DRAINAGE DETAILS
11 PROCESS AREA.DWG	11 PROCESSING AREA LAYOUT
12 EVAP POND DET.DWG	12 EVAPORATION POND DETAILS
13 EVAP X-SECT.DWG	13 EVAPORATION POND AND STABILIZATION/SOLIDIFICATION AREA CROSS SECTIONS
14 PROCESS X-SECT.DWG	14 PROCESSING AREA LAYOUT CROSS SECTIONS

I. KEITH GORDON, P.E.
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COVER SHEET AND DRAWING INDEX

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

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Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 10/21/2013	CAD: 01 COVER.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 1 of 14
APPROVED BY: IKG	geik@gordonenvironmental.com	

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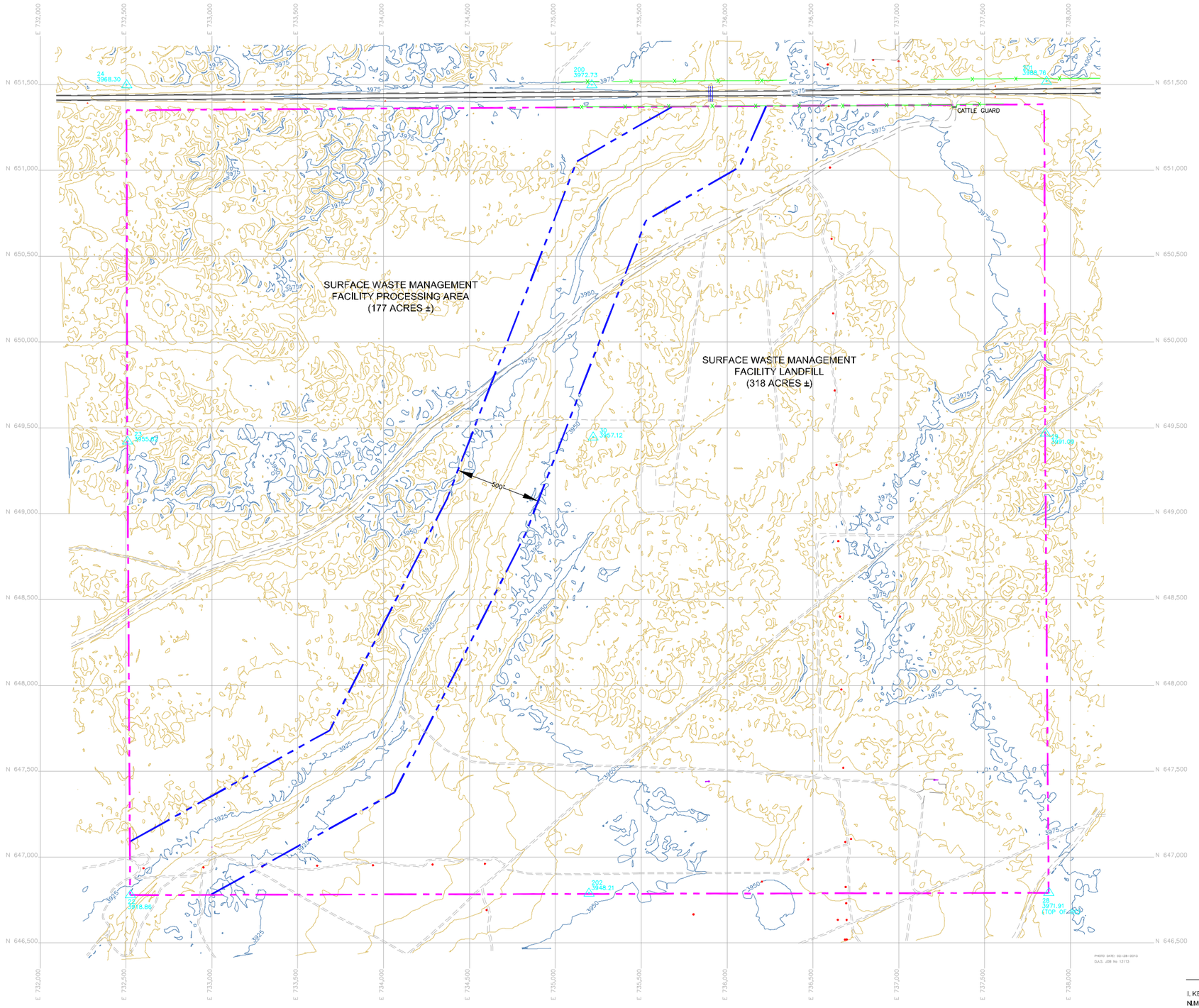

LEGEND

- SITE BOUNDARY (562 ACRES±)
- DRAINAGE FEATURE SETBACK (67 ACRES±)
- 3975 — 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- EXISTING FENCE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- POWER POLE
- CULVERT
- CATTLE GUARD
- ROAD SIGN
- ABANDONED WELL
- 203 3988.76 — SURVEY CONTROL POINT
- N 650,500 / E 738,000 — SITE GRID

SURVEY CONTROL POINT DATA			
POINT	NORTHING	EASTING	ELEVATION
22	646780.31	732525.87	3918.86
23	649422.09	732509.41	3955.82
24	651498.31	732504.10	3968.30
28	646793.35	737874.03	3971.91
29	649469.84	737853.32	3991.09
30	649446.48	735220.56	3957.12
200	651498.13	735212.57	3972.73
201	651518.82	737859.97	3988.76
202	646789.93	735196.38	3948.21

NOTES:

1. BASE MAP PROVIDED BY DALLAS AERIAL SURVEYS, INC
2. FIELD SURVEY PROVIDED BY PETTIGREW & ASSOCIATES PA (12/13/2012)
3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

NORTH

0 300 600

PHOTO DATE: 02-28-2013
D.A.S. JOB No 13113

I. KEITH GORDON, P.E.
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EXISTING SITE CONDITIONS

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

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213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 10/21/2013	CAD: 02 EXIST.DWG	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 2 of 14
APPROVED BY: IKG	gei@gordonenvironmental.com	

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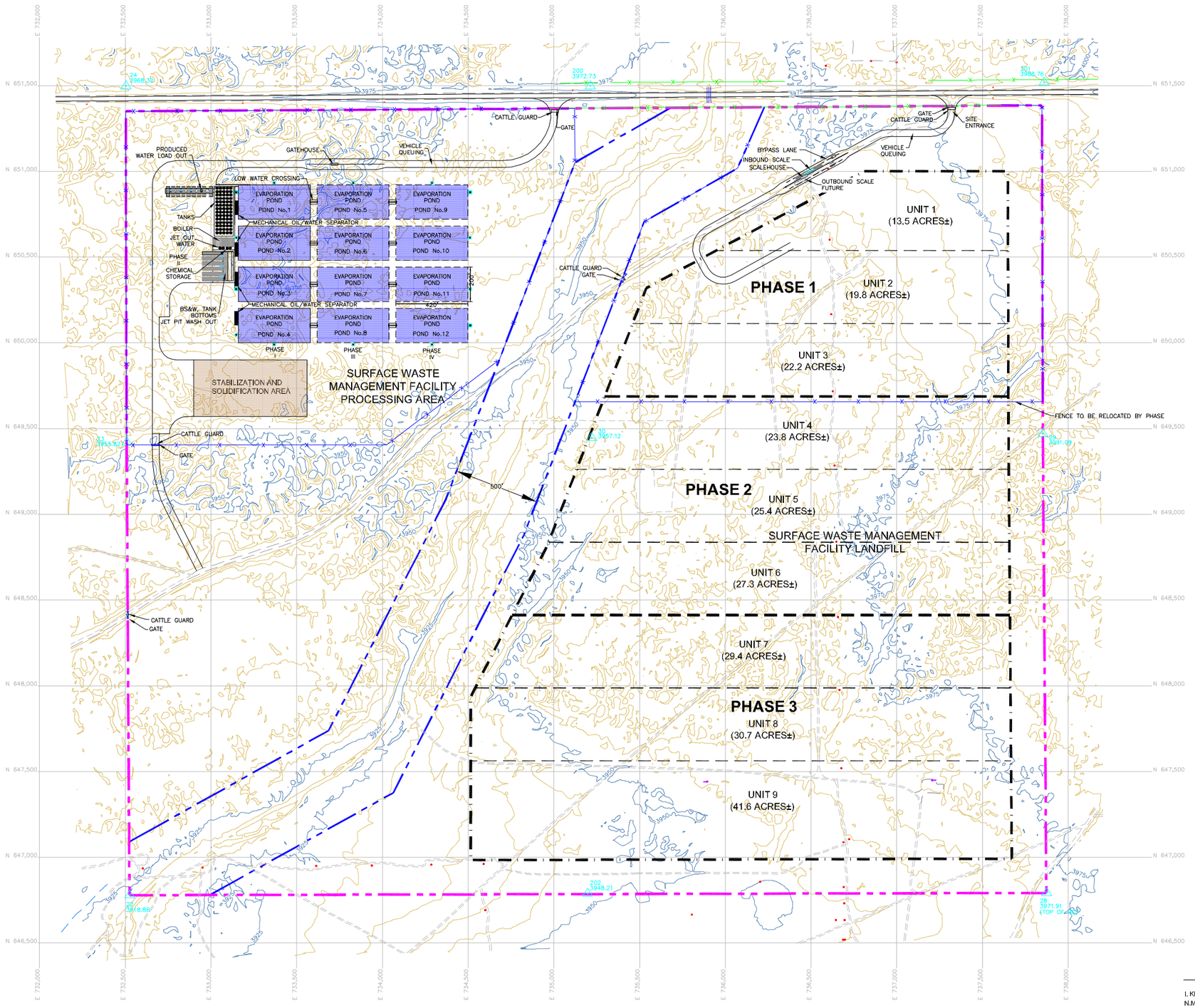

LEGEND

- SITE BOUNDARY (562 ACRES±)
- DRAINAGE FEATURE SETBACK (67 ACRES±)
- LIMIT OF WASTE
- LANDFILL PHASE BOUNDARY
- LANDFILL UNIT BOUNDARY
- 3975 — 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- EXISTING FENCE
- PROPOSED FENCE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- POWER POLE (TO BE RELOCATED IN ADVANCE OF CONSTRUCTION)
- EXISTING CULVERT
- CATTLE GUARD
- HYDROGEN SULFIDE MONITORING STATION
- ROAD SIGN
- ABANDONED WELL
- 201 3988.76 — SURVEY CONTROL POINT
- N 650,500 / E 738,000 — SITE GRID

SURVEY CONTROL POINT DATA

POINT	NORTHING	EASTING	ELEVATION
22	646780.31	732525.87	3918.86
23	649422.09	732509.41	3955.82
24	651498.31	732504.10	3968.30
28	646793.35	737874.03	3971.91
29	649469.84	737853.32	3991.09
30	649446.48	735220.56	3957.12
200	651498.13	735212.57	3972.73
201	651518.82	737859.97	3988.76
202	646789.93	735196.38	3948.21

NOTES:

1. BASE MAP PROVIDED BY DALLAS AERIAL SURVEYS, INC
2. FIELD SURVEY PROVIDED BY PETTIGREW & ASSOCIATES PA (12/13/2012)
3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

NORTH

0 300 600

I. KEITH GORDON, P.E.
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NOT FOR CONSTRUCTION
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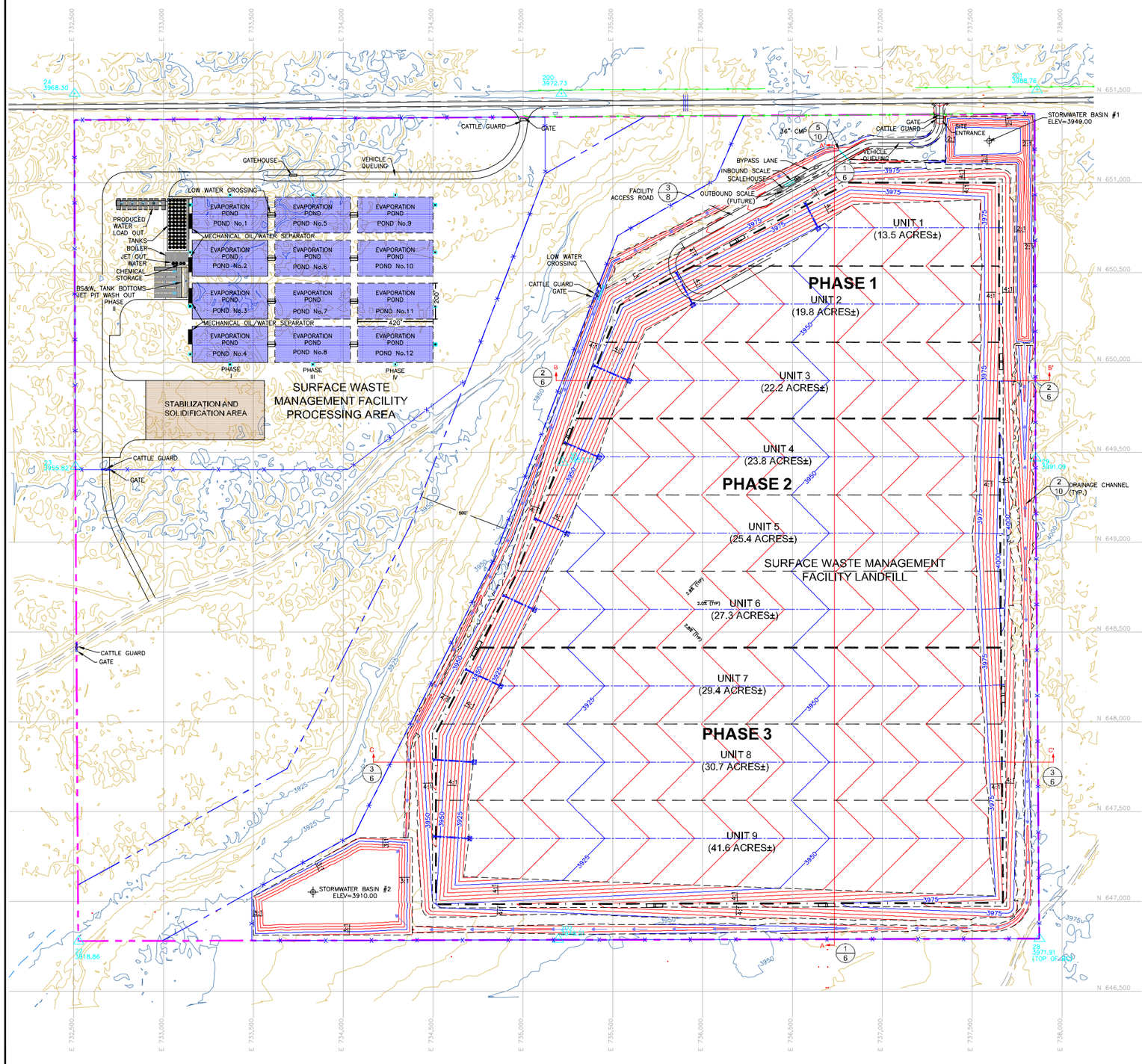
SITE DEVELOPMENT PLAN

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 06/10/2014	CAD: 03 SITE DEV.DWG	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 3 of 14
APPROVED BY: IKG	gel@gordonenvironmental.com	



LEGEND

- SITE BOUNDARY (562 ACRES±)
- WATER FEATURE SETBACK (67 ACRES±)
- LIMIT OF WASTE
- LANDFILL PHASE BOUNDARY
- LANDFILL UNIT BOUNDARY
- EXISTING FENCE
- PROPOSED FENCE
- 3975 — 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- 3975 — 25' DESIGN CONTOUR
- 5' DESIGN CONTOUR
- TOP/TOE OF SLOPE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- DIRECTION OF STORMWATER FLOW
- LEACHATE COLLECTION SUMP & EXTRACTION RISER PIPES
- 29 3991.09 — SURVEY CONTROL POINT
- EXISTING CULVERT
- NEW CULVERT
- HYDROGEN SULFIDE MONITORING STATION
- PPE AND EMERGENCY EQUIPEMENT
- ROAD SIGN
- N 650,500 / E 738,000 — SITE GRID
- A A' — CROSS SECTION LOCATION
- 2/6 — DETAIL NUMBER / SHEET NUMBER

SURVEY CONTROL POINT DATA

POINT	NORTHING	EASTING	ELEVATION
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200	651498.13	735212.57	3972.73
201	651518.82	737859.97	3988.76
202	646789.93	735196.38	3948.21

NOTES:

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3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

LANDFILL EXCAVATION AND PERIMETER BERM FILL VOLUMES

CUT VOLUME: 6257969 CUBIC YARDS
FILL VOLUME: 646225 CUBIC YARDS
NET VOLUME: 5611744 CUBIC YARDS <CUT>

NORTH

0 300' 600'

I, KEITH GORDON, P.E.
N.M. PROFESSIONAL ENGINEER NO. 10984

NOT FOR CONSTRUCTION
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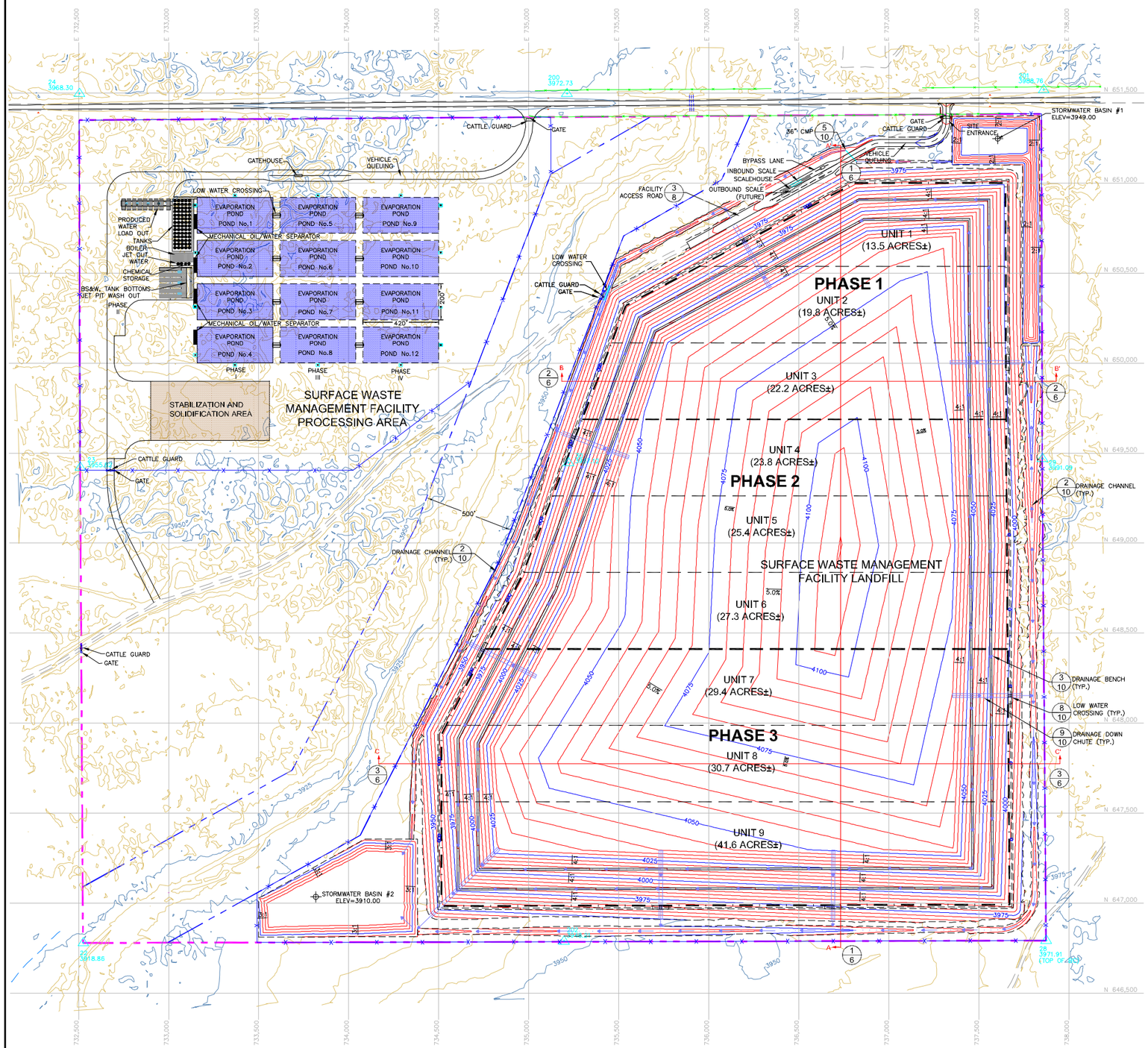
LANDFILL BASE GRADING PLAN

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 06/10/2014	CAD: 04 BASE GRADING.dwg	PROJECT #: 542.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 4 of 14
APPROVED BY: IKG	gel@gordonenvironmental.com	



LEGEND

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- LIMIT OF WASTE
- LANDFILL PHASE BOUNDARY
- LANDFILL UNIT BOUNDARY
- EXISTING FENCE
- PROPOSED FENCE
- 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- 25' DESIGN CONTOUR
- 5' DESIGN CONTOUR
- TOP/TOE OF SLOPE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- DIRECTION OF STORMWATER FLOW
- LEACHATE EXTRACTION RISER PIPES
- LEACHATE CLEANOUT RISER PIPES
- SURVEY CONTROL POINT
- POWER POLE
- EXISTING CULVERT
- NEW CULVERT
- HYDROGEN SULFIDE MONITORING STATION
- ROAD SIGN
- SITE GRID
- CROSS SECTION LOCATION
- DETAIL NUMBER / SHEET NUMBER

SURVEY CONTROL POINT DATA

POINT	NORTHING	EASTING	ELEVATION
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23	649420.79	732507.95	3955.82
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28	646792.06	737872.55	3971.24
29	649468.54	737851.84	3991.09
30	649445.19	735219.09	3957.12
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201	651518.82	737859.97	3988.76
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LANDFILL VOLUME

GROSS FILL VOLUME: 39,669,880 CUBIC YARDS

NORTH

0 300' 600'

I, KEITH GORDON, P.E.
N.M. PROFESSIONAL ENGINEER NO. 10984

LANDFILL
FINAL GRADING PLAN

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 06/10/2014	CAD: 05 FINAL GRADING .dwg	PROJECT #: 542.01.01	
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 5 of 14	
APPROVED BY: IKG	gek@gordonenvironmental.com		

NOT FOR CONSTRUCTION

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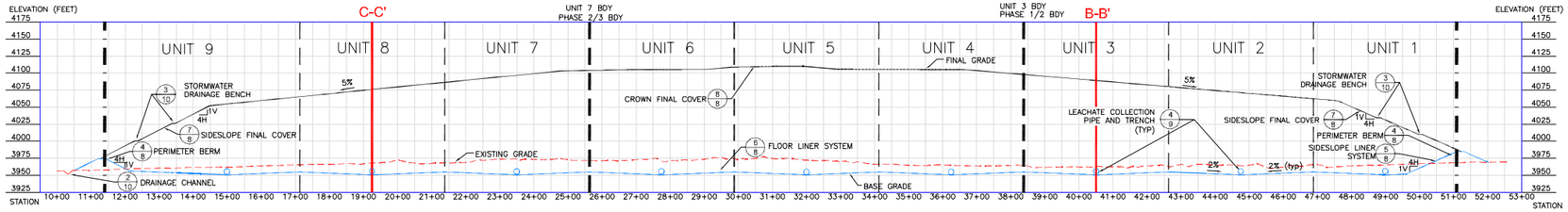
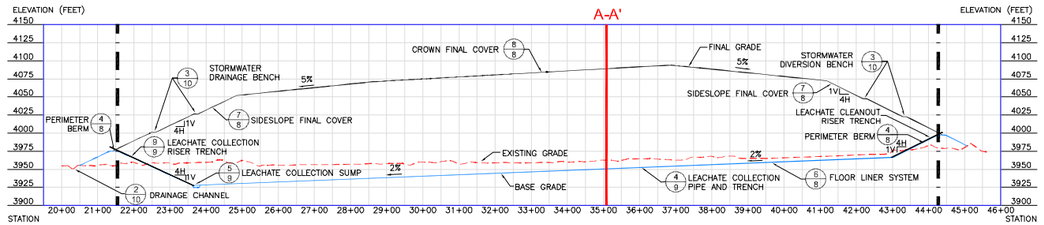
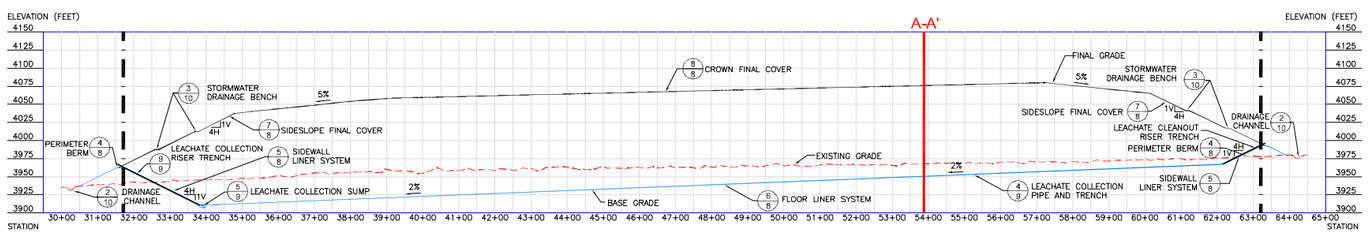


1/6 CROSS SECTION A-A'



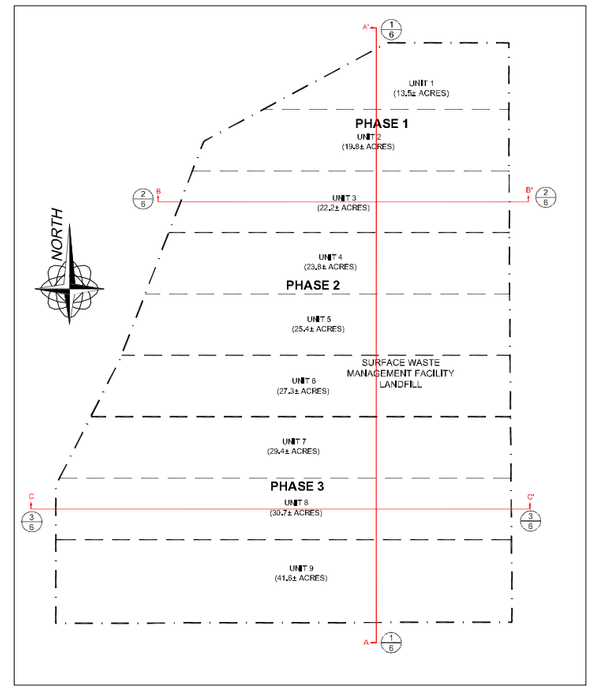
2/6 CROSS SECTION B-B'



3/6 CROSS SECTION C-C'

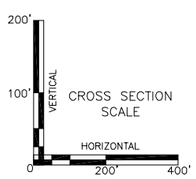
LEGEND

- LIMIT OF WASTE
- LANDFILL PHASE BOUNDARY
- LANDFILL UNIT BOUNDARY
- EXISTING GRADE
- BASE GRADE
- FINAL GRADE
- A A' CROSS SECTION LOCATION
- 7/8 DETAIL NUMBER / SHEET NUMBER



KEY MAP

N.T.S.



NOT FOR CONSTRUCTION

DrawingPlacad 2003\542.01.01\PERMIT PLANS\06 X-SECTIONS.dwg
Date/Time:Jun. 13, 2014-13:08:10 ; LAYOUT: D (LS)

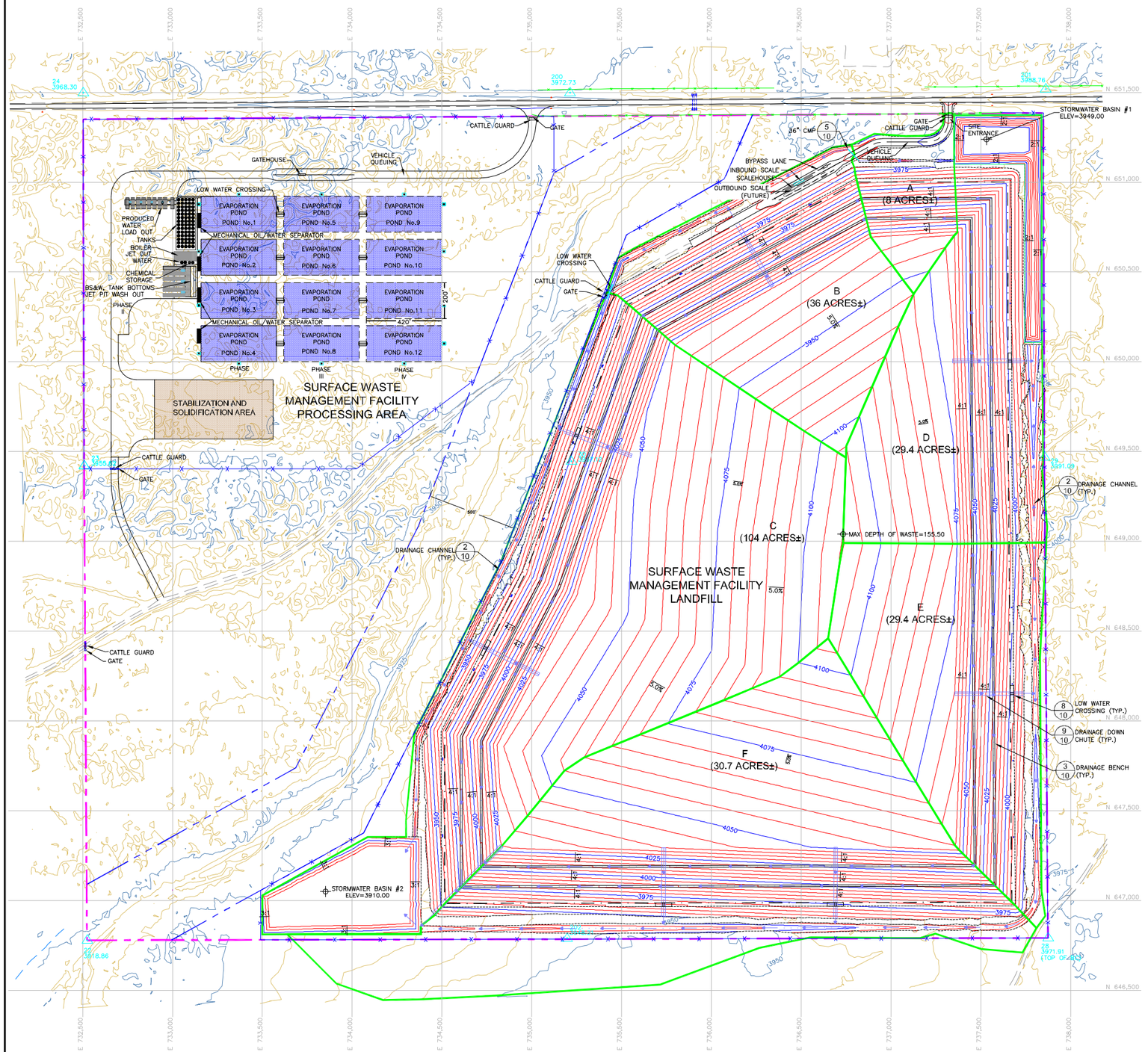
I. KEITH GORDON, P.E.
N.M. PROFESSIONAL ENGINEER NO. 10984

LANDFILL CROSS SECTIONS

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 10/21/2013	CAD: 06 X-SECTIONS.dwg	PROJECT #: 542.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 6 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	



LEGEND

- SITE BOUNDARY (562 ACRES±)
- WATER FEATURE SETBACK (67 ACRES±)
- LIMIT OF WASTE
- LANDFILL PHASE BOUNDARY
- LANDFILL UNIT BOUNDARY
- EXISTING FENCE
- PROPOSED FENCE
- 3975 — 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- 3975 — 25' DESIGN CONTOUR
- 5' DESIGN CONTOUR
- TOP/TOE OF SLOPE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- DIRECTION OF STORMWATER FLOW
- LEACHATE EXTRACTION RISER PIPES
- LEACHATE CLEANOUT RISER PIPES
- A (8 ACRES±) — DRAINAGE AREA
- SURVEY CONTROL POINT
- EXISTING CULVERT
- NEW CULVERT
- HYDROGEN SULFIDE MONITORING STATION
- ROAD SIGN
- DETAIL NUMBER / SHEET NUMBER
- SITE GRID

NOTES:

1. BASE MAP PROVIDED BY DALLAS AERIAL SURVEYS, INC
2. FIELD SURVEY PROVIDED BY PETTIGREW & ASSOCIATES PA (12/13/2012)
3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

STORMWATER DISCHARGE			
DRAINAGE ID	DRAINAGE AREA (ACRES)	FLOW RATE (CFS)	VOLUME (ACRE-FT)
A	8	42	1.5
B	36	103	6.6
C	104	183	19.1
D	43	142	7.9
E	39	103	7.2
F	89	196	16.3

RETENTION BASIN CAPACITIES					
BASIN ID	CONTRIBUTING DRAINAGE AREAS	DISCHARGE VOLUME (ACRE-FT)	BASIN CAPACITY W/ 1 FT. FREEBOARD (ACRE-FT)	BASIN MAX. CAPACITY W/O 1 FT. FREEBOARD (ACRE-FT)	FACTOR OF SAFETY
1	D+NE RUN-ON	55.2	61.0	65.3	1.2
2	A+B+C+E+F+SE RUN-ON	58.1	61.5	68.6	1.2

NORTH

0 200' 400'

NOT FOR CONSTRUCTION

DrawingsPplacad 2003\542.01.01\RAI 1\PERMIT PLAN SHEETS\07 DRAINAGE PLAN.dwg
Date/Time:Jun. 13, 2014-12:36:39 ; LAYOUT: D (LS)

I, KEITH GORDON, P.E.
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LANDFILL COMPLETION DRAINAGE PLAN

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
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213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
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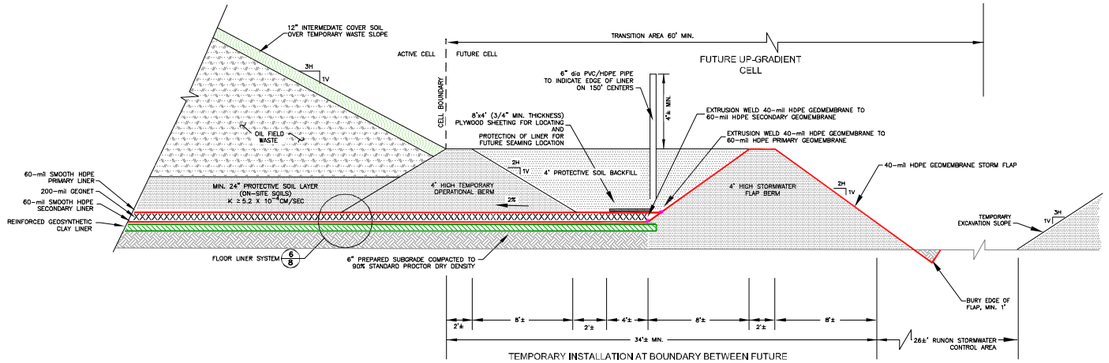
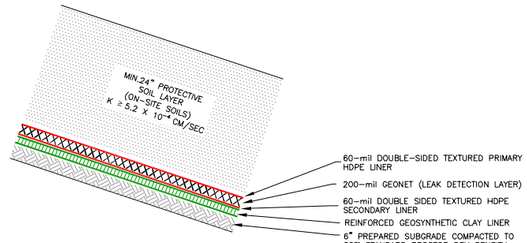
DATE: 06/10/2014	CAD: 07 COMPLETION PLAN.dwg	PROJECT #: 542.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 7 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	

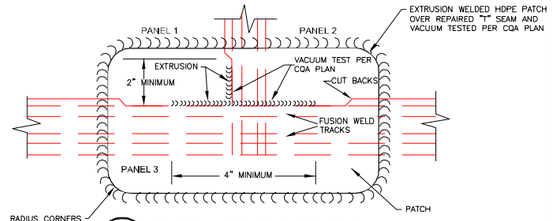


TEMPORARY INSTALLATION AT BOUNDARY BETWEEN FUTURE UPGRADIENT CELL AND ACTIVE DOWNGRADIENT CELL

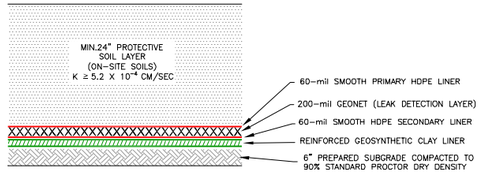
1/8 TYPICAL TRANSITION AREA LINER TERMINATION
NOT TO SCALE



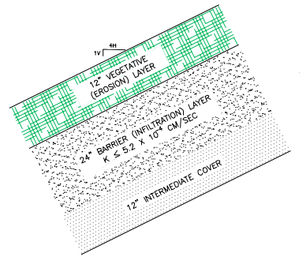
5/8 SIDEWALL LINER SYSTEM
NOT TO SCALE



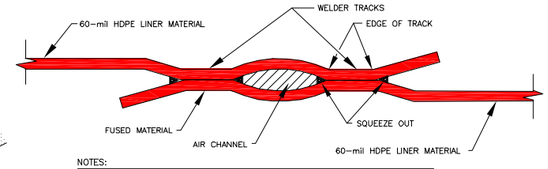
11/8 TYPICAL "T" AT BUTT SEAM
PLAN VIEW NOT TO SCALE



6/8 FLOOR LINER SYSTEM
NOT TO SCALE

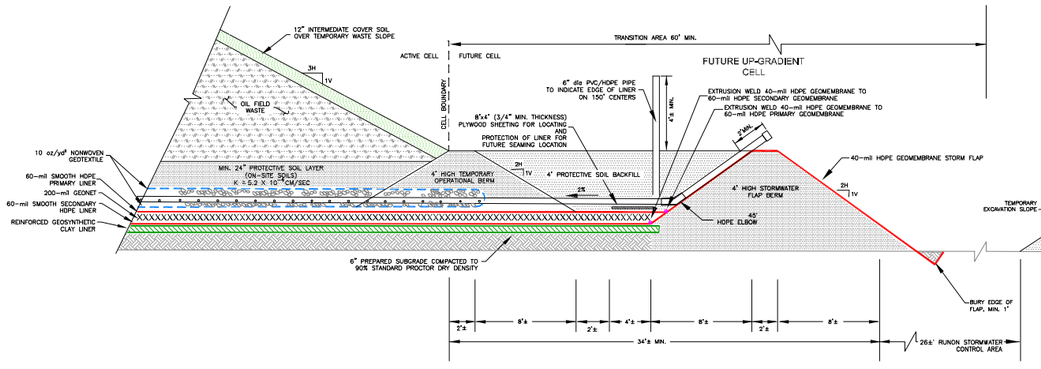


SIDESLOPE SECTION FINAL COVER EVAPOTRANSPORATION DESIGN
7/8 NOT TO SCALE

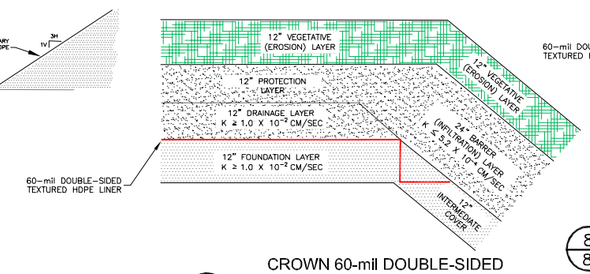


NOTES:
1. BOTH AREAS OF FUSED MATERIAL SHOULD BE VOID OF ANY SEAM LINES.
2. EDGE OF TRACKS NOT TO CUT THE LINER.
3. AIR CHANNEL SHOULD BE CLEAR.
4. BOTH WELDER TRACKS SHALL BE EQUAL WIDTHS.
5. SQUEEZE OUT SHOULD BE JUST BARELY VISIBLE IN ALL 4 LOCATIONS WHEN VIEWED IN THE TEST CROSS-SECTION.

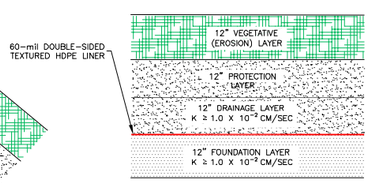
12/8 TYPICAL FUSION WELD
SECTION VIEW NOT TO SCALE



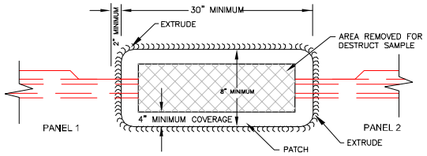
2/8 TEMPORARY LEACHATE COLLECTION RISER PIPE
NOT TO SCALE



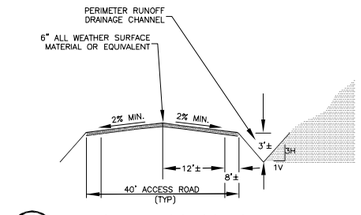
CROWN 60-mil DOUBLE-SIDED TEXTURED HDPE LINER TERMINATION
10/8 NOT TO SCALE



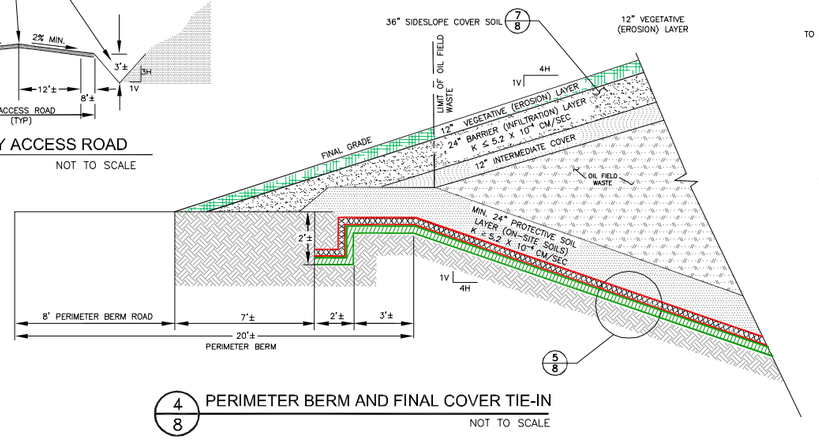
8/8 CROWN OF LANDFILL FINAL COVER SECTION PRESCRIPTIVE DESIGN
NOT TO SCALE



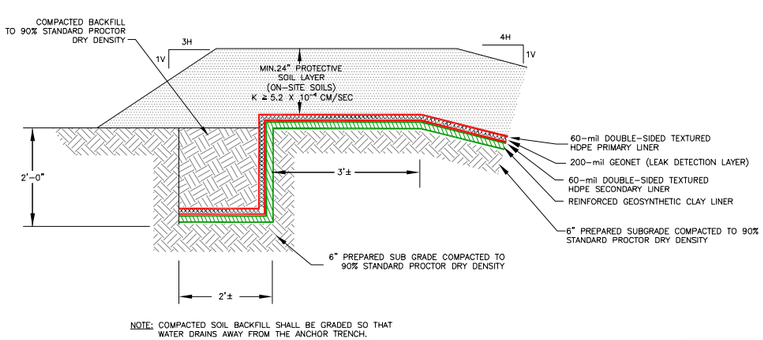
13/8 TYPICAL DESTRUCT SAMPLE PATCH 60-mil HDPE LINER
PLAN VIEW NOT TO SCALE



3/8 FACILITY ACCESS ROAD
NOT TO SCALE

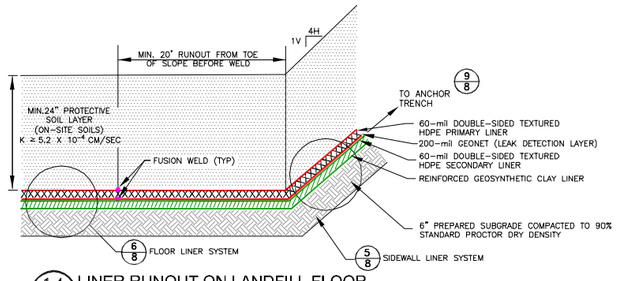


4/8 PERIMETER BERM AND FINAL COVER TIE-IN
NOT TO SCALE



NOTE: COMPACTED SOIL BACKFILL SHALL BE GRADED SO THAT WATER DRAINS AWAY FROM THE ANCHOR TRENCH.

9/8 ANCHOR TRENCH
SECTION VIEW NOT TO SCALE



14/8 LINER RUNOUT ON LANDFILL FLOOR
NOT TO SCALE

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LINER SYSTEM AND COVER DETAILS

DNCS ENVIRONMENTAL SOLUTIONS
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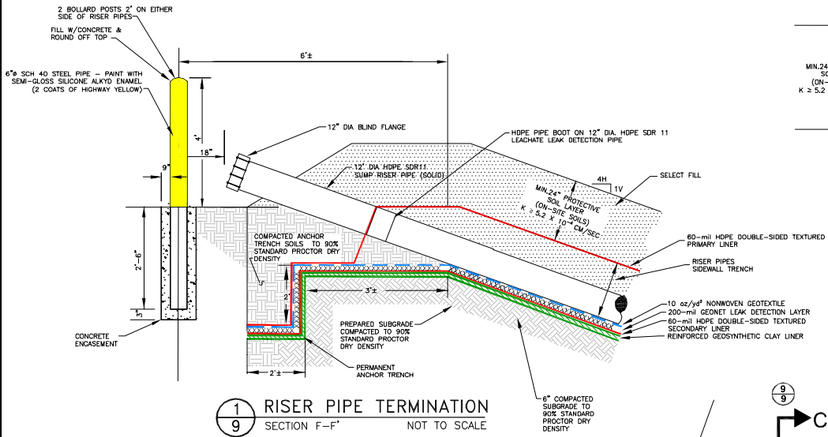
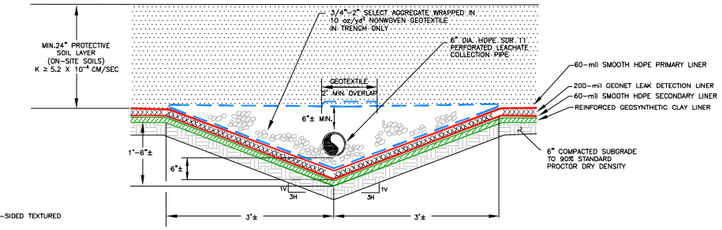
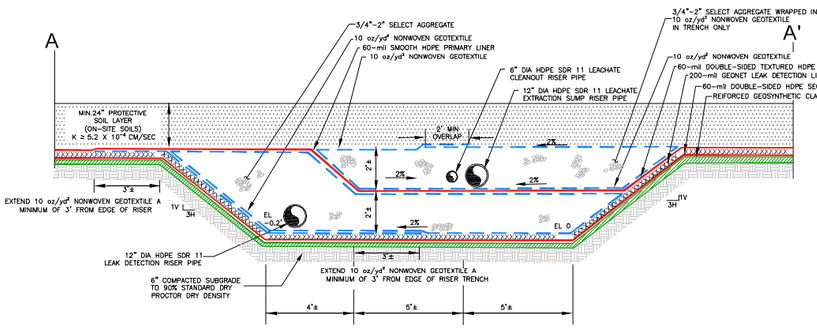
DATE: 10/21/2013	CAD: 08 LINER DET.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 8 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	



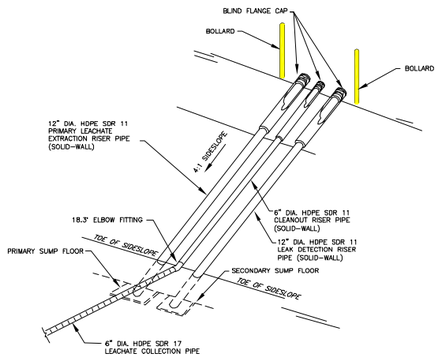
1/9 RISER PIPE TERMINATION
SECTION F–F' NOT TO SCALE



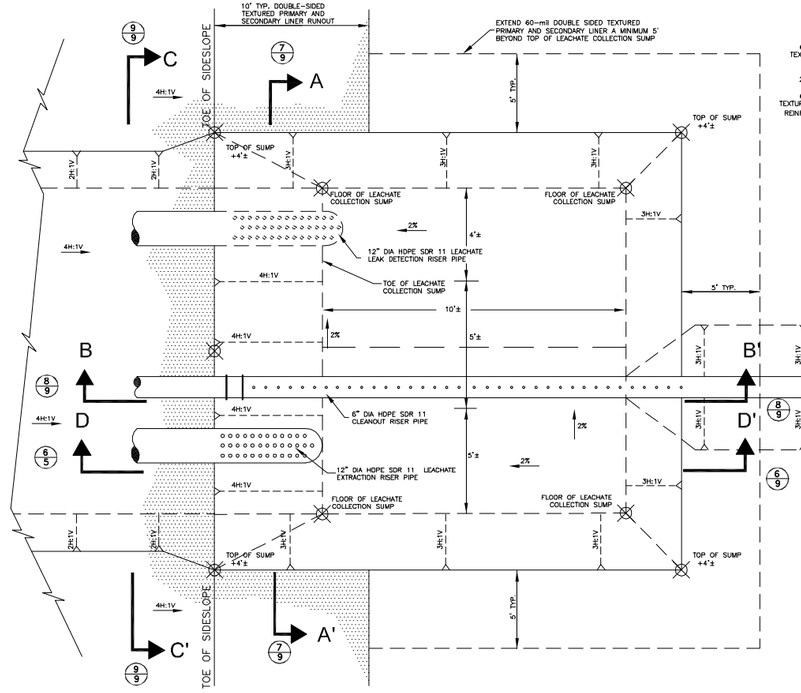
4/9 LEACHATE COLLECTION TRENCH AND PIPE CROSS SECTION E–E'
NOT TO SCALE



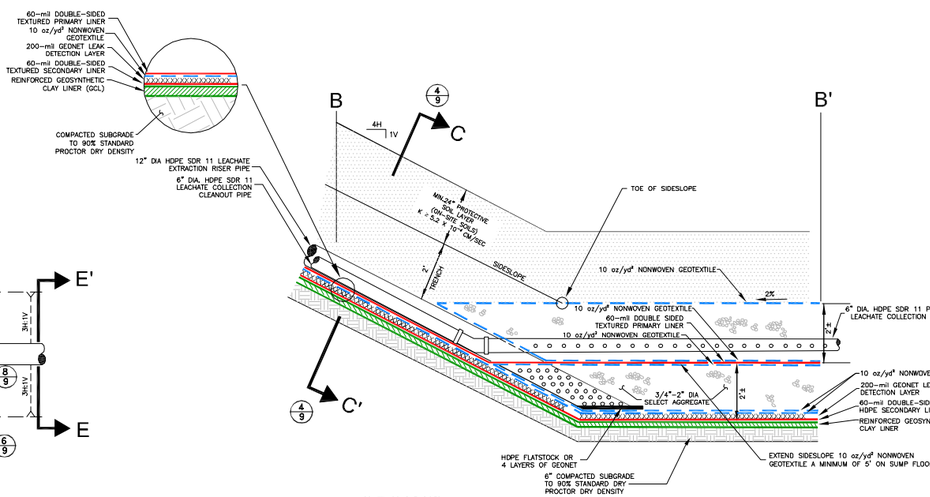
7/9 LEACHATE COLLECTION SUMP
SECTION A–A' NOT TO SCALE



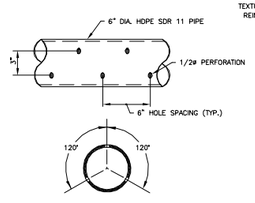
2/9 SUMP CLEANOUT/RISER CONFIGURATION SCHEMATIC
NOT TO SCALE



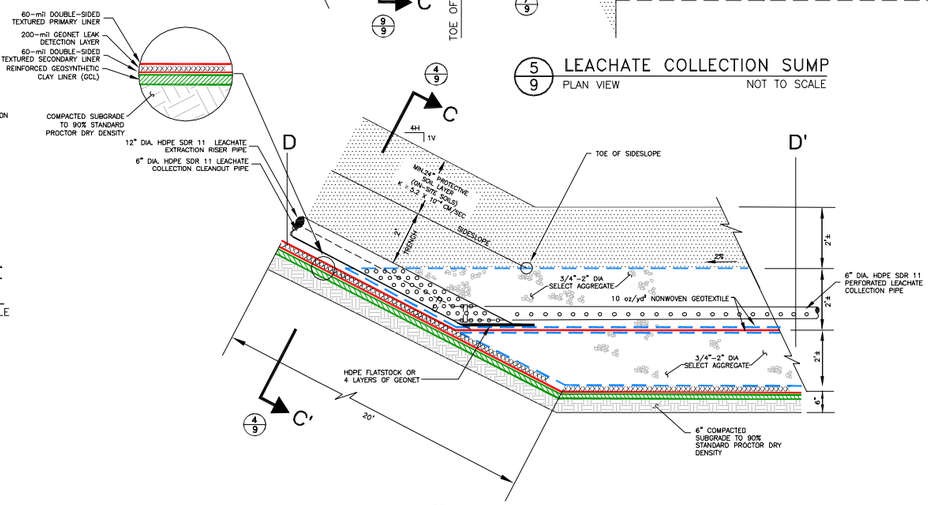
5/9 LEACHATE COLLECTION SUMP
PLAN VIEW NOT TO SCALE



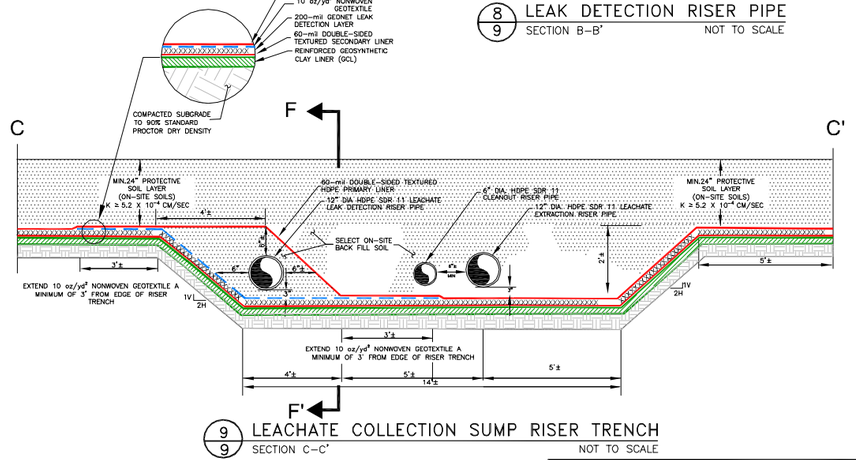
8/9 LEAK DETECTION RISER PIPE
SECTION B–B' NOT TO SCALE



3/9 PERFORATED LEACHATE COLLECTION PIPE
NOT TO SCALE



6/9 LEACHATE EXTRACTION RISER PIPE
SECTION D–D' NOT TO SCALE



9/9 LEACHATE COLLECTION SUMP RISER TRENCH
SECTION C–C' NOT TO SCALE
NOT TO SCALE

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LEACHATE COLLECTION SYSTEM DETAILS

DNCS ENVIRONMENTAL SOLUTIONS
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213 S. Camino del Pueblo
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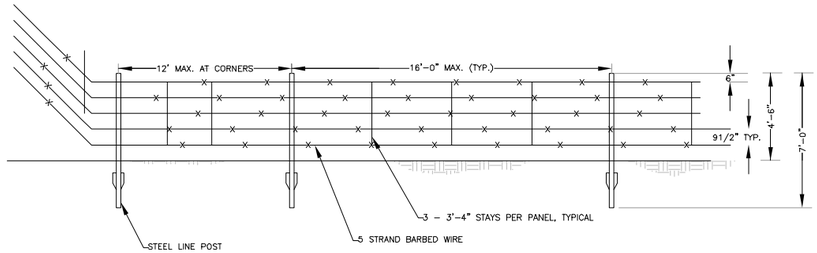
Fax: 505-867-6991

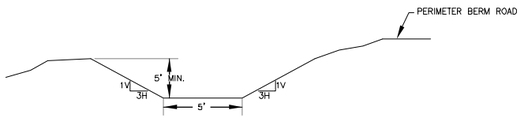
DATE: 10/21/2013	CAD: 09 LEACHATE DET.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: CWF/MRH	SHEET 9 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	

NOT FOR CONSTRUCTION
Drawing:P:\acad 2003\542.01.01\PERMIT PLANS\09 LEACHATE DET.dwg
Date/Time:Jun. 13, 2014-13:12:00



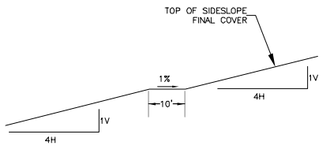
1/10 5-STRAND BARBED WIRE FENCE

NOT TO SCALE



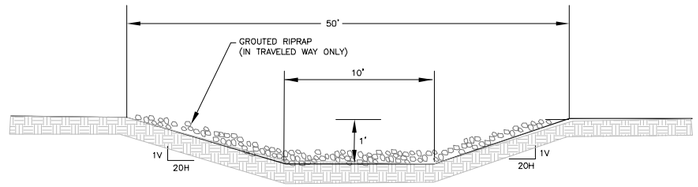
2/10 DRAINAGE CHANNEL TYPICAL SECTION

NOT TO SCALE



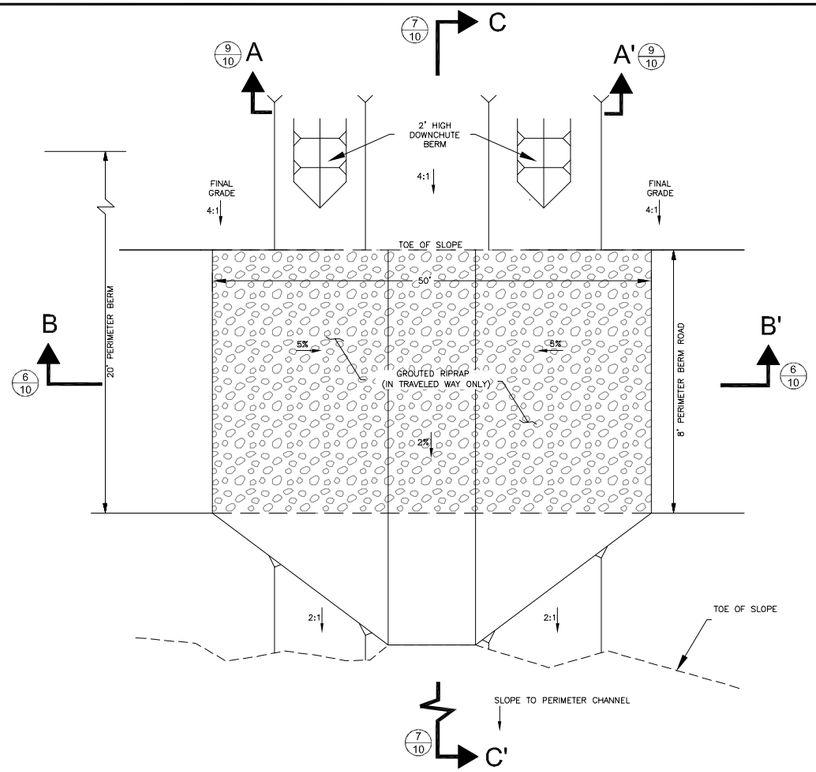
3/10 DRAINAGE BENCH

NOT TO SCALE



6/10 DOWNCHUTE LOW WATER CROSSING SECTION B-B'

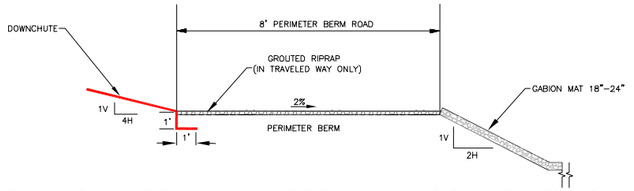
NOT TO SCALE



8/10 CHANNEL INTERSECTION/DOWNCHUTE LOW WATER CROSSING

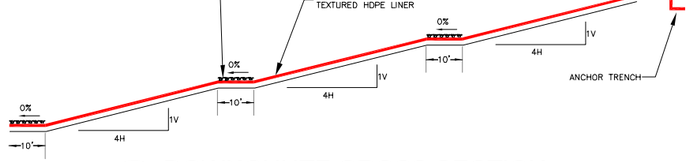
PLAN VIEW

NOT TO SCALE



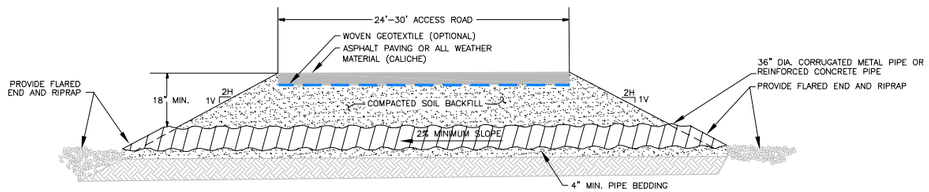
7/10 DOWNCHUTE LOW WATER CROSSING SECTION C-C'

NOT TO SCALE



4/10 DOWNCHUTE CROSS SECTION (LONGITUDINAL)

NOT TO SCALE

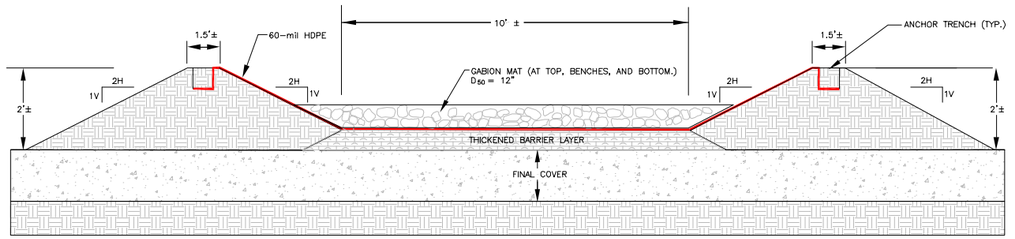


NOTES:

1. INVERT OF CORRUGATED METAL PIPE TO BE DETERMINED DURING INSTALLATION.
2. PROVIDE RIPRAP OR EQUIVALENT EROSION PROTECTION AT INLET AND OUTLET OF CULVERT.
3. PROVIDE FLARED END SECTION AT INLET AND OUTLET OF CULVERT TO PROVIDE A SMOOTH TRANSITION OF FLOW.

5/10 TYPICAL ROAD CULVERT INSTALLATION

NOT TO SCALE



9/10 TYPICAL RIP-RAP LINED PORTION OF DOWNCHUTE SECTION A-A'

NOT TO SCALE

NOT FOR CONSTRUCTION

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STORMWATER DRAINAGE DETAILS

DNCE ENVIRONMENTAL SOLUTIONS
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213 S. Camino del Pueblo
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Phone: 505-867-6990
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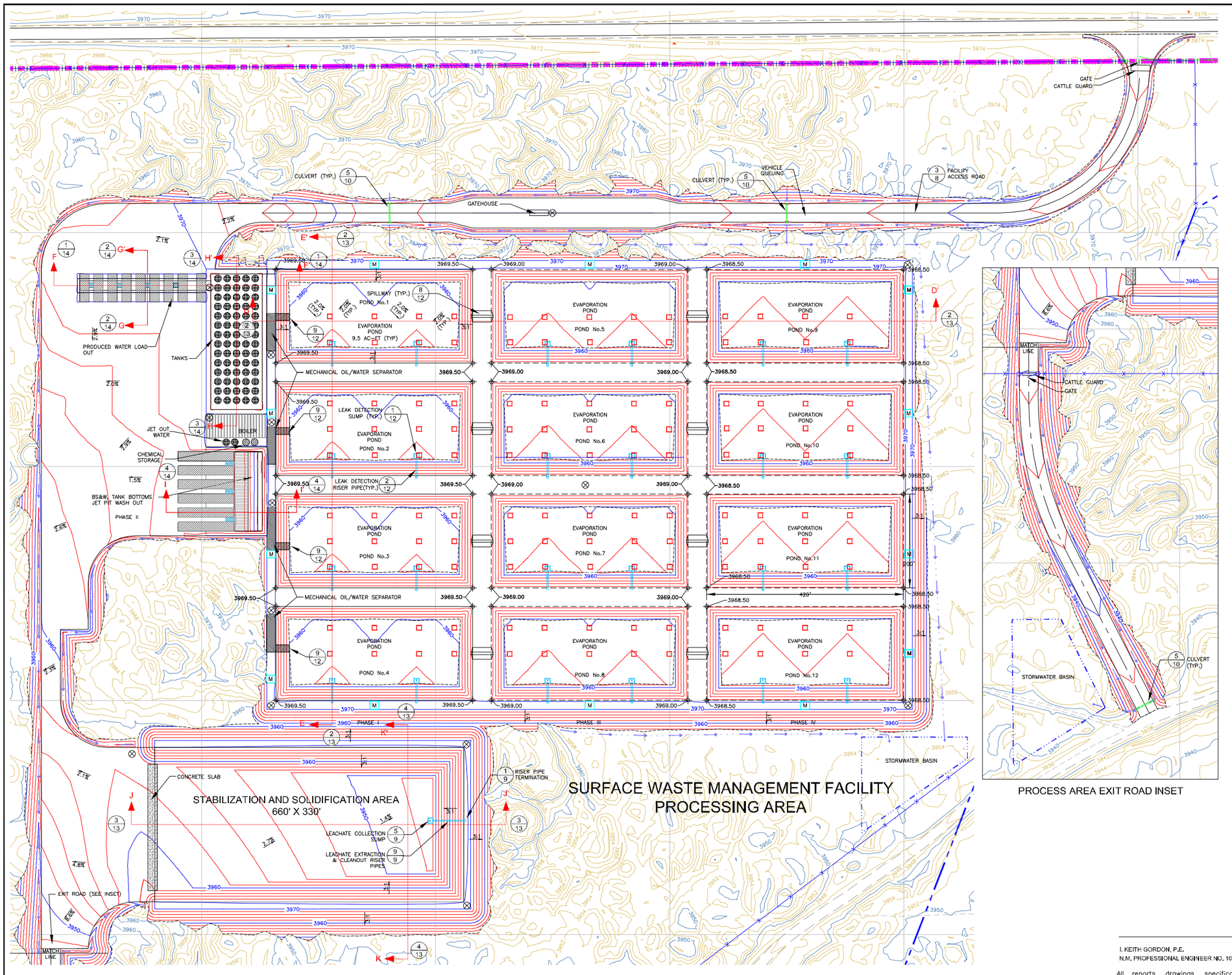
DATE: 06/13/2014	CAD: 10 STORMWATER DET.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 10 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	



PROCESS AREA EXIT ROAD INSET

LEGEND

- SITE BOUNDARY (562 ACRES±)
- DRAINAGE FEATURE SETBACK (67 ACRES±)
- 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- 25' DESIGN CONTOUR
- 5' DESIGN CONTOUR
- TOP/TOE OF SLOPE
- EXISTING FENCE
- PROPOSED FENCE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- DIRECTION OF STORMWATER FLOW
- CULVERT
- CATTLE GUARD
- ROAD SIGN
- M — HYDROGEN SULFIDE MONITORING STATION
- EVAPORATORS
- PPE AND EMERGENCY EQUIPEMENT
- LEAK DETECTION SUMP & RISER PIPE
- D D' — CROSS SECTION LOCATION
- 2/13 — DETAIL NUMBER / SHEET NUMBER
- N 650,500 / E 738,000 — SITE GRID

NOTES:

1. BASE MAP PROVIDED BY DALLAS AERIAL SURVEYS, INC
2. FIELD SURVEY PROVIDED BY PETTIGREW & ASSOCIATES PA (12/13/2012)
3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

VOLUME

ENTRANCE ROAD

CUT VOLUME	11583	CU. YD.
FILL VOLUME	6290	CU. YD.
NET VOLUME	5293	CU. YD.<CUT>

EVAP PONDS

CUT VOLUME	182856	CU. YD.
FILL VOLUME	106752	CU. YD.
NET VOLUME	76104	CU. YD.<CUT>

PROCESSING AREA

CUT VOLUME	51153	CU. YD.
FILL VOLUME	24228	CU. YD.
NET VOLUME	26925	CU. YD.<CUT>

STABILIZATION AND SOLIDIFICATION AREA

CUT VOLUME	11996	CU. YD.
FILL VOLUME	51002	CU. YD.
NET VOLUME	39006	CU. YD.<FILL>

EXIT ROAD

CUT VOLUME	18072	CU. YD.
FILL VOLUME	0	CU. YD.
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NORTH

0 100 200

NOT FOR CONSTRUCTION
DrawingsPlacad 2003\542.01.01\RAI 1\PERMIT PLAN SHEETS\11 PROCESS AREA.dwg
Date/Time:Jun. 13, 2014-11:52:27 ; LAYOUT: D (LS)

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PROCESSING AREA LAYOUT

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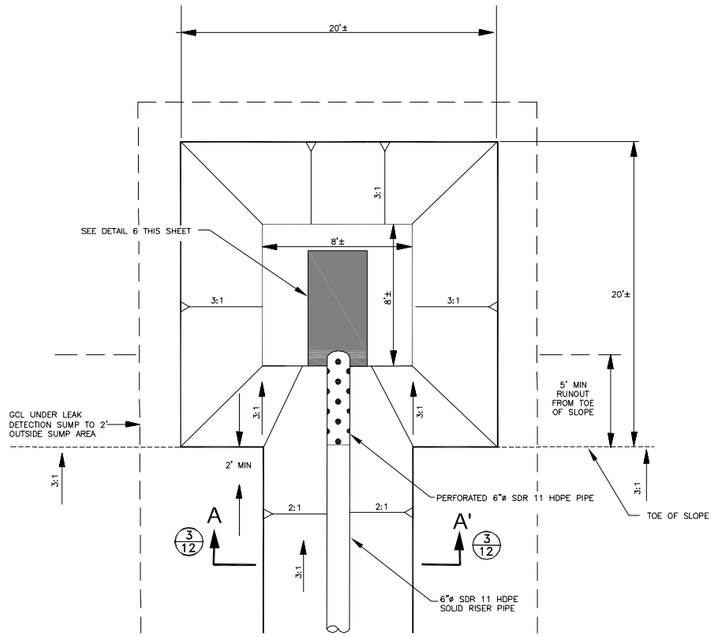
Fax: 505-867-6991

DATE: 06/13/2014	CAD: 11 PROCESS AREA .DWG	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 11 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	



1/12 LEAK DETECTION SUMP

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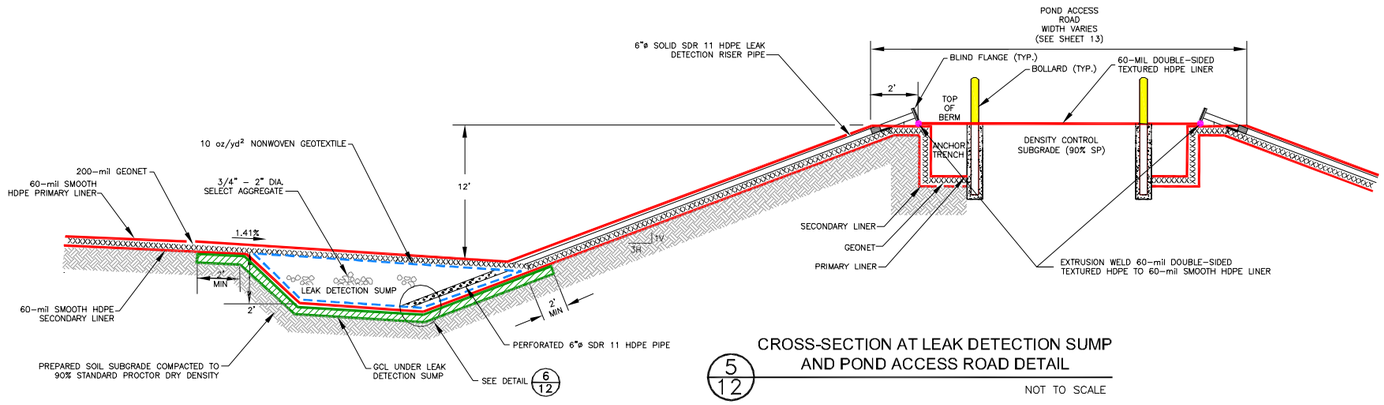

5/12 CROSS-SECTION AT LEAK DETECTION SUMP AND POND ACCESS ROAD DETAIL

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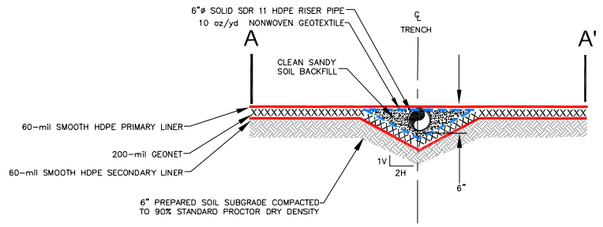

3/12 LEAK DETECTION SUMP RISER PIPE CROSS SECTION A-A'

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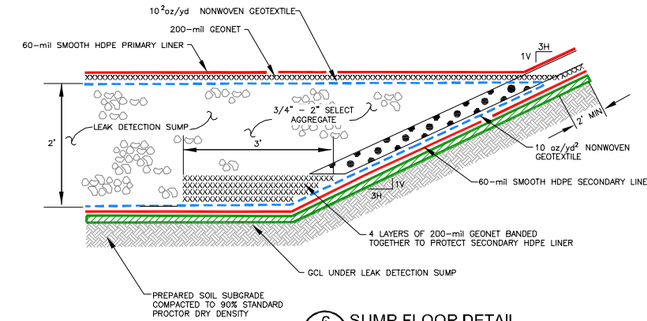
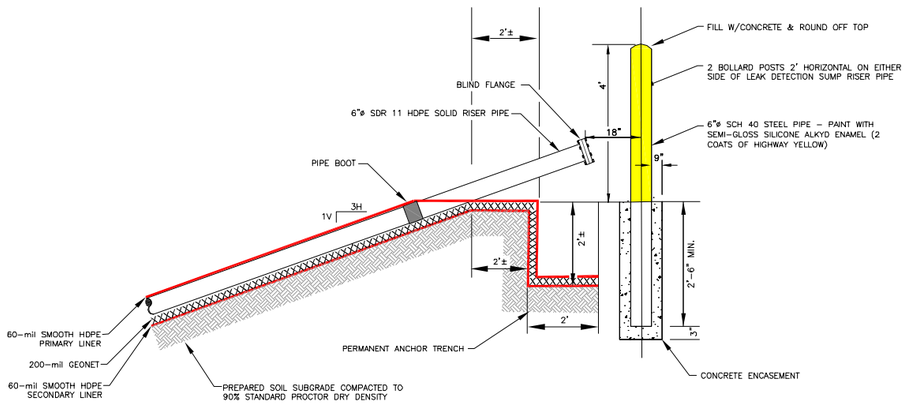


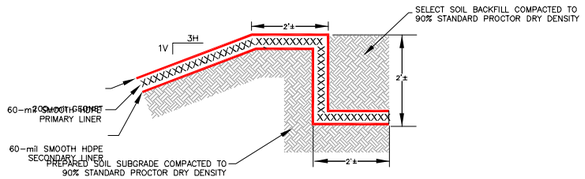
6/12 SUMP FLOOR DETAIL

NOT TO SCALE



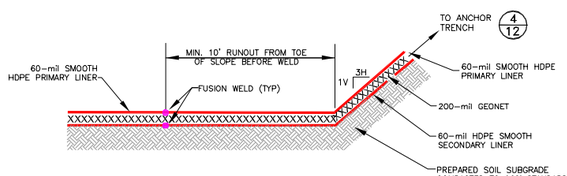
2/12 LEAK DETECTION SUMP RISER PIPE

SECTION VIEW NOT TO SCALE



4/12 ANCHOR TRENCH DETAIL

NOT TO SCALE



7/12 LINER RUNOUT ON POND FLOOR

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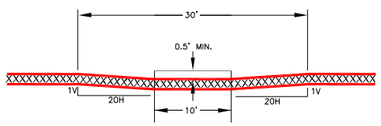
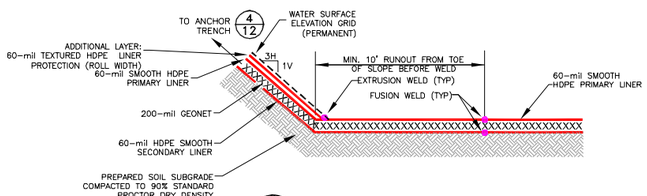


8/12 SPILLWAY DETAIL

NOT TO SCALE



9/12 POINT DISCHARGE LINER PROTECTION

NOT TO SCALE

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EVAPORATION POND DETAILS

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DATE: 10/21/2013	CAD: 12 EVAP POND DET.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	SHEET 12 of 14
APPROVED BY: IKG	gel@gordonenvironmental.com	

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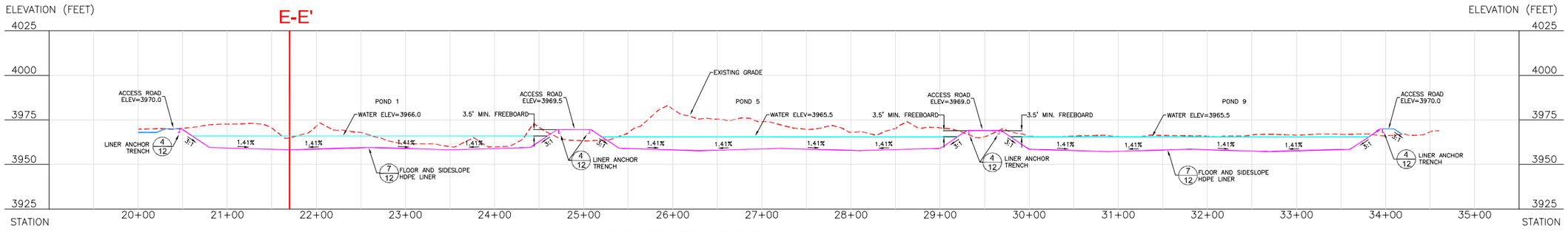
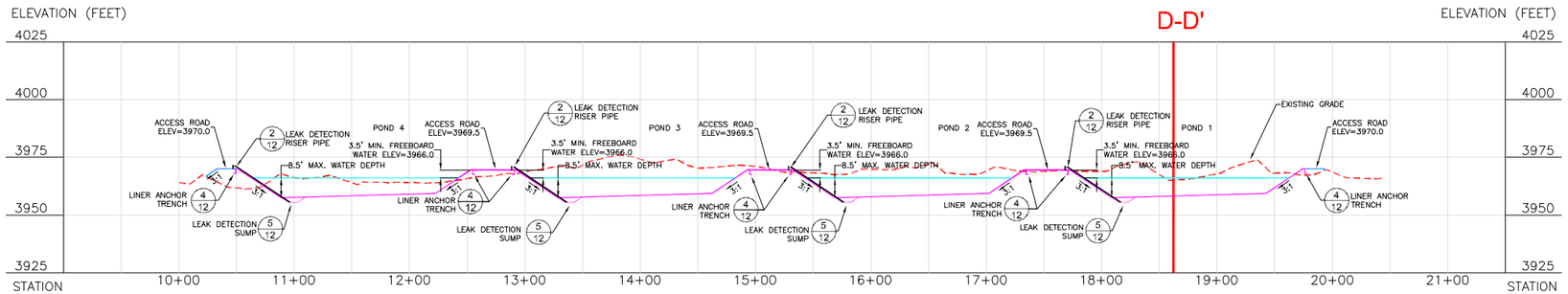
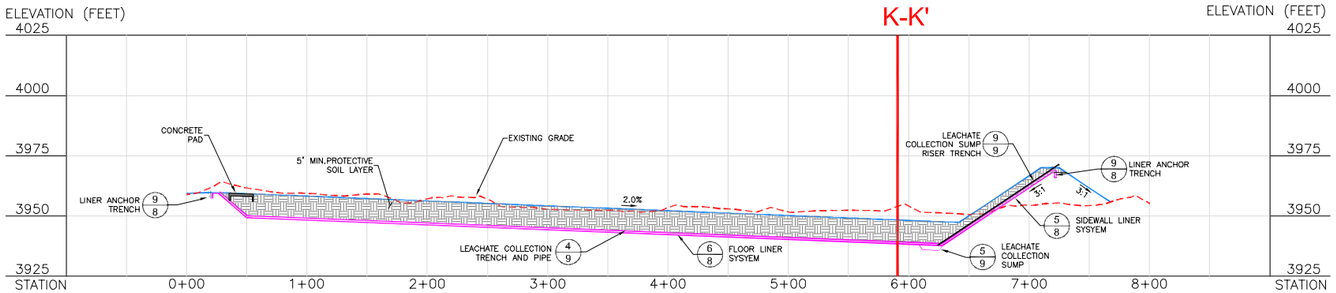
Drawing:P:\acad 2003\542.01.01\RAI 1\PERMIT PLAN SHEETS\12 EVAP POND DET.dwg
Date/Time:Jun. 13, 2014-12:44:01



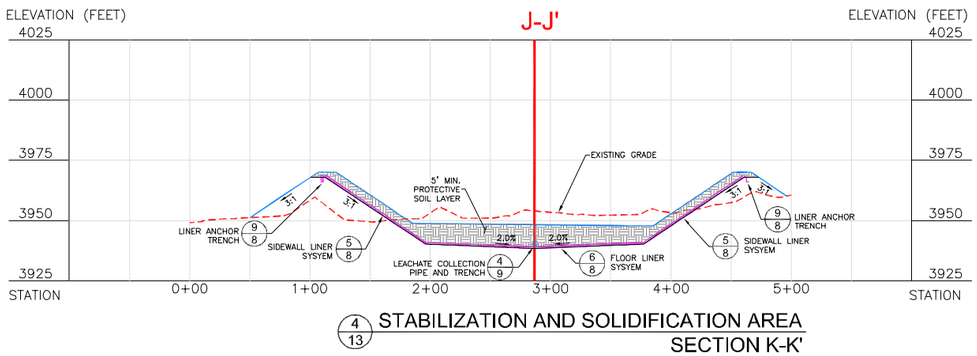
1/13 EVAPORATION PONDS SECTION D-D'



2/13 EVAPORATION PONDS SECTION E-E'



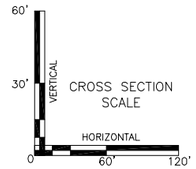
3/13 STABILIZATION AND SOLIDIFICATION AREA SECTION J-J'

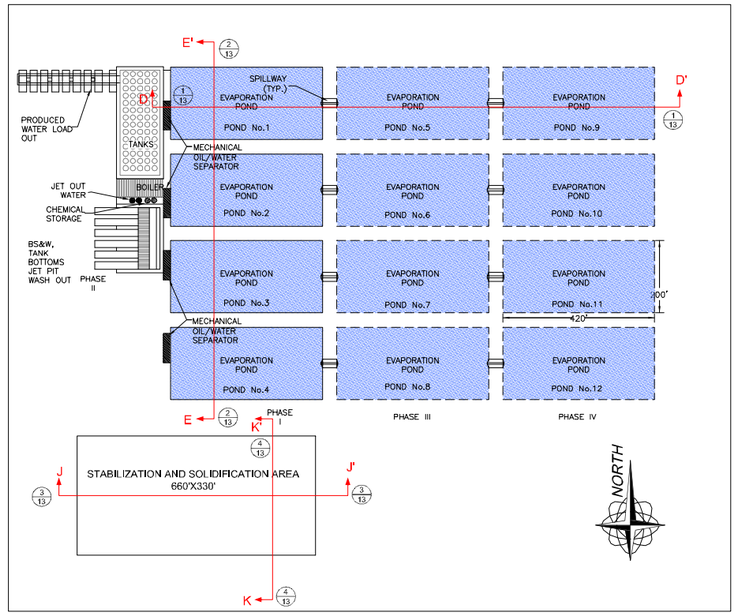


4/13 STABILIZATION AND SOLIDIFICATION AREA SECTION K-K'

LEGEND

- EXISTING GROUND
- DOUBLE LINER SYSTEM
- WATER SURFACE
- CROSS SECTION LOCATION (D D')
- DETAIL NUMBER / SHEET NUMBER (1/13)





KEY MAP
N.T.S.

NOT FOR CONSTRUCTION

Drawing:P:\acad 2003\542,01,01\RAI 1\PERMIT PLAN SHEETS\13 EVAP X-SECT.dwg
Date/Time:Jun, 13, 2014-12:49:11 ; LAYOUT: D (LS)

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N.M. PROFESSIONAL ENGINEER NO. 10984

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EVAPORATION POND AND STABILIZATION/SOLIDIFICATION AREA CROSS SECTIONS

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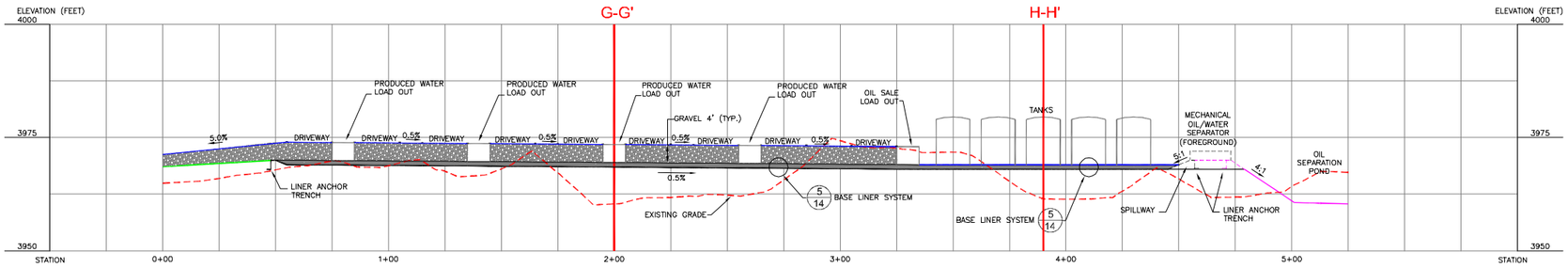
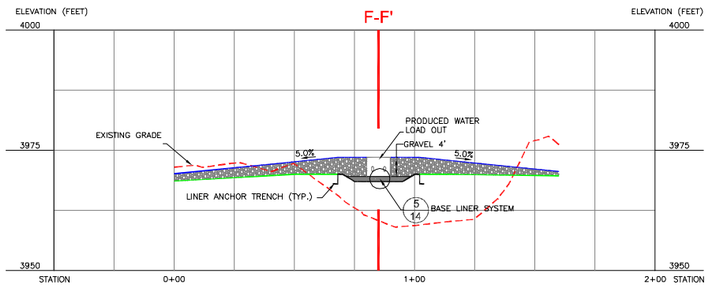
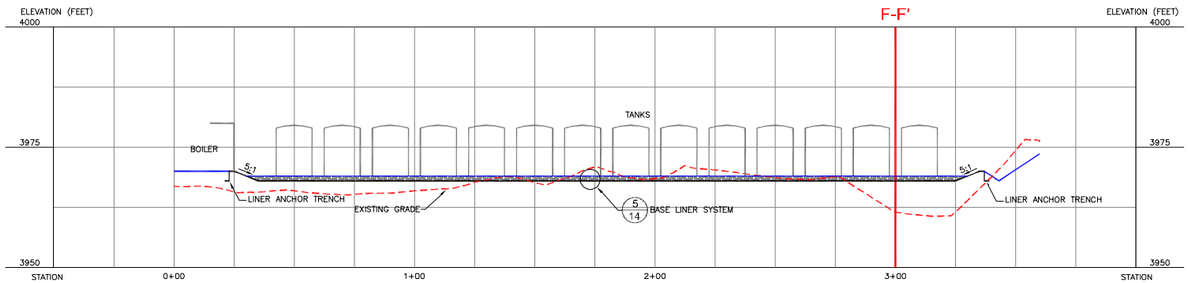
DATE: 10/21/2013	CAD: 13 EVAP X-SECT.dwg	PROJECT #: 542,01,01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 13 of 14
APPROVED BY: IKG	gel@gordonenvironmental.com	



1/14 PROCESSING AREA SECTION F-F'



2/14 PROCESSING AREA SECTION G-G'



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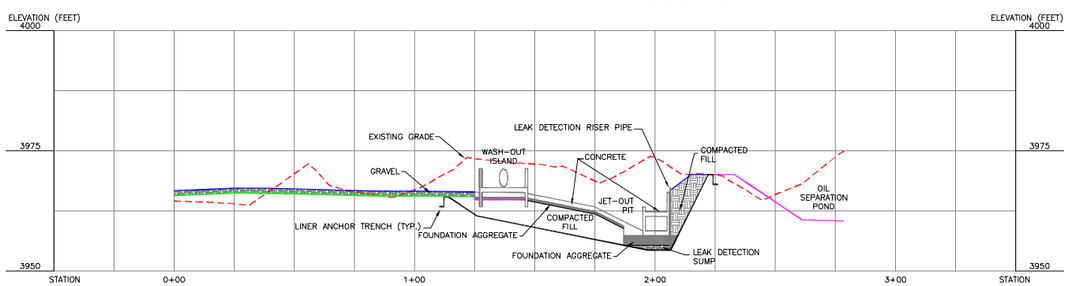


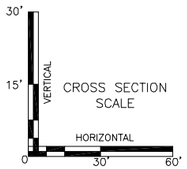
4/14 PROCESSING AREA SECTION I-I'

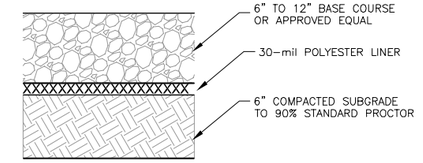
LEGEND

- EXISTING GROUND
- FINISHED GRADE
- SUBGRADE
- 30-mil POLYESTER LINER
- 60-mil HDPE LINER

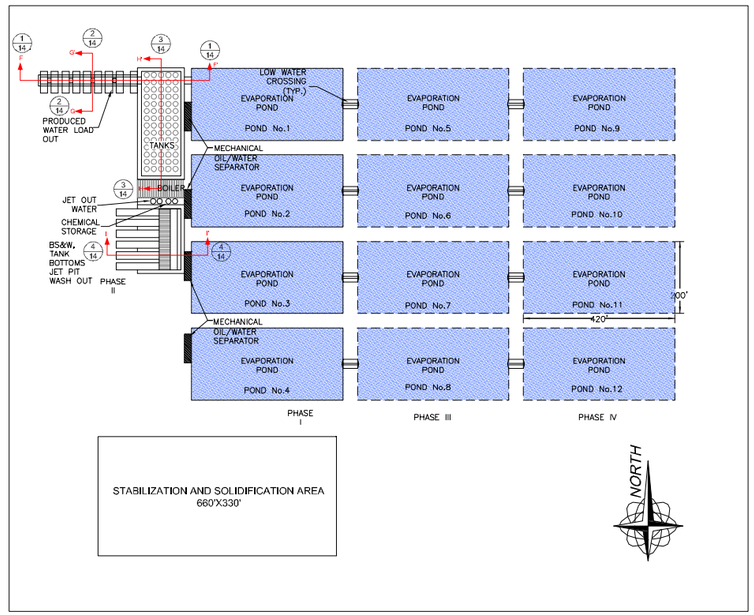
F F' CROSS SECTION LOCATION

1/14 DETAIL NUMBER / SHEET NUMBER





5/14 BASE LINER SYSTEM
NOT TO SCALE



KEY MAP
N.T.S.

NOT FOR CONSTRUCTION

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Date/Time:Jun. 13, 2014-13:15:14 ; LAYOUT: D (LS)

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PROCESSING AREA LAYOUT CROSS SECTIONS

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DATE: 06/10/2014	CAD: 14 PROCESS X-SECT.dwg	PROJECT #: 542.01.01
DRAWN BY: JMC	REVIEWED BY: MRH	SHEET 14 of 14
APPROVED BY: IKG	gek@gordonenvironmental.com	

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.B

LINER LONGEVITY ARTICLE:

GEOSYNTHETICS MAGAZINE, OCT/NOV 2008

How long will my liner last?

| What is the remaining service life of my HDPE geomembrane?

By Ian D. Peggs, P.E., P.Eng., Ph.D.

Introduction

In his keynote lecture at the GeoAmericas-2008 conference last March, Dr. Robert Koerner (et al., 2008) of the Geosynthetic Institute (GSI) reported the ongoing Geosynthetic Research Institute (GRI) work to make the first real stab at assessing the service lives of high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), reinforced PE, ethylene propylene diene terpolymer (EPDM), and flexible polypropylene (fPP) exposed geomembranes.

The selected environment simulated that of Texas, USA, in sunny ambient temperatures between ~7°C (45°F) and 35°C (95°F). Of course, an exposed black HDPE geomembrane in the sun will achieve much higher temperatures, probably in excess of 80°C (176°F).

I do not know what the temperature would be at 150-300mm above the liner (for those still specifying this parameter), but it is quite immaterial. The only temperature of concern is the actual geomembrane temperature.

The lifetimes are shown in **Table 1**, but it must be recognized that these data are for specific manufactured products with specific formulations. The "greater than" notation indicates that laboratory exposures (incubations) are still on-going, not that some samples have failed after the indicated time period. The PE-R-1 material is a thin LLDPE, so it might be expected to be the first to reach the defined end of life; the half-life—the time to loss of 50% of uniaxial tensile properties.

It is interesting to note that HDPE-1 and LLDPE-1 are proceeding apace, but it would be expected that the LLDPE-1 would reach its half-life earlier than HDPE-1. However, this does not automatically follow. With adequate additive formulations, perhaps LLDPE could be left exposed and demonstrate more weathering resistance than some HDPEs. This demonstrates the fact that all PEs, whether HD or LLD, are not identical—they can have different long-term performances dependent on the PE resin used and the formulation of the stabilizer package. However, such differences are not evident in the conventional mechanical properties such as tensile strength/elongation, puncture and tear resistances, and so on.

The two fPPs are performing well. However, there had also been an fPP-1, one of the first PP geomembranes that did not perform well. This was due to a totally inappropriate stabilizer formulation. That particular product lasted 1.5 years in service. In

Final Inspection continued on page 44

Type	Specification	Predicted Lifetime in Texas, USA
HDPE-1	GRI-GM13	>28 years (Incubation ongoing)
LLDPEE-1	GRI-GM17	>28 years (Incubation ongoing)
EPDM-1	GRI-GM21	>20 years (Incubation ongoing)
PE-R-1	GRI-GM22	≈17 years (reached halflife)
fPP-2	GRI-GM18 (temp. susp.)	>27 years (Incubation ongoing)
fPP-3	GRI-GM18 (temp. susp.)	>17 years (Incubation ongoing)

Table 1 | Estimated exposed geomembrane lifetimes

| Ian Peggs is president of I-CORP International Inc. and is a member of *Geosynthetics* magazine's Editorial Advisory Committee.

Final Inspection continued from page 56

the QUV weatherometer, it lasted 1,800 light hours at 70°C (158°F). Therefore, the lab/field correlation is that 1,000 QUV light hours is equivalent to a 0.83yr service life under those specific environmental conditions.

At another location in Texas, Koerner/GRI found 1,000hr of QUV exposure was equivalent to 1.1 year actual field exposure. Consequently, for Texas exposures GRI is using a correlation of 1000hr QUV exposure as equivalent to 1yr of in-service exposure. Clearly, the correlation would be different in less sunny and colder environments.

The failed fPP-1 liner was replaced with a correctly stabilized fPP that, subsequently, performed well.

So how can we evaluate the condition of our exposed liners in a simple and practical manner to ensure they will continue to provide adequate service lifetimes and to get sufficient warning of impending expiration?

For each installation, a baseline needs to be established, and changes from that baseline need to be monitored.

A liner lifetime evaluation program

Rather than be taken by surprise when a liner fails or simply expires, it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration. One can then plan for a timely replacement without the potential for accidental environmental damage and undesirable publicity. A program of periodic liner-condition assessment is proposed.

... it should be possible to monitor the condition of the liner to obtain a few years of notice for impending expiration.

While estimated correlations might be made for other locations using historical weather station sunshine and temperature data, there is no question that the best remaining lifetime assessments will be obtained using samples removed from the field installation of interest.

A lifetime in excess of 28yr, demonstrated for a recently-made HDPE geomembrane, is comparable to the present actual service periods of as long as 30-35yr. However, actual lifetimes of as low as ~15yr have also been experienced.

Do service lifetimes now exceeding 30yr mean that we might expect to see another round of stress cracking failures as exposed liners finally oxidize sufficiently on the surface to initiate stress cracking?

This would be frustrating after resolving the early 1980s problems with stress cracking failures at welds and stone protrusions when the liners contracted at low temperatures, but it is the way end-of-life will become apparent. And will that be soon or in another 5-20 years? It would be useful to know.

For baseline data, it would be useful to have some archive material to test, but that is not usually available. Manufacturers often discard retained samples after about 5 years. Perhaps facility owners should be encouraged to keep retained samples at room temperature and out of sunlight. The next best thing is to use material from the anchor trench or elsewhere that has not experienced extremes in temperature and that has not been exposed to UV radiation or to expansion/contraction stresses.

Less satisfactory options are to use the original NSF 54 specifications, the manufacturer's specifications, or the GRI-GM13 specifications at the appropriate time of liner manufacturing. The concern with using these specifications is that while aged material may meet them, there is no indication of whether the measured values have significantly decreased from the actual as-manufactured values that generally significantly exceed the specification.

A final option for the baseline would be to use the values at the time of the first liner assessment.

The first liner condition assessment would consist of a site visit during which a general visual examination would be done together with a mechanical probing of the edges of welds. A visual examination would include the black/gray shades of different panels that might indicate low carbon contents.

A closer examination should be done using a loupe (small magnifier) on suspect areas such as wrinkle peaks, the tops and edges of multiple extrusion weld beads, and the apex-down creases of round die-manufactured sheet.

The last detail is significant because the combination of oxidizing surface and exposed surface tension when the liner contracts at low temperatures and the crease is pulled flat can be one of the first locations to crack. The apex-up creases do not fail at the same time because the oxidized exposed surface is under compression (or less tension) when the crease is flattened out.

Appropriate samples for detailed laboratory testing will be removed.

It may be appropriate to do a water lance electrical integrity survey on the exposed sideslopes, but this would only be effective on single liners, and on double liners with a composite primary liner, a conductive geomembrane, or a geocomposite with a conductive geotextile on top.

A sampling and testing regime

A liner lifetime evaluation program should be simple, meaningful, and cost-effective.

While it will initially require expert polymer materials science/engineering input to analyze the test data and to define the critical parameters, it should ultimately be possible to use an expert system to automatically make predictions using the input test data.

Small samples will be taken from deep in the anchor trench and from appropriate

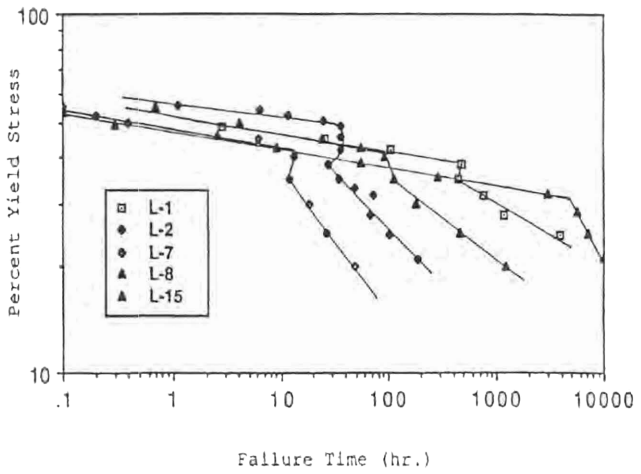

Figure 1 | Standard stress rupture curves for five HDPE geomembranes (Hsuan, et al. 1992)

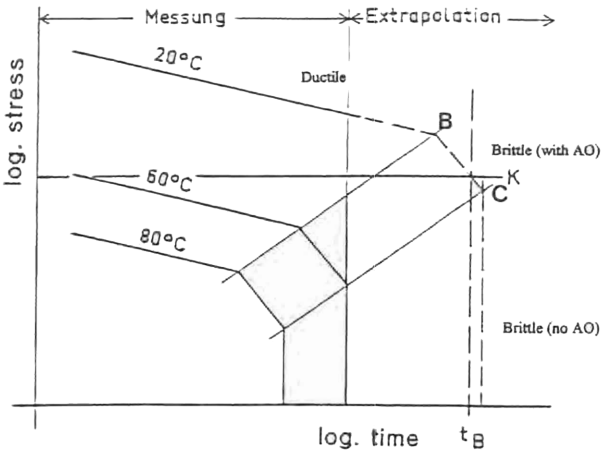

Figure 2 | Stress rupture curves showing third stage (Brittle no AO) oxidized limit. (Gaube, et al. 1985)

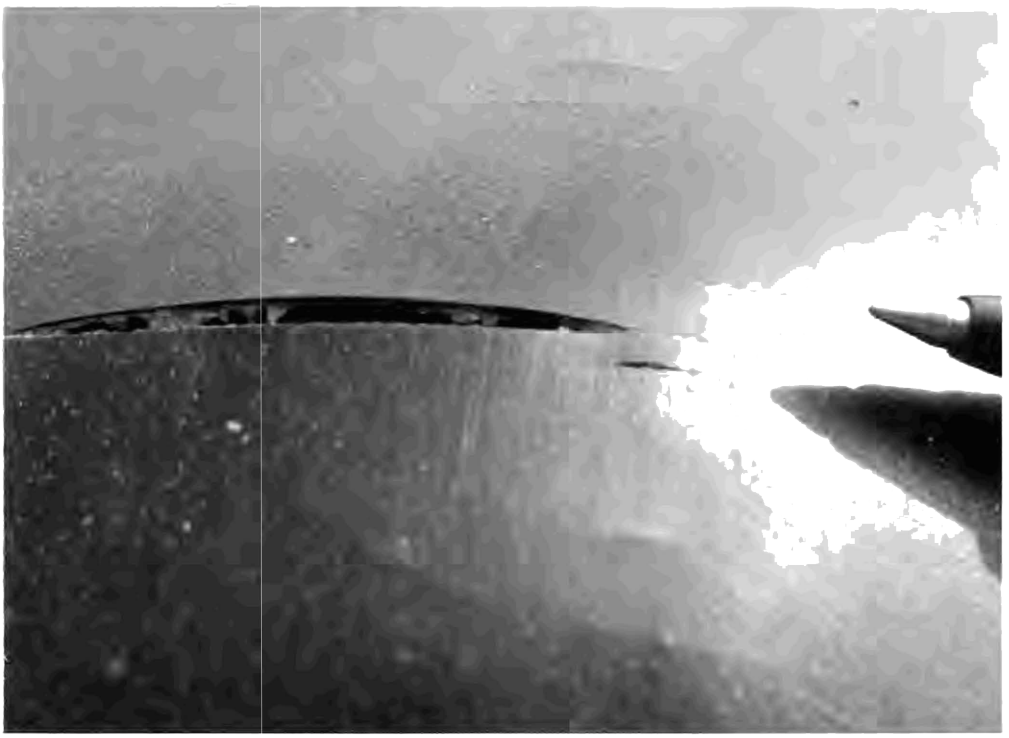

Figure 3 | Stress crack initiated by extruder die line at stone protrusion

exposed locations. Potential sites for future sample removal by the facility owner for future testing will be identified and marked by the expert during the first site visit.

The baseline sample(s) will be tested as follows:

- Single-point stress cracking resistance (SCR) on a molded plaque by ASTM D5397
- High-pressure oxidative induction time (HP-OIT) by ASTM D5885
- Fourier transform infrared spectroscopy (FTIR-ATR) on upper surface to determine carbonyl index (CI) on nonarchive samples only
- Oven aging/HP-OIT (GRI-GM13)
- UV resistance/HP-OIT (GRI-GM13)

The exposed samples will be tested as follows:

- Carbon content (ASTM D1603)
- Carbon dispersion (ASTM D5596)
- Single-point SCR on molded plaque (ASTM D5397)
- Light microscopy of exposed surface, through-thickness cross sections, and thin microsections (~15 µm thick) as necessary
- HP-OIT on 0.5-mm-thick exposed surface layers from basic sheet and from sheet at edge of extruded weld bead (ASTM D5885), preferably at a double-weld bead
- FTIR-ATR on exposed surface to determine CI
- Oven aging/HP-OIT on 0.5mm surface layer (GRI-GM13)
- UV resistance/HP-OIT on 0.5 mm surface layer (GRI-GM13)

Carbon content is done to ensure adequate basic UV protection. Carbon dispersion is done to ensure uniform surface UV protection and to evaluate agglomerates that might act as initiation sites for stress cracking.

HP-OIT is used to assess the remaining amount of stabilizer additives, both in the liner panels and in the sheet adjacent to an extrusion weld. Most stress cracking is observed at the edges of extrusion

weld beads in the lower sheet, so it is important to monitor this location.

While standard OIT (ASTM D3895 at 200°C) better assesses the relevant stabilizers effective at processing (melting) and welding temperatures, the relevant changes in effective stabilizer content during continued service, including in the weld zone, will be provided by measurement of HP-OIT. There will be no future high temperature transient where knowledge of S-OIT will be useful. It is expected that the liner adjacent to the weld bead will be more deficient in stabilizer than the panel itself. Therefore, S-OIT is not considered in this program.

Note that HP-OIT is measured on a thin surface layer because the surface layer may be oxidized while the body of the geomembrane may not. If material from the full thickness of the geomembrane is used it could show a significant value of OIT, implying that there is still stabilizer present and that oxidation is far from occurring. However, the surface layer could be fully oxidized with stress cracks already initiated and propagating. A crack will then propagate more easily through unoxidized material than would initiation and propagation occur in unoxidized material.

The fact that the HP-OIT meets a certain specification value in the as-manufactured condition provides no guarantee that thermo- and photo-oxidation protection will be provided for a long time. Stabilizers might be consumed quickly or slowly while providing protection. They may also be consumed quickly to begin with, then more slowly, or vice versa.

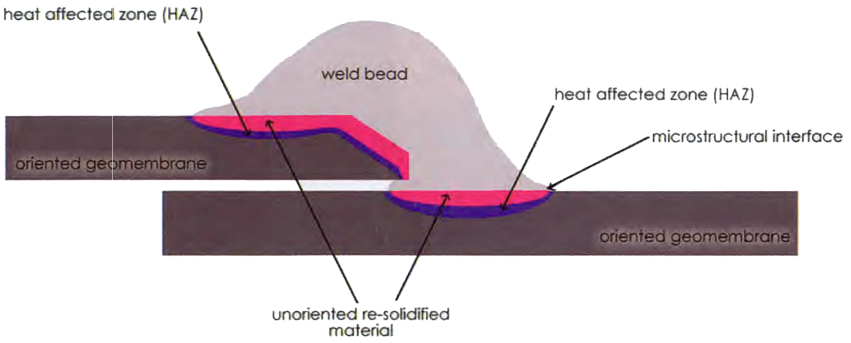

Figure 4 | Schematic of microstructure at extrusion weld

Hence, the need for continuing oven (thermal) aging and UV resistance tests. These two parameters, assessed by measuring retained HP- OIT, are critical to the assessment of remaining service life.

Oven (thermal) aging and UV resistance tests performed in this program will provide an extremely valuable data base that relates laboratory testing to in-service performance and that will further aid in more accurately projecting in-service performance from laboratory testing results.

Special considerations

Because we do not know, by OIT measurements alone, whether the surface layer is or is not oxidized (unless OIT is zero), and since we do not yet know at what level of OIT loss there might be an oxidized surface layer (the database has not yet been generated), FTIR directly on the surface of the geomembrane is performed using the attenuated total reflectance (ATR) technique to deny or confirm the presence of oxidation products (carbonyl groups).

Following the practice of Broutman, et al. (1989) and Duvall (2002) on HDPE pipes, if the ratio of the carbonyl peak at wave number 1760 cm-1 and the C-H stretching (PE) peak at wave number 1410 cm -1 is more than 0.10, there is a sufficiently oxidized surface layer that stress cracking might be initiated. For those familiar with the two slope stress rupture curve (**Figure 1**) where the brittle stress cracking region is the steeper segment below the knee, there is a third vertical part of the curve (**Figure 2**) where the material is fully oxidized and fracture occurs at the slightest stress. This is what will happen at the end of service life. But first note the times to initiation of stress cracking (the knees in the curves) in **Figure 1**—they range from ~10/hr to ~5,000/hr—clearly confirming that all HDPEs are not the same. Some are far more durable than others.

At the end of service life, at some level of OIT, there will be a critically oxidized surface layer that when stressed, such as at low temperatures by an upwards protruding stone, or by flexing due to wind uplift, will initiate a stress crack on the surface that will propagate downward through the geomembrane, as shown by the crack in **Figure 3**.

This crack, initiated at a stress concentrating surface die mark, occurred when the liner contracted at low temperatures, and tightened over an upwardly protruding stone. The straight morphology of the crack, and the ductile break at the bottom surface as the stress in the remaining ligament rose above the knee in the stress rupture curve, are typical of a stress crack. Note the shorter stress cracks initiated along other nearby die marks.

Stress cracks are preferentially initiated along the edges of welds because the adjacent geomembrane has been more depleted of stabilizers during the high temperature welding process. Thus, under further oxidizing service conditions, it will become the first location to

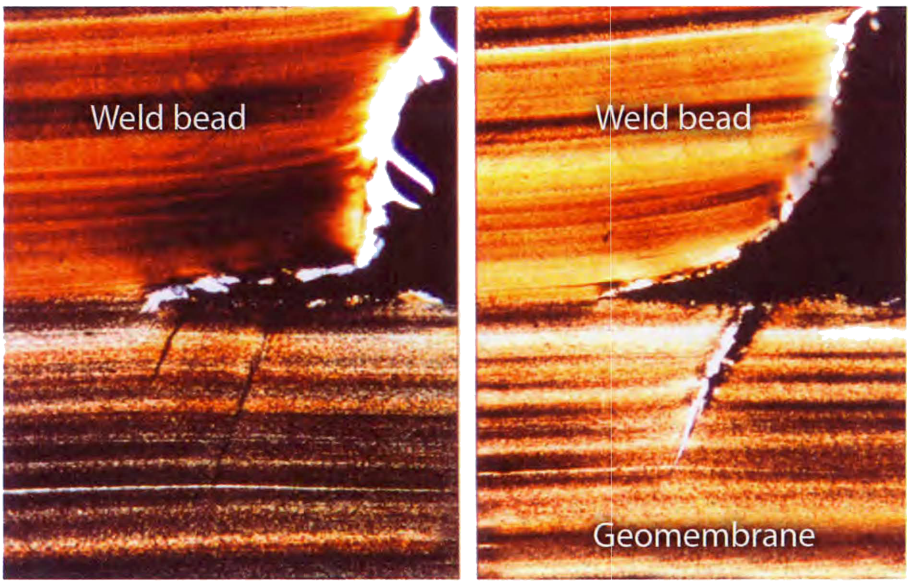

Figure 5 | Typical off-normal angle of precursor crazes (left) and stress crack (right) at edge of extrusion weld.

Type	Specification	Predicted Lifetime in Texas, USA
Side wall exposed	54	5
Side wall concrete side	81	71
Lower launder exposed	16	3
Lower launder concrete side	145	1

Table 2 | S-OIT values on solution and concrete liner surfaces (Peggs, 2008).

be oxidized to the critical level at which stress cracks will be initiated under any applied stress. In addition, the geometrical notches at grinding gouges and at the edges of the bead increase local stresses to critical levels for SC to occur.

I also believe that an internal microstructural flaw exists between the originally oriented geomembrane structure and the pool of more isotropic melted and resolidified material at the edge of the weld zone, as shown schematically in **Figure 4**. Most stress cracks occur at an off-normal angle at the edge of the weld bead that may be related to the angle of this molten-pool to oriented-structure interface (**Figure 5**). It is also known that stress increases the extraction of stabilizers from polyolefin materials.

With all of these agencies acting synergistically, it is not surprising that stress cracking often first occurs adjacent to extrusion welds.

Looking ahead

With the first field assessment test results available to us, and the extent of changes from the baseline sample known, removal of a second set of samples by the facility owner (at locations previously identified and marked by the initial surveyor), will be planned for a future time, probably in 2 or 3 years.

Why 2 or 3 years? In an extreme chemical environment, extensive reductions in S-OIT of studded HDPE concrete protection liners in mine solvent extraction facilities using kerosene/aromatic hydrocarbon/sulfuric acid process solutions at 55°C (131°F) have been observed on the solution and concrete sides of the liner (**Table 2**) within 1 year (Peggs 2008). But it is unlikely that such rapid decreases will be observed in air-exposed material.

With this second set of field samples, and with three sets of data points, practically reliable extrapolations of remaining lifetime can start to be made.

It is expected that a few years of notice for impending failures will be possible.

The key point to note in making these condition assessments is that, while all HDPE geomembranes have very similar conventional index properties, they can have widely variable photo-oxidation, thermal-oxidation, and stress-cracking resistances. Therefore, some HDPEs are more durable than others.

Thus, while one HDPE geomembrane manufactured in 1990 failed after 15 years in 2005, another HDPE geomembrane made in 1990 from a different HDPE resin (or more correctly a medium-density polyethylene [MDPE] resin), and with a better stabilizer additive package, could still have a remaining lifetime of 5, 20, or 30 years.

So, keep a close eye on those exposed liners and we'll learn a great deal more about liner performance and get notice of the end of service lifetime. And if owners can retain some archive material from new installations, so much the better.

References

Broutman L.J., Duvall, D.E., So, P.K. (1989). "Fractographic Study of a Polyethylene Sewer Pipe Failure." SPE Antec, pp 1599-1602.

Duvall, D.E. (2002). "Analyses of Large Diameter Polyethylene Piping Failures." Proceedings of the Society of Plastics Engineers, 60th Annual Technical Conference.

Gaube, E., Gebler, H., Müller, W., and Gondro, C. (1985). "Creep Rupture Strength and Aging of HDPE Pipes 30 Years Experience in Testing of Pipes." Kunststoffe 74 7, pp 412-415.

Koerner, R.M., Hsuan, Y.G., Koerner, G. (2008). "Freshwater and Geosynthetics: A Perfect Marriage." Keynote Lecture at GeoAmericas 2008, IFAI, Roseville, Minn., USA.

Hsuan, Y.G., Koerner, R.M., Lord, A.E., Jr., (1992). "The Notched Constant Tensile Load (NCTL) Test to Evaluate Stress Cracking Resistance." 6th GRI Seminar, MQC/MQA and CQC/CQA of Geosynthetics, Folsom, Pa., USA, pp 244-256.

Peggs, I.D., (2008). "The Performance of Concrete Protection liners in Mine SX/EW Mixers and Settlers: The Need for Chemical Resistance Testing." Proceedings of GeoAmericas 2008, IFAI, Roseville, Minn., USA.

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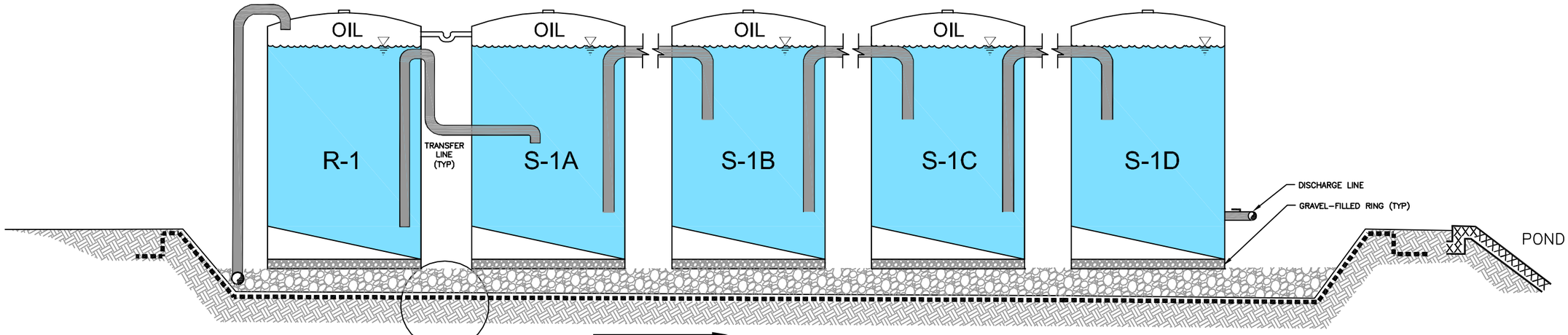
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.C

TYPICAL RECEIVING TANK INSTALLATION DETAILS



ELEVATION - SECTION A-A'

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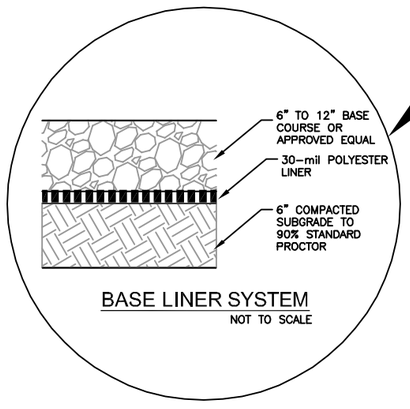

BASE LINER SYSTEM

NOT TO SCALE

TYPICAL RECEIVING TANK INSTALLATION DETAILS

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 10/02/13	CAD: TANK ELEV.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: DRT	ATTACHMENT III.I.C
APPROVED BY: IKG	gei@gordonenvironmental.com	

APPLICATION FOR PERMIT
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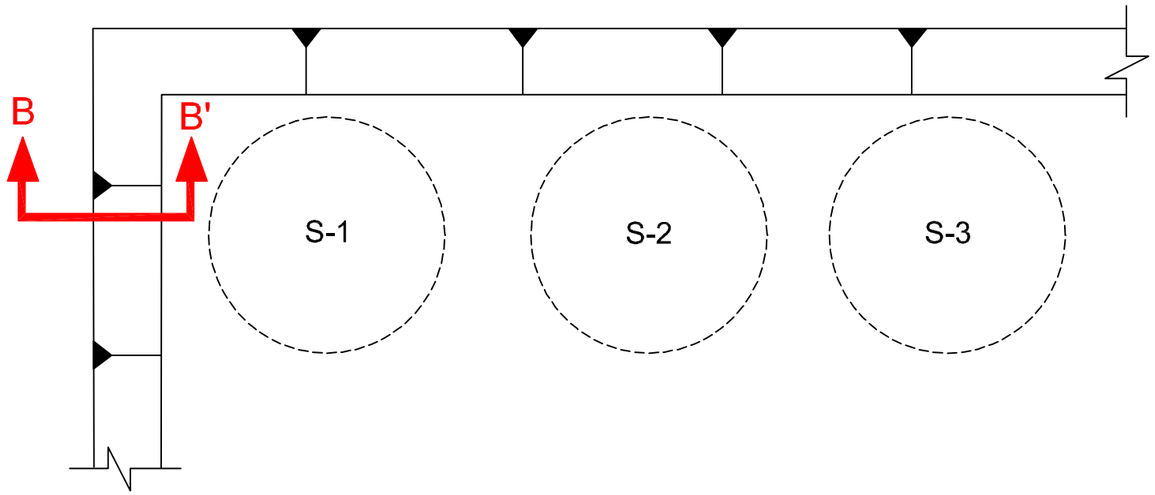
VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.D

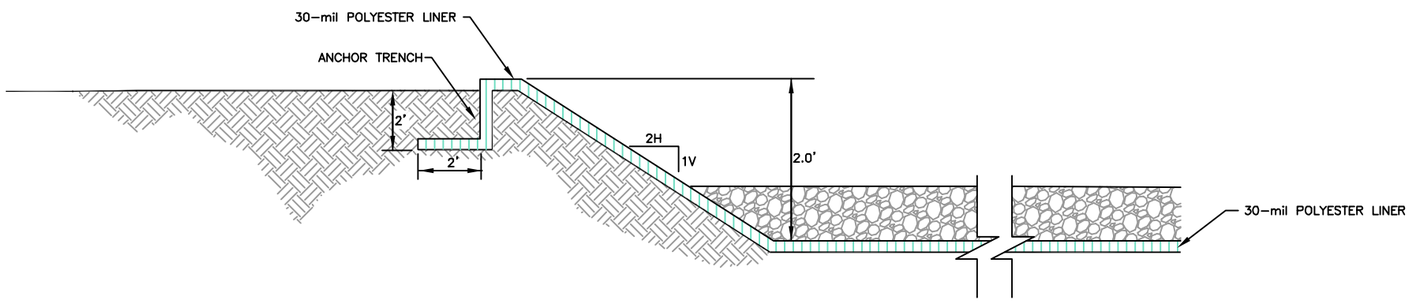
TYPICAL SALES TANK INSTALLATION DETAILS



PLAN VIEW
NOT TO SCALE

LEGEND

S-1 PROPOSED TANK



CROSS SECTION B-B'
NOT TO SCALE

TYPICAL SALES TANK INSTALLATION DETAILS

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

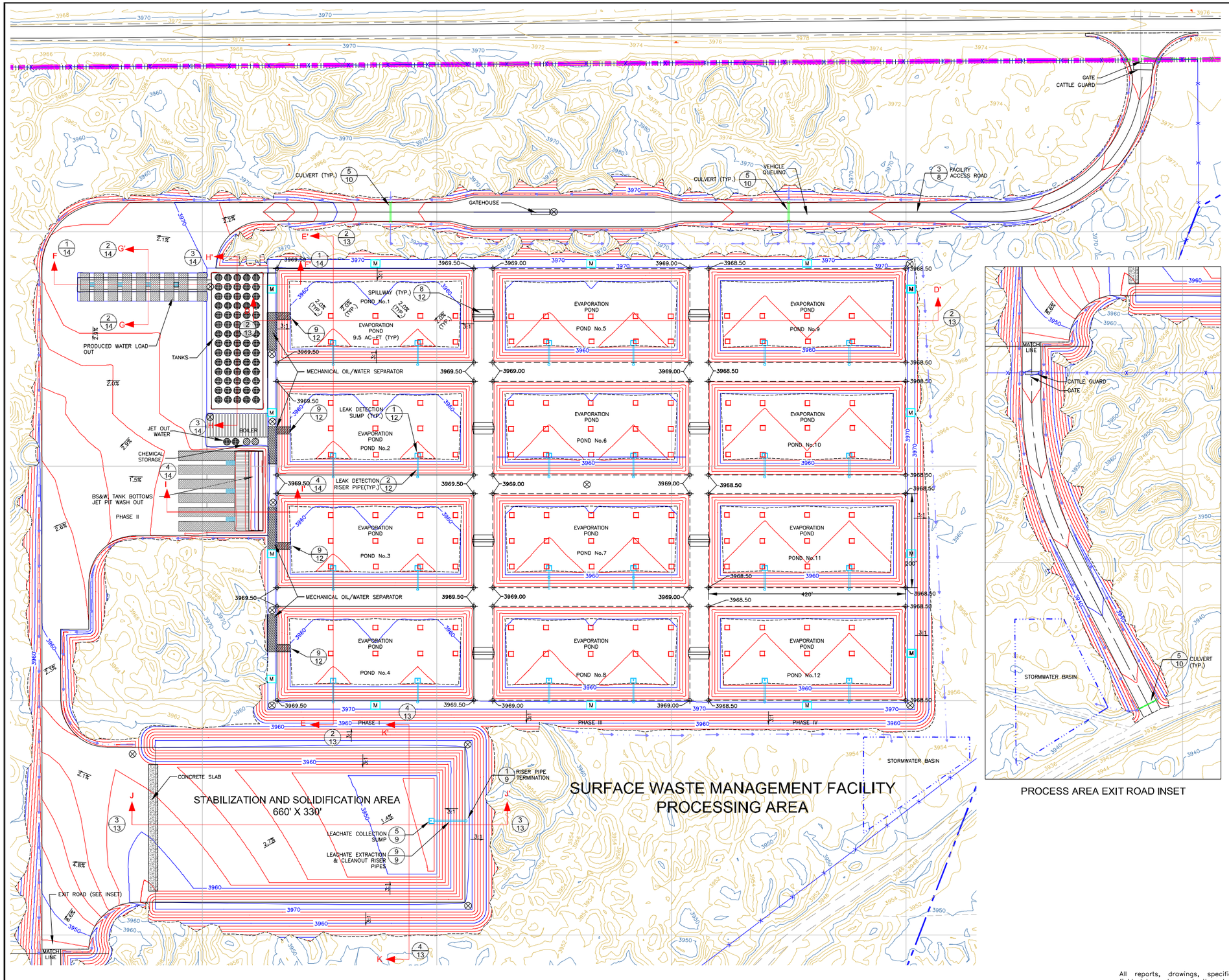
DATE: 10/02/13	CAD: TYP TANK.dwg	PROJECT #: 542.01.01
DRAWN BY: DMI	REVIEWED BY: MRH	ATTACHMENT III.I.D
APPROVED BY: IKG	gei@gordonenvironmental.com	

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.E

SITE SCHEMATIC



PROCESS AREA EXIT ROAD INSET

LEGEND

- SITE BOUNDARY (562 ACRES±)
- DRAINAGE FEATURE SETBACK (67 ACRES±)
- 25' EXISTING CONTOUR
- 5' EXISTING CONTOUR
- 25' DESIGN CONTOUR
- 5' DESIGN CONTOUR
- TOP/TOE OF SLOPE
- EXISTING FENCE
- PROPOSED FENCE
- PAVED ROAD AND SHOULDER (NM 529)
- EXISTING UNPAVED ROAD/TRAIL
- PROPOSED FACILITY ACCESS ROAD
- DIRECTION OF STORMWATER FLOW
- CULVERT
- CATTLE GUARD
- ROAD SIGN
- M — HYDROGEN SULFIDE MONITORING STATION
- EVAPORATORS
- PPE AND EMERGENCY EQUIPEMENT
- LEAK DETECTION SUMP & RISER PIPE
- D D' — CROSS SECTION LOCATION
- 2/13 — DETAIL NUMBER / SHEET NUMBER
- N 650,500 / E 738,000 — SITE GRID

NOTES:

1. BASE MAP PROVIDED BY DALLAS AERIAL SURVEYS, INC
2. FIELD SURVEY PROVIDED BY PETTIGREW & ASSOCIATES PA (12/13/2012)
3. DATE OF AERIAL PHOTOGRAPHY: 02-28-2013
4. SITE GRID BASED ON NEW MEXICO STATE PLANE COORDINATE SYSTEM, EAST ZONE, NAVD 88.
5. THE DNCS SURFACE WASTE MANAGEMENT FACILITY COMPRISES A TOTAL OF 495 ACRES ± (i.e., the processing area (177 acres ±) and the landfill (318 acres ±).

VOLUME

ENTRANCE ROAD

CUT VOLUME	11583	CU. YD.
FILL VOLUME	6290	CU. YD.
NET VOLUME	5293	CU. YD.<CUT>

EVAP PONDS

CUT VOLUME	182856	CU. YD.
FILL VOLUME	106752	CU. YD.
NET VOLUME	76104	CU. YD.<CUT>

PROCESSING AREA

CUT VOLUME	51153	CU. YD.
FILL VOLUME	24228	CU. YD.
NET VOLUME	26925	CU. YD.<CUT>

STABILIZATION AND SOLIDIFICATION AREA

CUT VOLUME	11996	CU. YD.
FILL VOLUME	51002	CU. YD.
NET VOLUME	39006	CU. YD.<FILL>

EXIT ROAD

CUT VOLUME	18072	CU. YD.
FILL VOLUME	0	CU. YD.
NET VOLUME	18072	CU. YD.<CUT>

NORTH

0 100 200

SITE SCHEMATIC

DNCS ENVIRONMENTAL SOLUTIONS
LEA COUNTY, NEW MEXICO

Gordon Environmental, Inc.
Consulting Engineers
213 S. Camino del Pueblo
Bernalillo, New Mexico, USA
Phone: 505-867-6990
Fax: 505-867-6991

DATE: 06/13/2014	CAD: SITE SCHEMATIC .DWG	PROJECT #: 542,01,01
DRAWN BY: DMI	REVIEWED BY: MRH	ATTACHMENT III.1.E
APPROVED BY: IKG	gel@gordonenvironmental.com	

NOT FOR CONSTRUCTION
Drawing:P:\acad 2003\542,01,01\RAI 1\SITE SCHEMATIC.dwg
Date/Time:Jun, 13, 2014-1:13:26 ; LAYOUT: D (LS)

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.F

TANK CAPACITY CALCULATIONS

ATTACHMENT III.1.F
Tank Capacity Calculations
DNCS Environmental Solutions

DNCS is a surface waste management facility.

A. Produced Water is delivered by trucking companies into one of twelve proposed heated Produced Water Receiving Tanks located within a bermed, lined containment area:

Proposed Tank No.	Volume	Permitted
R-1	1000 bbls	Permitted under this Application
R-2	1000 bbls	Permitted under this Application
R-3	1000 bbls	Permitted under this Application
R-4	1000 bbls	Permitted under this Application
R-5	1000 bbls	Permitted under this Application
R-6	1000 bbls	Permitted under this Application
R-7	1000 bbls	Permitted under this Application
R-8	1000 bbls	Permitted under this Application
R-9	1000 bbls	Permitted under this Application
R-10	1000 bbls	Permitted under this Application
R-11	1000 bbls	Permitted under this Application
R-12	1000 bbls	Permitted under this Application

i. The Receiving tanks serve to gravity separate solids and oil from the water. Solids collect in the bottoms and oil floats to the tops of the receiving tanks.
ii. The Receiving Tanks bottoms are solidified and taken to the OCD permitted Landfill.
iii. The Receiving Tanks are set on gravel or sand pads on top of a lined bermed impermeable pad.

B. Water from each Receiving Tanks flows in series through four additional Settling Tanks to remove oil prior to discharge in the mechanical oil water separator:

Proposed Tank No.	Volume	Permitted
S-1A	1000 bbls	Permitted under this Application
S-1B	1000 bbls	Permitted under this Application
S-1C	1000 bbls	Permitted under this Application
S-1D	1000 bbls	Permitted under this Application
S-2A	1000 bbls	Permitted under this Application
S-2B	1000 bbls	Permitted under this Application
S-2C	1000 bbls	Permitted under this Application
S-2D	1000 bbls	Permitted under this Application
S-3A	1000 bbls	Permitted under this Application
S-3B	1000 bbls	Permitted under this Application
S-3C	1000 bbls	Permitted under this Application
S-3D	1000 bbls	Permitted under this Application
S-4A	1000 bbls	Permitted under this Application
S-4B	1000 bbls	Permitted under this Application
S-4C	1000 bbls	Permitted under this Application
S-4D	1000 bbls	Permitted under this Application
S-5A	1000 bbls	Permitted under this Application
S-5B	1000 bbls	Permitted under this Application
S-5C	1000 bbls	Permitted under this Application
S-5D	1000 bbls	Permitted under this Application
S-6A	1000 bbls	Permitted under this Application
S-6B	1000 bbls	Permitted under this Application
S-6C	1000 bbls	Permitted under this Application

S-6D	1000 bbls	Permitted under this Application
S-7A	1000 bbls	Permitted under this Application
S-7B	1000 bbls	Permitted under this Application
S-7C	1000 bbls	Permitted under this Application
S-7D	1000 bbls	Permitted under this Application
S-8A	1000 bbls	Permitted under this Application
S-8B	1000 bbls	Permitted under this Application
S-8C	1000 bbls	Permitted under this Application
S-8D	1000 bbls	Permitted under this Application
S-9A	1000 bbls	Permitted under this Application
S-9B	1000 bbls	Permitted under this Application
S-9C	1000 bbls	Permitted under this Application
S-9D	1000 bbls	Permitted under this Application
S-10A	1000 bbls	Permitted under this Application
S-10B	1000 bbls	Permitted under this Application
S-10C	1000 bbls	Permitted under this Application
S-10D	1000 bbls	Permitted under this Application
S-11A	1000 bbls	Permitted under this Application
S-11B	1000 bbls	Permitted under this Application
S-11C	1000 bbls	Permitted under this Application
S-11D	1000 bbls	Permitted under this Application
S-12A	1000 bbls	Permitted under this Application
S-12B	1000 bbls	Permitted under this Application
S-12C	1000 bbls	Permitted under this Application
S-12D	1000 bbls	Permitted under this Application

i. The Settling Tanks increase the detention time available to provide additional gravity separation of oil from the water,
ii. The Settling Tank bottoms are taken to the Stabilization/Solidification Area.
iii. The Settling Tanks are set on gravel or sand pads on top of a lined bermed impermeable pad.

C. The separated oil flows into one of five heated Crude Oil Receiving Tanks:

Proposed Tank No.	Volume	Permitted
C-1	1000 bbls	Permitted under this Application
C-2	1000 bbls	Permitted under this Application
C-3	1000 bbls	Permitted under this Application
C-4	1000 bbls	Permitted under this Application
C-5	1000 bbls	Permitted under this Application

i. The Crude Oil Receiving Tanks are set inside the proposed lined containment berm.
ii. The Crude Oil Receiving Tanks are interconnected at the top of the tanks for oil removal.
iii. Water recovered from the Crude Oil Receiving Tanks is redirected to the Produced Water Receiving Tanks.
iv. Sludges recovered from the Crude Oil Receiving Tanks are stabilized, solidified and sent for landfill disposal.

D. The water from the Settling Tanks is discharged through one of up to four Dissolved Air Floatation (DAF) Units.

Proposed Tank No.	Volume	Permitted
D-1	10 bbls	Permitted under this Application
D-2	10 bbls	Permitted under this Application
D-3	10 bbls	Permitted under this Application
D-4	10 bbls	Permitted under this Application

i. The DAF Units are situated on the lined Evaporation Pond berm in a location where any leackage would drain
ii. The DAF use air bubles to lift any remaining oil from the water prior to dischage into one of four Ponds.
iii. The oil containing foam generated by the DAF is collected and discharged into the Crude Oil Receiving Tanks for further processing.

E.

Proposed Pond No.	Storage Volume	Permitted
P-1	73,700 bbls	Permitted under this Application

P-2	73,700 bbls	Permitted under this Application
P-3	73,700 bbls	Permitted under this Application
P-4	73,700 bbls	Permitted under this Application
P-5	73,700 bbls	Permitted under this Application
P-6	73,700 bbls	Permitted under this Application
P-7	73,700 bbls	Permitted under this Application
P-8	73,700 bbls	Permitted under this Application
P-9	73,700 bbls	Permitted under this Application
P-10	73,700 bbls	Permitted under this Application
P-11	73,700 bbls	Permitted under this Application
P-12	73,700 bbls	Permitted under this Application

i. Surface aeration and bleach are used to maintain water chemistry parameters:
:O_2 at or above 0.5 ppm one foot off the bottom of the pond.

:pH above 8

ii. H2S monitors are placed around the pond covering the four major points on the compass.
iii. The H2S monitors continually monitor the ambient air.
iv. Two chlorine monitors are placed around the ponds covering the North and West borders.
v. Treatment capacity of each Pond is 73,994 bbls (~9.5 acre feet)
vi. 3.5 Feet of Freeboard is proposed, storage volume does include freeboard
vii. Volume including freeboard is 122,640 bbls (15.76 acre-feet)per pond
viii. Inside grade shall be no steeper than 3H:1V
ix. Levees shall have an outside grade no steeper than 3H:1V
x. Levees' tops shall be wide enough to install an anchor trench and provide adequate room for inspection/maintenance.
xi. Liner seams shall be minimized and oriented up and down, not across a slope
Each pond shall have a:
:primary liner (60-mil HDPE liner, UV resistant)
:secondary liner (60-mil HDPE liner, UV resistant)
xii. Slope shall be 2% (2 ft V for 100 ft H)
xiii. A mechanical evaporation system shall be installed in each pond to enhance evaporation.
xiv. Approximate size of each pond is 200 x 420 feet x 7.6 feet deep

F. Bleach for H2S management is stored in two proposed chemical tanks:

Proposed Tank No.	Volume	Permitted
B-1	60 bbls	Permitted under this Application
B-2	60 bbls	Permitted under this Application

i. The Chemical Tanks are set on a bermed concrete pad that drains into the pond.
ii. The Bleach is pumped through lines to discharge points in each of the ponds.

G. Water from Pond 1 (P-1) is:
i. Pumped through lines to floating evaporators in Ponds 2, 3, and 4 (P-2, P-3, P-4).
ii. Three floating evaporators are situated in each Pond.
iii. Water that does not evaporate from Ponds 2, 3, or 4 is pumped to floating evaporators in Ponds 5 and 6.
iv. Water that does not evaporate from Ponds 5 and 6 is pumped to floating evaporators in Ponds 7 and 8.
v. Water that does not evaporate from Ponds 7 and 8 is pumped to floating evaporators in Ponds 9 and 10.

H. The Jet-Out Pit receives discharges from tankers bringing oil contaminated drilling mud, BS&W, tank bottoms and washout from tank cleanings.

Proposed Pit No.	Volume	Permitted
J-1	1000 bbls	Permitted under this Application

Proposed Tank No.	Volume	Permitted
WW-1	1000 bbls	Permitted under this Application
FW-1	1000 bbls	Permitted under this Application

i. Wash-Water for the Jet-Out Pit is recycled through a line from Pond-10 to WW-1. A pump connected to WW-1 pumps the water through a line to one of six wash-out stations for use cleaning the tankers.
ii. Fresh-Water for the Jet-Out Pit is discharged from the water supply through an air gap into FW-1. A pump connected to FW-1 pumps the water through a line to one of six wash-out stations for use cleaning the tanks.
ii. Oil from the Jet-Out Pit is transferred through a line to the Crude Oil Receiving Tanks for further Processing..
iii. Water from the Jet-Out Pit is transferred through a line to the Produced Water Receiving Tanks for processing.
iv. Sludges and sediments from the Jet Out Pit is removed with a bucket loader and transferred to the waste stabilization area for stabilization, solidification and disposal.

I. Oil from the Crude Oil Receiving Tanks C1-C5 completed the dewatering process with the finished product transferred to the Oil Sales Tanks.

Proposed Tank No.	Volume	Permitted
S-1	1000 bbls	Permitted under this Application
S-2	1000 bbls	Permitted under this Application
S-3	1000 bbls	Permitted under this Application
S-4	1000 bbls	Permitted under this Application
S-5	1000 bbls	Permitted under this Application

i. The proposed Oil Sales Tanks are set inside the lined berm next to the Crude Oil Receiving Tanks.
ii. Oil is removed from the Oil Sales tank to a tanker at the Oil Sales Load-Out

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.G

PIPE WALL THICKNESS INFORMATION

PVC PIPE DIMENSIONS

Nominal Pipe Size	Wall Thickness		Outside Diameters		
				Tolerance	
	Minimum	Tolerance	Average OD	Average	Out-of-Roundness
ASTM D 1785, PVC PIPE, SCHEDULE 40					
1	0.133	+0.020	1.315	±0.005	±0.010
1¼	0.140	+0.020	1.660	±0.005	±0.012
1½	0.145	+0.020	1.900	±0.006	±0.012
2	0.154	+0.020	2.375	±0.006	±0.012
2½	0.203	+0.024	2.875	±0.007	±0.015
3	0.216	+0.026	3.500	±0.008	±0.015
3½	0.226	+0.027	4.000	±0.008	±0.050
4	0.237	+0.028	4.500	±0.009	±0.050
5	0.258	+0.031	5.563	±0.010	±0.050
6	0.280	+0.034	6.625	±0.011	±0.050
8	0.322	+0.039	8.625	±0.015	±0.075
10	0.365	+0.044	10.750	±0.015	±0.075
12	0.406	+0.049	12.750	±0.015	±0.075
ASTM D 1785, PVC PIPE, SCHEDULE 80					
1	0.179	+0.021	1.315	±0.005	±0.010
1¼	0.191	+0.023	1.660	±0.005	±0.012
1½	0.200	+0.024	1.900	±0.006	±0.012
2	0.218	+0.026	2.375	±0.006	±0.012
2½	0.276	+0.033	2.875	±0.007	±0.015
3	0.300	+0.036	3.500	±0.008	±0.015
3½	0.318	+0.038	4.000	±0.008	±0.015
4	0.337	+0.040	4.500	±0.009	±0.015
5	0.375	+0.045	5.563	±0.010	±0.030
6	0.432	+0.052	6.625	±0.011	±0.035
8	0.500	+0.060	8.625	±0.015	±0.075
10	0.593	+0.071	10.750	±0.015	±0.075
12	0.687	+0.082	12.750	±0.015	±0.075
ASTM D 2241, PVC PIPE (SDR-PR), SDR 21 (200)					
1	0.063	+0.020	1.315	±0.005	±0.015
1¼	0.079	+0.020	1.660	±0.005	±0.015
1½	0.090	+0.020	1.900	±0.006	±0.030
2	0.113	+0.020	2.375	±0.006	±0.030
2½	0.137	+0.020	2.875	±0.007	±0.030
3	0.167	+0.020	3.500	±0.008	±0.030
3½	0.190	+0.023	4.000	±0.008	±0.050
4	0.214	+0.026	4.500	±0.009	±0.050
5	0.265	+0.032	5.563	±0.010	±0.050

Table A-2 (cont'd)
PIPE WEIGHTS AND DIMENSIONS *(IPS)*
PE3608 *(BLACK)*

OD			SDR	Nominal ID		Minimum Wall		Weight	
Nominal	Actual							lb. per	kg. per
in.	in.	mm.		in.	mm.	in.	mm.	foot	meter
			7	2.44	61.98	0.500	12.70	2.047	3.047
			7.3	2.48	63.08	0.479	12.18	1.978	2.943
			9	2.68	67.96	0.389	9.88	1.656	2.464
			9.3	2.70	68.63	0.376	9.56	1.609	2.395
			11	2.83	71.77	0.318	8.08	1.387	2.065
3	3.500	88.90	11.5	2.85	72.51	0.304	7.73	1.333	1.984
			13.5	2.95	74.94	0.259	6.59	1.153	1.716
			15.5	3.02	76.74	0.226	5.74	1.015	1.511
			17	3.06	77.81	0.206	5.23	0.932	1.386
			21	3.15	79.93	0.167	4.23	0.764	1.136
			26	3.21	81.65	0.135	3.42	0.623	0.927
			7	3.14	79.68	0.643	16.33	3.384	5.037
			7.3	3.19	81.11	0.616	15.66	3.269	4.865
			9	3.44	87.38	0.500	12.70	2.737	4.073
			9.3	3.47	88.24	0.484	12.29	2.660	3.958
			11	3.63	92.27	0.409	10.39	2.294	3.413
4	4.500	114.30	11.5	3.67	93.23	0.391	9.94	2.204	3.280
			13.5	3.79	96.35	0.333	8.47	1.906	2.836
			15.5	3.88	98.67	0.290	7.37	1.678	2.497
			17	3.94	100.05	0.265	6.72	1.540	2.292
			21	4.05	102.76	0.214	5.44	1.262	1.879
			26	4.13	104.98	0.173	4.40	1.030	1.533
			32.5	4.21	106.84	0.138	3.52	0.831	1.237
			7	3.88	98.51	0.795	20.19	5.172	7.697
			7.3	3.95	100.27	0.762	19.36	4.996	7.435
			9	4.25	108.02	0.618	15.70	4.182	6.224
			9.3	4.29	109.09	0.598	15.19	4.065	6.049
			11	4.49	114.07	0.506	12.85	3.505	5.216
5	5.563	141.30	11.5	4.54	115.25	0.484	12.29	3.368	5.012
			13.5	4.69	119.11	0.412	10.47	2.912	4.334
			15.5	4.80	121.97	0.359	9.12	2.564	3.816
			17	4.87	123.68	0.327	8.31	2.353	3.502
			21	5.00	127.04	0.265	6.73	1.929	2.871
			26	5.11	129.78	0.214	5.43	1.574	2.343
			32.5	5.20	132.08	0.171	4.35	1.270	1.890
			7	4.62	117.31	0.946	24.04	7.336	10.917
			7.3	4.70	119.41	0.908	23.05	7.086	10.545
			9	5.06	128.64	0.736	18.70	5.932	8.827
			9.3	5.11	129.92	0.712	18.09	5.765	8.579
			11	5.35	135.84	0.602	15.30	4.971	7.398
6	6.625	168.28	11.5	5.40	137.25	0.576	14.63	4.777	7.109
			13.5	5.58	141.85	0.491	12.46	4.130	6.147
			15.5	5.72	145.26	0.427	10.86	3.637	5.413
			17	5.80	147.29	0.390	9.90	3.338	4.967
			21	5.96	151.29	0.315	8.01	2.736	4.072
			26	6.08	154.55	0.255	6.47	2.233	3.322
			32.5	6.19	157.30	0.204	5.18	1.801	2.680

See ASTM D3035, F714 and AWWA C-901/906 for OD and wall thickness tolerances.
Weights are calculated in accordance with PPI TR-7.

Table A-2 (cont'd)
PIPE WEIGHTS AND DIMENSIONS *(IPS)*
PE3608 *(BLACK)*

OD			SDR	Nominal ID		Minimum Wall		Weight	
Nominal	Actual							lb. per	kg. per
in.	in.	mm.		in.	mm.	in.	mm.	foot	meter
			7	6.01	152.73	1.232	31.30	12.433	18.503
			7.3	6.12	155.45	1.182	30.01	12.010	17.872
			9	6.59	167.47	0.958	24.34	10.054	14.962
			9.3	6.66	169.14	0.927	23.56	9.771	14.541
			11	6.96	176.85	0.784	19.92	8.425	12.538
8	8.625	219.08	11.5	7.04	178.69	0.750	19.05	8.096	12.049
			13.5	7.27	184.67	0.639	16.23	7.001	10.418
			15.5	7.45	189.11	0.556	14.13	6.164	9.174
			17	7.55	191.76	0.507	12.89	5.657	8.418
			21	7.75	196.96	0.411	10.43	4.637	6.901
			26	7.92	201.21	0.332	8.43	3.784	5.631
			7	7.49	190.35	1.536	39.01	19.314	28.743
			7.3	7.63	193.75	1.473	37.40	18.656	27.764
			9	8.22	208.73	1.194	30.34	15.618	23.242
			9.3	8.30	210.81	1.156	29.36	15.179	22.589
			11	8.68	220.43	0.977	24.82	13.089	19.478
10	10.750	273.05	11.5	8.77	222.71	0.935	23.74	12.578	18.717
			13.5	9.06	230.17	0.796	20.23	10.875	16.184
			15.5	9.28	235.70	0.694	17.62	9.576	14.251
			17	9.41	239.00	0.632	16.06	8.788	13.078
			21	9.66	245.48	0.512	13.00	7.204	10.721
			26	9.87	250.79	0.413	10.50	5.878	8.748
			32.5	10.05	255.24	0.331	8.40	4.742	7.058
			7	8.89	225.77	1.821	46.26	27.170	40.433
			7.3	9.05	229.80	1.747	44.36	26.244	39.056
			9	9.75	247.57	1.417	35.98	21.970	32.695
			9.3	9.84	250.03	1.371	34.82	21.353	31.777
			11	10.29	261.44	1.159	29.44	18.412	27.400
12	12.750	323.85	11.5	10.40	264.15	1.109	28.16	17.693	26.330
			13.5	10.75	272.99	0.944	23.99	15.298	22.767
			15.5	11.01	279.56	0.823	20.89	13.471	20.047
			17	11.16	283.46	0.750	19.05	12.362	18.397
			21	11.46	291.16	0.607	15.42	10.134	15.081
			26	11.71	297.44	0.490	12.46	8.269	12.305
			32.5	11.92	302.73	0.392	9.96	6.671	9.928
			7	9.76	247.90	2.000	50.80	32.758	48.750
			7.3	9.93	252.33	1.918	48.71	31.642	47.089
			9	10.70	271.84	1.556	39.51	26.489	39.420
			9.3	10.81	274.54	1.505	38.24	25.745	38.313
			11	11.30	287.07	1.273	32.33	22.199	33.036
14	14.000	355.60	11.5	11.42	290.05	1.217	30.92	21.332	31.746
			13.5	11.80	299.76	1.037	26.34	18.445	27.449
			15.5	12.09	306.96	0.903	22.94	16.242	24.170
			17	12.25	311.25	0.824	20.92	14.905	22.181
			21	12.59	319.70	0.667	16.93	12.218	18.183
			26	12.86	326.60	0.538	13.68	9.970	14.836
			32.5	13.09	332.40	0.431	10.94	8.044	11.970

See ASTM D3035, F714 and AWWA C-901/906 for OD and wall thickness tolerances.
Weights are calculated in accordance with PPI TR-7.

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.H

TECHNICAL DATA AND SPECIFICATIONS FOR XR GEOMEMBRANES

Technical Data and Specifications for

XR® Geomembranes

XR-3®
XR-5®
XR-3® PW

Industrial, Municipal and Potable Water Grade Geomembranes

Seaman Corporation
1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

Seaman Corp. XR Geomembranes

Section 1 - Product Overview/Applications

- All XR Geomembrane products are classified as an Ethylene Interpolymer Alloy (EIA)
- XR-5 grade is high strength and chemically resistant for maximum resistance to high temperature, and broad chemical resistance, including acids, oils and methane
- XR-3 grade for moderate chemical resistant requirement applications such as stormwater and domestic wastewater
- NSF 61 approved XR-3 PW grade for potable water contact
- Heat weldable-thermal weldable for seams as strong as the membrane. Factory panels over 15,000 square feet (1400 sq meters) for less field seaming
- Stability is excellent, with low thermal expansion-contraction properties
- 30+ year application history

Product Application Chart

	XR-5			XR-3	XR-3 PW
	8130	**8138**	**6730**	**8228**	**8130**
High Puncture Resistance	X	X	X		X
UV Resistance	X	X	X	X	X
High Strength Applications	X	X	X		X
Floating Covers (Nonpotable)	X	X	X	X	
Diesel/Jet Fuel Containment	X	X	X		
Industrial Wastewater	X	X	X		
Stormwater	X	X	X	X	
Municipal/Domestic Wastewater	X	X	X	X	
Floating Diversion Baffles/Curtains	X		X		X
Potable Water					X
<-65 Deg F Applications	Contact Seaman Corp.				
Chemically Resistant Applications	X	X	X		

Section 2 - Physical Properties

Part 1- Material Specifications

Property	Test Method	8130 XR-5	8138 XR-5	6730 XR-5
Base Fabric Type Base Fabric Weight	ASTM D 751	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 7 oz/yd^2 nominal (235 g/m^2 nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	40 mils nom. (1.0 mm nom.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 +- 2 oz/sq yd (1017 +- 2 g/m^2)	38.0 +- 2 oz/sq yd (1288 +- 70 g/m^2)	30.0 +- 2 oz/sq yd (1017 +- 70 g/m^2)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	40/55 lbs. min. (175/245 N min.)	
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2,447 N min.)	550/550 lbs. min. (2,447/2,447 N min.)	600/550 lbs. min. (2,670/2,447 N min.)
Low Temperature Resistance	ASTM D 2136 4 hrs-1/8" Mandrel	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C	Pass @ -30° F Pass @ -35° C
Dimensional Stability	ASTM D 1204 100° C-1 Hr.	0.5% max. each direction	0.5% max. each direction	0.5% max. each direction
Hydrostatic Resistance	ASTM D 751 Procedure A	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)	800 psi min. (5.51 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)
Adhesion (minimum) Heat Welded Seam	ASTM D 751 Dielectric Weld	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	40 lbs./2in. RF weld min. (17.5 daN/5 cm min.)	15 lbs./in. RF weld min. (15 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 220 lbs/in @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in @ 160° F (Pass 534 N/2.54 cm @ 70° C)	
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,450 N min.)	550 lbs. min. (2,560 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2,000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss
Weathering Resistance	Carbon-Arc ASTM G 153	8,000 hours min. with no appreciable changes or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min. with no appreciable change or stiffening or cracking of coating
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C	0.025 kg/m^2 max. @70° F/21° C 0.14 kg/m^2 max at 212° F/100° C
Wicking	ASTM D 751	1/8" max (0.3 cm max)	1/8" max. (0.3 cm max.)	1/8" max. (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)	750 lbs. min. (3,330 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.	275 lbs. min. 1,200 N min.
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)
Environmental/Chemical Resistant Properties		See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8	See Chemical Resistance Table, Page 8
Puncture Resistance	FED-STD-101C Method 2031	350 lbs. (approx.)	350 lbs. (approx.)	
Cold Crack	ASTM D 2136 4 Hrs, 1/8" Mandrel	Pass at -30° F/-34° C	Pass @ -30° F/-34° C	Pass @ -30° F/-34° C

Section 2 - Physical Properties

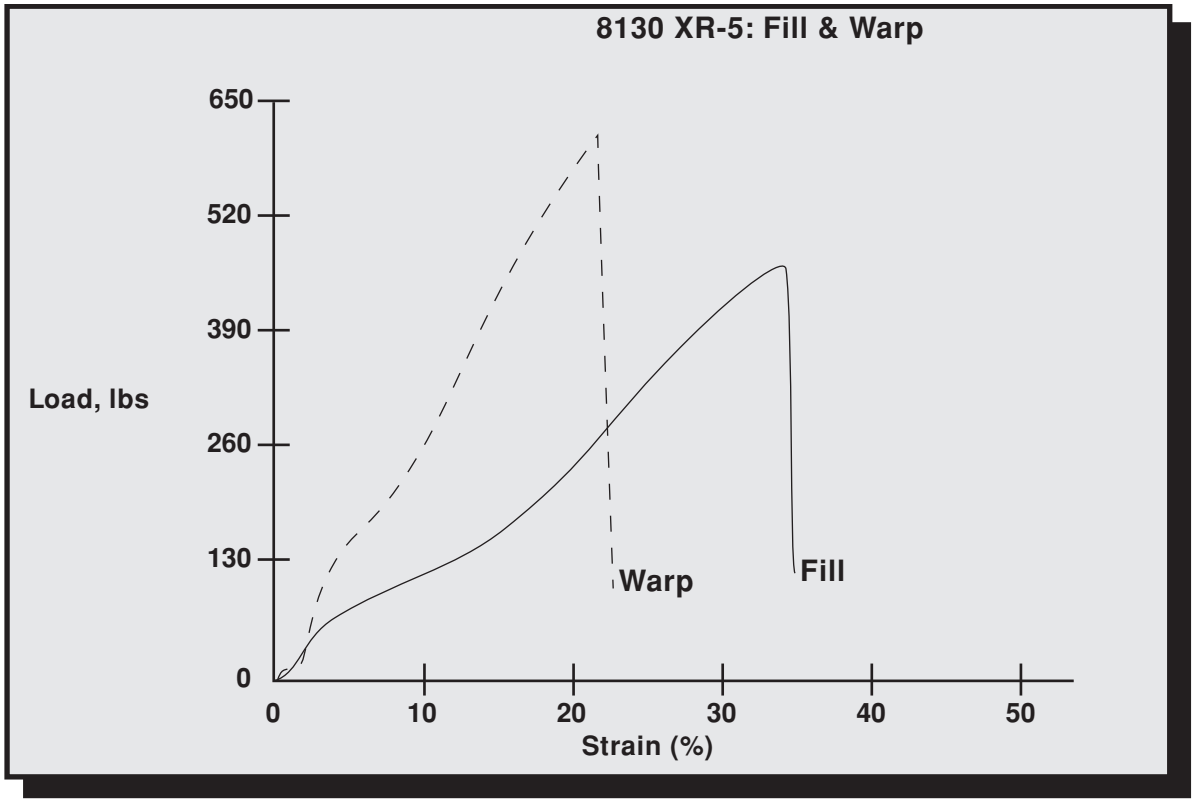
Part 1- Material Specifications (cont.)

Property	Test Method	8130 XR-3 PW	8228 XR-3
Base Fabric Type Base Fabric Weight	ASTM D 751	Polyester 6.5 oz/yd^2 nominal (220 g/m^2 nominal)	Polyester 3.0 oz/yd^2 nominal (100 g/m^2 nominal)
Thickness	ASTM D 751	30 mils min. (0.76 mm min.)	30 mils min. (0.76 mm min.)
Weight	ASTM D 751	30.0 +- 2 oz./sq. yd. (1017 +- 70 g/sq. m)	28.0 +- 2 oz./sq. yd. (950 +- 70 g/sq. m)
Tear Strength	ASTM D 751 Trap Tear	40/55 lbs. min. (175/245 N min.)	30/30 lbs. nom. (133/133 N nom.)
Breaking Yield Strength	ASTM D 751 Grab Tensile	550/550 lbs. min. (2,447/2447 N min.)	250/200 lbs. min. (1,110/890 N min.)
Low Temperature Resistance	ASTM D 2136 4hrs-1/8" Mandrel	Pass @ -30° F (Pass @ -35° C)	Pass @ -25° F (Pass @ -32° C)
Dimensional Stability	ASTM D 1204 100° C-1 hr.	0.5% max. each direction	5% max. each direction
Hydrostatic Resistance	ASTM D 751 Method A	800 psi min. (5.51 MPa min.)	300 psi min. (2.07 MPa min.)
Blocking Resistance	ASTM D 751 180° F	#2 Rating max.	#2 Rating max.
Adhesion-Ply	ASTM D 413 Type A	15 lbs./in. min. or film tearing bond (13 daN/5 cm min. or FTB)	12 lbs./in. (approx.) (10 daN/5 cm approx.)
Adhesion- Heat Welded Seam	ASTM D 751 Dielectrc Weld	40 lbs./2in. min. (17.5 daN/5 cm min.)	10 lbs./in min. (9 daN/5 cm min.)
Dead Load Seam Strength	ASTM D 751, 4-Hour Test	Pass 220 lbs/in. @ 70° F (Pass 980 N/2.54 cm @ 21° C) Pass 120 lbs/in. @ 160° F (Pass 534 N/2.54 cm @ 70° C)	Pass 100 lbs/in @ 70° F (Pass 445 N @ 21° C) Pass 50 lb @ 160° F (Pass 220 N @ 70° C)
Bonded Seam Strength	ASTM D 751 Procedure A, Grab Test Method	550 lbs. min. (2,450 N min.)	250 lbs. (approx.) (1,112 N min.)

Abrasion Resistance	ASTM D 3389 H-18 Wheel 1 kg Load	2000 cycles min. before fabric exposure, 50 mg/100 cycles max. weight loss	2000 cycles min.
Weathering Resistance	ASTM G 153	8000 hours min. with no appreciable change or stiffening or cracking of coating	8000 hours min.
Water Absorption	ASTM D 471, Section 12 7 Days	0.025 kg/m^2 max. @ 70° F/21° C 0.14 kg/m^2 max @ 212° F/100° C	0.05 kg/m^2 max. @ 70° F/21° C (approx.) 0.28 kg/m^2 max. @ 212° F/100° C (approx.)
Wicking	ASTM D 751	1/8" max. (0.3 cm max.)	1/8" max (0.3 cm max.)
Bursting Strength	ASTM D 751 Ball Tip	750 lbs. min. (3330 N min.)	350 lbs. (approx.) (1557 N min.)
Puncture Resistance	ASTM D 4833	275 lbs. min. 1200 N min.	50 lb typ. (225 N typ.)
Coefficient of Thermal Expansion/ Contraction	ASTM D 696	8 x 10^{-6} in/in/° F max. (1.4 x 10^{-5} cm/cm/° C max.)	8 x 10^{-6} in/in/° F max. (approx.) (1.4 x 10^{-5} cm/cm/° C max. approx.)
Environmental/Chemical Resistant Properties	ASTM D 741 7-Day Total Immersion With Exposed Edges	NSF 61 approved for potable water	Crude oil 5% max. weight gain Diesel fuel 5% max. weight gain
Puncture Resistance	FTMS 101C Method 2031	350 lbs. (approx.)	205 lbs. (approx.)
Tongue Tear	ASTM D 751		50 lbs. (approx.)

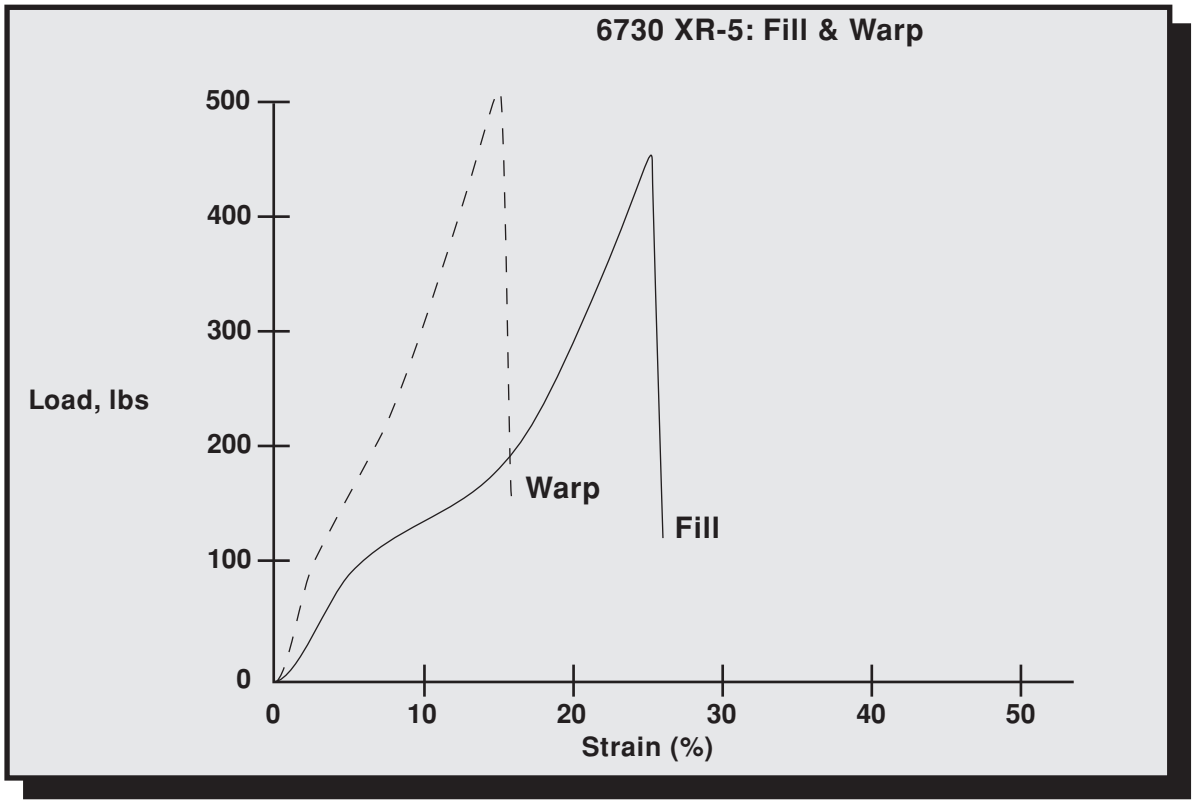
Part 2 - Elongation Properties Test

8130 XR-5



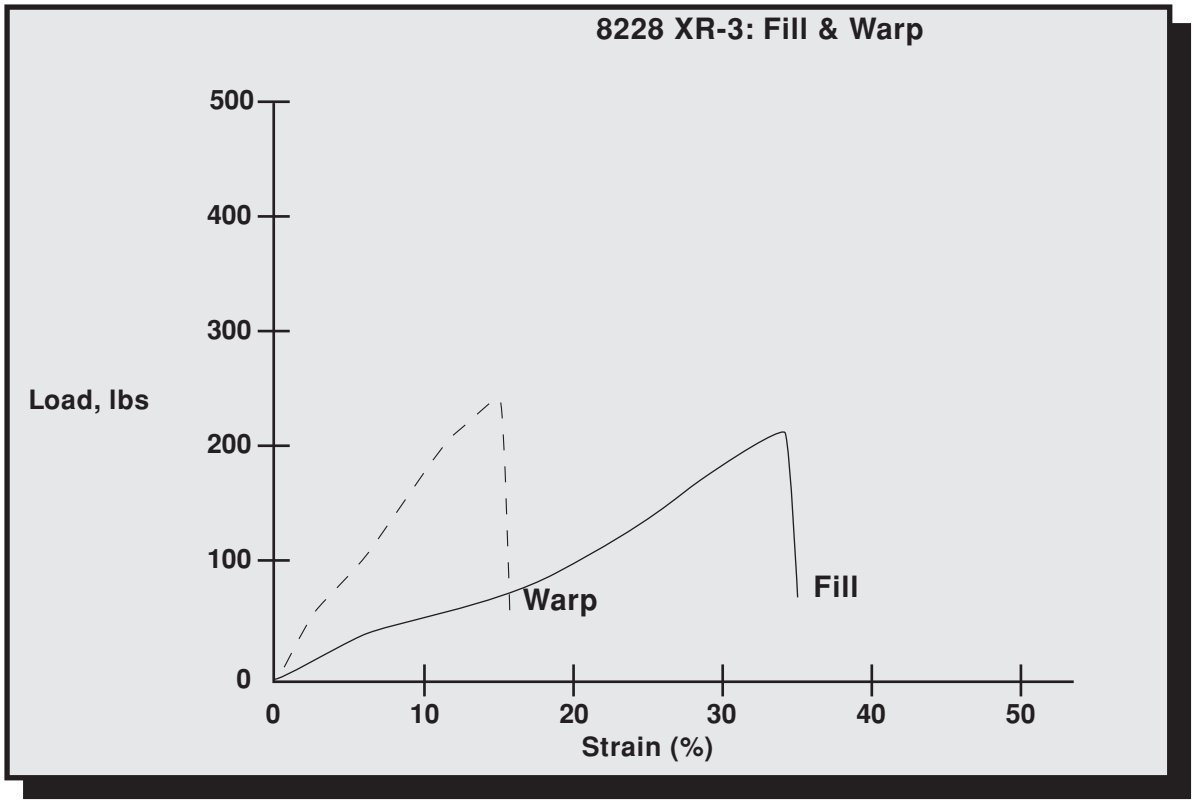
Part 2 - Elongation Properties Test

6730 XR-5



Part 2 - Elongation Properties Test

8228 XR-3



Section 3 - Chemical/Environmental Resistance

Part 1 - XR-5® Fluid Resistance Guidelines

The data below is the result of laboratory tests and is intended to serve only as a guide. No performance warranty is intended or implied. The degree of chemical attack on any material is governed by the conditions under which it is exposed. Exposure time, temperature, and size of the area of exposure usually varies considerably in application, therefore, this table is given and accepted at the user's risk. Confirmation of the validity and suitability in specific cases should be obtained. Contact a Seaman Corporation Representative for recommendation on specific applications.

When considering XR-5 for specific applications, it is suggested that a sample be tested in actual service before specification. Where impractical, tests should be devised which simulate actual service conditions as closely as possible.

EXPOSURE	RATING	EXPOSURE	RATING
AFFF	A	JP-4 Jet Fuel	A
Acetic Acid (5%)	B	JP-5 Jet Fuel	A
Acetic Acid (50%)	C	JP-8 Jet Fuel	A
Ammonium Phosphate	T	Kerosene	A
Ammonium Sulfate	T	Magnesium Chloride	T
Antifreeze (Ethylene Glycol)	A	Magnesium Hydroxide	T
Animal Oil	A	Methanol	A
Aqua Regia	X	Methyl Alcohol	A
ASTM Fuel A (100% Iso-Octane)	A	Methyl Ethyl Ketone	X
ASTM Oil #2 (Flash Pt. 240° C)	A	Mineral Spirits	A
ASTM Oil #3	A	Naphtha	A
Benzene	X	Nitric Acid (5%)	B
Calcium Chloride Solutions	T	Nitric Acid (50%)	C
Calcium Hydroxide	T	Perchloroethylene	C
20% Chlorine Solution	A	Phenol	X
Clorox	A	Phenol Formaldehyde	B
Conc. Ammonium Hydroxide	A	Phosphoric Acid (50%)	A
Corn Oil	A	Phosphoric Acid (100%)	C
Crude Oil	A	Phthalate Plasticizer	C
Diesel Fuel	A	Potassium Chloride	T
Ethanol	A	Potassium Sulphate	T
Ethyl Acetate	C	Raw Linseed Oil	A
Ethyl Alcohol	A	SAE-30 Oil	A
Fertilizer Solution	A	Salt Water (25%)	B
#2 Fuel Oil	A	Sea Water	A
#6 Fuel Oil	A	Sodium Acetate Solution	T
Furfural	X	Sodium Bisulfite Solution	T
Gasoline	B	Sodium Hydroxide (60%)	A
Glycerin	A	Sodium Phosphate	T
Hydraulic Fluid- Petroleum Based	A	Sulphuric Acid (50%)	A
Hydraulic Fluid- Phosphate Ester Based	C	Tanic Acid (50%)	A
Hydrocarbon Type II (40% Aromatic)	C	Toluene	C
Hydrochloric Acid (50%)	A	Transformer Oil	A
Hydrofluoric Acid (5%)	A	Turpentine	A
Hydrofluoric Acid (50%)	A	Urea Formaldehyde	A
Hydrofluosilicic Acid (30%)	A	UAN	A
Isopropyl Alcohol	T	Vegetable Oil	A
Ivory Soap	A	Water (200°F)	A
Jet A	A	Xylene	X
		Zinc Chloride	T

Ratings are based on visual and physical examination of samples after removal from the test chemical after the samples of Black XR-5 were immersed for 28 days at room temperature. Results represent ability of material to retain its performance properties when in contact with the indicated chemical.

Rating Key:
A – Fluid has little or no effect
B – Fluid has minor to moderate effect
C – Fluid has severe effect
T – No data - likely to be acceptable
X – No data - not likely to be acceptable

Vapor Transmission Data

Tested according to ASTM D814-55 Inverted Cup Method

Perhaps a more meaningful test is determination of the diffusion rate of the liquid through the membrane. The vapor transmission rate of Style 8130 XR-5® to various chemicals was determined by the ASTM D814-55 inverted cup method. All tests were run at room temperature and results are shown in the table.

Chemical	8130 XR-5 Black g/hr/m2
Water	**0.11**
#2 Diesel Fuel	**0.03**
Jet A	**0.11**
Kerosene	**0.15**
Hi-Test Gas	**1.78**
Ohio Crude Oil	**0.03**
Low-Test Gas	**5.25**
Raw Linseed Oil	**0.01**
Ethyl Alcohol	**0.23**
Naphtha	**0.33**
Perchlorethylene	**38.58**
Hydraulic Fluid	**0.006**
100% Phosphoric Acid	**7.78**
50% Phosphoric Acid	**0.43**
Ethanol (E-96)	**0.65**
Transformer Oil	**0.005**
Isopropyl Alcohol	**0.44**
JP4 (E-96)	**0.81**
JP8 (E-96)	**0.42**
Fuel B (E-96)	**6.28**
Fuel C (E-96)	**7.87**

Note: The tabulated values are measured Vapor Transmission Rates (VTR). Normal soil testing methods to determine permeability are impractical for synthetic membranes. An "equivalent hydraulic" permeability coefficient can be calculated but is not a direct units conversion. Contact Seaman Corporation for additional technical information.

Seam Strength

Style 8130 XR-5 Black Seam Strength After Immersion

Two pieces of Style 8130 were heat sealed together (seam width 1 inch overlap) and formed into a bag. Various oils and chemicals were placed in the bags so that the seam area was entirely covered. After 28 days at room temperature, the chemicals were removed and one inch strips were cut across the seam and the breaking strength immediately determined. Results are listed below.

Chemical	Seam Strength
None	340 Lbs. Fabric Break- No Seam Failure
Kerosene	355 Lbs. Fabric Break- No Seam Failure
Ohio Crude Oil	320 Lbs. Fabric Break- No Seam Failure
Hydraulic Fluid- Petroleum Based	385 Lbs. Fabric Break- No Seam Failure
Toluene	0 Lbs. Adhesion Failure
Naphtha	380 Lbs. Fabric Break- No Seam Failure
Perchloroethylene	390 Lbs. Fabric Break- No Seam Failure

Even though 1-inch overlap seams are used in the tests to study the accelerated effects, it is recommended that XR-5 be used with a 2-inch nominal overlap seam in actual application. In some cases where temperatures exceed 160ºF and the application demands extremely high seam load, it may be necessary to use a wider width seam.

Long Term Seam Adhesion

11 Years Immersion
ASTM D 751
Lbs./In.

Seam samples of 8130 XR-5® were dielectrically welded together and totally immersed in the liquids for 11 years. The samples were taken out, dried for 24 hours and visually observed for any signs of swelling, cracking, stiffening or degradation of the coating. The coating showed no appreciable degradation and no stiffening, swelling, cracking or peeling.

The adhesion, or resistance to separation of the coating from the base cloth, was then measured by ASTM D 751. Results show 8130 XR-5 maintains seam strength over this long period (11 years).

	Control	Crude Oil	JP-4 Jet Fuel	Diesel Fuel	Kerosene	Naphtha
8130 XR-5	20+	18	33	25	40	33*

Values in lbs./in.

*The naphtha sample was sticky.

We believe this information is the best currently available on the subject. We offer it as a suggestion in any appropriate experimentation you may care to undertake. It is subject to revision as additional knowledge and experience are gained. We make no guarantee of results and assume no obligation or liability whatsoever in connection with this information.

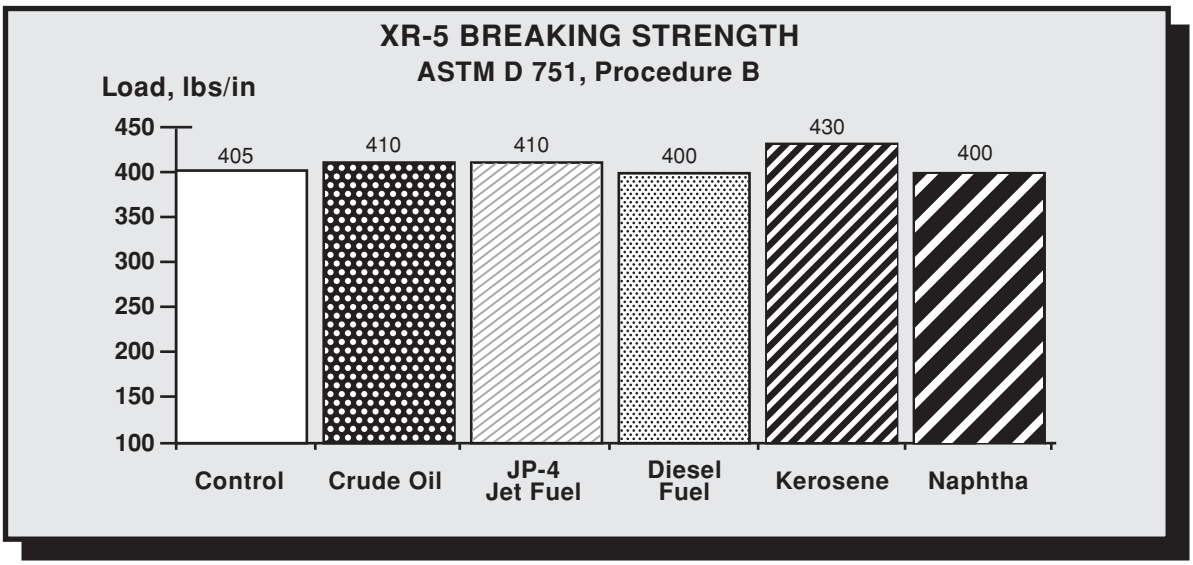
Fuel Compatibility - Long Term Immersion

Test: Samples of 8130 XR-5® Black were immersed in Diesel Fuel, JP-4 Jet Fuel, Crude Oil, Kerosene, and Naphtha for 6 1/2 years.

The samples were then taken out of the test chemicals, blotted and dried for 24 hours. The samples were observed for blistering, swelling, stiffening, cracking or delamination of the coating from the fiber.

Results: It was found in all cases that the 8130 XR-5, after immersion for six years, maintained its strength and there was no evidence of blistering, swelling, stiffening, cracking or delamination.

The strip tensile strength, or breaking strength, of the samples was measured after six years of immersion and the following are the results.



XR-3 Chemical Resistance Statement (Summary)

XR-3® is recommended for moderate chemical resistant applications such as stormwater and municipal wastewater and is not recommended for prolonged contact with pure solutions. XR-3 PW® membranes are recommended only for contact with drinking water and are resistant to low levels of chlorine found in drinking water. XR-5 has a broad range of chemical resistance which is detailed in this section.

Part 2: XR-5® Comparative Chemical Resistance

Chemical Resistance Chart
Comparative Chemical Resistance

	XR-5	HDPE	PVC	Hypalon	Polypropylene
Kerosene	A	B	C	C	C
Diesel Fuel	A	A	C	C	C
Acids (General)	A	A	A	B	A
Naphtha	A	A	C	B	C
Jet Fuels	A	A	C	B	C
Saltwater, 160° F	A	A	C	B	A
Crude Oil	A	B	C	B	C
Gasoline	B	B	C	C	C

A= Excellent B= Moderate C= Poor

Source: Manufacturer's Literature

XR-5 data based on conditions detailed in Section 3, Part 1.

Part 3: Weathering Resistance

Accelerated Weathering Test
XR-5 has been tested in the carbon arc weatherometer for over 10,000 hours of exposure and in the Xenon weatherometer for over 12,000 hours of exposure. The sample showed no loss in flexibility and no significant color change. Based on field experience of Seaman Corporation products and similar weatherometer exposure tests, XR-5 should have an outdoor weathering life significantly longer than competitive geomembranes, particularly in tropical or subtropical applications.

EMMAQUA Testing: ASTM E-838-81 was performed on a modified form of XR-5, FiberTite, used in the single-ply roofing industry. After 3 million Langleys in Arizona, no signs of degradation were noted with no evidence of cracking, blistering, swelling or adhesion delamination failure of the coating.

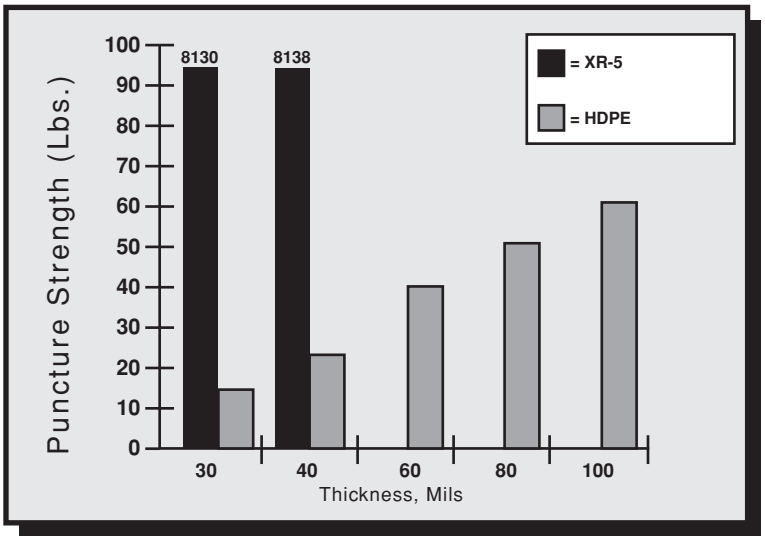
Natural Exposure
After over 17 years as a holding basin at a large oil company in the Texas desert, XR-5 showed no signs of environmental stress cracking, thermal expansion/contraction, or low yield strength problems. Temperature ranges from near zero to over 100° F.

In service approximately 17 years in a solar pond application at a research facility in Ohio, UV exposed samples, as well as immersed samples, retained over 90% of the tensile strength. Examination of the material determined there was little effect on the coating compound. The solar pond was exposed to temperatures from below zero to over 100° F.

XR5 was exposed for 12½ years in Sarasota, Florida, on a weathering rack, facing the southern direction at 45°. No significant color loss, cracking, crazing, blistering, or adhesion delamination failure of the coating was noted.

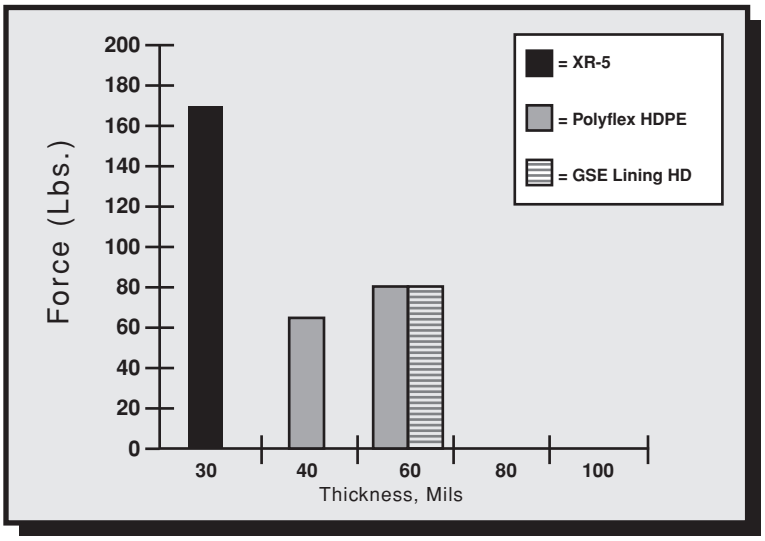
Section 4 - Comparative Physical Properties

XR-5/HDPE Comparative Properties

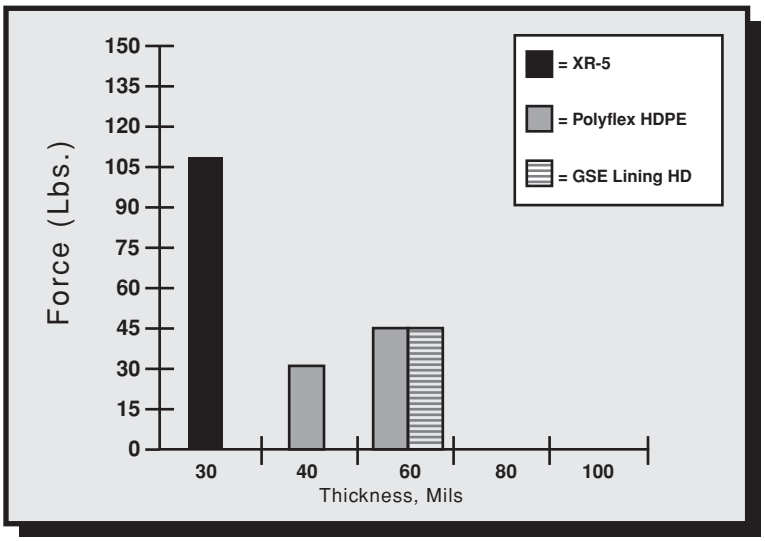


Puncture Resistance

1. ASTM D 751, Screwdriver Tip, 45° Angle (Room Temperature) Puncture Resistance, XR5 vs. HDPE



2. FED-STD-101C Method 2065 (Room Temperature)*



3. FED-STD-101C Method 2065 (70°C)*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

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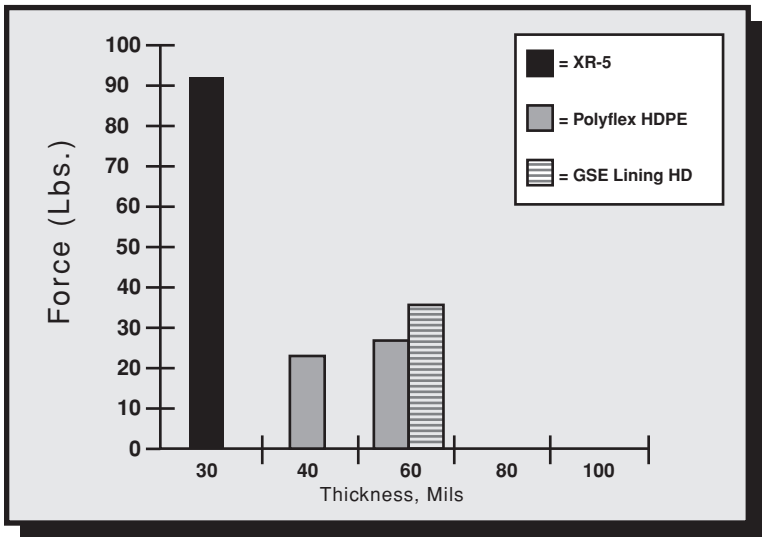
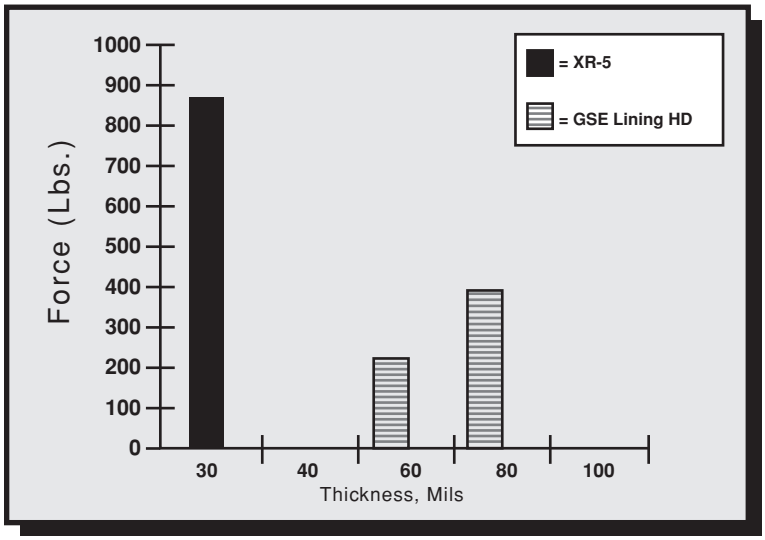
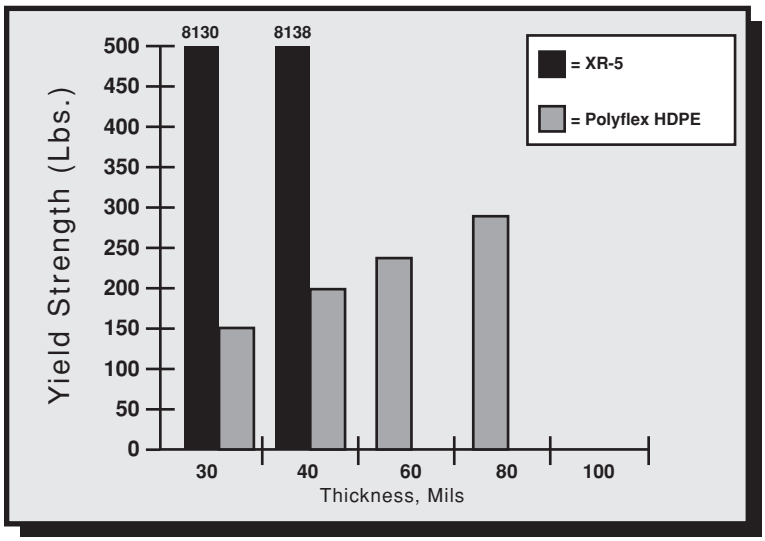


4. FED-STD-101C Method 2065 (100ºC)*



5. ASTM D 751 Ball Burst Puncture



Yield Strength

1. Yield Strength, XR-5 vs. HDPE

Test Method: Grab Tensile, ASTM D 751, 70° C

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

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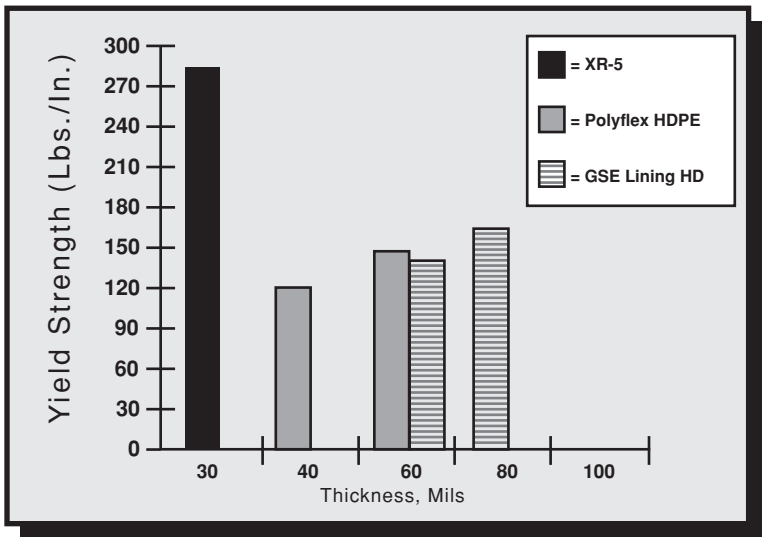
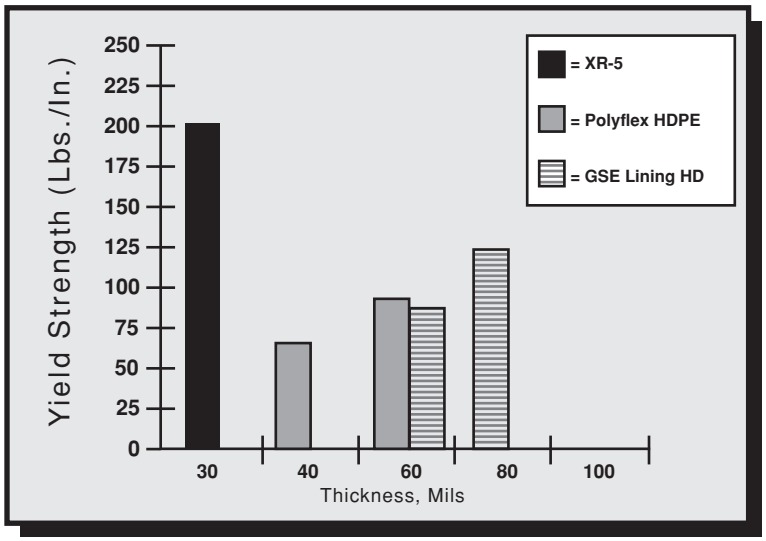
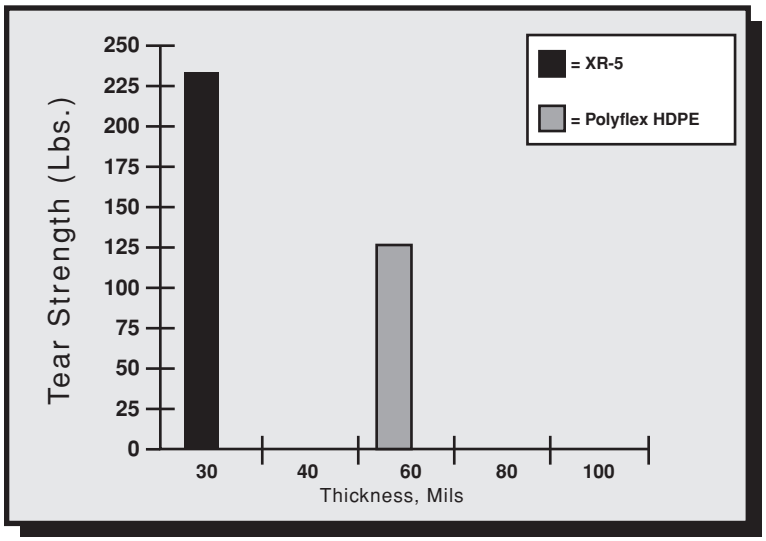


2. Strip Tensile, ASTM D 751, Room Temperature*



3. Strip tensile, ASTM D 751, 70ºC*



Tear Strength

1. Tongue Tear (8" x 10" Specimens), ASTM D 751, Room Temperature*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

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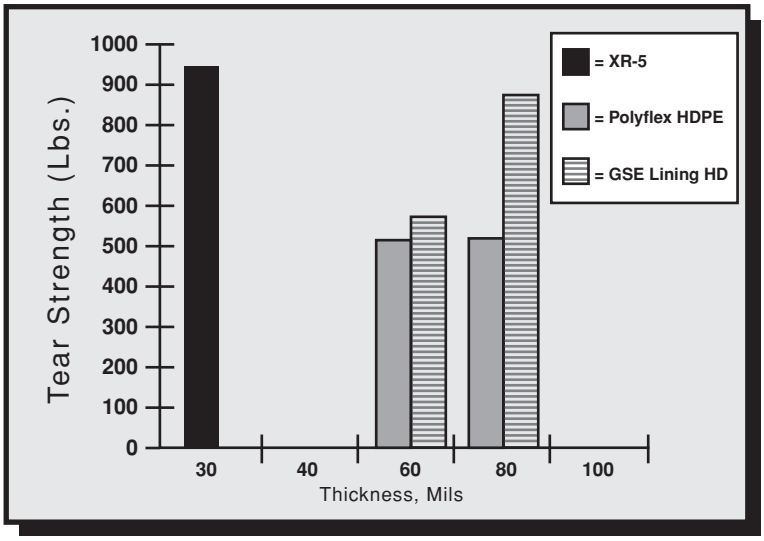
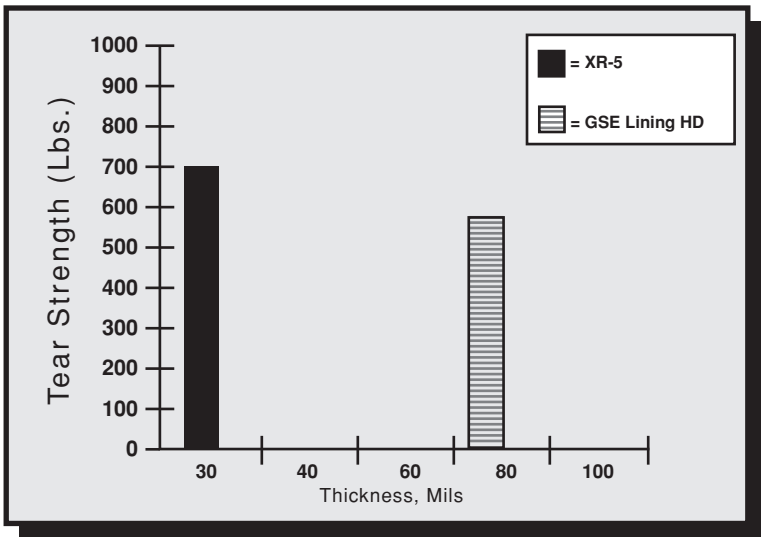


1. Graves Tear, ASTM D 624, Die C, Room Temperature*



2. Graves Tear, ASTM D 624, Die C, 70°C*

* Data provided by E.I. DuPont de Nemours & Co. Wilmington, Delaware

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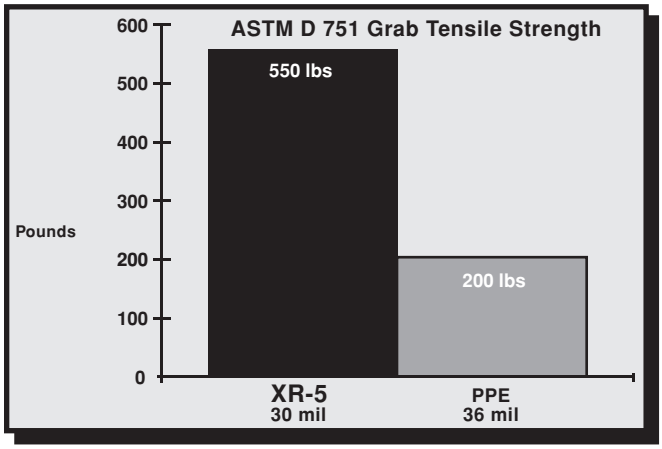
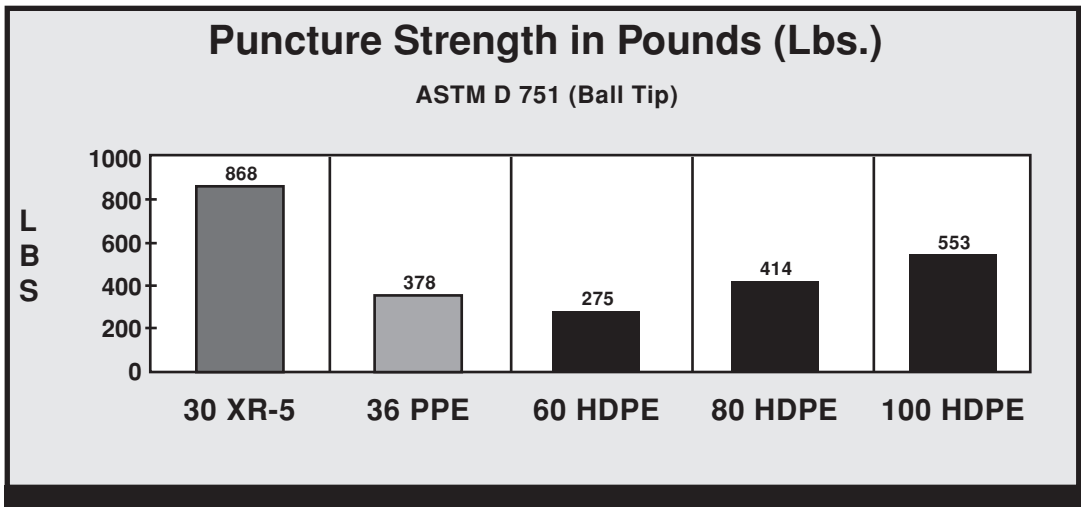
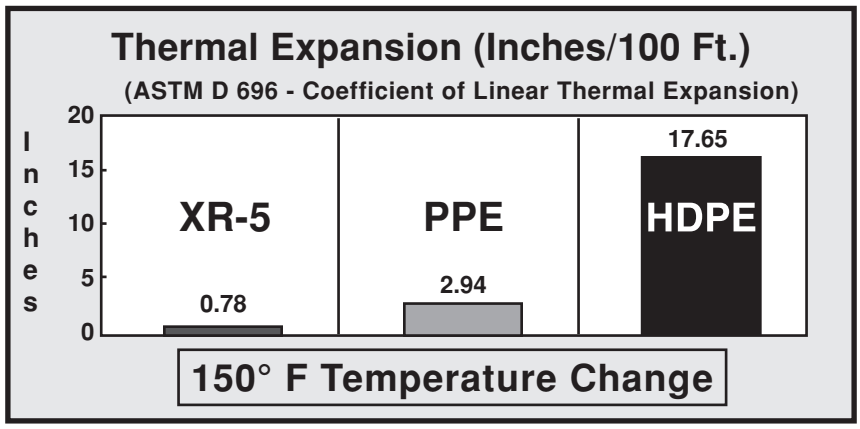
Grab Strength – XR-5® vs. Polypropylene Tensile



Puncture Strength Comparison



Coated Fabric Thermal Stability



Specification For Geomembrane Liner

(Sample specification: 8130 XR-5®. For other product specifications, go to www.xr-5.com)

General

1.01 Scope Of Work

Furnish and install flexible membrane lining in the areas shown on the drawings. All work shall be done in strict accordance with the project drawings, these specifications and membrane lining fabricator's approved shop drawings.

Geomembrane panels will be supplied sufficient to cover all areas, including appurtenances, as required in the project, and shown on the drawings. The fabricator/installer of the liner shall allow for shrinkage and wrinkling of the field panels.

1.02 Products

The lining material shall be 8130 XR-5 as manufactured by Seaman Corporation (1000 Venture Boulevard, Wooster, OH 44691; 330-262-1111), with the following physical specifications:

Base- (Type)	Polyester
Fabric Weight (ASTM D 751)	6.5 oz./sq. yd.
Finished Coated Weight (ASTM D 751)	30 ± 2 oz./sq. yd.
Trapezoid Tear (ASTM D 751)	40/55 lbs. min.
Grab Yield Tensile (ASTM D 751, Grab Method Procedure A)	550/550 lbs. min.
Elongation @ Yield (%)	20% min.
Adhesion- Heat Seam (ASTM D 751, Dielectric Weld)	40 lbs./2in. weld min.
Adhesion- Ply (ASTM D 413, Type A)	15 lbs./in. or film tearing bond
Hydrostatic Resistance (ASTM D 751, Method A)	800 psi min.
Puncture Resistance (ASTM D 4833)	275 lbs. min.
Bursting Strength (ASTM D 751 Ball Tip)	750 lbs. min.
Dead Load (ASTM D 751) Room Temperature	220 lbs. min.
(2" overlap seam, 4 hours) 160ºF	120 lbs. min.
Bonded Seam Strength (ASTM D 751 Grab Test Method, Procedure A)	575 lbs. min.
Low Temperature (ASTM D 2136, 4 hours- 1/8" Mandrel)	Pass @ -30ºF
Weathering Resistance ASTM G 153 Carbon Arc	8,000 hours min. With no appreciable changes or stiffening or cracking of coating
Dimensional Stability (ASTM D 1204, 212ºF 1 Hour, Each Direction)	0.5% max.
Water Absorption (ASTM D 471, 7 Days)	0.025 kg/m² max. @ 70ºF 0.14 kg/m² max. @ 212ºF
Abrasion Resistance ASTM D 3389, H-18 Wheel, 1000 g load	2000 cycles before fabric exposure; 50 mg/100 cycles max. wgt. Loss
Coefficient of Thermal Expansion/Contraction (ASTM D 696)	8 x 10^{-6} in/in/º F max.

1.03 Submittals

The fabricator of panels used in this work shall prepare shop drawings with a proposed panel layout to cover the liner area shown in the project plans. Shop drawings shall indicate the direction of factory seams and shall show panel sizes consistent with the material quantity requirements of 1.01.

Details shall be included to show the termination of the panels at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring.

Placement of the lining shall not commence until the shop drawings and details have been approved by the owner, or his representative.

1.04 Factory Fabrication
The individual XR-5® liner widths shall be factory fabricated into large sheets custom designed for this project so as to minimize field seaming. The number of factory seams must exceed the number of field seams by a factor of at least 10.

A two-inch overlap seam done by heat or RF welding is recommended. The surface of the welded areas must be dry and clean. Pressure must be applied to the full width of the seam on the top and bottom surface while the welded area is still in a melt-type condition. The bottom welding surface must be flat to insure that the entire seam is welded properly. Enough heat shall be applied in the welding process that a visible bead is extruded from both edges being welded. The bead insures that the material is in a melt condition and a successful chemical bond between the two surfaces is accomplished.

Two-inch overlapped seams must withstand a minimum of 240 pounds per inch width dead load at 70º F. and 120 pounds per inch width at 160º F. as outlined in ASTM D 751. All seams must exceed 550 lbs. bonded seam strength per ASTM D 751 Bonded Seam Strength Grab Test Method, Procedure A.

1.05 Inspection And Testing Of Factory Seams
The fabricator shall monitor each linear foot of seam as it is produced. Upon discovery of any defective seam, the fabricator shall stop production of panels used in this work and shall repair the seam, and determine and rectify the cause of the defect prior to continuation of the seaming process.

The fabricator must provide a Quality Control procedure to the owner or his representative which details his method of visual inspection and periodic system checks to ensure leak-proof factory fabrication.

1.06 Certification and Test Reports
Prior to installation of the panels, the fabricator shall provide the owner, or his representative, with written certification that the factory seams were inspected in accordance with Section 1.05.

1.07 Panel Packaging and Storage
Factory fabricated panels shall be accordian-folded, or rolled, onto a sturdy wooden pallet designed to be moved by a forklift or similar equipment. Each factory fabricated panel shall be prominently and indelibly marked with the panel size. Panels shall be protected as necessary to prevent damage to the panel during shipment.

Panels which have been delivered to the project site shall be stored in a dry area.

1.08 Qualifications of Suppliers
The fabricator of the lining shall be experienced in the installation of flexible membrane lining, and shall provide the owner or his representative with a list of not less than five (5) projects and not less than 500,000 square feet of successfully installed XR-5 synthetic lining. The project list shall show the name, address, and telephone number of an appropriate party to contact in each case. The manufacturer of the sheet goods shall provide similar documentation with a 10 million square foot minimum, with at least 5 projects demonstrating 10+ years service life.

The installer shall provide similar documentation to that required by the fabricator.

1.09 Subgrade Preparation By Others
Lining installation shall not begin until a proper base has been prepared to accept the membrane lining. Base material shall be free from angular rocks, roots, grass and vegetation. Foreign materials and protrusions shall be removed, and all cracks and voids shall be filled and the surface made level, or uniformly sloping as indicated

on the drawings. The prepared surface shall be free from loose earth, rocks, rubble and other foreign matter. Generally, no rock or other object larger than USCS sand (SP) should remain on the subgrade in order to provide an adequate safety factor against puncture. Geotextiles may be used to compensate for irregular subgrades. The subgrade shall be uniformly compacted to ensure against settlement. The surface on which the lining is to be placed shall be maintained in a firm, clean, dry and smooth condition during lining installation.

1.10 Lining Installation
Prior to placement of the liner, the installer will indicate in writing to the owner or his representative that he believes the subgrade to be adequately prepared for the liner placement.

The lining shall be placed over the prepared surface in such a manner as to assure minimum handling. The sheets shall be of such lengths and widths and shall be placed in such a manner as to minimize field seaming.

In areas where wind is prevalent, lining installation should be started at the upwind side of the project and proceed downwind. The leading edge of the liner shall be secured at all times with sandbags or other means sufficient to hold it down during high winds.

Sandbags or rubber tires may be used as required to hold down the lining in position during installation. Materials, equipment or other items shall not be dragged across the surface of the liner, or be allowed to slide down slopes on the lining. All parties walking or working upon the lining material shall wear soft-sole shoes.

Lining sheets shall be closely fit and sealed around inlets, outlets and other projections through the lining. Lining to concrete seals shall be made with a mechanical anchor, or as shown on the drawings. All piping, structures and other projections through the lining shall be sealed with approved sealing methods.

1.11 XR-5 Field Seaming
All requirements of Section 1.04 and 1.05 apply. A visible bead should be extruded from the hot air welding process.

Field fabrication of lining material will not be allowed.

1.12 Inspection
All field seams will be tested using the Air Lance Method. A compressed air source will deliver 55 psi minimum to a 3/16 inch nozzle. The nozzle will be directed to the lip of the field seam in a near perpendicular direction to the length of the field seam. The nozzle will be held 4 inches maximum from the seam and travel at a rate not to exceed 40 feet per minute. Any loose flaps of 1/8" or greater will require a repair.

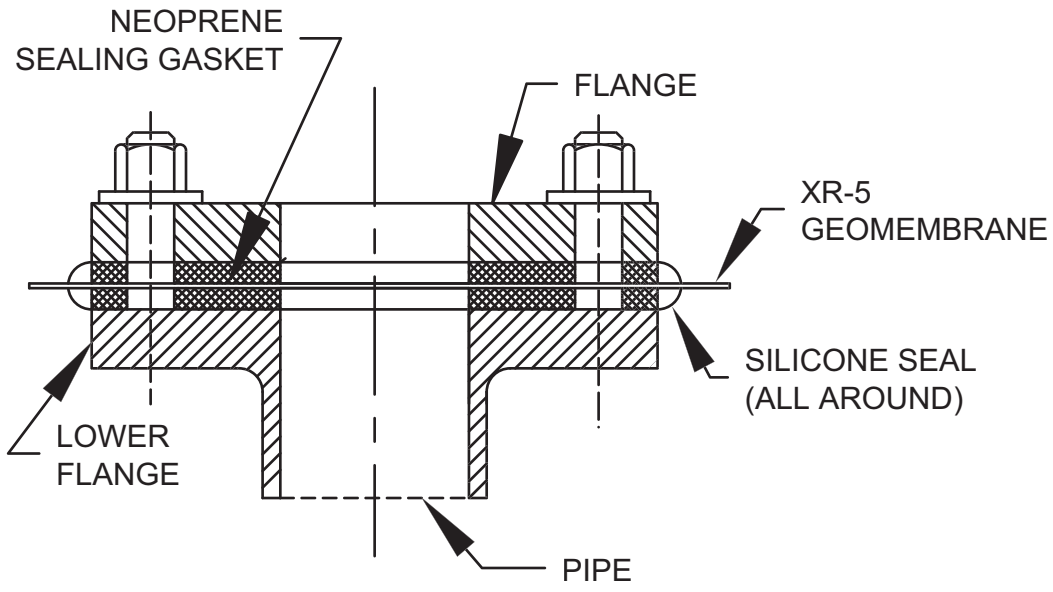
Alternatively all field seams should also be inspected utilizing the Vacuum Box Technique as described in Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber (ASTM D 5641-94 (2006)), using a 3 to 5 psi vacuum pressure. All leaks shall be repaired and tested.

All joints, on completion of work, shall be tightly bonded. Any lining surface showing injury due to scuffing, penetration by foreign objects, or distress from rough subgrade, shall as directed by the owner or his representative be replaced or covered, and sealed with an additional layer of lining of the proper size, in accordance with the patching procedure.

1.13 Patching
Any repairs to the lining shall be patched with the lining material. The patch material shall have rounded corners and shall extend a minimum of four inches (4") in each direction from the damaged area.

Seam repairs or seams which are questionable should be cap stripped with a 1" wide (min.) strip of the liner material. The requirements of Section 1.11 apply to this cap stripping.

1.14 Warranty
The lining material shall be warranted on a pro-rated basis for 10 years against both weathering and chemical compatibility in accordance with Seaman Corporation warranty for XR-5® Style 8130. A test immersion will be performed by the owner and the samples evaluated by the manufacturer. Workmanship of installation shall be warranted for one year on a 100% basis.



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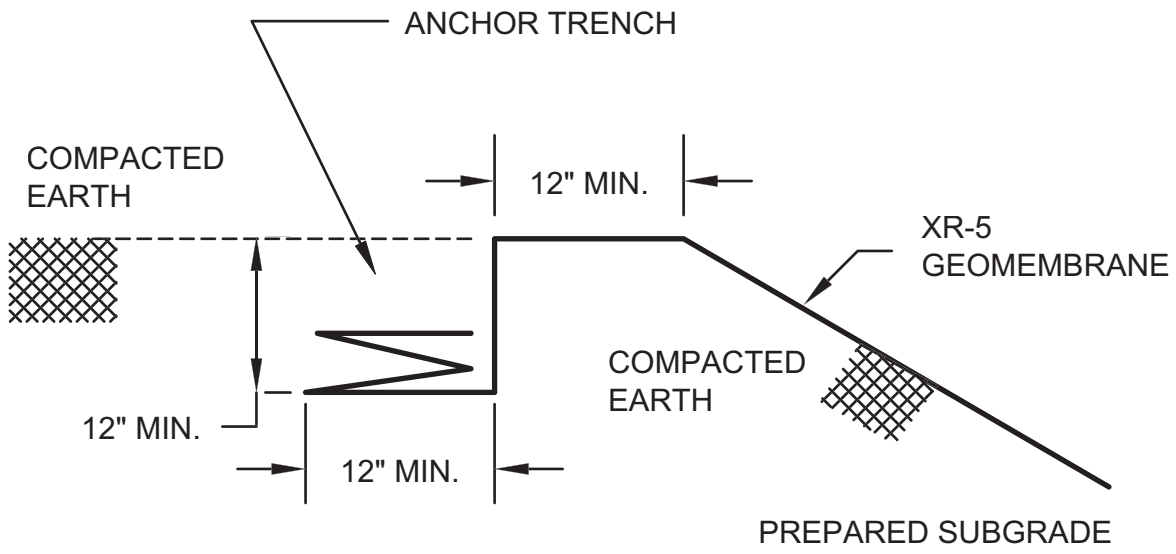
FLANGE CONNECTION
TO
PIPE SECTION

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-019



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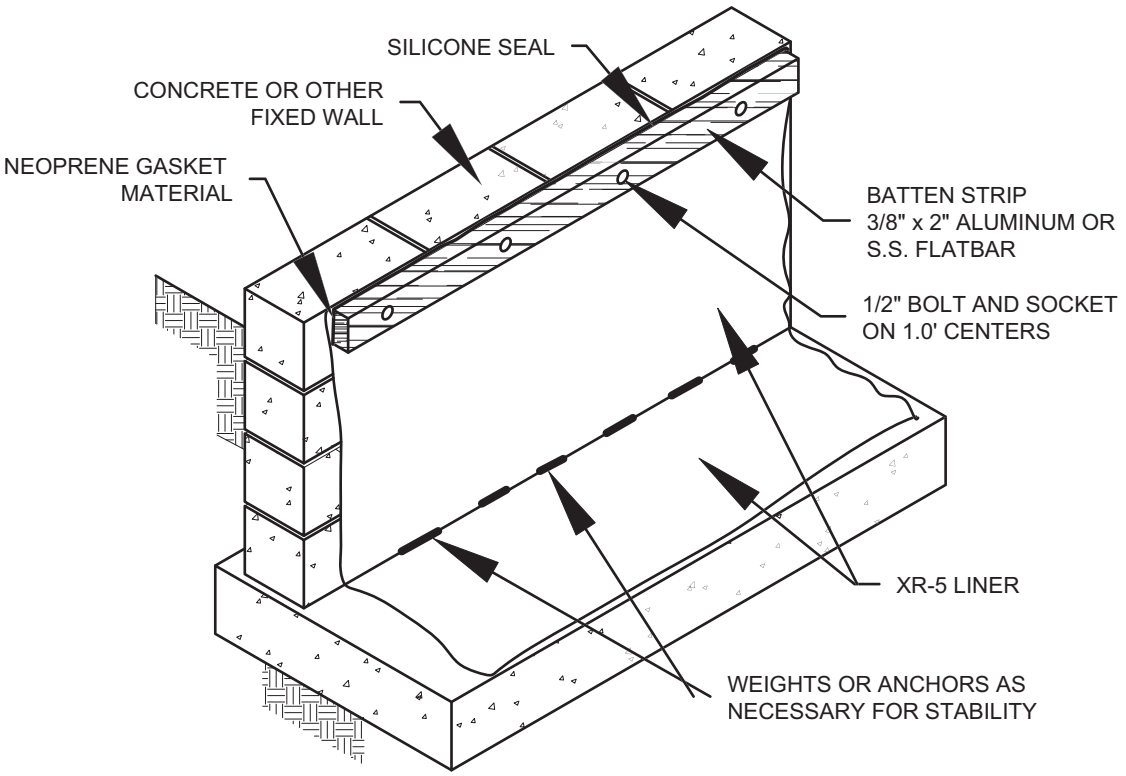
ELEVATION VIEW
TYPICAL ANCHOR DETAILS
XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-001



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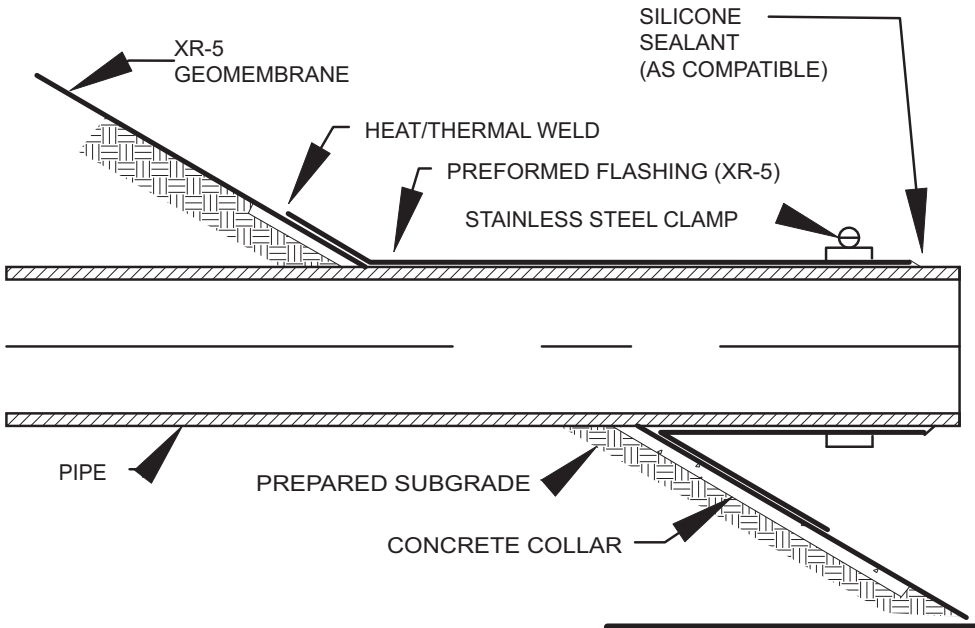
ANCHORING DETAIL
XR-5 LINER TO FIXED WALL

SCALE: NONE	
SHEET 1 of 1	DRAW NO. XRD-023



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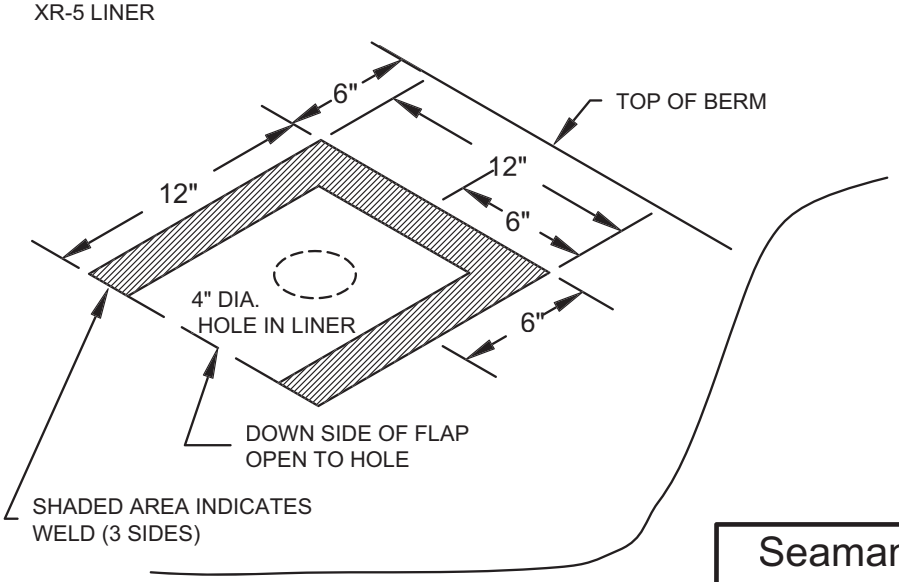
1000 Venture Blvd.,Wooster, Ohio 44691

ELEVATION VIEW
TYPICAL PIPE PUNCTURE
SEAL DETAIL XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-018



Seaman Corporation

ENGINEERED PRODUCTS GROUP

1000 Venture Blvd.,Wooster, Ohio 44691

PLAN VIEW
FLAP VENT DETAIL
XR-5 LINER

SCALE: NONE

SHEET 1 of 1

DRAW NO. XRD-012

Section 6 - Warranty Information

Warranty

XR-5® is offered with Seaman Corporation standard warranty which addresses weathering and chemical compatibility for a 10-year period. A test immersion is required with subsequent testing and approval by Seaman Corporation.

Instructions for XR-5 Test Immersions and Warranty Requests

1. Completely immerse six Style 8130 XR-5 samples (8-1/2" x 11" size) in the liquid to be contained.
2. At the end of approximately thirty days, retrieve three of the samples. The samples should be rinsed with fresh water and dried.
3. Send the three samples to:

   Attn: Geomembrane Department
   Seaman Corporation
   1000 Venture Blvd.
   Wooster, OH 44691

4. Keep the other three samples immersed until further notice in case longer immersion data is required.
5. Complete and return the information form on the liner application.

8228 XR-3® and all PW Geomembranes are offered with a standard 10-year warranty for weathering. The attached information form should be completed.

XR® Membrane Application and Utilization Form

Installation Owner and Address:

Physical Location of Installation:

Expected Date of Installation: _____

Expected Beginning Date of Service: _____

Description of Application:
(Example: impoundment used to contain brine on an emergency basis.)

Physical Features of Application:
(Example: 1.3 million gallon earthen impoundment with overall top dimensions of 160′ x 160′ with 3:1 slopes and 10′ deep.)

Description of Liquid:

(Describe content of liquid including pollutants and expected temperature extremes in basin and at application point. Attach analysis of liquid chemistry, composition taken on a representative basis.)

Operational Characteristics:

(Describe the operation of the facility such as filling schedules, fluctuating liquid levels, operating temperatures, etc.)

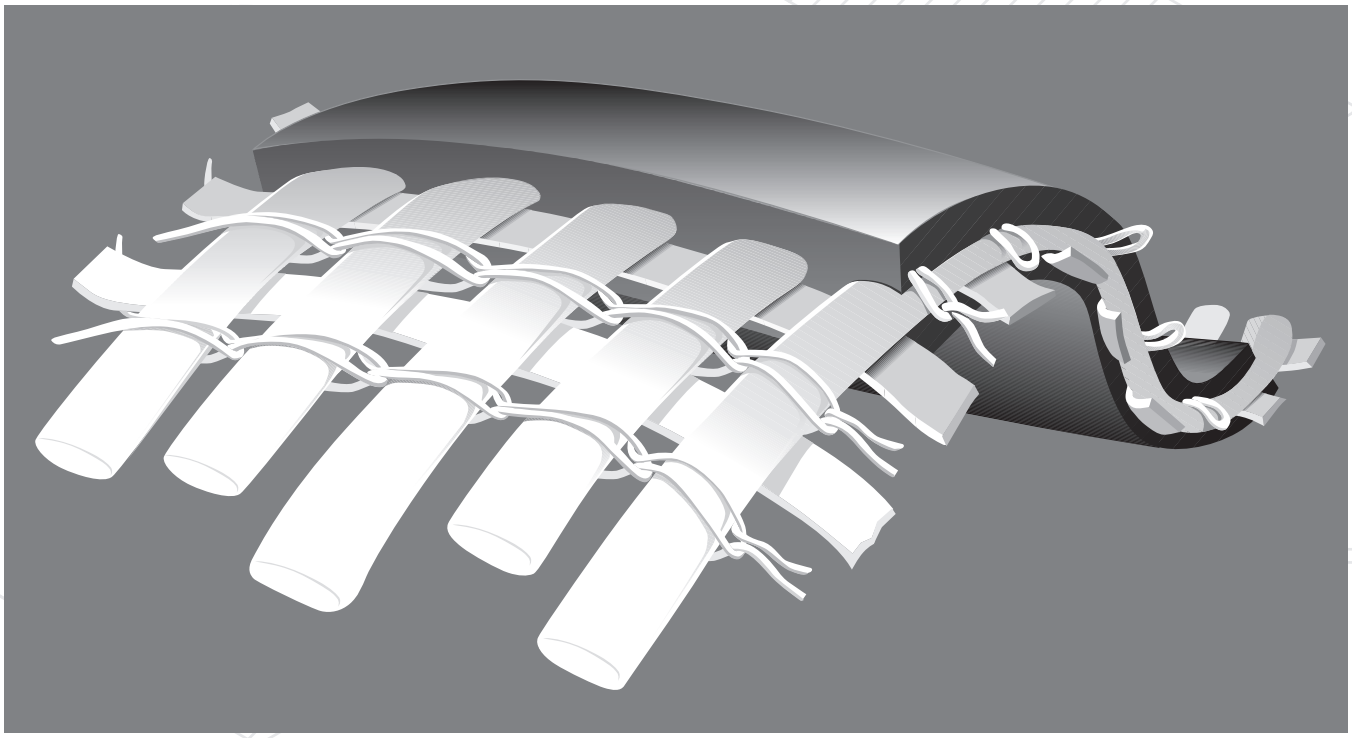
Performance Requirements, Etc:

(State any other requirements, such as rate of permeability required.)

Owner represents the information herein is complete and accurate, and understands and agrees that issuance of Seaman Corporation Warranty for XR products are conditioned upon such completeness and accuracy.

OWNER'S SIGNATURE

Reference Materials:



XR-5®: High Performance Composite Geomembrane

Seaman Corporation
1000 Venture Blvd.
Wooster, Ohio 44691
(330) 262-1111
www.xr-5.com

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.I

SMOOTH HDPE GEOMEMBRANE

SMOOTH HDPE GEOMEMBRANE
ENGLISH UNITS

Property	Test Method	Minimum Average Values				
		30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mils	ASTM D 5199					
minimum average		30	40	60	80	100
lowest individual reading		27	36	54	72	90
Sheet Density, g/cc	ASTM D 1505/D 792	0.940	0.940	0.940	0.940	0.940
Tensile Properties[1]	ASTM D 6693					
1. Yield Strength, lb/in		63	84	126	168	210
2. Break Strength, lb/in		114	152	228	304	380
3. Yield Elongation, %		12	12	12	12	12
4. Break Elongation, %		700	700	700	700	700
Tear Resistance, lb	ASTM D 1004	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	54	72	108	144	180
Stress Crack Resistance[2], hrs	ASTM D 5397 (App.)	300	300	300	300	300
Carbon Black Content[3], %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596			--Note 4--		
Oxidative Induction Time (OIT)						
Standard OIT, minutes	ASTM D 3895	100	100	100	100	100
Oven Aging at 85°C	ASTM D 5721					
High Pressure OIT - % retained after 90 days	ASTM D 5885	60	60	60	60	60
UV Resistance[5]	GRI GM11					
High Pressure OIT[6] - % retained after 1600 hrs	ASTM D 5885	50	50	50	50	50
Seam Properties	ASTM D 6392 (@ 2 in/min)					
1. Shear Strength, lb/in		57	80	120	160	200
2. Peel Strength, lb/in - Hot Wedge		45	60	91	121	151
- Extrusion Fillet		39	52	78	104	130
Roll Dimensions						
1. Width (feet):		23	23	23	23	23
2. Length (feet)		1000	750	500	375	300
3. Area (square feet):		23,000	17,250	11,500	8,625	6,900
4. Gross weight (pounds, approx.)		3,470	3,470	3,470	3,470	3,470

1 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; Break elongation is calculated using a gauge length of 2.0 inches.
2 The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.
3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.
5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

APPLICATION FOR PERMIT
DNCS ENVIRONMENTAL SOLUTIONS

VOLUME III: ENGINEERING DESIGN AND CALCULATIONS
SECTION 1: ENGINEERING DESIGN

ATTACHMENT III.1.J

COMPUTER AIDED EARTHMOVING SYSTEM

Computer Aided Earthmoving System

CAES for Landfills

Landfill Compactors
Track-Type Tractors
Wheel Tractor Scrapers
Motor Graders

System Components	
Communications Radio	TC900B
GPS Antenna	L1/L2
GPS Receiver	MS840
In-Cab Display	CAES Touch Screen Display
CAESoffice™/METSmanager	

Computer Aided Earthmoving System for Landfills

Advanced GPS technologies for earthmoving equipment improve machine efficiency, maximize air space utilization, and extend landfill life.

Caterpillar is helping customers revolutionize the way they compact trash, grade slopes and manage their operation with new technology solutions for landfills. Solutions that provide greater accuracy, higher productivity, lower operating costs, more profitability and longer landfill life.

The Computer Aided Earthmoving System (CAES) is a high technology earthmoving tool that allows machine operators to achieve maximum landfill compaction, desired grade/slope, and conserve and ensure even distribution of valuable cover soil with increased accuracy without the use of traditional survey stakes and crews. Using global positioning system (GPS) technology, machine-mounted components, a radio network, and office management software, this state-of-the-art machine control system delivers real-time elevation, compaction and grade control information to machine operators on an in-cab display. By monitoring grade and compaction progress, operators have the information they need to maximize the efficiency of the machine, resulting in proper drainage and optimum airspace utilization.

This advanced technology tool also aids in the identification of site-specific storage areas for hazardous, medical, industrial, and organic waste requiring special handling and placement records.

Applications

CAES is an ideal tool for landfill planning, engineering, surveying, grade control, and production monitoring applications in dump areas. CAES is specifically designed for use on landfill compactors, track-type tractors, wheel tractor scrapers, and motor graders.

On-Board Components

- CAES Touch Screen Display
- GPS Receiver
- GPS Antenna (L1/L2)
- Communications Radio

Off-Board Components

- GPS Reference Station
- Radio Network
- CAESoffice/METSmanager

Operation

CAES uses GPS technology, a wireless radio communications network, and office software to map landfills, create site plans, locate a machine's position, and track compaction and earthmoving progress with complete accuracy.

The receiver uses signals from GPS satellites to determine precise machine positioning. Two receivers are used to capture and collect satellite data – one located at a stationary spot on the landfill site, and another located on the machine. Signals from the ground-based reference station and on-board computer are used to remove errors in satellite measurements for centimeter accuracy.

The CAES-enabled machine is driven over the site to create a digital terrain design file. Using the radio network and office software, landfill terrain data is transmitted from the machine to the landfill office. Landfill managers can then send the work plan from the office to the in-cab display to show operators the work to be done.

The in-cab display provides the operator with an overhead and cross-sectional three-dimensional surface view of the color-coded work plan and precise machine location. The software continuously updates terrain and machine position information as the machine traverses the site.

CAES gives the operator the ability to control grade by monitoring progress on the in-cab display, which shows a graphical representation of lift thickness and compaction density. Cut/fill numbers are displayed in real-time as the machine moves across the site, which allows the operator to know precise elevation, material spread, compaction passes, and required cut or fill at any point on the job.

The *compactor* display shows colored grids representing the number of compaction passes the machine has made across each area. As the compactor wheel travels over an area, the screen changes color to acknowledge the pass. Green areas indicate when optimum compaction has been reached. The system also monitors thick lift information and visually displays when a lift exceeds maximum site parameters.

In *tractor, scraper and motor grader* applications, the color display graphically shows the operator cut, fill, and grade work to be done according to plan. As the machine works, the screen changes color. Green indicates when the operator has achieved plan grade.

By providing immediate feedback on the accuracy of each pass, CAES operators have the information and confidence they need to work more efficiently, productively and profitably.

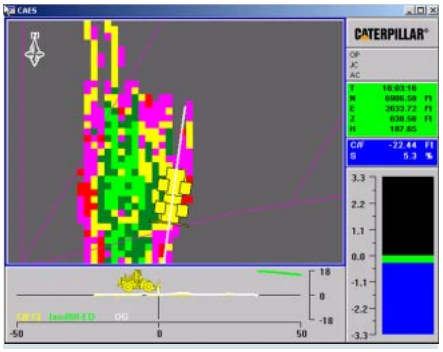
On-Board Components

Communications Radio. The rugged radio, mounted on the roof of the machine, is used for transmitting, repeating and receiving real-time data from GPS receivers. The radio broadcasts real-time, high-precision data for GPS applications. Under normal conditions, the 900 MHz radio broadcasts data up to 10 km (6.2 miles) line-of-sight. Coverage can be enhanced with a network of repeaters, which allows coverage over a broader area. Optimized for GPS with increased sensitivity and jamming immunity, the radio features error correction and high-speed data transfer, ensuring optimum performance. A 450 MHz radio solution is also available.

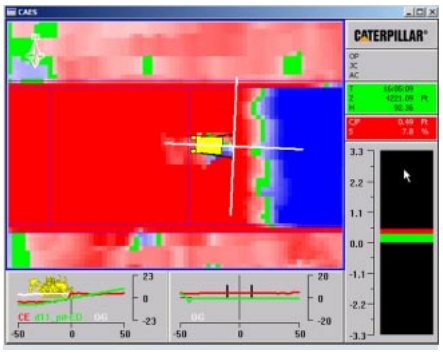
GPS Antenna (L1/L2). The dual frequency external antenna, mounted on the roof of the machine and reference station, is used to pick up the signals from the GPS satellites to determine the machine's position for high precision, real-time machine guidance and control. A low-noise amplifier provides sensitive performance in demanding applications. The compact, low profile design and sealed housing ensure reliable performance in harsh weather conditions.

GPS Receiver. The dual frequency real-time kinematic (RTK) GPS receiver is used to send and receive data simultaneously across the radio network. The system computes differential corrections for real-time positioning with centimeter accuracies, to ensure precise machine guidance and control.

CAES Touch Screen Display. The in-cab graphical display provides real-time operating information to the operator. Designed for simple operation, the 264 mm (10.4 in) custom configurable, integrated touch screen display allows operators to easily interface with the CAES system. The display utilizes the latest infrared touch and transflective backlight technology for superior viewing in bright light conditions and a broad-range dimmable backlight for viewing in low light conditions. Designed for reliable performance in extreme operating conditions, the unit is guarded against shock and sealed to keep out dust and moisture.



Compactor Screen



Dozer Screen

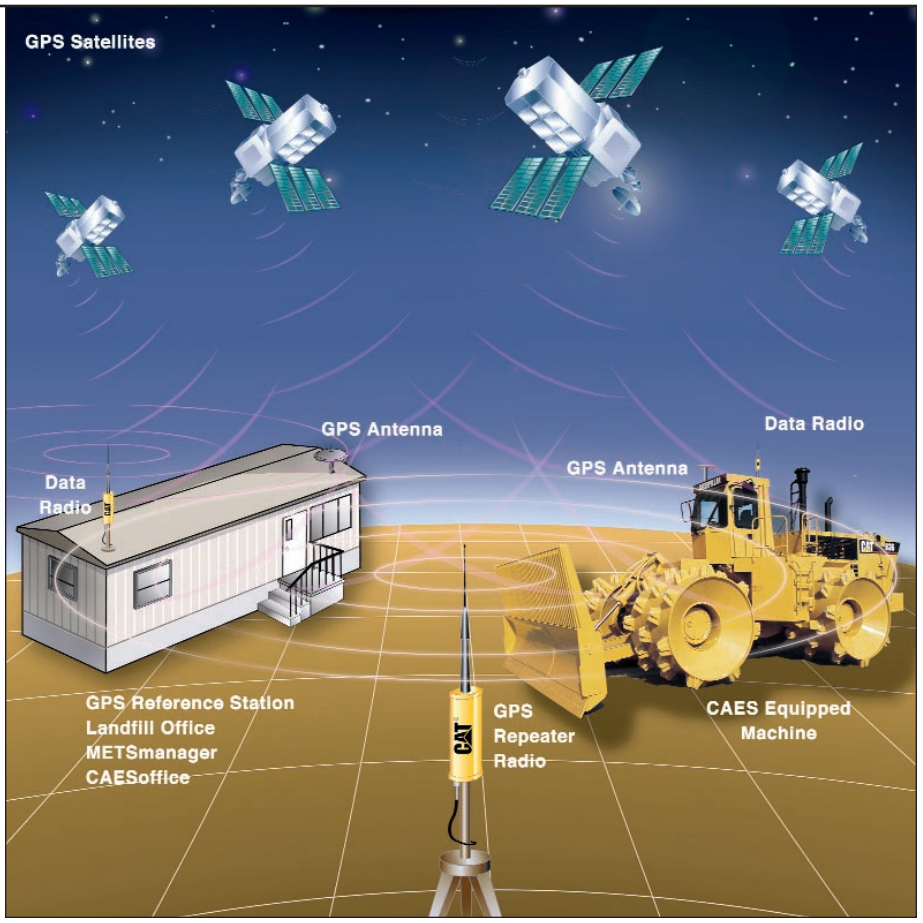
Off-Board Components

GPS Technology. Global Positioning System (GPS) technology uses 24+ satellites that orbit above the earth and constantly transmit their positions, identities and times of signal broadcasts to earth-based satellite sensors. The GPS receiver is an electronic box, which measures the distance to each visible satellite from an antenna on the ground. Through trilateralization, the receiver determines where the satellite is in respect to the center of the earth. The GPS receiver uses its own position and GPS satellite positions to calculate errors and corrections for computing exact location and precise positioning with centimeter accuracy.

GPS Reference Station. A GPS reference station is used to achieve the centimeter level accuracy needed in a landfill application. The reference station sends GPS information over a radio link to the GPS receiver on the CAES-enabled machine. The receiver combines the information with its own observations to compute precise positioning.

Radio Network. The radio network for CAES has two channels. GPS correction data is transmitted over one channel, while the other channel is used to send site planning and production data to the machine and from the machine back to the site office. By utilizing the same radio as a repeater the range can be extended to provide seamless coverage around local obstacles such as hills or large buildings. Up to four radio repeaters may be used to provide extended coverage.

Landfill Planning Software. Site planning and surveying begins with the landfill planning software. CAES is compatible with most third party CAD planning software packages. Data formats used between the CAES software and the planning software are industry standard .DXF and ASCII.



CAESoffice™. The powerful Caterpillar-designed CAESoffice software enables landfill management to monitor CAES-equipped machines and work progress throughout the site in near real-time. The data is stored in a database format for easy customized access, reporting and editing.

METSmanager. This software package allows for integration of the landfill planning system and the machine. It provides the user interface for CAES and controls all communications over the wireless radio network. METSmanager reads design files in standard .DXF formats, converts them to CAES format (.CAT), and sends the design files to the on-board display on the machine over the radio network. This program continually updates the site model by regularly requesting data transmissions from the machine to the office.

- **File Window.** Displays design files (.DXF) created using the site planning package, and holds application configuration files for GPS receivers and files converted from .DXF to the CAES on-board software format (.CAT).
- **Machines Window.** Shows icons of each machine equipped with CAES on-board software. Allows multiple machines to be monitored at the same time.
- **Messages Window.** Contains a list of recent error, warning, confirmation, or information messages generated by METSmanager.
- **Communications Queue Window.** Lists all file transmissions scheduled to occur over the radio network and displays transmission status for all files.

Specifications

TC900B Communications Radio

- Technology: Spread spectrum
- Modes: Base, repeater, rover
- Optimal Range: 10 km (6 miles), line-of-sight
- Typical Range: 3-5 km (2-3 miles) varies w/terrain and operating conditions. Repeaters may be used to extend range
- Frequency Range: 902-928 MHz
- Networks: Ten, user selectable
- Transmit Power: Meets FCC requirements, 1 watt max.
- License Free (U.S. and Canada)
- Wireless Data Rates: 128 Kbps[2]
- Operating Temperature: –40° C to 70° C (–40° F to 158° F)
- Storage Temperature: –40° C to 85° C (–40° F to 185° F)
- Humidity: 100%
- Sealing: Exceeds MIL-STD-810E, sealed to ±34.5 kPa (±5 psi), immersible to 1 m (39 in)
- Vibration: 8 gRMS, 20-2000 Hz
- Operational Shock: ±40 g, 10 msec
- Survival Shock: ±75 g, 6 msec
- Electrical Input: 10.5 to 20V DC
- Nominal Current: 250 mA (3 W)1
- Transmit Current: 1000 mA (12 W)1
- Protection: Reverse polarity
- Control Interface: SAE J1939 CAN
- Emissions and Susceptibility: CE compliant, exceeds ISO 13766
- Input Connector: 8-pin
- Network Connector: 8-pin
- Height: 250 mm (10 in)
- Width: 85 mm (3.4 in)
- Weight: 0.9 kg (2.0 lb)

Radios outside of U.S. and Canada operate on different frequencies. Please contact your Cat Dealer for specifics.

L1/L2 GPS Antenna

- Operating Temperature: –40° C to 70° C (–40° F to 158° F)
- Storage Temperature: –55° C to 85° C (–67° F to 185° F)
- Height: 151mm (6 in)
- Width: 330 mm (13 in)
- Depth: 72 mm (2.8 in)
- Weight: 1.695 kg (3.8 lb)

MS840 GPS Receiver

- Tracking: 9 channels L1 C/A code, L1/L2 full cycle carrier, fully operational during P-code encryption
- Signal Processing: Supertrak multibit technology, Everest multipath suppression
- Positioning Mode –
- Synchronized RTK: 1 cm + 2 ppm horizontal accuracy/2 cm + 2 ppm vertical accuracy, 300 ms latency, 5 Hz std. maximum rate
- Low Latency: 2 cm + 2 ppm horizontal accuracy/3 cm + 2 ppm vertical accuracy, <20 ms latency, 20 Hz maximum rate
- DPGS: <1m accuracy, <20 ms latency, 20 Hz maximum rate
- Range: Up to 20 km from base for RTK
- Communication: 3x RS-232 ports, baud rates up to 115,200
- Control Interface: SAE J1939 CAN
- Configuration: RS-232 Serial connection
- Operating Temperature: –20° C to 60° C (–4° F to 140° F)
- Storage Temperature: –30° C to 80° C (–22° F to 176° F)
- Humidity: 100%
- Operational Vibration: 3 gRMS
- Survival Vibration: 6.2 gRMS
- Operational Shock: ±40 g
- Survival Shock: ±75 g
- Electrical Input: 12/24V DC, 9 watts
- Height: 5.1 cm (2.0 in)
- Width: 14.5 cm (5.7 in)
- Depth: 23.9 cm (9.4 in)
- Weight: 1.0 kg (2.25 lb)

CAES Touch Screen Display

- LCD Display: 264 mm (10.4 in) 640 × 480 transflective color VGA
- Buttons: touch screen
- Touch Screen: 3.17 mm (0.125 in) resolution infrared high light rejection
- Back Light: 200 cd/m2, 200:1 dimming ratio
- Processor: Intel Pentium CPU
- Memory: 64 MB Ram
- Solid State Disk: Internal 128 MB, external compact flash
- Operating Environment: Embedded WinNT
- Operating Temperature: –20° C to 70° C (–4° F to 158° F)
- Storage Temperature: –50° C to 85° C (–58° F to 185° F)
- Sealing: IP68 sealed to ±5 psi
- Humidity: 100%
- Electrical Input: 9-32V DC
- Power Supply: 5 amp @ 40W load dump, reverse voltage, ESD, over voltage protection
- Connector: 70-pin
- Discrete I/O: 8 digital ports; 5 PMW inputs
- Mounting: bracket or panel
- Height: 261 mm (10.28 in)
- Width: 315 mm (12.4 in)
- Depth: 93 mm (3.66 in)
- Weight: 3.17 kg (8.5 lb)

CAESoffice/METSmanager PC Requirements

- Pentium II/III processor w/ 128 MB memory
- 21 in. monitor (SVGA color 1024 × 768 resolution) with 2MB video memory
- Windows NT 4.0 or higher with latest service pack
- Modem- internal or external (required for remote support)
- Required ports: serial (suggest 2 serial, 1 parallel)
- CD ROM drive
- 3.5 in disk drive
- Mouse or suitable pointing device
- Hard Drive Space: 200 MB min.

Customer Support. For over 25 years, Caterpillar has been providing electronic and electrical components and systems for the earthmoving industry – real world technology solutions that enhance the value of Cat products and make customers more productive and profitable. Your Cat Dealer is ready to assist you with matching machine systems to the application or obtaining responsible, knowledgeable support. For additional information, please contact us at LANDFILLGPS@CAT.com

Computer Aided Earthmoving System for Landfills

Landfill Compactors
Track-Type Tractors
Wheel Tractor Scrapers
Motor Graders

www.CAT.com

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