Attachment L

Engineering Report

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ATTACHMENT L ENGINEERING REPORT

1 GENERAL

1.1 Introduction

Gandy Marley Inc. (GMI) submitted a Resource Conservation and Recovery Act (RCRA) Part B Permit Application to construct and operate the proposed Triassic Park Waste Disposal Facility (EPA ID No. NM0001002484) to be located in Chaves County, New Mexico. This Engineering Report was updated by Daniel B. Stephens & Associates, Inc. (DBS&A) based on the original Engineering Report prepared for the Triassic Park Permit Application by TerraMatrix/Montgomery Watson (TerraMatrix). This Engineering Report presents the detailed design of the Triassic Park Waste Disposal Facility submitted in support of the Triassic Park Waste Disposal Facility RCRA Part B Application.

1.1.1 Background

In 1994, GMI contracted the S.M. Stoller Corporation to perform site characterization work and to prepare RCRA Part A and Part B Permit Applications for location of a hazardous waste treatment, storage and disposal facility on a 480 acre parcel of privately owned land located in Chaves County, New Mexico. The proposed site is located in Section 17 and 18 of R31E, T11S which lies approximately 42 miles east of Roswell, New Mexico and 36 miles west of Tatum, New Mexico.

In August 1994, GMI contracted with TerraMatrix to prepare preliminary designs for the various site facilities and to assist S.M. Stoller in the preparation of the RCRA Part B Permit submittals. S.M. Stoller and TerraMatrix worked jointly to respond to comments and requests for additional information made by the New Mexico Environmental Department (NMED). The Facility design as presented herein is a product of several design iterations which incorporated additional information and design modifications as suggested by the NMED. The Facility permit was approved by NMED in 2002.

In 2011, GMI contracted DBS&A to update the engineering design for the Triassic Park Waste Disposal Facility, which is yet to be constructed. The design updates include elimination of some operations and waste types planned under the original design and permit. Details of the changes are described in this Engineering Report.

1.1.2 Objective and Scope

The primary objective of this report is to present the detailed design and engineering analyses required under Title 40, Code of Regulations (40 CFR), Part 264 and Title 20, New Mexico Administrative Code 4.1 (20 4.1 NMAC) in support of the Triassic Park Waste Disposal Facility

RCRA Part B Permit Application. This engineering report presents information applicable to the following site features and facilities.

- Site arrangement
- Landfill

Updates to the engineering design for the renewal of the Triassic Park permit include elimination of the following facilities that were part of the original permitted design.

- Evaporation Pond
- Truck Roll-Off Area
- Stabilization facility
- Drum Handling facility
- Liquid Waste Storage facility
- Truck Wash facility

1.1.3 Report Organization

Sections 2 and 3 of this report describe the design elements and engineering analyses for the general facility arrangement and the landfill. Sections 4 through 9 describing facilities that have been eliminated from the 2002 Engineering Report have been removed. A list of references used in the report follows the removed sections. Detailed design drawings are provided as Permit Application Attachment L1. The Construction Quality Assurance (CQA) Plan is provided as Permit Attachment M. The landfill action leakage rate and response action plan and its supporting engineering analyses are provided as Permit Attachment J. See the attachments in Volumes 4 of the Part B Permit Application for construction specifications (Attachment Z), laboratory test results (Attachment AA), engineering calculations (Attachment BB), surface water control plan (Attachment CC), and manufacturer information (Attachment DD).

The drawings in Permit Application Attachment L1 present final designs for the RCRA-permitted facilities. Details on the non-RCRA components of the facilities may be supplemented during the bidding and construction phase. GMI will supply the additional details on the non-RCRA components of the design to NMED for review and approval prior to the start of construction.

1.2 Regulatory Criteria and Guidance

The following federal and state regulations, as well as federal guidance documents were used in the design.

- New Mexico Hazardous Waste Regulations, 20.4.1 NMAC.

- Federal Hazardous Waste Regulations, 40 CFR, Part 264.
- U.S. Environmental Protection Agency (US EPA), 1984. Permit Applicants Guide Manual for Hazardous Waste Land Treatment Storage and Disposal Facilities.
- U.S. Environmental Protection Agency, 1988. Lining of Waste Containment and Other Impoundment Facilities, Part 1 of 2 and Part 2 of 2.
- U.S. Environmental Protection Agency, 1988. Seminar Presentations - Requirements for Hazardous Waste Landfill Design, Construction and Closure.
- U.S. Environmental Protection Agency, 1996. Technical Guidance Document. Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.
- United States Environmental Protection Agency, July, 1990. Seminars - Design and Construction of RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Final Covers, Washington, DC.

Additional supporting reference documents are presented in the reference list.

1.3 Summary of Geologic and Hydrologic Conditions

Regional and site geologic and hydrologic conditions are discussed in the Triassic Park Waste Disposal Facility Part B Permit Application (52). This site characterization work was performed by the S.M. Stoller Corporation and is based on a series of exploration drilling and test pit programs conducted at the site and review of New Mexico Oil Conservation Division well logs. One of the results of primary importance to this engineering report stemming from the site characterization report is the identification of the “most favorable area” for the location of the landfill. A brief summary of the site geologic and hydrologic conditions based on the Part B Permit Application is presented below.

1.3.1 Regional Conditions

The geologic formations present within the region where the Triassic Park Facility is situated range from Quaternary through Triassic in age. These include Quaternary alluvium, Tertiary Ogallala Formation, and the Triassic Dockum Group. Permian sediments do not outcrop in this region.

1.3.2 Site Geology

Site stratigraphy generally consists of, from top down, 2- to 20-foot thicknesses of Quaternary alluvial materials; 30- to 100-foot thicknesses of Upper Dockum mudstones, siltstones, and sandy siltstones; and up to 600-foot thicknesses of Lower Dockum mudstones. Permeability testing of mudstones core samples was found to average 2.2 x 10^{-7} centimeters per second (cm/s) and siltstones averaged 1 x 10^{-4} cm/s (52).

Based on the regional geologic features, the potential for subsurface subsidence and the occurrence of sinkholes is considered negligible. In addition, there are no identified faults within the project area. The proposed site is located in a geologically stable area with low seismic activity potential. Design ground accelerations of 0.04 g were used in engineering evaluations presented in this report (1).

1.3.3 Site Hydrogeology

The Part B Permit Application Section 3, Ground Water Protection, provides a detailed discussion of the site geology and supporting investigation activities, as well as site groundwater characteristics and supporting groundwater flow modeling. Based on these assessments, the "most favorable" area for the landfill construction was identified (see Application Figure 3-12 of Section 3). The footprint for the proposed landfill generally conforms to the "most favorable" area. Cross sections shown on Permit Application Drawing No. 7 show the landfill base and geologic foundation intercepts.

1.4 Additional Field and Laboratory Studies

In addition to the site characterization drilling and test pitting programs described above, a test pit program to characterize near surface soil conditions and laboratory studies to identify geotechnical properties of the soils and proposed liner components was conducted. Attachments W and X of the Part B Permit Application present the results of the test pit program, soil index tests, and interface shear tests performed on the soil and geosynthetic liner materials.

1.5 Summary of Climatological Data

Site climatological data, including temperature and precipitation, were obtained from the National Oceanic and Atmospheric Administration (NOAA) Class A recording station in Roswell, New Mexico. Climate conditions of the area are typical of semiarid regions characterized by dry, warm winters with minimal snow cover and hot, somewhat moister summers (52). Other climatological data required for modeling were obtained from Weather Underground and the National Solar Radiation Database.

Moderate temperatures at the Triassic Park Facility are typical throughout the year, with annual average high and low temperatures of 75 degrees Fahrenheit (°F) and 45°F, respectively. Temperatures throughout the year often exhibit a large diurnal variation in Roswell. While winter morning temperatures below freezing are possible, days when the temperature fails to rise above freezing are rare. Average temperatures in the months of June, July, and August exceed 90°F and often exceed 100°F.

Precipitation is light and unevenly distributed throughout the year. Winter is the season of least precipitation, averaging less than 0.6 inch of rainfall per month for the months of November through March. Snow averages about 5 inches per year, but often melts within 24 hours of each snowfall event. More than half of the annual precipitation in Roswell is the result of monsoonal moisture associated with the months of June through September. Storm events are usually brief but often intense.

Precipitation for the project area varies greatly from year to year. For example, Roswell's record low and high annual precipitation values are, respectively, 2.9 inches in 2003 and 32.9 inches in 1941. The maximum 24-hour rainfall was 5.65 inches in October 1901. The average annual precipitation rate for Roswell for a 118-year period from 1894 to 2011 is 11.6 inches.

The prevailing wind direction is from the south with a normal mean wind speed of 9.6 miles per hour (mph) at Roswell.

2. GENERAL FACILITY DESIGN ELEMENTS

2.1 General Facility Design Elements

2.1.1 General

General facility design elements include the overall facility layout, traffic plan, and site wide stormwater control design. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness. This section describes the site layout and provides rationale for the individual facility locations and roadway network. In addition, the site wide stormwater control feature system is described.

2.1.2 Facility Layout

Drawing No. 4, Facility Layout, illustrates the proposed locations of all site facilities, including the site waste receiving, disposal facilities; the site maintenance area; soil stockpiles; surface water control features; water storage basins; and interconnecting access roadways. The locations of these facilities are governed by the landfill layout and construction sequencing, existing roads leading to the Facility, and existing topography and surface water drainage. Additional rationale for the Facility layout is discussed below.

Facility entrance and receiving areas, including the security gate, administration trailer, truck untarping and sampling stations, chemical laboratory, and truck staging area, are located near the Facility entrance in the northeast corner of the site. This arrangement facilitates site access security; incoming waste load inspection, sampling, testing, and weighing; and provides vehicle parking, truck staging, and emergency vehicle access.

The Facility maintenance shop area is located next to the Phase 1A landfill along the western perimeter haul road. Earthmoving and construction equipment will be able to access the maintenance shop from the south, thus reducing interference with site operations traffic and minimizing wear to the perimeter road surface. The stormwater detention basin is located in the northwest corner of the site because this is a natural low point to which clean runoff from the Facility will be directed.

Stockpile and clay processing areas are located along the east side of the Facility. These areas provide adequate soil storage space and allow construction equipment to operate separately from other site operations. The landfill location is governed by subsurface geologic and hydrogeologic characterization discussed in Section 1.3.3.

2.1.3 Facility Traffic Plan

Drawing No. 26, Traffic Plan, illustrates the site roadway locations and grades, traffic flow directions, traffic control features, and emergency vehicle access lanes at the Facility entrance. Roadway locations are governed by Facility locations and operations requirements. Expected vehicle types and volumes, proposed road types and their intended uses, traffic control features, and individual facility traffic patterns are discussed below. Road design analyses are discussed in Section 2.2.1.

Table L-1 lists the types of vehicles, their gross vehicle weight, and estimated traffic volume per day which will travel on the site roadways. The traffic volumes shown in Table L-1 are estimated based on an assumed waste receipt volume. Actual traffic volumes may vary.

2.1.3.a Main Facility Roads

Drawing No. 26, Traffic Plan, identifies the extent of the main Facility roadways. These roads include the Facility entrance road, landfill access road, and east and west landfill perimeter roads. Permit Application Drawing No. 27, Perimeter Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. The main facility road network will serve the majority of site traffic into and out of the landfill and the waste processing facilities. Construction equipment will typically be restricted to construction haul roads and the cut slope access ramp into the landfill.

2.1.3.b Unimproved Access Roads and Temporary Construction Haul Roads

Unimproved access roads and temporary construction haul roads (not shown on the drawings) will be constructed as required by site operations and construction contractors. Access roads to the stormwater detention basin, soil stock pile areas, and along the site perimeter fence or along power lines are typical locations for these roads. In general, these roads will be constructed by removing loose materials and vegetation and compacting the underlying soils. No road surface gravels will be placed; however, provisions for surface water drainage, such as culverts and ditches, as well as, erosion control features will be included.

The truck staging area located at the south end of the Facility entrance will provide space for waste haul trucks awaiting disposal approval. This area will be surfaced with gravel and will drain to the stormwater detention basin. Any localized spills will be cleaned up as required by the Contingency Plan presented as Permit Attachment C.

Parking areas for site personnel vehicles will be designated near the administration trailer, chemical laboratory, and maintenance shop area. These areas will also likely be gravel-surfaced.

2.1.3.c Traffic Control Features

Traffic control features incorporated in the site traffic plan include the main Facility entrance gate, stop signs, posted speed limits, and warning and informational signs. Temporary road dividers such as K-rails (also known as California rails) are also often used to separate two-way traffic in high volume areas. Stop sign locations, as shown on Drawing No. 26, Traffic Plan, will serve to control traffic at main roadway intersections and at the various waste processing unit entrances. Speed limits will be posted on all roadways. The main Facility road and unimproved access roads will be posted at 15 mph. Temporary construction haul roads will be posted at 35 mph. Additional signage will be posted to identify restricted areas, facility personal protective equipment (PPE) requirements, truck entrance areas, and facility names and access driveways.

Also shown on Drawing No. 26, Traffic Plan, are the emergency vehicle access lanes at the Facility entrance. These lanes will remain clear at all times.

2.1.3.d Landfill Traffic Pattern

The landfill design incorporates three access ramps. The two northern ramps will be used by waste haul trucks and landfill operations equipment. These 30-foot-wide ramps will accommodate 2-way traffic when necessary; however, in general, the east ramp will be used for incoming traffic and the west ramp for exiting traffic. The third ramp located on the southern cut slope will provide access for earthmoving equipment involved with landfill expansion construction activities. Incoming waste haul trucks will be released from the truck staging area and use the south access road and northeast ramp to enter the landfill. Empty haul trucks will exit the landfill via the northwest ramp and exit the site via the north access road.

2.1.4 Facility Stormwater Control

Facility stormwater control is provided in the design by a network of surface water run-on and runoff diversion channels and collection and detention basins. These facilities were designed to collect and contain the required 25-year, 24-hour storm event of 4.30 inches. Since the original permit was approved, the 25-year, 24-hour storm event increased from 4.30 to 4.39 inches. The rainfall-runoff analysis was recalculated with the new storm event and new peak discharges were calculated. The stormwater channels as previously designed can accommodate the increase in flow. The original diversion ditch calculations are provided in Attachment BB of the Part B Permit Application; the new analysis is provided in Attachment L4.

2.1.4.a Site Vicinity Drainage Pattern

The proposed site is located on the far eastern flank of the Pecos River Basin. The land surface gently slopes to the west at approximately 40 to 50 feet per mile toward the river. The sloping plain is characterized by low relief hummocky wind-blown deposits, sand ridges, and dunes. The Caprock escarpment (or Mescalero Rim) is one of the most prominent topographic features in southeastern New Mexico. East of the proposed site, the escarpment has approximately 200 feet of relief. Upgradient sources of surface water flow are bounded by the Caprock escarpment. The U.S. Geological Survey (USGS) Topographic Maps (7.5 minute series) for Mescalero and Mescalero N.E. in the Surface Water Control Plan in Attachment CC of Part B Permit Application of the areas pertinent to the site. The watershed associated with the east diversion channel encompasses an area of approximately 378 acres beginning at the Caprock escarpment and continuing down to the site's east property line.

2.1.4.b Surface Water Run-On Diversion Channels

The east diversion channel located on the eastern edge of the landfill property line provides run-on control from the east watershed area. The remaining topography surrounding the site grades away from the site. The discharge location for this channel coincides with existing natural drainages to the north of the site as indicated on Drawing No. 25. The east diversion channel will remain in place after the landfill cover system is constructed.

2.1.4.c Surface Water Run-Off Channels

To control the runoff from the facilities area, several collection channels and culverts were designed to divert the peak discharge from the 25-year, 24-hour storm event to a stormwater detention basin. The locations of the collection channels (Ditch 1 through 6), culverts, and detention pond are shown on Drawing 25. Channels 1 and 2 are located along the inside of the perimeter road at the toe of the final cover slope. The channels divert runoff from the final cover to channel 5 located at the northwest corner of the landfill. Channels 3 and 4 run along the outside edge of the perimeter road. Channel 3 collects the majority of runoff from the disturbed facilities areas immediately to the east and north of the landfill footprint. Channel 4 collects runoff from the west and south perimeter road. Both channels also discharge to channel 5 at the northwest corner of the landfill. Channel 5 collects the runoff from ditches 1, 2, 3, and 4 and conveys it to the detention pond. Channel 6 collects runoff from the facilities located near the entrance to the site and routes it to the detention pond.

Two ditches, Ditches 7 and 8 are located in the Phase 1A landfill. These channels are designed to divert runoff from unlined areas of the landfill to the clean water collection basin located in the south end of the landfill.

2.1.4.d Surface Water Detention Basins

There will be three lined storm water detention basins located on the site. A stormwater detention basin will be located in the northwest corner of the site as shown on Drawing No. 25. Two additional storm water detention basins will be located within the landfill cell. The clean stormwater collection basin will be located in the toe of the Phase 1A cut slope and a contaminated water basin will be located within the lined portion of Phase 1A extending from the waste fill slope to the clean stormwater collection basin berm, as shown on Drawing No. 10.

A berm has been included at the base of the access road to the stormwater collection basin of Phase 1A to prevent access road runoff into the contaminated water basin.

2.1.4.e Final Cover

The landfill Final Cover Grading Plan is shown on Permit Application Drawings No. 21 and 22. An access road to the top of the landfill is located along the western side of the landfill. The surface water control ditch adjacent to the road will reduce erosion and control surface runoff of the cover. The ditch dimensions and details are shown on Drawing No. 25 and Permit Application Drawing 27.

2.2 General Facility Design Analyses

2.2.1 Road Designs

Permit Application Drawing No. 27, Main Facility Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. Construction Specification Section 02225, Road Base, provides details regarding road construction materials and placement execution. Calculations presented in Attachment BB of Part B Permit Application evaluate the main facility road design and specification relative to the expected traffic conditions identified in Table L-1. As described in the calculations, the main facility bearing capacity of 2,000 pounds per square foot (psf) is suitable for the expected traffic loading.

2.2.2 Facility Surface Water Control Design Analyses

All surface water calculations were conducted utilizing the SEDCAD+ computer model developed by Civil Software Design (70). Channels were sized based on Manning's equation for open channel flow. The methodology and assumptions used in the design of the surface water control system are presented in the Surface Water Control Plan in Attachment CC of the Part B Permit Application. Drawing No. 25 presents a layout of the surface water control plan, a schedule of channel and culvert dimensions, and installation criteria.

2.2.2.a Detention Basin Design Analyses

The stormwater detention basin is designed to contain the stormwater discharge from the entire active site area given flows from a 25-year, 24-hour storm event. In order to assess the required size of the surface water detention basin, a worst-case stormwater volume discharge area was identified. The worst-case scenario assumed that the final cover was in place and the runoff from the entire landfill footprint along with the runoff from the surrounding facilities area are all diverted to the basin. The total drainage area is approximately 265.5 acres. Of the 265.5 acres, 44 percent is assumed to be reclaimed and revegetated and the remaining 56 percent is considered to be disturbed. The total runoff was computed to be approximately 51.4 acre-feet (ac-ft). Total volume of the detention pond at the invert of the spillway is 66.1 ac-ft.

2.2.2.b Erosion Control

Channels with flow velocities less than 5 feet per second (fps) from a 25-year event will not require erosion protection. Channels with peak flow velocities greater than 5 fps from a 25-year event but less than 5 fps from an average storm (2-year event) will also not utilize erosion protection. During average storm events these channels should be stable; however, during major storm events the channels may show signs of erosion in some areas. These areas will be repaired as required following all major storm events. Channels with peak flow velocities greater than 5 fps from an average storm will be lined with gravel or riprap, as required. Channels are designed with 1 foot of freeboard.

To minimize sediment transport to receiving streams, the east diversion channel will be lined with gravel. A riprap apron will be constructed at the end of the east diversion channel to dissipate the flow before entering the natural channel and mitigate erosion. The location and details of the discharge apron are shown on Drawing No. 25. Design calculations are shown in Attachment L4 and Attachment BB of Part B Permit Application. Channels 7 and 8, which direct clean water runoff on the side slope of the landfill into the clean water collection basin, will be lined with a high density polyethylene (HDPE) liner.

2.2.3 Operations and Maintenance

The regulated facility will be constructed in accordance with the Design Drawings (Permit Attachment L1), Specifications (Permit Attachment L2), and Construction Quality Assurance Plan (Permit Attachment M). In general, all maintenance and repairs to the facility will be completed to meet the requirements of the original Design Drawings and Specifications and will be monitored in compliance with the CQA Plan and Operations and Maintenance Plan (Permit Attachment N).

3. LANDFILL

3.1 Landfill Design

3.1.1 General

Landfill design elements include ultimate and interim landfill layout and phasing; subgrade design; liner system design; and leachate collection system, leak detection system, and vadose monitoring sump design. This section describes each of these design elements. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness.

3.1.2 Landfill Layout and Phasing

The proposed landfill footprint illustrated on Drawing No. 4 generally conforms to the most favorable area as previously described. The landfill footprint is divided into three phases (Phase 1, Phase 2, and Phase 3) with each phase having a separate leachate collection, leak detection, and vadose detection system. These phases will be further subdivided based on development sequencing and landfill waste receipt rates. The limits of Phase 1A, the first area of the landfill to be developed, are shown on Drawings No. 8, 9, and 10. Details of the ultimate landfill configuration and the Phase 1A configuration are discussed below.

3.1.2.a Ultimate Landfill Configuration

Drawings No. 6, 7, and 22 illustrate the proposed ultimate configuration of the landfill for Phases 1, 2 and 3. The landfill footprint, defined by the crest line, encompasses approximately 101 acres. The final cover area, which will extend 20 feet beyond the crest line, is approximately 107 acres. The final cover for Phase 1A, including revegetation, is shown on Permit Application Drawing No. 22. No waste will be placed outside of the crest line of the landfill, and leachate percolating vertically through the waste mass will be contained by the slope and floor liner systems.

The subsurface, or basal, portion of the landfill will be excavated to a depth of approximately 100 feet. At this depth, the floor and sumps of the landfill will be located in the Lower Dockum Unit (Permit Application Drawing No. 7). All side slope angles are 3 horizontal: 1 vertical (3H:1V) and the base in each landfill phase grades approximately 3 percent with a minimum of 2 percent towards its respective sump area. The basal liner system anchor trench is located approximately 4 feet beyond the crest of the landfill (Drawing No. 12). Sumps are located at convenient locations in each phase to allow for subphase landfill development, to provide space for access ramps, and to maintain leachate collection system flow lengths capable of detecting a leak in a timely manner.

As shown on Permit Application Drawings No. 7 and 22, the final cover system will reach a maximum elevation of approximately 4,205 feet. The cover system will crest at the mid-point of the landfill and will slope at six percent outwards. Slopes around the perimeter of the landfill will be 4H:1V.

3.1.2.b Phase 1A Landfill Configuration

Phase 1A landfill development is illustrated on Drawings No. 8, 9, 10, and 11. The basal liner system will cover the entire north 3H:1V slope, the slopes below the access ramps, and most of the Phase 1A floor. Waste placement will occur only on lined areas as shown on Drawing No. 10.

Landfill access ramps located on the east and west sides of Phase 1A grade at 10 percent from the crest to the floor surface. The 30-foot-wide ramps can facilitate two-way traffic. Drawing No. 14 illustrates the access ramp cross sections when waste placement takes place below the ramps and when waste placement takes place above the ramps.

Drawing No. 13 shows slope runoff diversion ditches located along the access ramps that discharge into a collection basin positioned at the toe of the cut slope. This temporary stormwater control feature will collect runoff from unlined slope areas above the access ramp and from the cut slope area during Phase 1A waste filling. Clean water collected in the basin may be used for dust control within the landfill or may be pumped out of the basin and discharged into the site surface water control system.

3.1.3 Subgrade Excavation, Liner System, LCRS, LDRS, and Vadose Zone Monitoring System Sump Design

3.1.3.a Subgrade Excavation

Drawing No. 6 shows the ultimate anticipated landfill excavation and structural fill contours. The crest of the landfill generally follows the site’s surface topography which grades from the southeast to the northwest. Fill areas along the south and west sides of the landfill combined with cut areas along the landfill's north side provide sufficient grade differences for perimeter drainage ditches to move stormwater runoff to the detention basin located in the northwest corner of the site. Drawing No. 5 indicates the initial cut and fill areas that would be required for the initial site development. This would require grading around the perimeter of the landfill and in the waste processing areas.

Specification Section 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

3.1.3.b Liner System

Drawing No. 12 shows the landfill basal liner components intended for the floor, slopes, and anchor trench areas. The landfill liner system is a double lined system consisting of (from bottom up) a prepared subgrade, a composite (geosynthetic clay liner [GCL] and geomembrane) secondary liner, a geocomposite leak detection drainage layer, a primary geomembrane liner, a geocomposite leachate collection drainage layer, and a protective soil layer. Details of each liner component are discussed below:

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *16-foot compacted clay liner (CCL) around landfill perimeter*

  During excavation, Quaternary Sands will be exposed around the perimeter of the landfill to depths ranging from 2 to 10 feet. As shown on Permit Application Drawing No. 23, 16 feet of sand material, measured laterally, will be removed and replaced with a CCL component. The purpose of the CCL is to provide the liner with enhanced water barrier qualities in the Quaternary Sand areas. The CCL will be extended into the Upper Dockum Unit to a depth of at least 2 feet. The CCL (permeability, K less than or equal to 1×10^{-7} cm/s) in combination with the overlying GCL, described below, will serve as a low permeability barrier layer to restrict infiltration of leachate into the subgrade. The CCL will consist of clay material (soils classified as CL or CH by the Unified Soil Classification System [USCS]) obtained during excavation of the landfill. Specification Section 02221, Clay Liner, describes clay material requirements, including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Soil liner leachate compatibility tests (ASTM D5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the Construction Quality Assurance (CQA) Plan (Permit Attachment M). The results of the permeability testing performed in compacted samples are shown in the appendices.

- *Geosynthetic clay liner (GCL)*

  The GCL will serve as a low permeability (K less than or equal to 5×10^{-9} cm/s) barrier layer to restrict infiltration of leachate into the subgrade. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6-ounce material and the lower geotextile will be a woven 4 ounce material. Specification Section 02780, Geosynthetic Clay Liners, describes minimum GCL properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance (CQA).

  Site specific compatibility tests (ASTM D5084) will be conducted prior to operations.

  Manufacturer published information on the compatibility of the GCL with typical leachate materials is provided in Attachment DD of the Part B Permit Application.

- *60-mil-thick high density polyethylene (HDPE) geomembrane liner (textured on both sides)*

  The 60-mil HDPE liner placed on top of the GCL is the second component of the composite secondary liner. Together, the GCL and HDPE liner form a highly efficient barrier layer to restrict percolation of leachate into the subgrade (see Section 3.2.7, HELP

Modeling). HDPE texturing increases the friction angle between the geomembrane and the underlying and overlying geotextile liner elements. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance. Section 3.2.1 discusses slope stability analyses for the landfill liner system.

Site-specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the Facility. Manufacturers' Published Information on the compatibility of the HDPE with typical leachate materials is provided in Attachment DD of the Part B Permit Application.

- *Geocomposite leak detection drainage layer (transmissivity greater than or equal to 2.2 x 10^{-4} square meters per second [m^2/s] as tested under actual field conditions) consisting of:*
  - a 7 ounce geotextile (non-woven);
  - a geonet; and
  - a 7 ounce geotextile (non-woven).

The high-transmissivity geocomposite leak detection drainage layer provides a means to transmit and remove leachate percolating through any leaks in the primary geomembrane layer above. The upper and lower geotextiles serve to filter sediments from the leachate and cushion the geomembranes, respectively. Flow calculations discussed in Section 3.2.8 and presented in Permit Attachment J indicate that the geocomposite, in combination with the centrally located 8-inch-diameter drain pipe, are capable of removing leachate in a timely manner such that head on the underlying geomembrane will remain less than 1 foot. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

The arrangement for the 8-inch-diameter drain pipes and surrounding drainage gravel and filtration geotextile, which are located in the floor of the leak detection layer and the leachate collection layer, are illustrated on Drawing No. 12. Specification Section 02714, Filter or Cushion Geotextile, describes minimum geotextile properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

Calculations demonstrating the leak detection system performance capabilities are presented in Section 3.2.7, HELP Modeling and Section 3.2.8, LCRS, LDRS, and VZMS Hydraulic Analyses.

- *60-mil-thick HDPE geomembrane liner (textured on both sides)*

  This HDPE geomembrane serves as the primary barrier layer of the double liner system. Specification Section 02775, Geomembrane Liners, discussed above also applies to this geomembrane layer.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the Facility. Manufacturers' published information on the compatibility of the HDPE with typical leachate materials is provided in Attachment DD of Part B Permit Application.

- *Geocomposite leachate collection and removal drainage layer (transmissivity greater than or equal to 2.2 x* 10^{-4} m^2*/s as tested under actual field conditions) consisting of:*
  - a 7 ounce geotextile (non-woven);
  - a geonet; and
  - a 7 ounce geotextile (non-woven).

  This geocomposite layer serves as the primary leachate collection and removal system. Leachate percolating through the overlying waste fill will drain through the geocomposite to the central drain pipe and then flow to the leachate collection sump where it will be removed via the slope riser pipes. This material is the same used in secondary leak detection layer. The floor drain pipe arrangement is also the same.

  Primary geocomposite flow calculations are presented in Attachment BB of the Part B Permit Application, and the performance demonstrations are provided in the HELP Modeling discussed in Section 3.2.7.

- *2-foot-thick protective soil layer*

  A 2-foot-thick protective soil layer will be placed above the primary leachate collection geocomposite. The protective soil layer will extend over all lined floor and side slope areas. The purpose of the soil layer is to protect the underlying geosynthetics from damage due to vehicle traffic or from waste debris settlement. Specification Section 02716, Protective Soil Layer, describes material requirements including particle size, placement requirements, and survey and field quality control requirements. This soil layer will be placed during construction of the liner system.

3.1.4 LCRS, LDRS, and VZMS Sumps

The leachate collection and removal system (LCRS), leak detection and removal system (LDRS), and vadose zone monitoring system (VZMS) each have a separate sump from which fluids can be collected and removed. The liner systems on the landfill floor continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated into the drainage systems. Also, because liquids may be present, clay soil liner components have been added below the primary geomembrane liner and below the secondary GCL liner. These clay soil liner elements are not required by the regulations but are added to enhance the barrier qualities of the liner elements in the sump. Drawings describing the sump arrangements in Phase 1A include Permit Application Drawings No. 15, 16, 17, and, 18. As shown on the drawings, the sumps are square pyramidal shapes which lie concentrically above one another. The slope riser pipes enter their respective sumps at the sump base and are horizontally offset to provide adequate space for slope riser trenches. The slope riser trench arrangement enables the vadose and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the landfill rather than in the sump area. The leachate collection riser pipe lies on top of the primary geomembrane and therefore no liner penetration is required. Table L-2 lists the dimensions, volumes, flow capacity, slope riser pipe dimensions, pump type and capacity, and fluid level instrumentation included in each of the sumps. Performing curves for the proposed pumps are shown in Attachment DD of the Part B Permit Application.

3.1.4.a LCRS Vertical Riser

In addition to its side slope riser, the LCRS sump also has a vertical riser which will extend from the LCRS through the waste fill and final cover system to the surface. The vertical riser is a redundant design feature that provides additional access to the LCRS sump whereby a second pump can be added to rapidly increase leachate removal rates. As shown on Permit Application Drawings No. 17 and 20, the vertical riser arrangement consists of three pipes and three vertical riser pipe pads. The innermost pipe is an 18-inch-diameter stainless steel pipe that rests on an HDPE flatstock and extends from the bottom of the LCRS sump through an opening in the concrete vertical riser pad above. Because this pipe is not attached to the concrete pad, any settlement that the concrete pad incurs will not be transferred to the pipe. The concrete vertical riser pad rests on the LCRS gravel and provides support for the second pipe which will extend through the waste fill to the surface. This pipe is wrapped with a double layer of HDPE. This arrangement isolates the pipes from the surrounding waste, which reduces downdrag forces resulting from waste settlement. Calculations that evaluate the downdrag forces and structural design of the concrete vertical riser pad are included in Attachment BB of the Part B of the Permit Application.

3.1.4.b Crest Riser Pad Arrangement

Permit Application Drawing No. 19 illustrates the slope riser piping and valves, the double-lined 9,000-gallon polyethylene tank (poly tank) system for leachate storage, and the concrete containment pad. Also indicated are high and low level tank cutoff switches, flexible piping connections between the inner and outer poly tanks, the fluid level sight gauge, 50 gallons per minute (gpm) leachate discharge pump and control panel locations.

The double-lined poly tank consists of two tanks, one inside of the other. The inner tank will have a capacity of 9,000 gallons and the outer secondary containment tank will have a minimum capacity of 15,500 gallons that includes the inner tank capacity. Tank tie-down details have been provided by the manufacturer and are included in Attachment DD of Part B Permit Application. A chemical resistance chart for the tanks is provided in Attachment DD of the Part B Permit Application.

The concrete containment pad will slope towards the landfill crest. The leachate storage tank and containment pad are a connected, integral component of the landfill and are considered part of the regulated unit. A concrete pad will be placed in the loading/unloading areas for tanker trucks. This pad will be sloped providing drainage toward the sump areas. Calculations on the bearing capacity of the concrete pad are detailed in Attachment BB of the Part B Permit Application. Should a catastrophic failure of the tank or piping system occur, leachate will flow back into the landfill leachate collection system rather than be released to unlined areas. The landfill liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the landfill leachate collection system. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

3.1.5 Waste Filling Sequence

As mentioned previously in Section 3.1.2, landfill development will begin in Phase 1A, and is anticipated to proceed southward into Phase 2, and then finish in Phase 3. The extent of landfill subphases will be based on waste receipt rates.

Liner installation in Phase 1A will take place in two stages: the slope and floor area below the access ramps and the slope area above the access ramps. The initial stage of the Phase 1A liner installation will consist of liner placement below the access ramps and is the only portion relevant to this permit application. The approximate area that will be lined during the Phase 1A construction is 14.9 acres which is delineated on Drawing No. 10.

Detailed planning for Phase 1B, Phase 2, and Phase 3 liner installation, access ramp location, and waste fill sequencing is not covered by this Permit and will be determined and permitted in the future; however, the ultimate landfill configuration is anticipated to be developed as follows. When the waste fill approaches the Phase 1A limits defined in Drawing No. 10, the cut slope will be advanced southward into Phase 2 and the remaining floor and slope areas of Phase 1 will be lined. At this time, the stormwater collection basin in the landfill will be removed from Phase 1 and reestablished in Phase 2. Waste filling in Phase 1 will continue during this liner expansion. As the waste fill extends beyond and above the access ramps, a ramp will be established in the south waste fill slope to provide access to the newly lined floor areas of Phase 1. Waste filling will take place in 5- to 10-foot-thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 foot.

3.1.6 Final Cover

Permit Application Drawings No. 21, 22, and 23 illustrate the landfill's ultimate waste fill configuration and final cover design. The final cover system is a composite cover consisting of (from top down) a vegetative cover, a geocomposite drainage layer, a geomembrane layer, a geosynthetic clay layer, a prepared subgrade layer, and a cover soil layer. Details of each component of this 4.5-foot-thick cover system are discussed below.

- *2.5-foot-thick vegetative cover*

  The vegetative cover will provide a substrate for plant growth on the cover surface and protect the underlying geosynthetics from frost and sun exposure damage. Establishment of plant growth will enhance evapotranspiration of precipitation that soaks into the vegetative cover and will reduce soil erosion due to rainwater runoff. Specification Section 02227, Vegetative Cover, discusses vegetative cover material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Specification Section 02900, Vegetation and Seeding, identifies seed mixtures, site preparation, and planting requirements for cover vegetation.

- *Geocomposite drainage layer (transmissivity $\geq 2 \times 10^{-4}$ m^2/s) consisting of:*

  - a 7 ounce geotextile (non-woven);
  - a geonet; and
  - a 7 ounce geotextile (non-woven).

  The high-transmissivity geocomposite drainage layer provides a means to transmit and remove precipitation percolating through the vegetative cover above. The upper and lower geotextiles serve to filter sediments from the rainwater and cushion the geomembrane below. Flow calculations discussed in Section 3.2.7 and presented in Attachment BB of Part B of the Permit Application indicate that the geocomposite, in combination with the vegetative cover above, is capable of removing 99 percent of the precipitation falling on the cover. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *60-mil-thick HDPE geomembrane (textured on both sides)*

  The 60-mil HDPE liner placed below the geocomposite drainage layer and on top of the GCL is the primary barrier layer of the cover system. Together with the underlying GCL, the HDPE geomembrane forms a highly efficient barrier layer to restrict percolation of rainwater into the waste fill (see Section 3.2.7, HELP Modeling). HDPE texturing serves to increase the geocomposite/geomembrane/GCL friction angles to enhance slope stability. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

  Site-specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the Facility. Manufacturers' published information on the compatibility of the HDPE is presented in Attachment DD of the Part B Permit Application.

- *Geosynthetic clay liner (GCL)*

  In conjunction with the overlying HDPE geomembrane, the GCL will serve as a low permeability (K less than or equal to 5×10^{-9} cm/s) barrier layer to restrict infiltration of precipitation runoff into the waste fill. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6 ounce material and the lower geotextile will be a woven 4-ounce material. Specification Section 02780, Geosynthetic Clay Liners, describes the minimum GCL properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, material construction quality assurance.

  Manufacturer published information on the compatibility of the GCL with typical leachate materials is provided in Attachment DD of the Part B Permit Application.

- *6-inch-thick prepared subgrade layer*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *2-foot-thick cover soil layer*

  The cover soil layer placed on the surface of the waste fill serves to isolate the waste and any near surface debris from the overlying cover elements and also provides a base for the prepared subgrade layer. Specification Section 02226, Cover Soil, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

As shown on Permit Application Drawing No. 23 the final cover system will extend 20 feet outside the crest of the landfill. In addition, the waste fill terminates inboard of the crest line. Rainwater that percolates through the vegetative cover will flow in the cover system's geocomposite layer to the drainage pipe located in the cover anchor trench. The water will then be discharged to the landfill perimeter drainage ditch system. Rainwater that percolates through the cover system and comes in contact with the waste will flow vertically downward and be captured in the LCRS.

Prior to closure of the landfill, an assessment will be made of the landfill waste gas generating potential. If it is concluded that gas generation may result in gas build-ups beneath the barrier layer of the cover or releases following closure exceeding applicable air quality standards, then provisions shall be made to collect and monitor gas generation and release during the post-closure period. If this occurs, the latest technology available shall be implemented into the construction of the cover system.

Permit Application Drawing No. 22 indicates the location of the cover access road and surface water diversion ditches. Traffic on the cover access road will be limited to light vehicles such as pick up trucks. Surface water drainage ditches on the cover are included to reduce runoff flow lengths and thereby reduce surface soil erosion. Sections 3.2.10 and 3.2.11 discuss ditch sizing and cover soil erosion, respectively.

Waste settlement impacts on the 6 percent and 4H:1V cover slopes are discussed in Section 3.2.2.

3.1.7 Landfill Clean Stormwater Control Features

Drawings No. 8 through 14and 25 illustrate the landfill's clean stormwater control features designed to contain and control rainwater runoff and run-on for the required 25-year, 24-hour storm event. These features include the landfill's stormwater collection basin and slope runoff drainage ditches, cover system drainage ditches, perimeter drainage ditch, and the culverts and drainage ditches leading to the stormwater detention pond. The clean stormwater control features are designed to minimize the quantity of water that contacts or potentially contacts waste material in the landfill. Clean stormwater collected within the Phase 1A landfill excavation, but not within the lined waste disposal cell, will be discharged to the site-wide surface water control system. The systems designed to contain and manage contaminated stormwater and leachate within the Phase 1A landfill are described in Sections 3.1.8 and 3.1.9.

During the Phase 1A waste filling, runoff from the slope areas above the access ramps and from the cut slope area will be diverted to the HDPE lined collection basin located near the toe of the cut slope on the floor of the landfill. HDPE lined diversion ditches located on the side of the access ramps will carry slope runoff to the stormwater collection basin. The landfill perimeter ditches located on either side of the perimeter road will intercept runoff from areas outside of the landfill and divert this water to the stormwater detention basin.

During the operational period of future Phases 2 and 3, when the final cover system is partially installed in some areas and waste filling continues to take place in other areas, runoff from the final cover will be diverted to the stormwater detention basin. Following the post-closure period, after the effectiveness of the landfill cover has been demonstrated, the stormwater detention basin may be removed from service and the area regraded to its approximate predisturbance state. Runoff from the landfill cover will be allowed to flow into the natural drainages which existed prior to construction.

Section 3.2.10 summarizes surface water calculations performed to size the landfill's stormwater control features. The calculations are presented in Attachments L4 and L5.

3.1.8 Landfill Contaminated Stormwater Control Features

Drawings No. 8 through 14 and 24 illustrate the landfill's stormwater control features designed to contain and control stormwater runoff and run-on and isolate potentially contaminated runoff from clean runoff for the required 25-year, 24-hour storm event. Contaminated or potentially contaminated stormwater within the Phase 1A landfill is collected within the lined contaminated water basin. Runoff from the active waste filling area will drain to the contaminated water basin at the south end of the landfill. When the Phase 1A landfill has been filled to the maximum extent, the contaminated water basin has a minimum storage capacity of 17 acre-feet. At earlier stages of filling, the basin is larger, providing greater storage capacity.

The contaminated water basin is not its own separate entity, but is a part of the Phase 1A landfill that will not initially receive waste. The layout of the contaminated water basin is shown on Drawings No. 10, 11, 13, and Permit Application Drawing 24. Because the contaminated water basin is only a portion of the landfill set aside to store stormwater, it will not be removed as the landfill is expanded to the south; rather, waste will be placed over the top of the contaminated water basin.

Section 3.2.10 summarizes surface water calculations performed to size the landfill's stormwater control features. The calculations are presented in Attachments L4 and L5.

3.1.9 Leachate and Contaminated Stormwater Recirculation Evaporation System

Leachate and contaminated stormwater generated from precipitation falling within the Phase 1A landfill waste disposal area will be managed by recirculation and enhanced evaporation within the regulated unit. The stormwater will be applied to the protective soil cover through a piping and sprinkler network. Tanker trucks may also be used to apply water for dust control on the landfill roads and cover soil.

Modeling of recirculation rates was performed to determine the viability of recirculation of contaminated stormwater and possible effects on the volume of stormwater entering the leachate collection system. Model approach, assumptions, input files, and results are presented in Permit Attachment L5. The UNSAT-H model was used to evaluate potential for stormwater recirculation, specifically to estimate the increase in water percolation through the daily cover and waste. UNSAT-H uses daily climate data, including the added application of recirculation water, and soil and water hydraulic properties to compute evaporation, runoff, moisture storage, and percolation through the waste and soil profile. The model used several conservative conditions, including only one layer of waste and daily cover and use of climate data for the second wettest precipitation year on record. In the model, stormwater application rates are limited to 0.5 inch per day. The recirculation of stormwater adds approximately 50 percent additional water application to the precipitation rate in a given year.

The modeling results show that during average years, with annual precipitation around 11.7 inches, no increase in leachate is expected. For extremely wet years, the model results indicate that there is an increase in stormwater movement through the daily cover and waste to the leachate collection, but well within the design flow capacity of the LCRS. Leachate generation rates in arid climate landfills typically decrease as the thickness of waste placement increases. The modeling results show that the recirculation system can be used effectively to manage stormwater runoff and leachate within the lined landfill cell during the early portion of waste placement under conditions of either average or extremely wet precipitation conditions.

3.2 Landfill Design Analyses

3.2.1 Slope Stability

3.2.1.a Cut Slope Stability

Prior to filling, unsupported cut slopes will exist on all sides of the landfill. These slopes were analyzed for static and dynamic stability using the Janbu Simplified Method. A computerized slope stability program (XSTABL) was used to analyze the cut slopes (51). Strength parameters used for soil and rock materials were estimated using design overburden pressures and plasticity index data gathered from laboratory testing of site soil materials correlated to published data

(53). The material properties used in the analyses are summarized in Calculation E-1, presented in Attachment BB of Part B Permit Application.

The site grading plans (Drawings No. 5 and 6) indicate that the maximum cut slopes will be 3H:1V and maximum height will be approximately 100 feet. Results for the critical 3H:1V slope indicate a static factor of safety of 1.4 for the critical short term (undrained) condition. Stability during seismic loading was estimated by applying a pseudo-static earthquake force in the Janbu analysis. Results based on the 0.04 g design acceleration indicate a dynamic factor of safety of 1.2 for the short term (undrained) condition.

The stability of the outward slopes was also evaluated. Results indicate a static factor of safety of 1.3 and a dynamic factor of safety of 1.1. These slopes were analyzed using Bishop's Method (Appendix E-34).

The temporary cut slope along the south side of Phase 1A was analyzed using Bishop's Method giving a static factor of safety of 1.1 (Calculation E-37 in Attachment BB of the Part B Permit Application).

3.2.1.b Waste Fill Stability

Waste fill stability was considered for both the Phase 1A and ultimate landfill configurations. In both cases a face failure through the waste and along the lining system, and a basal failure along the lining system was considered. The analysis assumed a 4H:1V waste fill slope and floor at design base grades. The Sarma analysis method was used to calculate the factor of safety and acceleration coefficient (Kc). Kc is the net acceleration that would have to be applied to a slide mass to initiate movement.

Phase 1A Waste Fill Stability

Critical inputs for the Phase 1A stability analysis were as follows:

- *GCL, saturated undrained condition: friction angle = 2° and C=440 psf*

  Based on testing performed by Geosyntec Inc. using actual site soils and a needle punched GCL, the critical failure interface under saturated conditions occurs in the bentonite layer between the geotextile components of the GCL. It should be noted that this value is highly conservative since the GCL is most likely to remain in an unsaturated state during the life of the landfill. Additionally, the type of GCL tested was the needle punched variety. Other types of GCLs with stitching between the geotextile components offer substantially greater interface shear strengths.

  - *Design ground acceleration = 0.04 g*
  - *Waste friction angle ϕ = 29° (29)*

- *Design fill configuration shown on Drawing No. 10*

Results of the Phase 1A analyses presented in Calculation No. E-3, Phase 1A Filling Plan Stability, indicated a static factor of safety of 1.5 and a dynamic factor of safety of 1.0. These factors of safety are considered acceptable for the interim fill configuration of Phase 1A.

Ultimate Landfill Configuration Waste Fill Stability

The ultimate landfill configuration analyses used the same liner interface strength inputs as the Phase 1A evaluation and the final waste configuration shown on permit Application Drawing No. 22. The results of the ultimate configuration waste fill stability analyses presented in Calculation No. E-4, Ultimate Filling Plan Waste Stability, indicated a static factor of safety of 3.7 and a dynamic factor of safety of 1.5. These factors of safety are considered acceptable for the ultimate waste fill configuration.

3.2.1.c Protective Soil Layer Stability

An infinite slope model approach was used to evaluate the stability of the protective soil layer on the 3H:1V landfill slopes which considered the loading scenario of the protective soil layer only, and a loading scenario with a D6 dozer (9.8 pounds per square inch [psi] track loading [17]) on top of the protective soil. The analysis considered saturated and undrained soil conditions. The soil/geotextile interface shear strength was based on a friction angle of 31° and an adhesion of 15 psf obtained from interface shear tests. The results of the analyses indicated a static factor of safety of 2.0 for the soil only case and a static factor of safety of 1.8 for the case with the dozer loading. Both factors of safety are considered acceptable. Calculation E-2, Protective Soil Layer Stability, is presented in Attachment BB of the Part B Permit Application.

3.2.1.d Cover Stability

The cover system stability analysis focused on two potential failure mechanisms: a deep block failure through the waste and along the basal liner system, and an infinite slope failure within the cover system. Both stability analyses were conducted for static and dynamic conditions assuming undrained soil conditions. The block failure analysis assumed a zero head condition on the liner system while the infinite slope failure analyses considered a zero head condition and a head condition of 2.5 feet in the cover. As with other stability analyses, a design ground acceleration of 0.04 g, waste friction angle of 29°, and liner interface strength of $\phi = 2°$ and $c = 440$ psf was assumed.

The results of the analyses indicated a static factor of safety of 2.8 and dynamic factor of safety of 1.5 for the deep block failure. The infinite slope analyses indicated a static factor of safety of 10.9 and dynamic factor of safety of 6.5 for the zero head condition and a static factor of safety of 5.2 and dynamic factor of safety of 3.1 for the 2.5 feet head condition. All of these factors of safety are considered acceptable. Calculation E-5, Cover Stability, is presented in Attachment BB of the Part B Permit Application.

3.2.2 Settlement

3.2.2.a Subgrade Settlement

Total settlement of the landfill base due to settlement of the subgrade and prepared subgrade layers was calculated to ensure that the base liner grades did not fall below EPA's recommended minimum of 2 percent.

Subgrade settlement was modeled assuming the subgrade behaves as an elastic medium (33). This assumption implies that any settlement occurs during placement of a given load. Therefore, settlement in the subgrade should occur during the operating life of the landfill and post-closure settlement should be negligibly small. The most important parameter used in this analysis is the elastic modulus of the subgrade. The elastic modulus used was 72,000 kips per square foot (ksf) which was obtained from conservative estimates for unweathered mudstone (35). The maximum calculated settlements near the center of the landfill are expected to be on the order of 5 inches. Settlement should progressively decrease towards the toe of the sideslopes. These settlements are not expected to result in any excessive stress in the liner system. Details of the subgrade settlement analysis are presented in Calculation E-9 in Attachment BB of the Part B Permit Application.

3.2.2.b Final Cover Grades Due to Waste Settlement

As previously mentioned, waste placed at the Facility will consist of hazardous waste which contains no free liquids. All drummed solid material and lab packs will be stacked horizontally in rows within the landfill and the voids between drums filled with compacted bulk wastes. Bulk waste filling will take place in 5- to 10-foot-thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 foot.

EPA guidelines (61 and 62) suggest a minimum of 3 percent for final cover grades on hazardous waste landfills. The proposed 6 percent initial design cover grade was analyzed to determine the maximum settlement factor to maintain the final 3 percent grade after settlement. The calculated maximum settlement factor was 7 percent. The analysis assumed that the waste settlement is uniform. Calculation E-11, Waste Settlement, presents waste settlement computations in Attachment BB of the Part B Permit Application.

EPA estimates, based on finite element modeling, indicate that settlement factors of 11.5 percent are appropriate for hazardous waste landfills (43). This model considered that the most significant portion of the waste would be solidified material buried in steel drums, with the drums having a maximum allowable void space of 10 percent. This model may not be applicable to the Triassic Park Facility because there should be less void space in the waste than that assumed for the model.

In order to mitigate this potential discrepancy between the suggested 11.5 percent and calculated 7 percent, the post-closure waste settlement of Phase 1A should be monitored. The monitoring results will be compared to the estimated settlement factor of 7 percent. If settlement is greater than 7 percent, cover grades of subsequent phases will be steepened to accommodate the settlement and maintain the minimum 3 percent final grade.

3.2.3 Geosynthetics Strength and Performance Analyses

3.2.3.a Geomembranes

Settlement Induced Stress
The maximum settlement will occur at the base of the cell slopes where the waste load is highest. The subgrade settlement is estimated to be approximately 0.5 foot. This settlement will vary from this calculated maximum at the slope toe to zero at the slope crest. Resulting stresses of 65 psi in the geomembrane are much lower than the 2200 psi geomembrane yield stress. Differential settlement is therefore not expected to damage the liner (38). Details of the liner stress analysis are presented in Calculation E-12, Settlement Induced Stress, in Attachment BB of Part B Permit Application.

Thermal Induced Stress
Due to the 2-foot-thick protective soil layer above the liner, the 60-mil HDPE geomembrane liner will not be subject to extended periods of contraction and expansion from daily temperature differentials. Temperature restrictions for installation of geomembrane are discussed in Specification Section 02775.

Tear and Puncture
All geomembranes in the landfill liner and cover system are overlain by at least one layer of geotextile. Review of the puncture resistance of the geotextiles indicates a worst case factor of safety of 3.5 (see Calculation E-17, Geomembrane Puncture Resistance in Landfill and Calculation E-21, Puncture Resistance of Geotextile/Geocomposite [37]). Therefore, the proposed 60-mil HDPE is adequate to resist puncture stresses.

3.2.3.b Geocomposites

The geocomposite is intended to act as a lateral drainage layer in both the LCRS and the LDRS. The geonet in the core of the geocomposite is the drainage media and the overlying and underlying geotextile act as filters. The primary design criterion of the geocomposite is the transmissivity. As part of the design process the typical transmissivity values reported in the literature and by manufacturers have been reduced to account for clogging of the geotextile, penetration of the geotextile in to the geonet, and creep of the geonet.

In order to confirm the actual transmissivity of the material that arrives on the site, the specifications require that the material be tested as part of the conformance testing program. The specific test methods, including backing materials, normal loads, seating times, gradients, and test durations, are detailed in the specifications and meet actual design conditions (57).

3.2.3.c Geotextiles

Geotextile Filtration

Geotextiles are used in a number of locations in both the liner and cover sections for filtration. Specifically, the geotextiles act as filters between the clay liners and drainage layers or between the granular leachate collection material, protective soil cover or general fill and a drainage layer. All of the soil materials expected to be used for either the liners, covers, protective soil cover or general fill are conservatively expected to be fine grained with more than 50 percent of the material passing the Number 200 sieve.

The design criteria outlined by Task Force 25 (34) indicated that for soil material with more than 50 percent passing the #200 sieve, the apparent opening size (AOS) of the geotextile should be less than 0.297 mm. The current geotextile specifications require that the AOS is less than 0.212 mm. Therefore, the geotextile should adequately retain any of the on-site soils. Calculation E-20, Geotextile/Geocomposite filtration, compares specified material AOS values to site soil analyses results.

Geotextile Cushion

The puncture resistance during installation of the proposed geotextile materials was analyzed. The analysis, which used standard design equations (37), was based on the maximum ground pressure exerted by construction equipment, the largest average aggregate size that will be in contact with the geotextile, and the minimum puncture strength properties specified in the General Specifications. Based on these parameters the calculated safety factor for puncture is 3.6, which is acceptable (see Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposite, in Attachment BB of the Part B Permit Application).

3.2.3.d Geosynthetic Clay Liner

No specific design analyses were conducted on the GCL other than determining the interface friction angle of the material in the liner and cover section. The GCL has a specified permeability of 5×10^{-9} cm/s which exceeds EPA's criteria of 1×10^{-7} cm/s. Detailed specifications for the GCL are presented in the specifications. The critical parameters for the GCL will be confirmed through a conformance testing program on the material that is delivered to the site.

3.2.3.e Geosynthetics Leachate Compatibility

Specific leachate compatibility tests have not been conducted on the soil or geosynthetic liner components for the Triassic Park Facility. These tests have not been conducted at this time, because the specific manufacture of the liner components has not been selected and there is not a representative leachate available for testing. EPA (57) recommends that compatibility testing be done on the specific (manufacturer and resin type) liner materials selected for use in a facility and a representative leachate for the facility. Therefore, it is proposed that testing be completed prior to construction once the geosynthetic materials have been selected. Because the Facility will not be in operation, a representative leachate will not be available. However, as recommended by EPA (57), market studies can be used to characterize expected waste streams and a synthetic leachate can be developed for use in compatibility testing.

Although compatibility has not been completed, it is expected that the geosynthetic materials selected for the liner and leachate collection system for the Triassic Park Facility have a long track record of successful use at a variety of waste disposal facilities (both municipal waste and hazardous waste) across the U.S. Therefore, it is not expected that there will be any compatibility issues that would impact the current design. However, as mentioned above, site specific testing will be completed and the results submitted to NMED for approval prior to construction. Supporting information on the compatibility of the HDPE and GCL components of the lining system with various leachates is presented in Attachment DD of the Part B Permit Application.

3.2.4 Sump Compacted Clay Liner

In the sump base a compacted clay liner (CCL) will be placed in addition to a GCL layer. The CCL will provide an added thickness to the liner in the area of the sump where leachate is expected to have the longest residence time and the largest head. The specifications for processing, placement, and compaction are detailed in the specifications. The placement criteria in terms of moisture content and dry density is defined by a window with limits defined by the zero air voids curve, a percent saturation line, a minimum dry density and a minimum moisture content. A graph indicating these specific limits is presented in the specifications which were based on actual laboratory testing conducted as part of this study (Appendix Z of the Part B Permit Application). This method of specifying a compaction window for a CCL is recommended by EPA and is detailed in a series of articles by Craig Benson (12).

As part of the CQA program samples of the material to be used as the compacted clay liner will be obtained and tested to confirm the permeability criteria (1×10^{-7} cm/s) can be met. In addition, samples will be taken from the in-place liner to confirm the permeability.

3.2.5 Anchor Trench Design

The pullout capacity of the primary and secondary geosynthetics from the landfill anchor trench was determined. It was assumed the geosynthetics will pull out of the trench with single-sided shear. Single-sided shear is believed to occur rather than double-sided shear because there is less shearing resistance for single-sided shear. Assumed interface friction angles were based on previous laboratory testing for similar materials at low normal stresses. Based on the trench geometry, critical HDPE geomembrane properties, and assumed interface friction angles, both the secondary and primary liners will pull out prior to tearing. Stability calculations for both the secondary and primary liner systems indicate that there are no net downslope forces on the anchor trench because the liner systems are held in place by friction (see Calculation E-15, Anchor Trench Pullout Capacity, in Attachment BB of the Part B Permit Application).

3.2.6 Access Ramp Design

Calculation E-24, Wheel Loading on Access Ramp, presented in Appendix E in Attachment BB of Part B Permit Application, evaluated the puncture resistance of the geomembrane on the landfill access ramps. The ramps grade at 10 percent from the crest of the landfill to the floor. Drawing No. 14 shows the access ramp configuration during initial Phase 1A filling below the ramps and the final configuration after the slope areas above the ramp are lined.

The ramp section consists of the following components (from top down):

- 1-foot thickness of roadbase material;
- 12-ounce cushion geotextile (enveloping the top and sides of the underlying subbase);
- 2-foot thickness of subbase material; and
- Basal liner geosynthetics (geocomposite/60-mil HDPE/geocomposite/60-mil HDPE/GCL/ prepared subgrade).

The calculation considered a Caterpillar 631 scraper which weighs approximately 168,000 pounds when fully loaded (17). A factor of safety of 4.6 against puncture of the HDPE is considered acceptable for this loading condition.

An assessment of the stability of the Ramp Liner System under breaking forces from a loaded scraper was also analyzed (38). This analysis utilized the strength parameters from the interface shear testing program. The results presented in Calculation E-6 in Attachment BB of the Part B Permit Application indicate a factor of safety of 4.3 against sliding on the ramp.

3.2.7 HELP Modeling

Hydrologic Evaluation of Landfill Performance (HELP) (48) modeling was performed to demonstrate equivalency of the proposed Triassic Park landfill liner and cover system with EPA's Minimum Technology Requirement (MTR) systems. This demonstration was submitted to NMED for review and was subsequently approved by NMED on March 11, 1996 and EPA on March 14, 1996. The report entitled, Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1), dated March 1996 presents the HELP modeling performed.

The HELP modeling approach used to evaluate the hydrologic performance of the proposed landfill liner and cover alternative follows the NMED's Draft Guidance Document for Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20.9.1. NMAC). This approach was selected because it allows a direct comparison between MTR liner system and an alternative liner system. The results can be used to demonstrate performance equivalency required under 40 CFR §264.301(d).

The conclusions of the HELP modeling as stated in the report are as follows:

- there is little difference between the proposed alternative and MTR in terms of percolation rates through the bottom liner over the life of the Facility. The differences that exist in Years 0 through 10 are not significant. The proposed alternate liner performance can therefore be considered equivalent to the MTR liner performance;

- hydraulic pressure on the primary and secondary liners of both the MTR and proposed alternate liner system is well below the regulatory maximum of 12 inches; and

- the cover system leakage is less than or equal to the leakage of the liner system. It effectively reduces precipitation infiltration which will allow the waste to drain once the cover is in place.

3.2.8 LCRS, LDRS, and VZMS Hydraulic Analyses

Analyses performed to evaluate the effectiveness of the LCRS, LDRS, and VZMS are discussed below. Also discussed are slope and vertical riser pipe strength evaluations and the concrete crest riser pad structural analyses.

3.2.8.a Leachate Collection and Removal System Analyses

Based on HELP modeling data presented in Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1), dated March 1996, maximum LCRS flow rates of 116.8 gallons per acre per day (gpad) for slope areas and 50.9 gpad for floor areas occur during year 11 of the simulated Facility life. For Phase 1A, which has a slope surface area of 7.9 acres and floor surface area of approximately 3.4 acres, this totals to approximately 1,100 gallons per day (gpd). Calculation E-31, LCRS Pumping Capacity (Attachment BB of Part B Permit Application), estimates the flow capacity of the LCRS sump design to be approximately 618,000 gpd (based on Dupuit-Forchniemer Equation [11]).

The flow capacity of the LCRS sump far exceeds the flow rates delivered from the LCRS as determined from the HELP modeling. A Grundfos 50-gpm pump, which has the capacity to remove 72,000 gpd, is recommended for the LCRS sump. In addition, should flow rates into the LCRS increase beyond those predicted by the HELP modeling or the capacity of the 50-gpm pump, a second leachate removal pump can quickly be added via the vertical riser system, thus increasing the leachate removal rates.

3.2.8.b Leak Detection and Removal System Analyses

Adequacy of the leak detection and removal system for Phase 1A is addressed in the landfill action leakage rate (ALR) calculation presented in the Action Leakage Rate and Response Action Plan (Permit Attachment J). In this calculation, leakage rates into the LDRS, as determined by EPA's recommended method (66), were compared to flow capacities of the LDRS geocomposite drainage layer and the LDRS sump. Based on these calculations, the flow capacity of the LDRS sump exceeds the flow capacity of the LDRS geocomposite drainage layer and the flow capacity of the LDRS geocomposite drainage layer exceeds the leakage rate into the LDRS. A Grundfos 50-gpm pump, which has the capacity to remove 72,000 gpd, is recommended for the LDRS sump.

3.2.8.c Vadose Monitoring System Analyses

The VZMS sump serves as a detection system for leakage of the secondary LDRS. A Grundfos 25-gpm pump is recommended for vadose monitoring sump. In the event that a leak develops in the LDRS sump, leachate will flow to the VZMS sump where it can be collected and removed.

3.2.8.d Evaluation of Slope Riser Pipe and Vertical Riser Pipe Strengths

Calculation E-26, Pipe Crushing, presented in Attachment BB of the Part B Permit Application, considers the stresses and deflections to the slope riser pipes. Based on this calculation, the 18-inch-diameter HDPE SDR 11 slope riser pipe ring deflection at maximum burial depths of 160 feet is 0.4 percent. This is less than the manufacturer's recommended ring deflection limit of 2.7 percent (45).

The downdrag loads on the vertical riser pipe were evaluated in Calculation E-30 (Attachment BB of the Part B Permit Application) to determine if the vertical riser pipe could damage the liner. The vertical downdrag loads are developed as a result of waste settlement around the vertical pipe. In order to limit the downdrag loads acting on the liner, the lower portion of the vertical riser was de-coupled from the upper portion. The upper portion was founded on a large concrete pad that is located on top of the sump gravel. In addition, a friction break consisting of a double wrap of HDPE was included around the steel vertical riser pipe.

3.2.9 Action Leakage Rate and Response Action Plan

The landfill liner components were used to develop an Action Leakage Rate (ALR) and Response Action Plan (RAP). This plan and its supporting calculations are presented in their entirety as Permit Attachment J. The results are summarized below.

An ALR and RAP for the proposed Triassic Park Waste Disposal Facility landfill are required under 40 CFR §264.302. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the LDRS may remove without the fluid head on the bottom liner exceeding 1 foot (54). The RAP describes the steps to be taken in the event the ALR is exceeded in landfill. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA-recommended method for determining the landfill ALR presented in Federal Register Vol. 57, No. 19 (67) and in references No. 65 and 66 were used to calculate the ALR for the landfill. Using the flow equation for geonets and applying field representative geocomposite transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the landfill was determined to be 900 gpad.

The ALR value of 900 gpad is above the EPA-recommended value of 100 gpad. The primary reason for this difference is that the EPA value is based on a sand drainage layer with a permeability of 1×10^{-2} cm/s compared to the geocomposite drainage layer transmissivity of 2.2×10^{-4} m^2/s proposed for the Triassic Park Facility landfill.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in Permit Attachment J.

Steps outlined in the RAP closely follow the recommended actions presented in Federal Register Volume 57, No. 19 (67).

3.2.10 Surface Water Drainage Analyses

Design parameters for HDPE lined Channels 7 and 8 located above the landfill access ramps are presented on Drawing No. 25 (Sheet 2 of 2). The methodology, assumptions, and runoff calculations for these channels and the collection basins discussed below are presented in Permit Attachment L4.

The clean stormwater collection basin located at the toe of the 2H:1V cut slope in the south end of the landfill will contain the runoff from the 15 acres of unlined area of Phase 1A (above the access ramps). The total runoff from the 25-year, 24-hour event is approximately 4.6 ac-ft. Total volume of the detention pond assuming 1 foot of freeboard is 5.2 ac-ft.

The contaminated water basin at the toe of the Phase 1A waste fill slope is designed to contain the runoff from the entire 15.6-acre fill area of Phase 1A. The total runoff from the 25-year, 24-hour event is approximately 4.4 ac-ft. The contaminated water basin is approximately 560 feet by 200 feet and can store approximately 17.0 ac-ft assuming 1 foot of freeboard. This is the minimum capacity of the basin, which occurs when the landfill Phase IA has reached capacity. Prior to the landfill reaching capacity, the basin will have more than 17.0 ac-ft of storage space. The contaminated water basin will be constructed at the same time as the rest of the Phase 1A landfill so it can accommodate runoff from waste placed in Phase 1A.

3.2.11 Soil Erosion Analyses

Due to the temporary nature of the 2H:1V cut slope and the 3H:1V subgrade slopes above the access ramps, severe soil erosion of these slope areas is not anticipated. The 2H:1V cut slope will be excavated during future landfill construction and the 3H:1V subgrade areas above the access roads will be conditioned prior to liner placement as required in the specifications.

Erosional features such as rills and localized slumping in exposed areas of the protective soils layer on the 3H:1V slope areas will be repaired following rain events.

3.2.12 Frost Protection

The maximum frost depths in the Roswell area indicate that frost may reach 23 inches during the winter months. In addition, site-specific frost penetration modeling for the site indicated a maximum design freezing depth of 2.3 feet for this cover. Studies by Kraus (39) evaluating the effects of frost on geosynthetic clay liners indicate that there is little change in the permeability of the GCLs due to frost. Because the landfill utilizes GCLs in combination with HDPE as barrier elements for both the liner system and the cover system, frost damage to these layers is not expected. However, the 2.5-foot-thick vegetative layer on the cover system will also provide frost protection for underlying geosynthetics and soil components in the cover section; 2 feet of protective soil is specified on the side slopes of the landfill. Due to the relatively short time period that the side slopes will be exposed without waste placement, the 2-foot cover thickness is considered adequate.

3.2.13 Earthwork Volumetrics

Table L-3 lists the material quantities for subgrade excavation, structural fill, cover and liner soil components, and the net waste airspace available for Phase 1A development. Table L-3 also lists material quantities for the final landfill configuration.

REFERENCES

1. Algermissen, S.T., Perkins, D.M., Thenhaus, P.C., Hanson, S.L., and Bender, B.L., 1982. *Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States*, Open-File Report 82-1003, United States Department of the Interior Geological Survey.

2. American Society for Testing and Materials Symposium, 1984. ASTM Technical Publication: *Hydraulic Barriers in Soil and Rock.*

3. American Society for Testing and Materials, 1990. *Geosynthetic Testing for Waste Containment Applications.*

4. American Society for Testing and Materials, 1992. *Slurry Walls: Design, Construction, and Quality Control.*

5. American Society for Testing and Materials, 1994. *Hydraulic Conductivity and Waste Contaminant Transport in Soil.*

6. American Society for Testing and Materials, 1997. *Testing and Acceptance Criteria for Geosynthetic Clay Liners.*

7. American Society of Civil Engineers, 1990. *Waste Containment Systems: Construction, Regulation, and Performance.*

8. American Society of Civil Engineers, 1995. *Landfill Closures Environmental Protection and Land Recovery.*

9. Barfield, B.J., Warner, 1995 and Haan, C.T. (1995). *"Applied Hydrology and Sedimentology for Disturbed Areas."* Chapter 5 (Oklahoma Technical Press, Oklahoma).

10. Barfield, Warner, and Haan, 1981. *Applied Hydrology and Sedimentology for disturbed Areas.* Oklahoma Technical Press, Stillwater, Oklahoma.

11. Bear, J., 1979. *"Hydraulics of Groundwater", Department* of Civil Engineering Technician - Israel Institute of Technology, Haifa Israel.

12. Benson, Craig, H., Zhai, Huaming, Wang, Xiaodong, *"Estimating Hydraulic Conductivity on Compacted Clay Liners", Journal of Geotechnical Engineering, Vol. 120, No. 2,* February 1994.

13. Bonaparte, R. And Gross, B.A., "*Field Behavior of Double-Liner Systems*", Waste Containment Systems Construction, Regulation, and Performance, ASCE Geotechnical Special Publication No. 26, November 1990, pp. 52-83.

14. Bowles, Joseph E., 1988. *Foundation Analysis and Design, Fourth Edition,* Peoria, IL.

15. Burtell, R., TerraMatrix, Inc., Engineering and Environmental Services, January, 1994. *Solid Waste Disposal Facility Criteria, Technical Manual*

16. Day, Steve R. 1994. The Compatibility of Slurry Cutoff Wall Material with Contaminated Groundwater. Hydraulic Barriers in Soil and Rock.

17. Caterpillar Tractor Co., 1985. Caterpillar Performance Handbook, Peoria, IL.

18. Department Of Transportation Regulations

19. Daniel, D. and Koerner, R., 1995. Waste Containment Facilities Guidance for Construction, Quality Assurance and Quality Control of Liner and Cover Systems.

20. Daniel, D. And Koerner, R., 1997. Waste Containment Facilities Guidance for Construction, Quality Assurance and Quality Control of Liner and Cover Systems.

21. Department of Civil and Environmental Engineering, Utah State University, Logan, UT, Structural Performance of Perforated and Slotted High-Density Polyethylene Pipes Under High Soil Cover, 1987.

22. Departments of the Army and the Air Force, 1966. "Calculation Methods for Determination of Depths of Freeze and Thaw in Soils" - TM 5-8526.

23. Department of the Navy, Naval Facilities Engineering Command, 1983. "Soil Mechanics", Design Manual 7.1.

24. Department of the Navy, Naval Facilities Engineering Command, 1982. "Foundations and Earth Structures", Design Manual 7.2.

25. Department of the Navy, Naval Facilities Engineering Command, 1983. "Soil Dynamics, Deep Stabilization, and Special Geotechnical Construction", Design Manual 7.3.

26. Ecklund, A. Given. 1985. A Laboratory Comparison of the Effects of Water and Waste Leachate on the Performance of Soil Liners. Hydraulic Barriers in Soil and Rock.

27. Environmental Protection Agency Seminar Publication. Requirements for Hazardous Waste Landfill Design, Construction, and Closure.

28. Finno, Richard J. and William Schubert, 1986. Clay Liner Compatibility in Waste Disposal Practice. Hydraulic Barriers in Soil and Rock.

29. Giroud, J.P., Gross, B.A., and Darrasse, J., *"Flow in Leachate Collection Layers"* to be published, 1993.

30. Gross, B.A., Bonaparte, R., and Giroud, J.P., *"Evaluation of Flow from Landfill Leakage Detection Layers"*, Proceedings, Fourth International Conference on Geotextiles, Vol. 2, The Hague, June 1990, pp. 481-486.

31. Hewitt, R.D., Daniel, D.E., 1996. *Hydraulic Conductivity of Geosynthetic Clay Liners Subjected to Freeze Thaw,* Journal of Geotechnical Engineering. To be published.

32. Holtz, Robert D., Ph.D, P.E., Kovacs, Ph.D., P.E., 1981. *An Introduction to Geotechnical Engineering.*

33. Hsai-Yang Fang, Ph.D., 1991. Foundation Engineering Handbook, Second Edition.

34. Joint Committee Report of AASHTO-AGC-ARTBA, American Association of State, Highway and Transportation Officials, 1991. *Report on Task Force 25,* Washington DC.

35. Jumikis, Alfreds R., 1983. Series on Rock and Soil Mechanics, Vol. 7, *"Rock Mechanics, Second Edition".*

36. Koerner, R.M., 1994. *"Designing with Geosynthetics, Third Edition",* Prentice Hall, Englewood Cliffs, NJ.

37. Koerner, R., and Richardson, G. 1987. *Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments*.

38. Koerner, R., 1990. *Designing with Geosynthetics, 2nd Ed.* Prentice Hall, Englewood Cliffs, NJ.

39. Kraus, J.F., Genson, C.H., Erickson, A.E., Chaberlin, F.J., 1997. Freeze-Thaw Cycling and Hydraulic Conductivity of Bentonic Barriers, Journal of Geotechnical and Geoenvironmental Engineering.

40. Lo, Irene et al, 1994. Hydraulic Conductivity and Absorption Parameters for Pollutant Transport through Montmorillonite and Modified Montmorillonite Clay Liner Materials. Hydraulic Barriers in Soil and Rock.

41. Merrit, F., 1983. Standard Handbook for Civil Engineers, Third Edition, McGraw-Hill Inc.

42. Mitchell, James K and Fritz T Madsen. 1987. Chemical Effects on Clay Hydraulic Conductivity. Hydraulic Barriers in Soil and Rock.

43. Murphy, W.L. and Gilbert, P.A. (1985). Settlement *and cover subsidence of hazardous waste landfills*. U.S. Environmental Protection Agency, EPA/600/2-85/035, April 1985.

44. Peterson, Stanley R. and Glendon W. Gee, 1985. Interactions Between Acidic Solutions and Clay Liners: Permeability and Neutralization. Hydraulic Barriers in Soil and Rock.

45. Phillips Driscopipe, Inc., a Subsidiary of Phillips 66 Company, 1991. Systems Design

46. Renard, K.G., Foster, G.R., Weosies, G.A., McCool, D.K., Yoder, D.C., coordinators, 1996. Predicting Soil Erosion by Water, A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Agriculture Handbook No. 703, U.S. Department of Agriculture.

47. Shackelford, Charles D, 1994. Waste-Soil Interactions that Alter Hydraulic Conductivity Hydraulic Barriers in Soil and Rock.

48. Schroder, P.R. (1989). "The Hydrologic Evaluation of Landfill Performance (HELP) Model." USACE Waterways Experiment Station, Vicksburg, MS, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH, Version 2.05, September, 1989.

49. Schwope, A., Costas, P., Lyman, W., Arthur D. Little, Inc., October, 1985. Resistance of Flexible Membrane Liners to Chemicals and Wastes.

50. Seed, Raymond B., Mitchell, James K., and Seed, H. Bolton, 1988. Slope Stability Failure Investigation: Landfill Unit B-19, Phase I-A, Kettleman Hills, California, College of Engineering, Department of Civil Engineering, University of California Berkeley, California, Report No. UCB/GT/88-01.

51. Sharma, S. (1994). "XSTABL: An Integrated Slope Stability Analysis Program for Personal Computers." Interactive Software Designs, Inc., Moscow, ID.

52. TerraMatrix/Montgomery Watson, SM Stoller Corp., Triassic Park Waste Disposal Facility RCRA Part B Permit Application Volumes 1 and 2, December 1997.

53. Terzaghi, K., and Peck, R., 1967. Soils Mechanics in Engineering Practice

54. Title 40 – Code of Federal Regulations (40 CFR), Part 264.

55. Urban Hydrology For Small Watersheds, TR-55, 1986, Soil Conservation Service, USDA.

56. U.S. Environmental Protection Agency, 1984. Permit Applicants' Guide Manual for Hazardous Waste Land Treatment Storage and Disposal Facilities.

57. U.S. Environmental Protection Agency, December, 1987. Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments.

58. U.S. Environmental Protection Agency, 1988. Lining of Waste Containment and Other Impoundment Facilities, Part 1 of 2.

59. U.S. Environmental Protection Agency, 1988. Lining of Waste Containment and Other Impoundment Facilities, Part 2 of 2.

60. U.S. Environmental Protection Agency, 1988. Seminar Presentations - Requirements for Hazardous Waste Landfill Design, Construction and Closure.

61. U.S. Environmental Protection Agency (1989a). "Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments." EPA/530-SW-89-047, July 1989.

62. U.S. Environmental Protection Agency, (1989b). "Seminar Publication: Requirements for Hazardous Waste Landfill Design, Construction and Closure." EPA/625/4-89/022, August 1989.

63. U.S. Environmental Protection Agency, July, 1990. Seminars - Design and Construction of RCRA/CERCLA Final Covers, Washington, DC.

64. U.S. Environmental Protection Agency, 1991. Technical Guidance Document: Inspection Techniques for the Fabrication of Geomembrane Field Seams.

65. U.S. Environmental Protection Agency, 1992(a). Action Leakage Rates for Leak Detection Systems.

66. U.S. Environmental Protection Agency, 1992(b). "Action Leakage Rates for Leak Detection Systems", EPA/530-R-92-004, Jan. 1992, 69 p.

67. U.S. Environmental Protection Agency, 1992(c). "Rules and Regulations", Federal Register, Volume 57, No. 19.

68. U.S. Environmental Protection Agency, 1996. Technical Guidance Document, Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.

69. Vancouver Geotechnical Society, 6th Annual Symposium, 1991. Geosynthetics: Design and Performance., Vancouver, B.C.

70. Warner, R.C., Schwab, P.J., 1992, SEDCAD+, Version 3, by Civil Software Design, LLC.

Table L-1. Expected Vehicle Types

Vehicle Type	Off Highway/ On Highway	Gross Vehicle Weight (lb)	Estimated Traffic Volume (units/day)
Waste Haulers			
Roll-off trucks	On highway	<100,000	30–70
End dump trucks (bulk waste)	On highway	<100,000	30–70
Other miscellaneous trucks	On highway	<100,000	0–5
Site Operations Vehicles			
Vacuum trucks	On highway	<100,000	0–5
Tanker trucks	On highway	<100,000	0–5
Roll-off trucks	On highway	<100,000	10–30
Flat-bed trucks	On highway	<100,000	0–5
Maintenance vehicles	On highway	<100,000	0–5
LF waste compactors	Off highway	<100,000	0–2
Excavators	Off highway	>100,000	0–2
Backhoes	Off highway	<100,000	0–2
Landfill scrapers	Off highway	>100,000	0–2
Water trucks	On highway	<100,000	0–20
Front end loaders	Off highway	<100,000	0–2
Fork lifts	Off highway	<100,000	0–2
Construction Vehicles (restricted to construction roads)			
End dump trucks	Off highway	<100,000	NA
Water trucks	On highway	<100,000	NA
Compactors	Off highway	<100,000	NA
Graders	Off highway	<100,000	NA
Dozers	Off highway	<100,000	NA
Excavators	Off highway	<100,000	NA
Other			
Employee vehicles	On highway	<100,000	30–50

Table L-2. Landfill Sump Arrangement Summary

	LCRS	LDRS	VZMS
Fluid capacity [a] (gallons)	102,900	16,840	1,965
Pipe dimensions (length/diameter)	30 ft/18 in	15 ft/18 in	10 ft/12 in
Flow capacity [b] (gallons per day)	618,480	135,400	For detection
Pump type/capacity [c] (gallons per minute [gpm])	Grundfos/50 gpm	Grundfos/50 gpm	Grundfos/25 gpm
Fluid level instrumentation	Yes	Yes	Yes

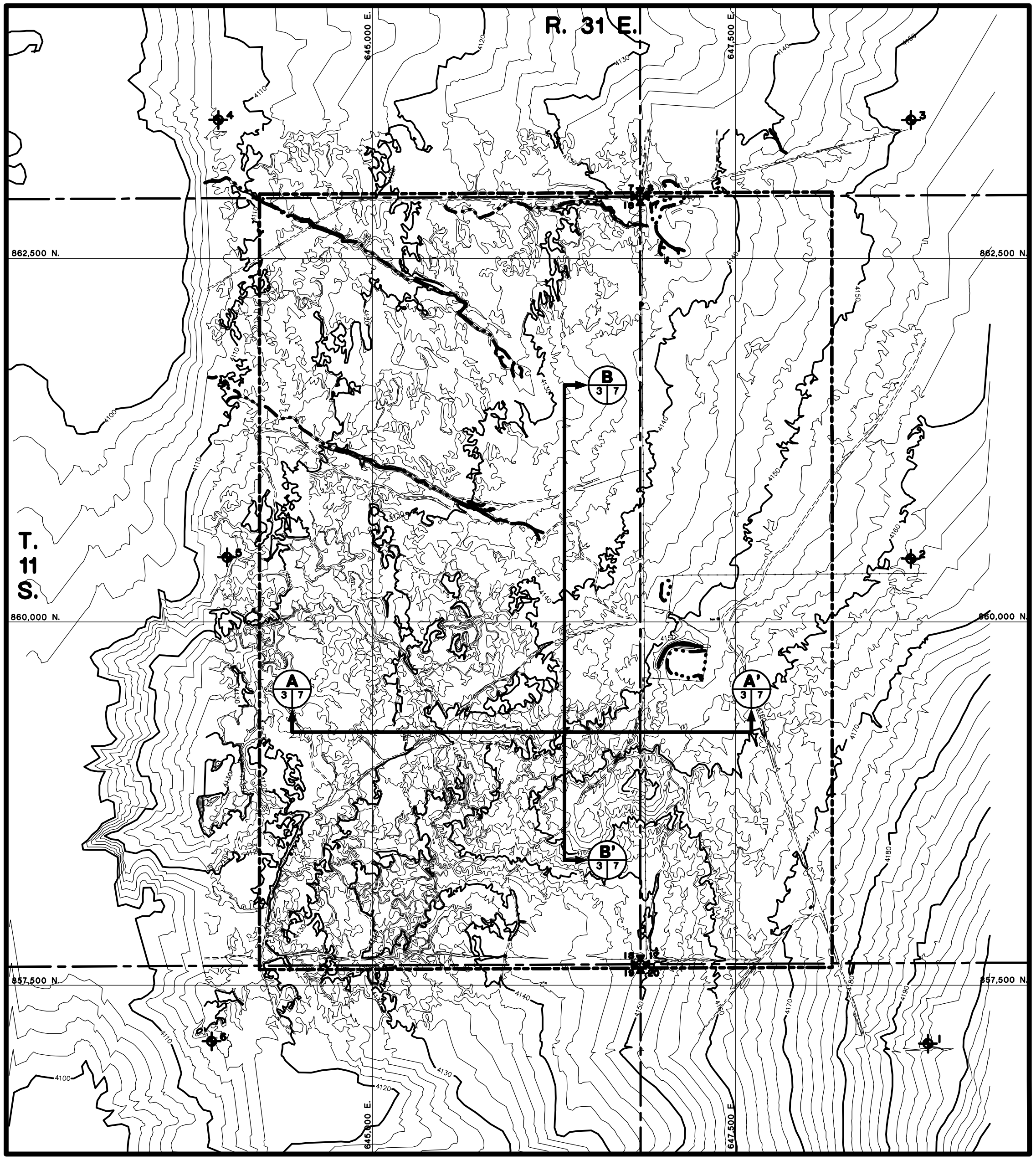
[a] 0.3 x net volume accounts for gravel space.
[b] Determined from Dupuit-Forcheimer equation for flow from the sump gravel to collection pipe.
[c] Expected pump type and flow capacity for side slope riser.

Table L-3. Landfill Phase 1A Material Balance and Ultimate Landfill Material Balance

	Loose or Compacted Cubic Yards	Bank Cubic Yards
Material Balance Phase 1A		
Design Capacity Total Airspace Liner Area Cover Area (Top of Waste) Volume of cover (NOT included in airspace) Volume of Liner (NOT included in airspace) Remaining Airspace Volume of Daily Cover (20% of total) Total Waste Capacity Total Soil Requirements Volume of Daily Cover (20% of total) Volume of Liner Material (0.5 foot) Volume of Cover (4 feet) Total Volume of Soil Required Total Cut Volume Cut/Fill Balance Difference	170,119 lcy 92,194 ccy 718,385 ccy	691,540 bcy 14.5 acres 11.9 acres 0 bcy 0 bcy 691,540 bcy 138,308 bcy 553,232 bcy 138,308 bcy 83,813 bcy 653,077 bcy 875,198 bcy 2,797,921 bcy 1,922,723 bcy
Material Balance Ultimate Landfill		

Design Capacity Total Airspace Liner Area Cover Area (Top of Waste) Volume of cover (NOT included in airspace) Volume of Liner (NOT included in airspace) Remaining Airspace Volume of Daily Cover (20% of total) Total Waste Capacity Total Soil Requirements Volume of Daily Cover (20% of total) Volume of Liner Material (0.5 foot) Volume of Cover (4 feet) Total Volume of Soil Required Total Cut Volume Cut/Fill Balance Difference	3,340,333 lcy 92,194 ccy 718,385 ccy	13,997,654 bcy 103.9 acres 101.2 acres 0 bcy 419,063 bcy 13,578,591 bcy 2,715,718 bcy 10,862,873 bcy 2,715,718 bcy 88,813 bcy 653,077 bcy 3,452,608 bcy 10,281,466 bcy 6,828,858 bcy

lcy = 1.23 bcy
ccy = 1.1 bcy



SURVEY CONTROL POINTS

CONTROL POINT NUMBER	NORTHING	EASTING	ELEVATION
1	857,099.19	648,823.16	4,197.55
2	860,435.24	648,704.91	4,161.92
3	863,453.55	648,706.31	4,152.96
4	863,454.95	643,940.29	4,105.99
5	860,445.06	644,000.06	4,113.51
6	857,114.96	643,893.71	4,116.20

NOTES:

1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEY PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING. ADDITIONAL TOPO TAKEN FROM MESCALERO POINT, NEW MEXICO 7.5 MINUTE SERIES, DATED 1973.
3. SURVEY CONTROL POINTS SET IN FIELD WITH REBAR AND CAP BY JOHN WEST ENGINEERING COMPANY, AUGUST 1997.

SCALE
400' 0 400' 800'
CONTOUR INTERVAL 2 FT.

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
1	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	T.Smith	P.Corser

PATRICK G. CORSER NEW MEXICO 12236 REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date *Patrick G. Corser, NM P.E. 12236*

TRIASSIC PARK WASTE DISPOSAL FACILITY

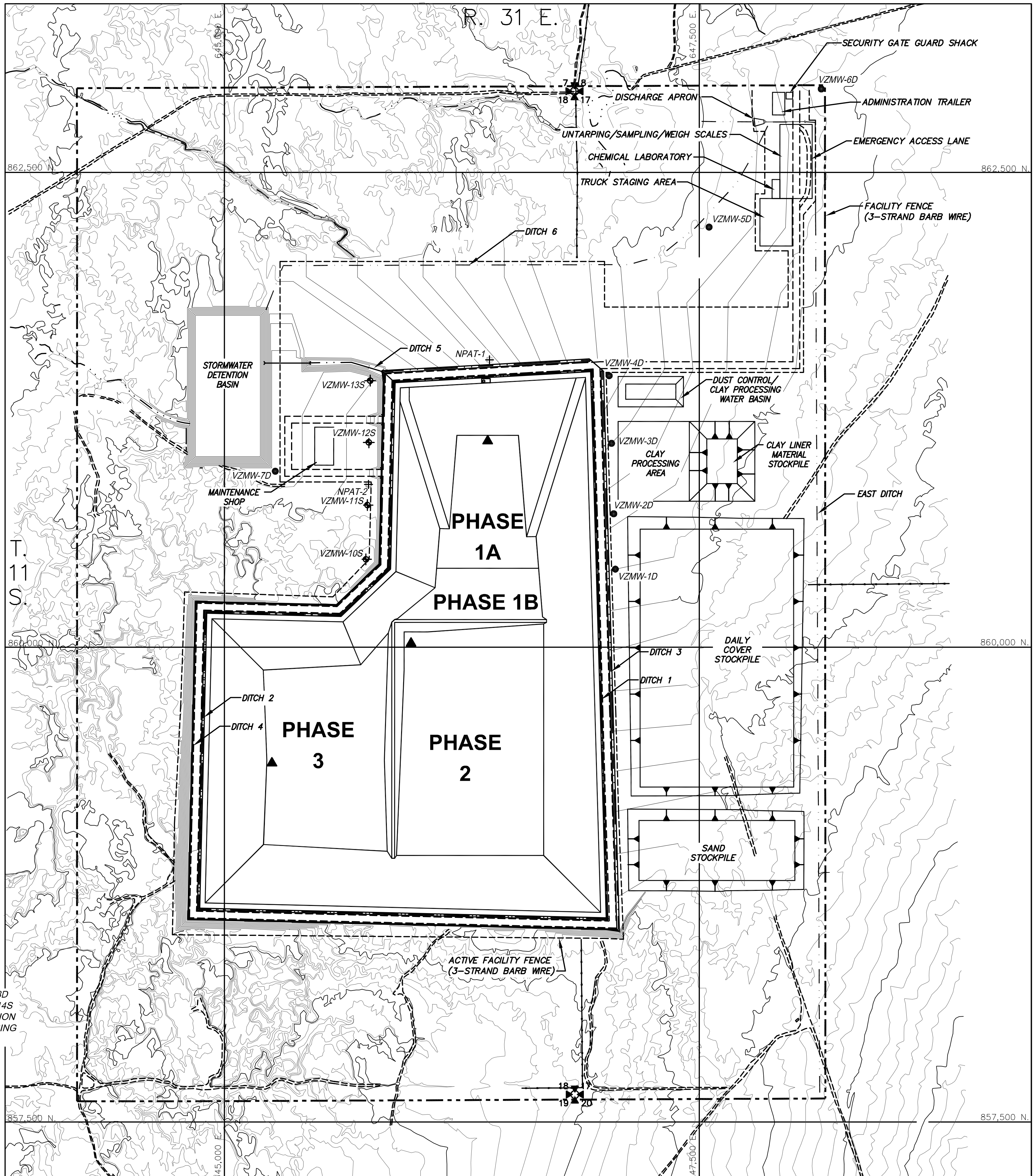
DRAWING TITLE:

EXISTING TOPOGRAPHY

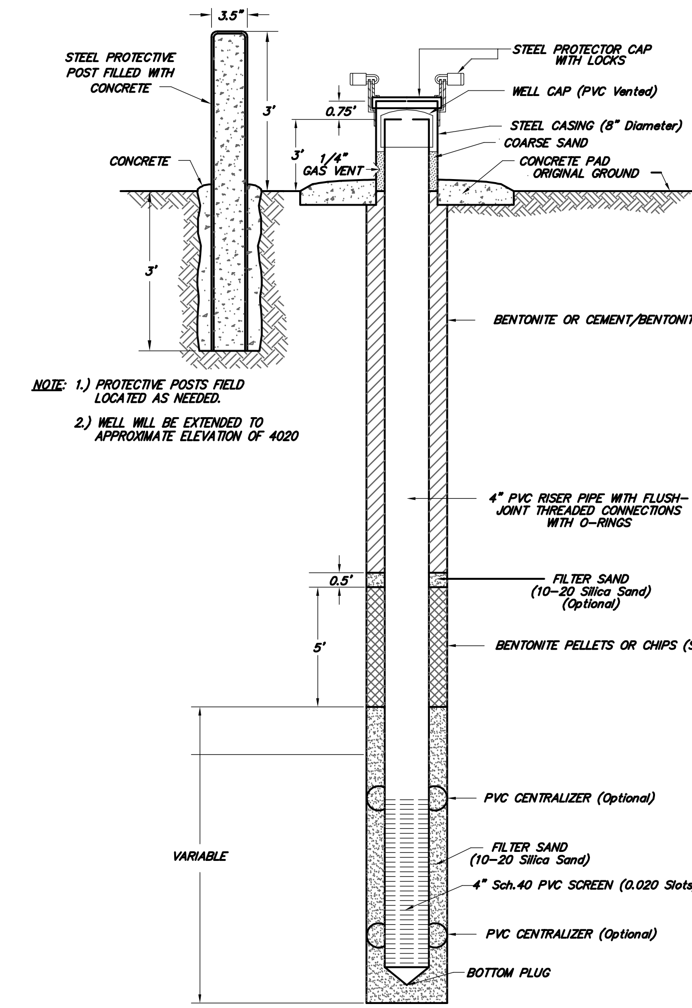
TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 1 Sheets
SCALE: AS NOTED
DRAWING No. 3

AutoCAD FILE: GANDY-TOPO1.DWG PROJECT NUMBER: 602-0200

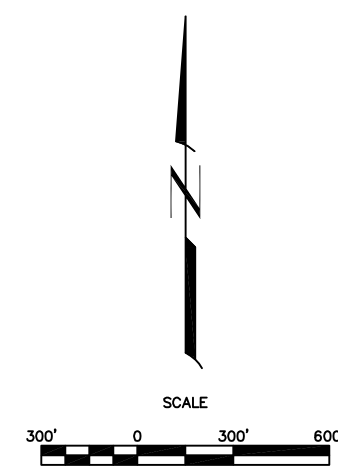


VZMW-8D
VZMW-14S
(LOCATION OF BORING PB-14)



NOTE: 1.) PROTECTIVE POSTS FIELD LOCATED AS NEEDED.
2.) WELL WILL BE EXTENDED TO APPROXIMATE ELEVATION OF 4020

TYPICAL VADOSE ZONE MONITORING WELL INSTALLATION DETAIL



LEGEND

- Existing contour
- Regraded contour
- Deep monitoring well
- Shallow monitoring well
- Vadose zone sump
- Neutron probe access tube
- Facility and active facility fences (3-strand barb wire)

NOTES:
1. VADOS ZONE MONITOR WELLS VZMW-9D AND VZMW-15S ARE LOCATED APPROXIMATELY 3,300 FEET NORTHEAST OF THE FACILITY BOUNDARY WITHIN 15 FEET OF THE LOCATION OF BORING WW-1.

PRELIMINARY - NOT FOR CONSTRUCTION

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_01B_facility_layout_04.dwg

Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

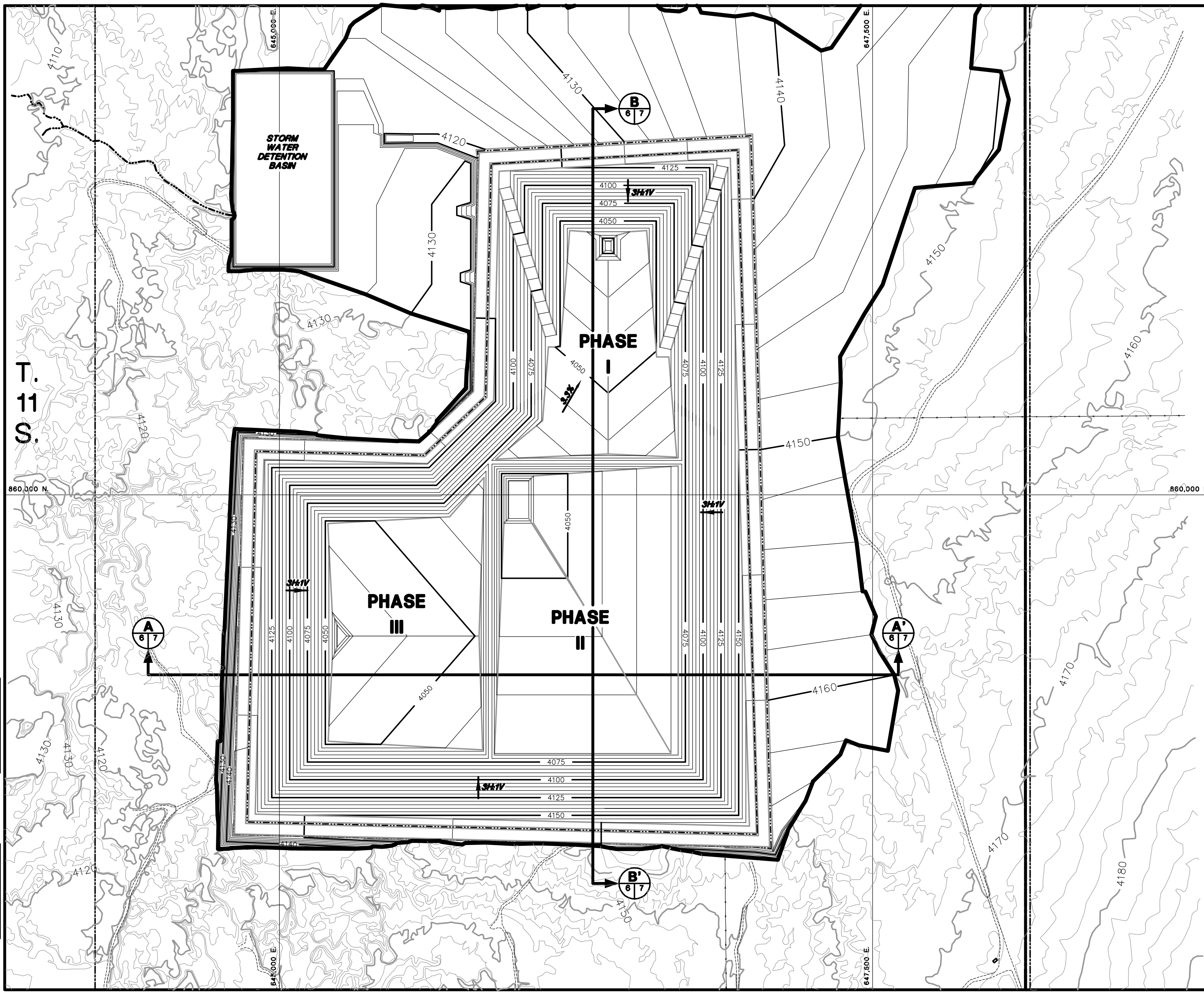
FACILITY LAYOUT

GUNDAR PETERSON
NEW MEXICO
16036
4/30/2012
LICENSED PROFESSIONAL ENGINEER

JOB NO.
ES11.0141

SHEET 1 of 1
DWG NO. 4

XREF: S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\VR_DRAWINGS\TITLEBLOCK\TB_22X34



AutoCAD FILE: GMI-ULFP.DWG
PROJECT NUMBER: 602-0200

NOTES:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING.
3. BASE GRADES FOR PHASES II AND III TO BE MODIFIED PRIOR TO CONSTRUCTION TO ACHIEVE A MINIMUM OF 2%.

PATRICK G. CORSER
NEW MEXICO
12236
REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date *Patrick G. Corser, NM P.E. 12236*

N

SCALE

200' 0 200' 400'

CONTOUR INTERVAL 5 FT.
SURFACE TOPOGRAPHY CONTOUR INTERVAL 2 FT.

Not For Construction

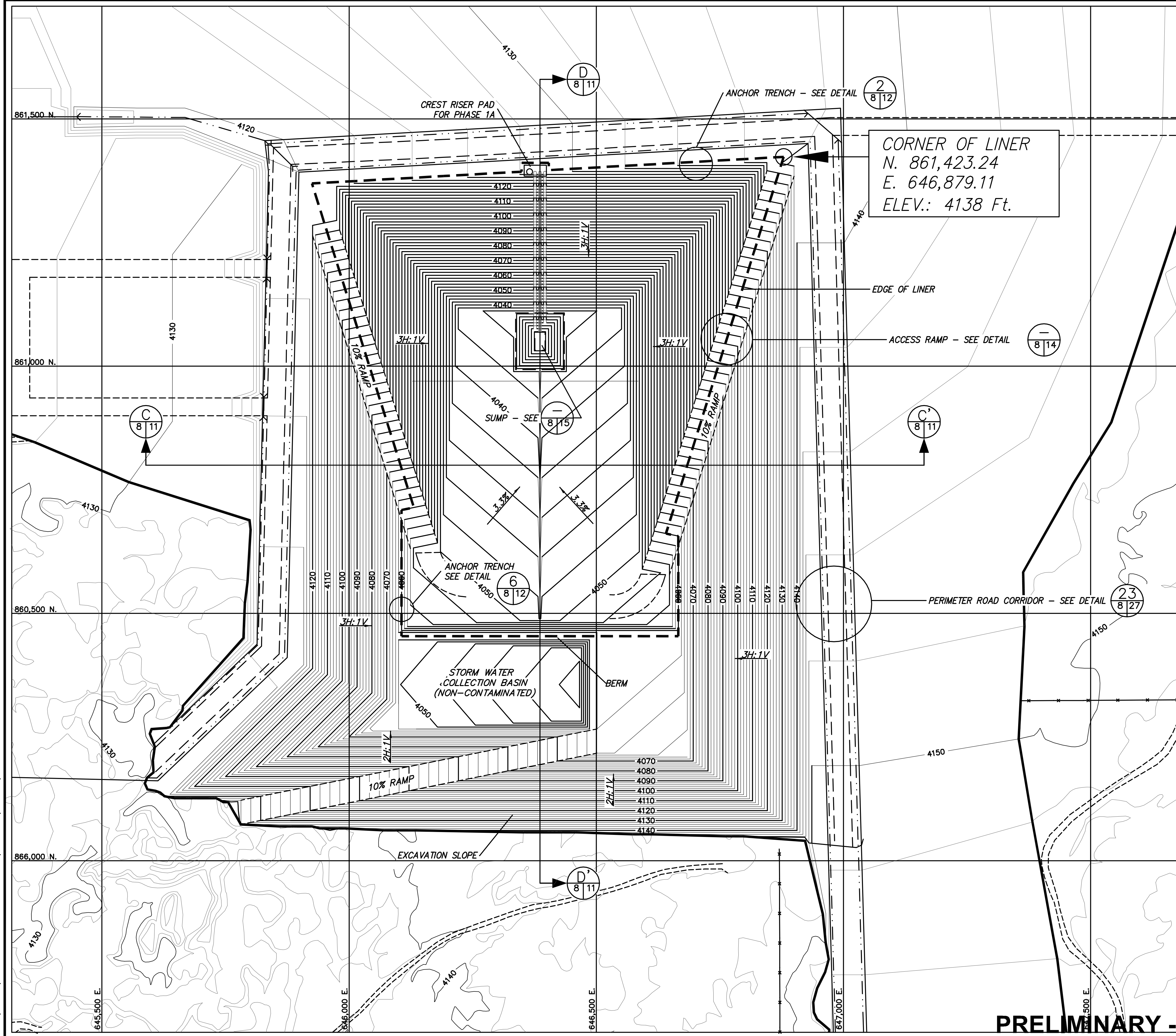
REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revisions	10/4/00	J.Pellicer	K.Conrath	P.Corser
1	November 1998 Revision	10/29/98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	EWS	P.Corser

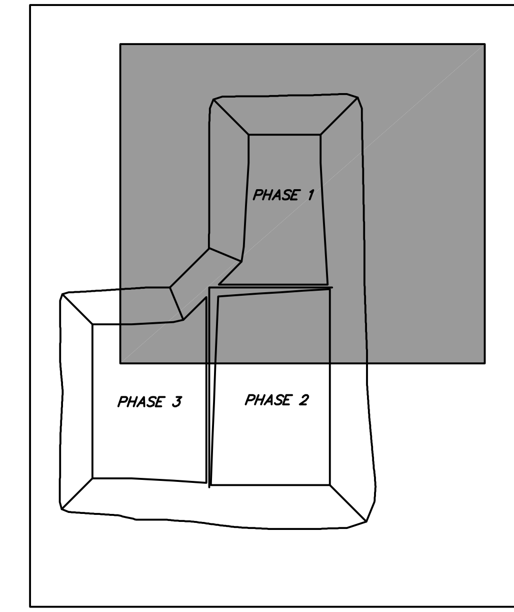
TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE: ***ULTIMATE LANDFILL EXCAVATION PLAN***

TerraMatrix
MONTGOMERY WATSON
Mining Group

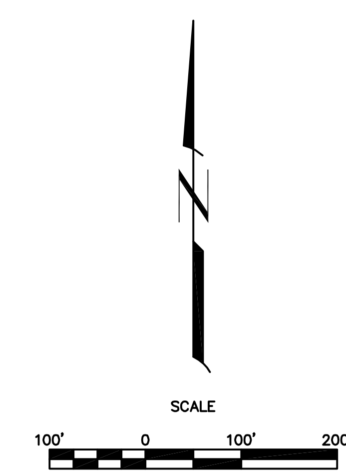
Sheet 1 Of 1 Sheets
SCALE: AS NOTED
DRAWING No. 6





MAP KEY

NOTES:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING.



PRELIMINARY - NOT FOR CONSTRUCTION

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_02B_detailed_excav_plan_08.dwg

Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

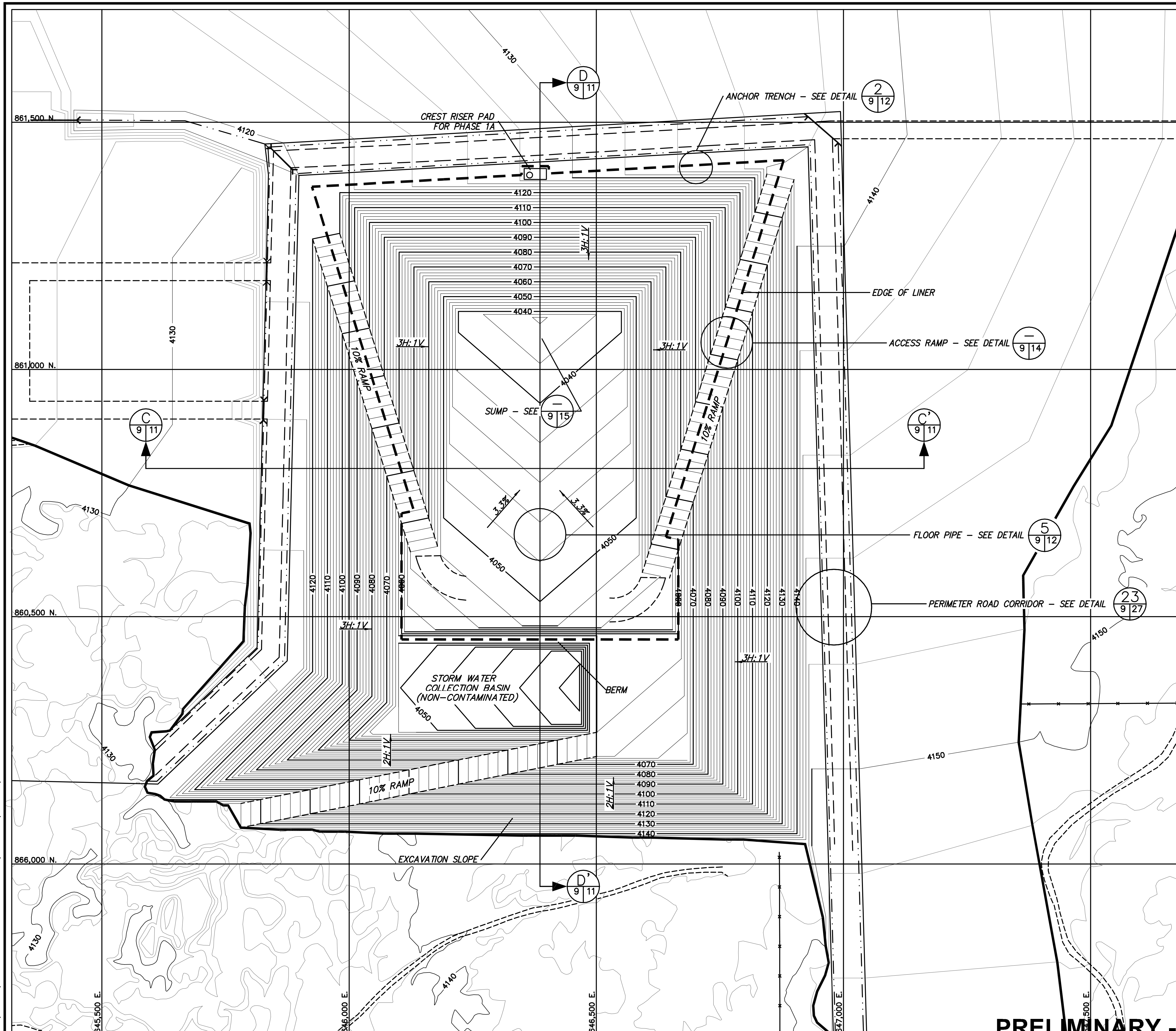
DETAILED EXCAVATION PLAN - PHASE 1A

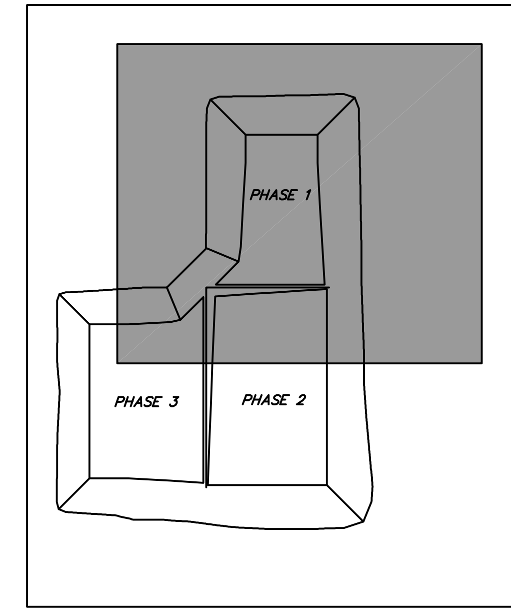
GUNDAR PETERSON NEW MEXICO 16038 4/30/2012 LICENSED PROFESSIONAL ENGINEER

JOB NO.
ES11.0141

SHEET 1 of 1
DWG NO. 8

XREF: S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\VR_DRAWINGS\TITLEBLOCK\TB_22X34





MAP KEY

NOTES:

1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING.

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

Daniel B. Stephens & Associates, Inc.
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6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KOB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY CHAVEZ COUNTY, NEW MEXICO

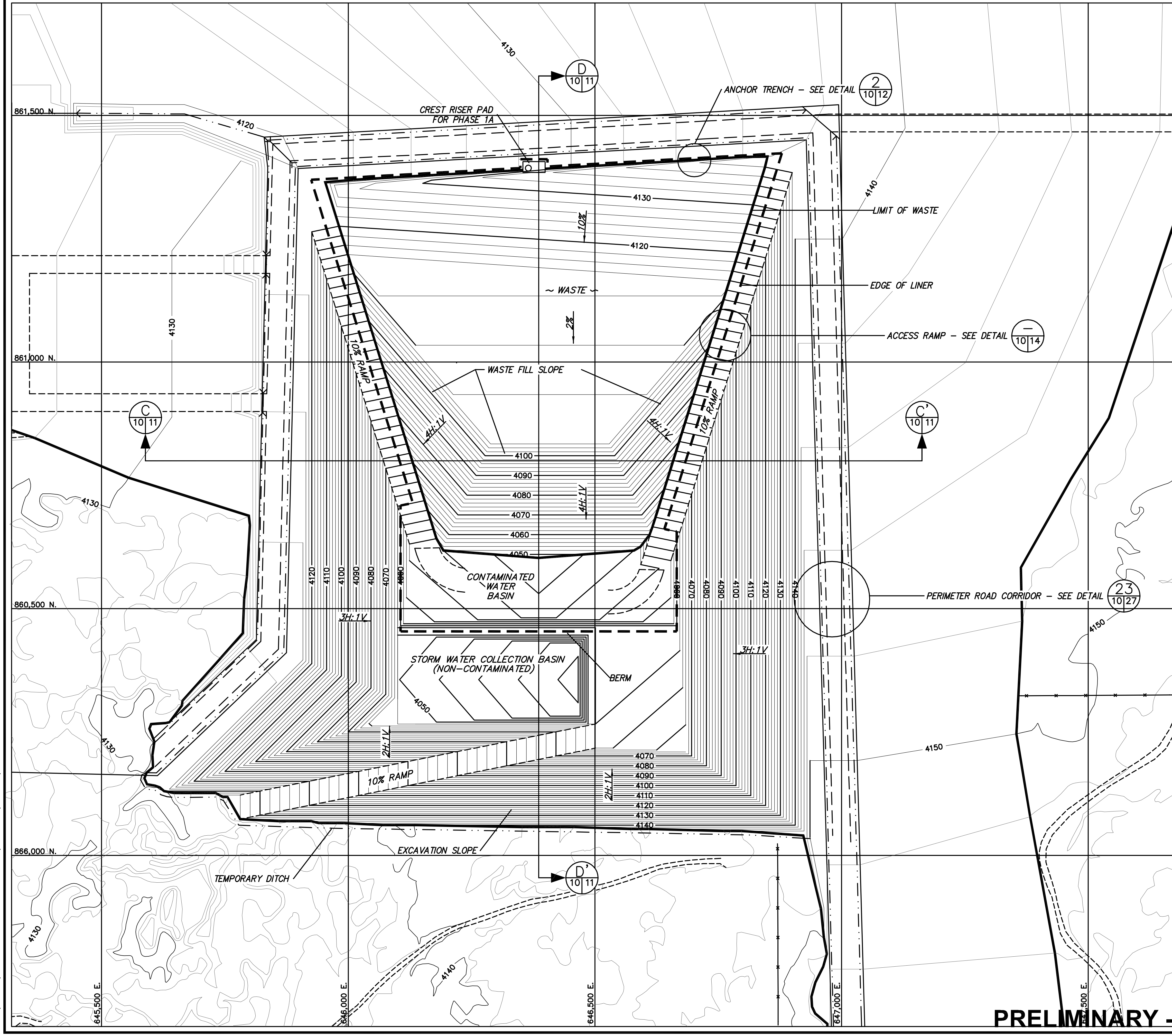
TOP OF PROTECTIVE SOIL LAYER - PHASE 1A

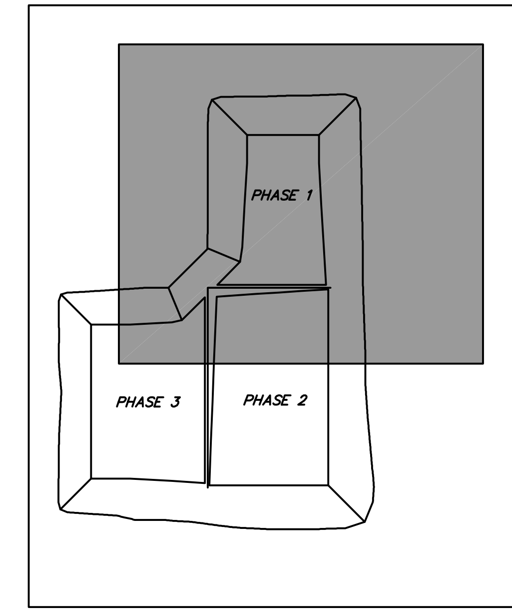
GUNDAR PETERSON
NEW MEXICO
16036
LICENSED PROFESSIONAL ENGINEER

JOB NO. ES11.0141

SHEET 1 of 1
DWG NO. 9

PRELIMINARY - NOT FOR CONSTRUCTION





MAP KEY

NOTES:

1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. TOPOGRAPHY FROM AERIAL SURVEYS PERFORMED AUGUST 1997 BY KOOGLE AND POULS ENGINEERING.
3. WASTE FILL VOLUME FOR PHASE 1A: 553,200 CY

SCALE

100' 0 100' 200'

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_D10_filling_plan_1A.dwg

Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

FILLING PLAN - PHASE 1A

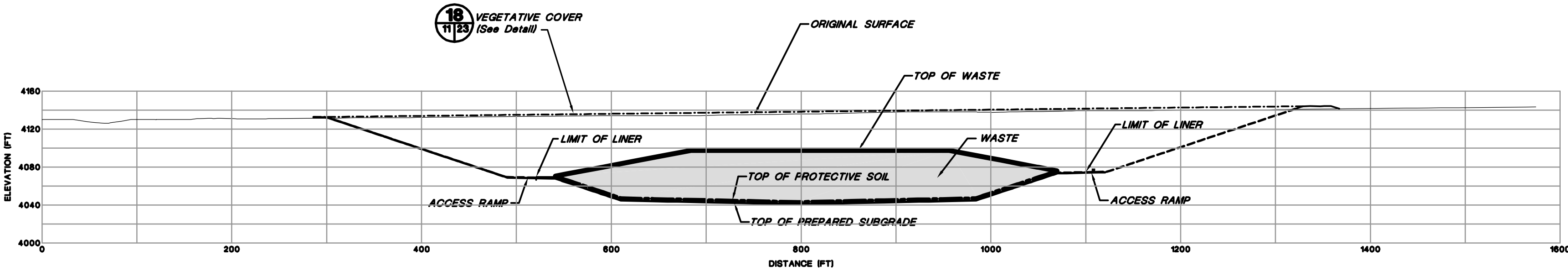
GUNDAR PETERSON NEW MEXICO 16038 LICENSED PROFESSIONAL ENGINEER 1/30/2012

JOB NO. ES11.0141

SHEET 1 of 1
DWG NO. 10

PRELIMINARY - NOT FOR CONSTRUCTION

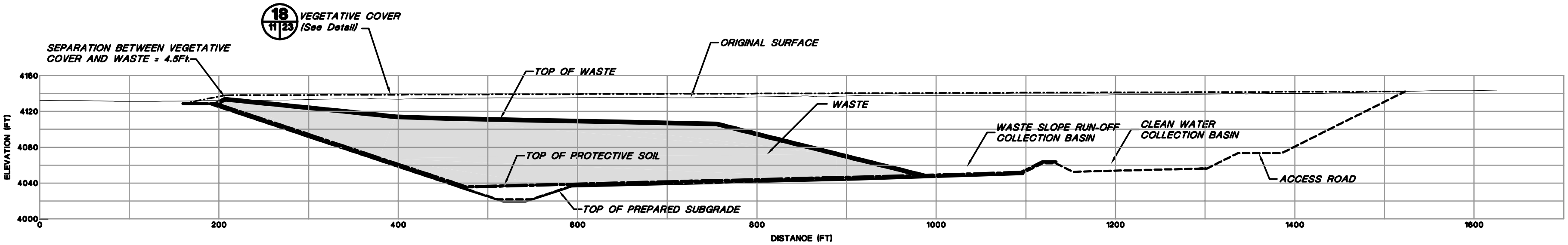
XREF: S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\VR_DRAWINGS\TITLEBLOCK\TB_22X34



C 9 11 C 10 11 **PHASE 1A CROSS-SECTION C-C'**

HORIZONTAL SCALE
0 60' 120'

VERTICAL SCALE
0 60' 120'

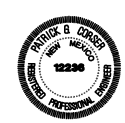


D 8 11 D 9 11 D 10 11 **PHASE 1A CROSS-SECTION D-D'**

HORIZONTAL SCALE
0 60' 120'

VERTICAL SCALE
0 60' 120'

NOTES:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. DAILY COVER WILL CONSIST OF SOIL SPREAD ON TOP OF THE WASTE PLACEMENT AREA. MINIMUM DAILY COVER THICKNESS WILL BE APPROXIMATELY 0.5 FEET.



PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ______ *Patrick G. Corser, NM P.E. 12236*

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
3	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
2	NOVEMBER 1999 UPDATES	11/02/99	J.Troncoso	M.Mathisen	P.Corser
1	NOVEMBER 1998 REVISION	10/28/98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	T.Smith	P.Corser

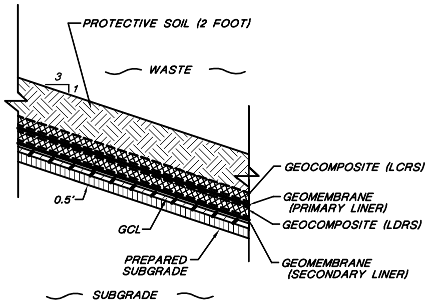
TRIASSIC PARK
WASTE DISPOSAL FACILITY

DRAWING TITLE:
PHASE 1A CROSS-SECTIONS

TerraMatrix
MONTGOMERY WATSON
Mining Group

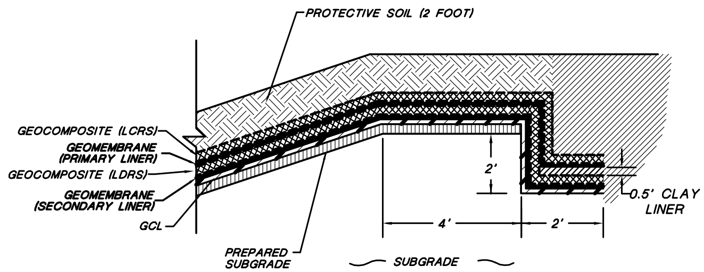
Sheet 1 Of 1 Sheets
SCALE: AS NOTED
DRAWING No. 11

AutoCAD FILE: GANDY-PH1XSEC.DWG PROJECT NUMBER: 602-0200



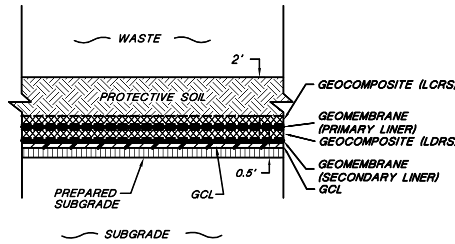
SLOPE LINER SYSTEM DETAIL (1 — 7 | 12)

Not To Scale



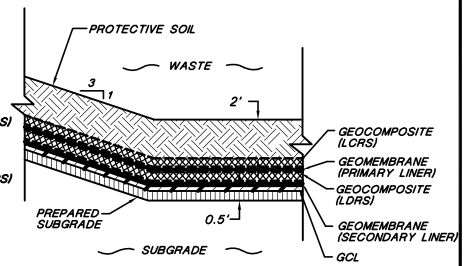
LINER ANCHOR TRENCH DETAIL (2 — 8 | 12; 2 — 9 | 12; 2 — 10 | 12; 2 — 23 | 12; 2 — 24 | 12)

Not To Scale



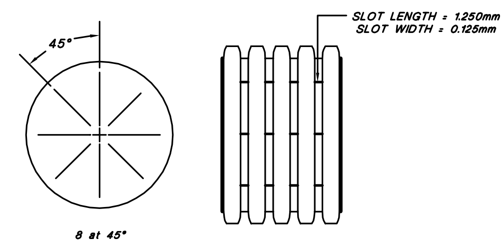
FLOOR LINER SYSTEM DETAIL (3 — 7 | 12; 3 — 24 | 12)

Not To Scale



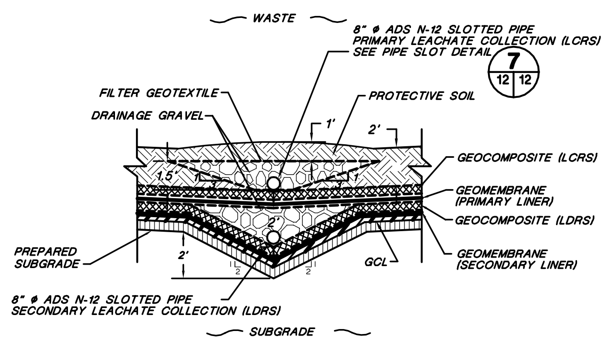
TOE OF SLOPE LINER SYSTEM DETAIL (4 — 7 | 12)

Not To Scale



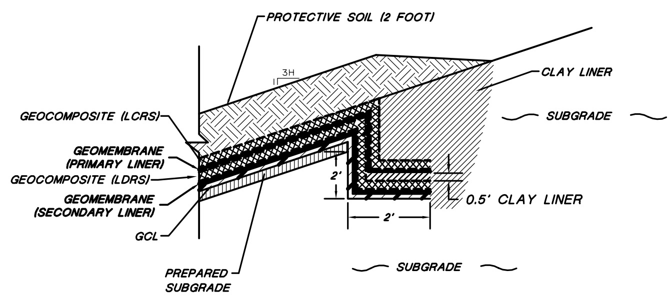
ADS N-12 PIPE SLOT DETAIL (7 — 12 | 12)

Not To Scale



FLOOR PIPE DETAIL (5 — 9 | 12)

Not To Scale



SLOPE ANCHOR TRENCH (6 — 8 | 12; 6 — 13 | 12)

Not To Scale

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

PATRICK G. CORSER — NEW MEXICO — 12236 — REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date   Patrick G. Corser, NM P.E. 12236

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
1	NOVEMBER 1998 REVISION	10/29/98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	K.Conrath	P.Corser

TRIASSIC PARK WASTE DISPOSAL FACILITY

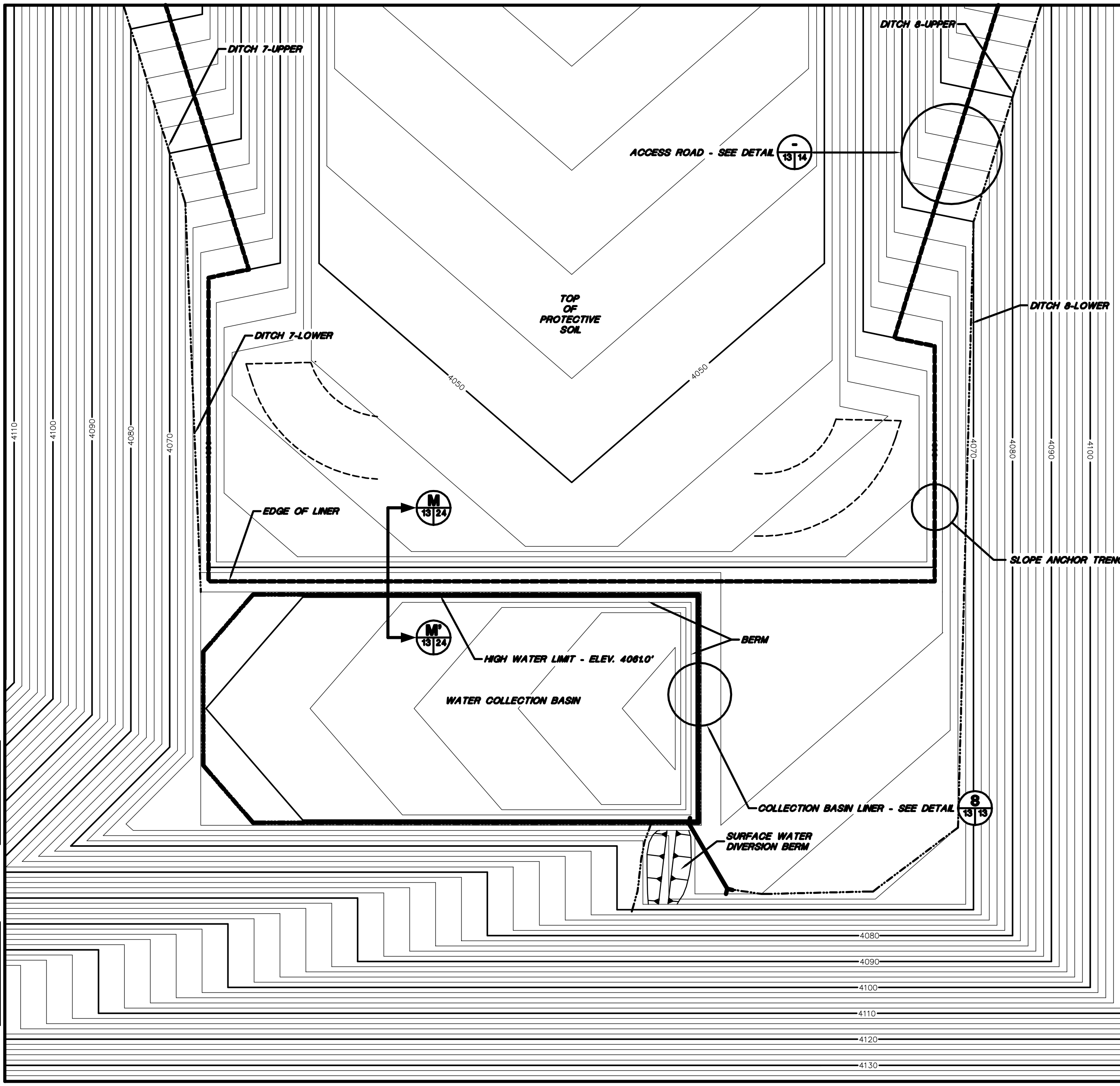
DRAWING TITLE:

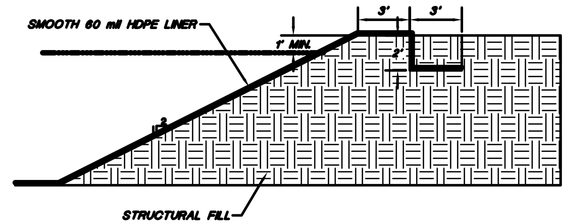
LINER DETAILS

TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 1 Sheets
SCALE: As Shown
DRAWING No. 12

AutoCAD FILE: LNRDTLS.DWG
PROJECT NUMBER: 602-0200





8 13 13 **COLLECTION BASIN BERM DETAIL**

NOT TO SCALE

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

PATRICK G. CORSER NEW MEXICO 12236 REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ____ Patrick G. Corser, NM P.E. 12236

SCALE

40' 0 40' 80'

CONTOUR INTERVAL 2 FT.

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revision	10/4/00	J.Pelliccer	K.Conrath	P.Corser
1	NOVEMBER 1998 REVISION	10/29/98	J.Pelliccer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	T.Smith	P.Corser

TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:

COLLECTION BASIN PLAN AND DETAILS

TerraMatrix MONTGOMERY WATSON Mining Group

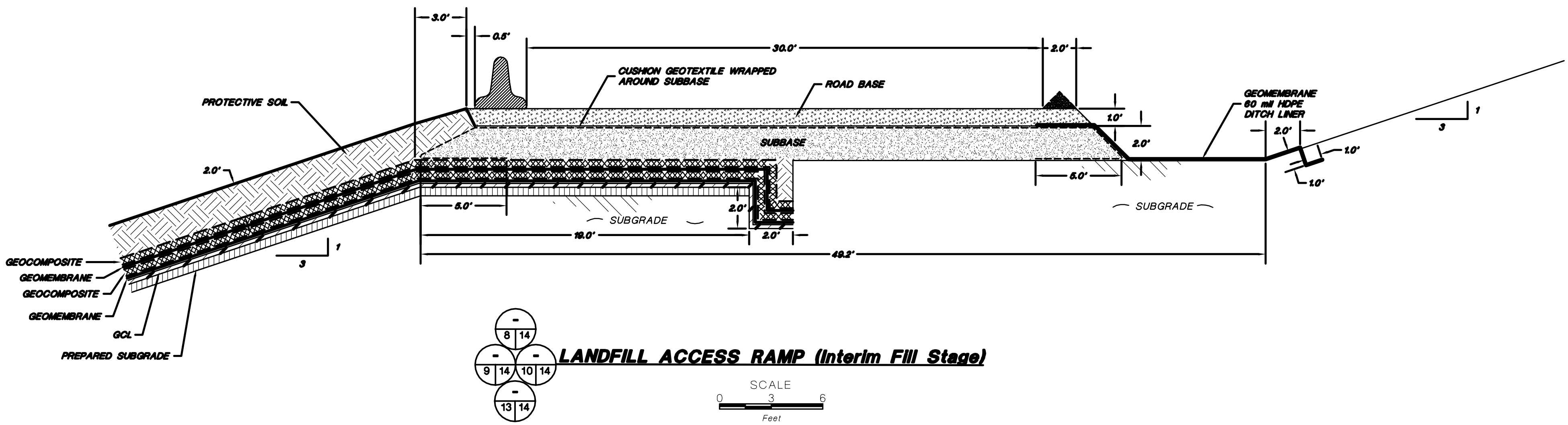
Sheet 1 Of 1 Sheets

SCALE: AS NOTED

DRAWING No. 13

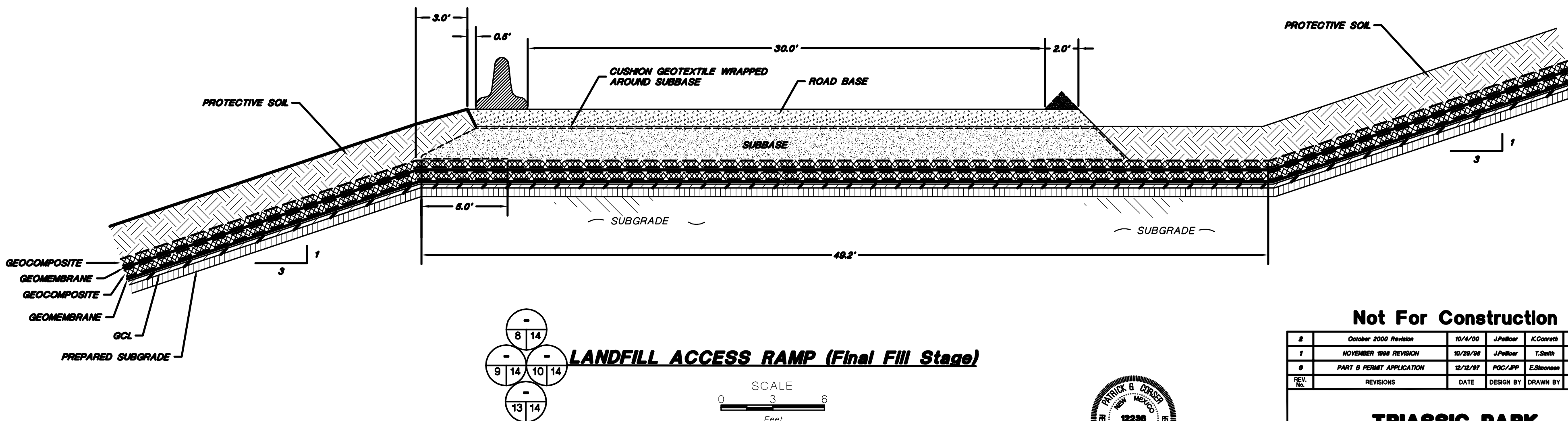
AutoCAD FILE: GANDY-CPOND.DWG

PROJECT NUMBER: 602-0200



LANDFILL ACCESS RAMP (Interim Fill Stage)

SCALE
0 3 6
Feet



LANDFILL ACCESS RAMP (Final Fill Stage)

SCALE
0 3 6
Feet

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

PATRICK G. CORSER NEW MEXICO 12236 REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date ______ Patrick G. Corser, NM P.E. 12236

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
1	NOVEMBER 1998 REVISION	10/29/98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	E.Simonsen	P.Corser

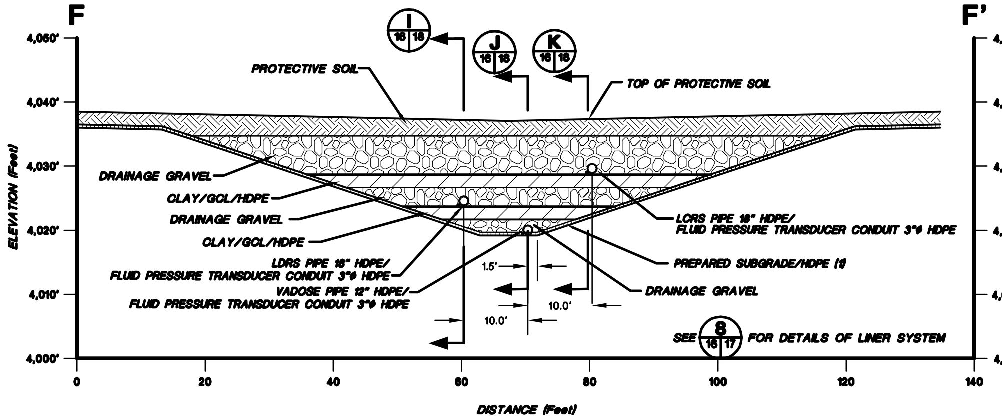
TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:
TYPICAL LANDFILL ACCESS RAMP DETAILS

TerraMatrix MONTGOMERY WATSON Mining Group

Sheet 1 Of 1 Sheets
SCALE: AS NOTED
DRAWING No. 14

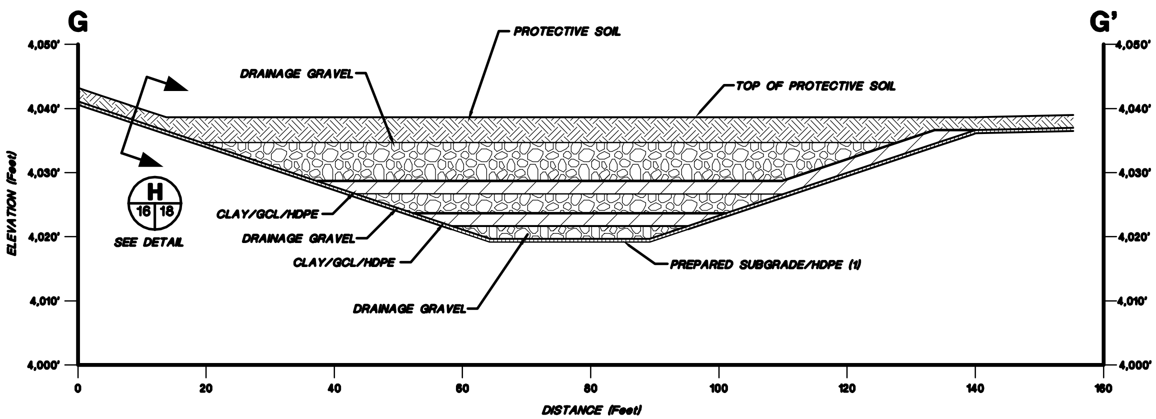
AutoCAD FILE: RAMP-DETAIL.DWG PROJECT NUMBER: 602-0200



F 15 16 **SUMP - CROSS-SECTION F-F'**

HORIZONTAL SCALE
0 10.0' 20.0'

VERTICAL SCALE
0 10.0' 20.0'



G 15 16 **SUMP - CROSS-SECTION G-G'**

HORIZONTAL SCALE
0 10.0' 20.0'

VERTICAL SCALE
0 10.0' 20.0'

NOTE:
FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".

PATRICK G. CORSER
NEW MEXICO
12236
REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date *Patrick G. Corser, NM P.E. 12236*

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
1	NOVEMBER 1998 REPORT	10/29/98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	E.Simonsen	P.Corser

TRIASSIC PARK WASTE DISPOSAL FACILITY

DRAWING TITLE:

SUMP CROSS-SECTIONS - PHASE 1A

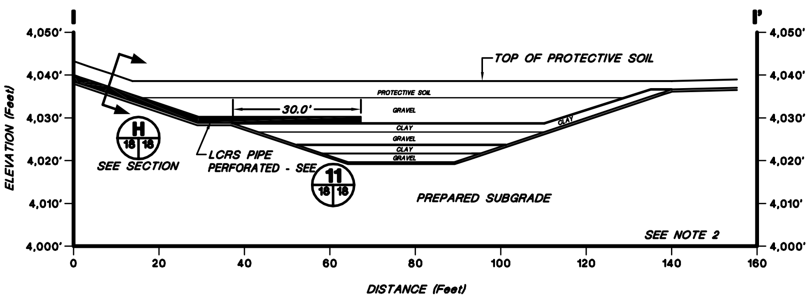
TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 1 Sheets

SCALE: See Scale Bar

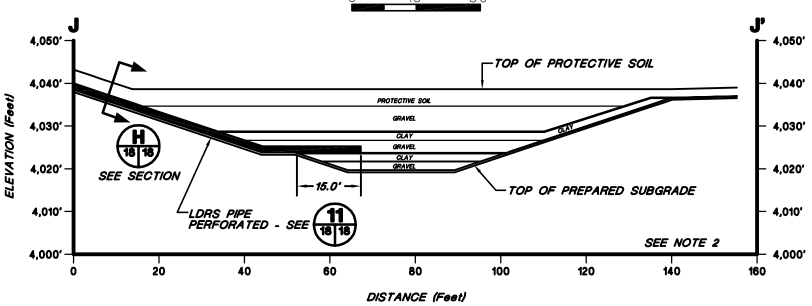
DRAWING No. 16

AutoCAD FILE: SUMPPLAN-XSEC.DWG PROJECT NUMBER: 602-0200



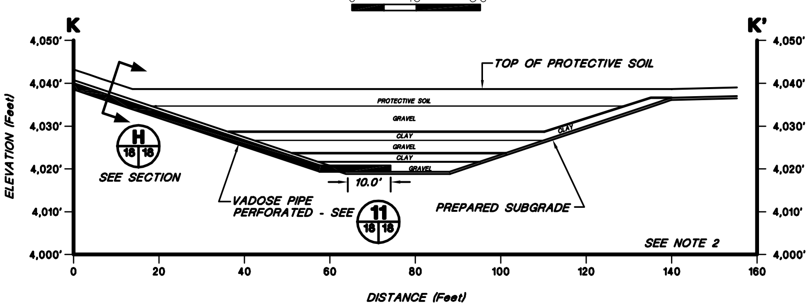
I 18 18 LCRS PIPE PLACEMENT IN SUMP

HORIZONTAL SCALE
0 15' 30'
VERTICAL SCALE
0 15' 30'



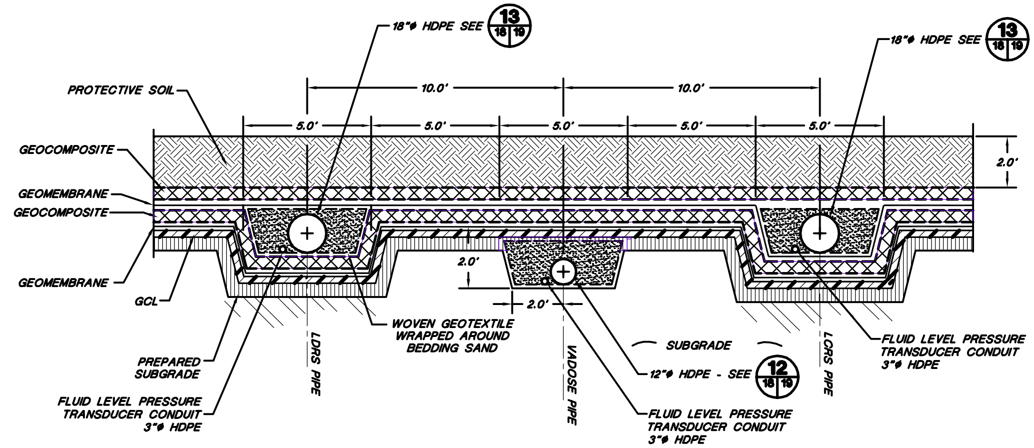
J 18 18 LDRS PIPE PLACEMENT IN SUMP

HORIZONTAL SCALE
0 15' 30'
VERTICAL SCALE
0 15' 30'



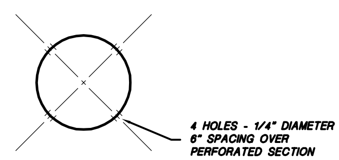
K 18 18 VADOSE PIPE PLACEMENT IN SUMP

HORIZONTAL SCALE
0 15' 30'
VERTICAL SCALE
0 15' 30'



H 18 18 H 18 18 LDRS, VADOSE AND LCRS PIPES SLOPE SECTION

Not To Scale



11 18 18 PIPE PERFORATION DETAIL

Not To Scale

NOTE:
1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. SEE 8 18 17 FOR LINER DETAILS IN SUMP.

PATRICK G. CORSER
NEW MEXICO
12236
REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL ENGINEER'S STATEMENT

I, Patrick G. Corser, state that this drawing was prepared under my supervision and all the information presented hereon is true and correct to the best of my knowledge and information.

Date   Patrick G. Corser, NM P.E. 12236

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	October 2000 Revision	10/4/00	J.Pellicer	K.Conrath	P.Corser
1	NOVEMBER 1998 REVISION	10.29.98	J.Pellicer	T.Smith	P.Corser
0	PART B PERMIT APPLICATION	12/12/97	PGC/JPP	K.Conrath	P.Corser

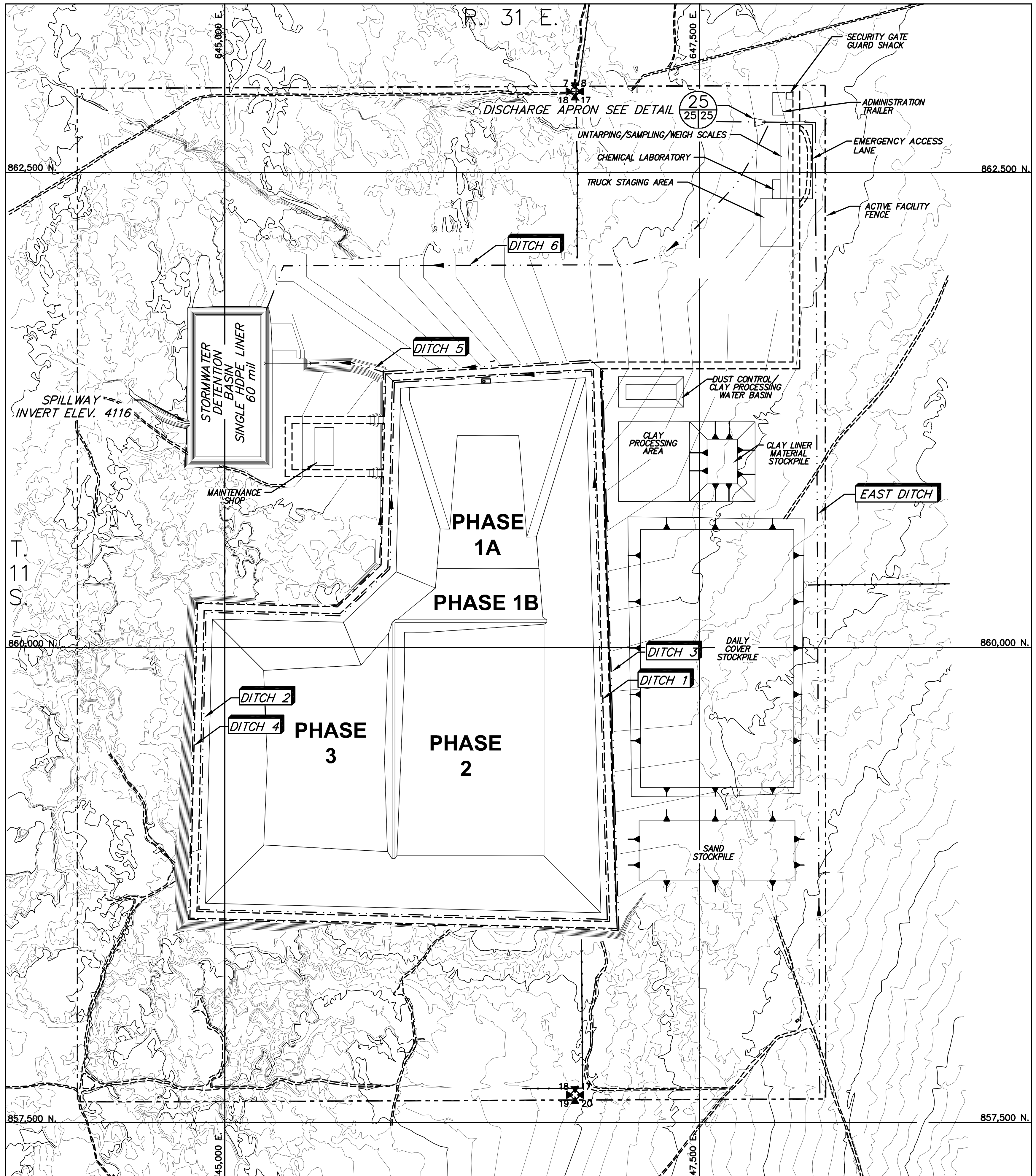
TRIASSIC PARK WASTE DISPOSAL FACILITY

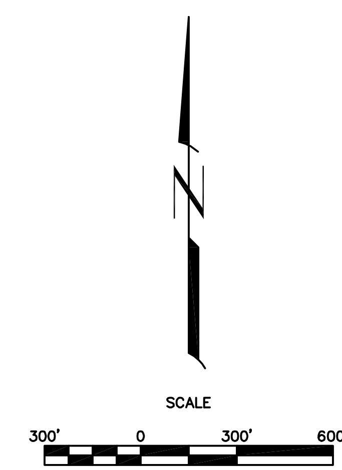
DRAWING TITLE:
VADOSE, LDRS, LCRS CROSS-SECTIONS AND DETAILS

TerraMatrix
MONTGOMERY WATSON
Mining Group

Sheet 1 Of 1 Sheets
SCALE: See Scale Bar
DRAWING No. 18

AutoCAD FILE: PS-DETAIL.DWG
PROJECT NUMBER: 602-0200





PRELIMINARY - NOT FOR CONSTRUCTION

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_05B_surface_water_control_25.dwg

Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

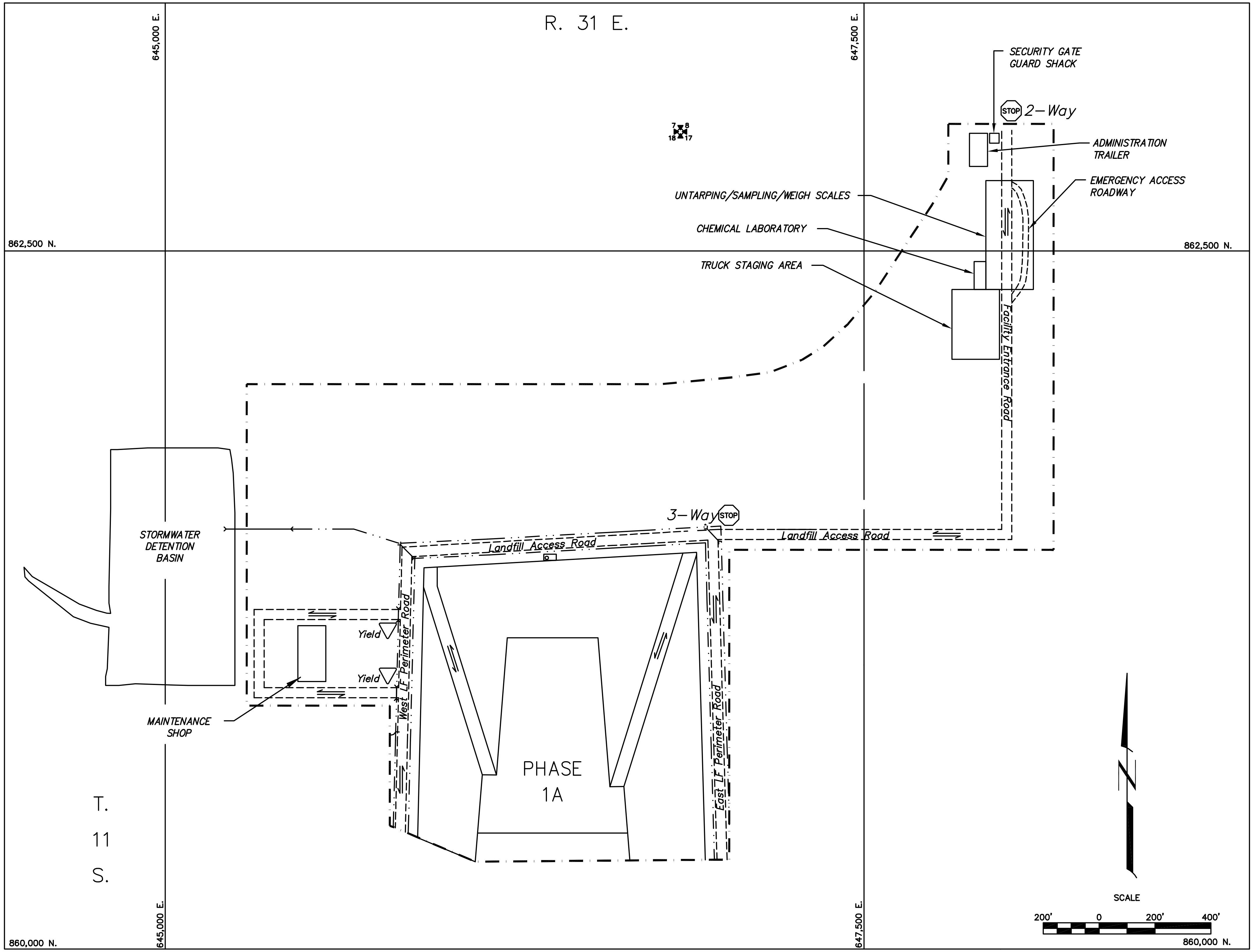
SURFACE WATER CONTROL FEATURES

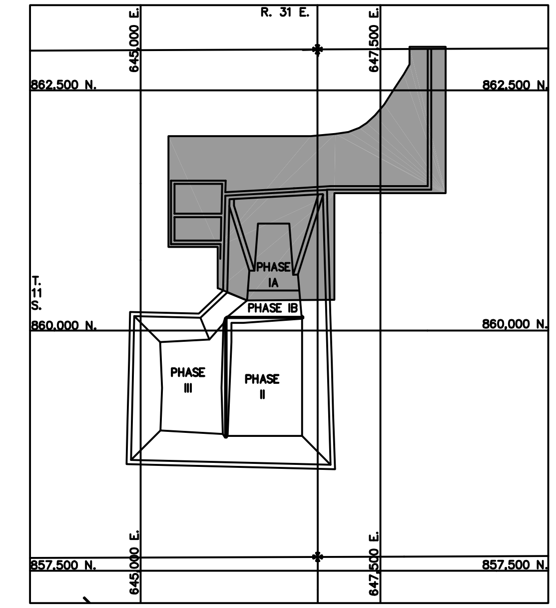
GUNDAR PETERSON NEW MEXICO 16038 LICENSED PROFESSIONAL ENGINEER

JOB NO. ES11.0141

SHEET 1 of 2
DWG NO. 25

XREF: S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\VR_DRAWINGS\TITLEBLOCK\TB_22X34





MAP KEY

NOTES:

1. FOR GENERAL NOTES AND LEGEND INFORMATION SEE DRAWING No. 2, "INDEX, LEGEND AND GENERAL NOTES".
2. UNIMPROVED ROADS AND CONSTRUCTION HAUL ROADS NOT SHOWN. GRAVEL LINED ACCESS ROADS ARE 2 WAY TRAFFIC. ALL SITE ACCESS ROADS SPEED LIMIT IS 15 MPH, CONSTRUCTION HAUL ROAD SPEED LIMIT IS 35 MPH.

NO	DATE	BY	REVISION MADE
0	10/18/11	GDP	PART B PERMIT APPLICATION RENEWAL

FILE NAME: S:\Projects\ES11.0141_Triassic_Park_Permit_Renewal\VR_Drawings\ES11_0141_07B_traffic_plan_26-2.dwg

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DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 10/4/2011

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

TRAFFIC PLAN

GUNDAR PETERSON
NEW MEXICO
16038
LICENSED PROFESSIONAL ENGINEER

JOB NO.
ES11.0141

SHEET 2 of 2
DWG NO. 26

PRELIMINARY - NOT FOR CONSTRUCTION

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