Attachment I
Vadose Zone Monitoring System Work Plan

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Attachment I. Vadose Zone Monitoring System Work Plan

1 INTRODUCTION

1.1 Background

NMED, in a Final Order on March 18, 2003 granted Gandy Marley, Inc. (GMI) (Permittee) a Groundwater Monitoring Waiver for its proposed Triassic Park Waste Disposal Facility. The Groundwater Monitoring Waiver remains in effect upon issuance of this Permit. The landfill is the only unit that is permitted for hazardous waste management.

Hydrogeologic conditions at the site act to minimize the potential for migration of leachate liquids from the facility to the uppermost aquifer. The conservative modeling calculations presented in the Groundwater Monitoring Waiver Request report estimated that the migration time for potential leaks from the disposal facility to the uppermost aquifer would be greater than 1000 years. A Vadose Zone Monitoring System (VZMS) shall be installed as an alternative to conventional groundwater monitoring to detect potential leaks in a timely manner.

This Work Plan presents the design of a VZMS at the site and also is an attachment to the Permit Application. It includes a discussion of the location and design of the vadose zone monitoring wells and methods for characterizing liquids and organic vapors that may accumulate in vadose zone wells and sumps from various sources. This Work Plan also discusses how data will be collected to select chemical parameters indicative of fluids (waste or non-waste) and organic vapors that may occur at the site. A summary of monitoring frequency, sampling procedures, laboratory analyses, and data reporting associated with the monitoring system are included in the Work Plan. Figure 2, Location of Sumps and Monitoring Wells, presents a map of the proposed facility showing significant site features, including the locations of the waste management units, vadose zone monitoring wells, and sumps.

This VZMS Work Plan is consistent with the requirements of Permit Part 4.

1.2 Project Scope and Objectives

This Work Plan presents the design and operating parameters for the VZMS at the site. The vadose zone monitoring program for the facility allows for measurement and collection of fluids and organic vapors beneath or downgradient of the facility and identification of the potential source(s) associated with these fluids or organic vapors. The following items are included as part of this Work Plan. References to the Part B Permit Application or the Permit are presented where additional detail is required.

i. A description of the methodology for installing a VZMS capable of detecting fluids and organic vapors migrating from the waste management units.

ii. A description of the methodology for developing baseline data characterizing the chemical characteristics of non-leachate fluids that may accumulate in sumps or vadose zone monitoring wells.

iii. A methodology for selection of appropriate indicator parameters that will be used to identify leachate fluids and organic vapors during future monitoring at the site.

iv. A description of the methodology to be used for collecting field and laboratory analytical data as part of the vadose zone monitoring program at the site.

v. A description of the actions and modifications to the monitoring program, if fluids or organic vapors are detected in the monitoring system.

The primary VZMS consists of a vadose zone monitoring sump located beneath the landfill Phase 1A cell. A secondary system consists of a series of vadose zone monitoring wells located adjacent to the landfill Phase 1A cell and on the periphery of the facility. Neutron access probe tubes are also located adjacent to the landfill Phase 1A cell.

This Work Plan also describes how the chemical characteristics of non-leachate fluids from various sources (i.e., stormwater detention basin, rainwater, consolidation water, and water supply) are characterized. These data shall be used to develop a list of indicator parameters and/or water profiles that can enable distinguishing between non-leachate and leachate fluids and organic vapors.

Additional components of the vadose zone monitoring system presented in this Work Plan include the following:

- monitoring frequency;
- sampling procedures;
- laboratory analyses;
- data management;
- data reporting; and
- health and safety

The methods described within this Work Plan include the necessary elements for a Quality Assurance Project Plan (QAPP). The QAPP objectives are designed to assure that sampling, chain of custody, laboratory analysis, data measurements, and reporting activities provide valid quality data that are representative of conditions at the site and are legally defensible.

1.3 Project Organization

The NMED HWB is the lead regulatory agency for this Hazardous Waste Management Permit. GMI is the Permittee and will prepare or review project documents prior to their submittal to the HWB. A qualified engineering and environmental contractor shall prepare the VZM work plan and also be responsible for coordination of field activities, subcontractors, data management, review, and reporting of information concerning site characteristics and interpretation of data developed during the studies. Additional contractors or subcontractors are expected to conduct monitoring well construction and laboratory analyses.

1.4 Geology and Hydrology

A detailed discussion of regional and site-specific geology and hydrology is provided in the Groundwater Monitoring Waiver Request (Permit Attachment H) and Section 3 of the Part B Permit Application. A brief summary of the site-specific geology and hydrology is presented below.

1.4.1 Site-Specific Geology

The thickness of the surface Quaternary alluvial deposits (fine to very fine wind-blown sands) at the site varies from less than 10 to 35 feet. Two distinct Tertiary units, the Upper and Lower Dockum, exist beneath the alluvial deposits at the site. Within the proposed facility boundary, the Upper Dockum unit does not exceed 100 feet in thickness and the Lower Dockum is approximately 700 feet thick. The Upper Dockum consists of mudstones interbedded with siltstones and sandy siltstones. The Upper Dockum mudstones have an average permeability of 2.5×10^{-7} centimeters per second (cm/s) and the siltstones have an average permeability of 1.2×10^{-5} cm/s. The Upper Dockum sediments were deposited in a fluvial environment and individual lithologies are frequently discontinuous and do not correlate over long distances.

The Lower Dockum was deposited in a lacustrine environment resulting in a thick accumulation of predominantly mudstones interbedded with thin siltstones. This unit is very homogeneous compared to the Upper Dockum. The Lower Dockum has an average permeability of 5.7×10^{-8} cm/s and represents a significant geologic barrier to downward migration of potential leachate from the proposed facility.

The site is located in a geologically stable region of the United States based upon its distance from tectonic centers and historically low seismic activity. There are no identified faults in the immediate area of the site.

1.4.2 Site-Specific Hydrology

There are no perennial stream drainages on or near the site. The nearest surface drainage is the Pecos River, which is located approximately 30 miles to the west.

The basal sandstone unit (Santa Rosa Sandstone) within the Lower Dockum is considered the "uppermost aquifer" in the region. Previous exploratory drilling, consisting of approximately 50 boreholes within the site boundary, did not encounter groundwater within potential Triassic host sediments. Water is not being produced from the Triassic sediments within a 4-mile radius of the site. Groundwater flow in the uppermost aquifer is generally easterly in the direction of the regional dip of the unit.

Based on drilling information, the western boundary of the Quaternary Ogallala Aquifer is located topographically between 0.5 and 2 miles east and stratigraphically above the site. Because of its stratigraphic and physical location, it is highly unlikely that the proposed disposal facility will have any impact on this aquifer.

Perched groundwater was encountered in several wells during subsurface characterization for the Part B Permit Application. Brackish groundwater was identified in a perched zone (~42 feet below ground surface [bgs]) borehole PB-14, which is located to the southwest outside of the site footprint and appeared to be due to a lithologic depression on the surface of the Lower Dockum unit. Groundwater was also encountered in wells WW-1, WW-2, PB-1, and PB-26, which are located 2,000 feet or more either to the north or south of the site. Additional detail on the results of this drilling can be found in Section 3 of the Part B Permit Application.

1.4.3 Site Model

There are several types of potential conduits for liquid and organic vapors movement through bedrock, including the following:

- primary permeability (i.e., connected interstitial voids) in either bedrock or alluvial material;
- bedding planes (i.e., between lithologic subunits within the Upper Dockum unit or along the contact between the Upper and Lower Dockum units); and
- secondary permeability (i.e., faults and fractures), although there is no evidence of faults in the area.

Consequently, if there were a release of liquids or organic vapors from the landfill, fluid or organic vapors could migrate vertically and/or laterally via one of the above-mentioned conduits. It is likely that lateral migration of the liquids or organic vapors along the dip of the units (i.e., along bedding planes) would dominate the flow regime. Therefore, a monitoring well located down dip of the Facility and screened across the Upper Dockum/Lower Dockum contact and up into the Upper Dockum unit (i.e., across the interbedded silty and sandy silty lithologic units) would be the most likely locations to observe these fluids or organic vapors if they ever were to occur.

Additionally, fluids or organic vapors that may have been released from the landfill could migrate through alluvium and along the alluvium/Upper Dockum contact, such that a shallow well located downdip of the unit and screened across the contact and up into the alluvium would be the most likely place to observe these fluids or organic vapors. Furthermore, all non-leachate fluids, except consolidation water, are expected to appear first in the shallow wells.

2 VADOSE ZONE MONITORING SYSTEM INSTALLATION

The landfill cells will be constructed in phases. The Phase 1A landfill cell is the permitted unit and shall include a central sump system. The VZMS shall be installed prior to the initial acceptance of waste at the Facility.

This Work Plan addresses the vadose zone monitoring sumps and vadose zone monitoring wells associated with the Phase 1A landfill cell. Construction details for the vadose zone monitoring sumps are provided in the design document Design Drawings, Triassic Park Waste Disposal Facility, Chaves County, New Mexico (Montgomery Watson, Revised October 2000).

2.1 Vadose Zone Sumps

The landfill cell will have a triple leachate detection/removal sump system. Figure 4, Typical Landfill Sump Detail Cross-Section, provides a cross section of the landfill sump system. The uppermost leachate collection and removal system (LCRS) consists of collection piping located above a primary liner system. The LCRS shall be sloped such that any leachate above the primary liner drains to the sump within the landfill cell. A secondary landfill leak detection and removal system (LDRS), similar in design to the LCRS, shall be located below the LCRS and primary liner. Beneath the LDRS and its secondary liner shall be a vadose zone monitoring sump fitted with a transducer that shall serve as a detection and removal system in the event of leakage through the primary and secondary liners. The vadose zone sump piping and gravel arrangement shall be similar to the LCRS and LDRS arrangements.

The Permit Application provides additional details on the sump transducers. Operation and maintenance of the sumps and transducer is covered in the Operation and Maintenance Manual included in the Permit Application.

2.2 Vadose Zone Monitoring Wells

2.2.1 Well Locations

Vadose zone monitoring wells will be constructed and maintained to be capable of yielding sufficient fluid and organic vapors samples that are representative of the various fluid and organic vapors sources, as required by 20.4.1.500 (incorporating 40 CFR § 264.97(a)(2)). A minimum of 15 vadose zone monitoring wells and two neutron probe access tubes shall be

installed to detect potential migration of fluids and organic vapors from the landfill (Phase 1A cell), as shown in Figure 2. The vadose zone monitoring wells shall include six shallow wells (screened across the alluvium-Upper Dockum contact), eight deeper wells (screened across the Upper Dockum-Lower Dockum contact, and one very deep well (screened within-Lower Dockum to 100 feet above the Santa Rosa Sandstone). Of the 15 vadose zone monitoring wells, 11 will be located within the Facility boundary at locations shown in Figure 2. The other four vadose zone monitoring wells will be installed outside the Facility at locations where previous investigation borings have encountered perched groundwater. The two neutron access probes will be located on the north and west sides of the Phase 1A landfill, as shown in Figure 2.

2.2.2 Vadose Zone Monitoring Well Construction

A utility clearance will be conducted at all boring locations to ensure that no subsurface utilities or obstacles exist in the area. This shall be conducted using methods appropriate to the conditions of each location (e.g., utility locates, geophysics, utility maps, or Facility personnel knowledge). The vadose zone monitoring wells shall be installed using an air-rotary drill rig with no drive casing or other method approved by NMED. Soil samples from cuttings shall be logged and collected for use in characterizing fluids that may accumulate in the sumps and vadose zone monitoring wells, as described in Section 3. These samples also shall be collected for use in determining baseline chemical analyses. For additional well construction requirements, see Permit Part 4.

2.2.2.a Deep Monitoring Wells

The deeper monitoring wells will be installed primarily to monitor for the possible detection of saturation and organic vapors above the Upper Dockum/Lower Dockum contact. Of the nine deep monitoring wells, eight wells shall be installed with well screens across the Upper Dockum/Lower Dockum contact and up into the Upper Dockum. The one very deep vadose zone monitoring well shall be installed within the Lower Dockum Unit above the lower sandstone formation (Santa Rosa Sandstone). The very deep well shall be screened from 50 feet below the top of the Lower Dockum Unit down to 100 feet above the top of the Santa Rosa Sandstone.

The nine deep vadose zone monitoring wells shall be installed at the following locations:

i. four deep monitoring wells shall be located in a line along the eastern boundary of the Phase 1A landfill, spaced at approximately 350-foot intervals;

ii. one deep monitoring well shall be located at the northeast corner of the Facility;

iii. one deep monitoring well shall be located at the midpoint between the northeast corner of the Phase 1A landfill and the northeast corner of the Facility;

iv. one off-site deep monitoring well shall be installed approximately 3,300 feet northeast of the Facility, within 15 feet of the location of boring WW-1;

v. one off-site monitoring well shall be installed approximately 550 feet west of the Facility, near the southwest Facility corner, within 15 feet of the location of boring PB-14; and

vi. The deepest monitoring well shall be installed adjacent to the southeast corner of the stormwater detention basin.

The on-site geologist shall log the boring and confer with the driller regarding lithology changes that identify the Upper Dockum/Lower Dockum contact. Drilling shall use continuous coring to log the lithology in detail at deep borings VZMW-1D and VZMW-4D and very deep boring VZMW-7D. All geologic cores shall be labeled as to depth, photographed, boxed, stored, and be available for inspection for the operating life of the Facility. The location of the contact shall be confirmed using a downhole geophysical tool (i.e., gamma ray and neutron logging methods). Monitoring wells that will continually undergo neutron logging shall have baseline logs created in both open and cased boreholes. It is estimated that the total depths for the deep landfill monitoring wells will range between 140 and 185 feet based on well location, final grading at the site, and the anticipated depth of the Upper Dockum/Lower Dockum contact.

The deep vadose zone monitoring wells shall be screened from 20 feet beneath the alluvium/Upper Dockum contact to 5 feet below the Upper Dockum/Lower Dockum contact. Details of the well construction are shown on Figure 2 and 2a.

Five feet of solid 4-inch-diameter Schedule 80 PVC casing will be placed at the bottom of the borehole to serve as a liquid collection sump. Above this casing, 4-inch-diameter Schedule 80 PVC flush-threaded 0.010-inch slotted well screen shall extend to 20 feet below the top of the alluvium/Upper Dockum contact. The top of the screened interval shall extend to a depth that enables a minimum 10-foot seal below the alluvium/Upper Dockum contact and a minimum of eight feet from the bottom of the adjacent shallow well's screened interval, if applicable. This will result in 80- to 100-foot screened intervals in the deep wells. Solid 4-inch-diameter Schedule 80 PVC casing shall then be installed to the surface. Bottom caps shall be attached with stainless steel rivets. Additionally, in order to minimize the chances of the bottom of the well being inadvertently broken out, extra care shall be taken to ensure that the filter pack is placed, while still hanging the well casing under tension, with maximum density around the end of the well casing for added stability.

The casing shall be lowered into the borehole a section at a time by hanging the casing from the drill rig. The casing shall remain suspended from the drilling rig after all of the well casing has been attached and during the emplacement of filter pack material and grout to ensure that the casing remains straight. Centralizers also shall be used to ensure that the well is straight. It is important for the well to be plumb (i.e., vertical) to allow adequate visual monitoring of the

wells. This shall be accomplished by drilling the borehole straight, which is the responsibility of the driller, as well as using the methods described above.

Following placement of the well casing, fine-grained sand (e.g., 20/40 silica sand) shall be placed in the annulus to form a filter pack. Sand shall be placed from total depth to 3 to 5 feet above the top of the well screen. Above the filter pack, 3 to 5 feet of transitional sand (i.e., 100-mesh sand) shall be placed to prevent migration of the grout seal into the filter pack during emplacement. The main advantage of using transitional sand versus bentonite pellets is that it does not require hydration and will prevent any confusion of the source of the water if it were to enter into the well sump. The wells shall be completed by pumping a grout mixture to form a seal from the top of the transitional sand to the top of the borehole using a tremie pipe. The grout mixture shall consist of a high solids (~20 to 30%) bentonite grout mixed to the manufacturer's specifications. The top of the well shall be cemented with concrete and set with aboveground well protection. No water will be used in the construction of the well, except in the grout mixture, which shall be pre-mixed above ground prior to emplacement in the annulus to avoid any free water entering the well or annulus during well construction.

2.2.2.b Shallow Monitoring Wells

The shallow monitoring wells shall be installed to monitor for the possible detection of saturation and organic vapors above the alluvium/Upper Dockum contact. The six shallow monitoring wells will be screened across the alluvium/Upper Dockum contact.

The shallow vadose zone monitoring wells shall be installed at the following locations:

i. four shallow monitoring wells shall be located in a line along the western boundary of the Phase 1A landfill, spaced at approximately 330-foot intervals;

ii. one off-site shallow monitoring well shall be installed approximately 3,300 feet northeast of the Facility, within 15 feet of the deep vadose zone monitoring well near the location of borehole WW-1; and

iii. one off-site monitoring well shall be installed approximately 550 feet west of the Facility, near the southwest facility corner, within 15 feet of the deep vadose zone monitoring well near the location of boring PB-14.

If there is greater than eight feet of alluvium present, the shallow vadose zone monitoring wells shall be drilled to approximately 3 feet below the alluvium/Upper Dockum contact, with a 5-foot screened interval extending two feet below and three feet above the contact. Details of the well construction are shown on Figures 2 and 2a. If between five and eight feet of alluvium is encountered, the shallow vadose zone monitoring wells shall be constructed with a shorter screened interval and shorter filter pack, while maintaining at least three feet of grout seal above the filter sand. If less than five feet of alluvium is present, driven (direct-push) wells will be

installed. The on-site geologist shall log the boring and confer with the driller regarding lithology changes that identify the alluvium/Upper Dockum contact.

The thickness of the alluvium averages around ten feet across the site. A minimum 3-foot surface seal will be necessary to install a properly constructed monitoring well. One foot of solid 4-inch-diameter Schedule 80 PVC casing shall be placed at the bottom of the borehole to serve as a liquid collection sump. Above this casing, 5 feet (less for wells installed in 5 to 8 feet of alluvium) of 4-inch-diameter Schedule 80 PVC flush-threaded 0.010-inch slotted well screen shall extend to three feet above the alluvium/Upper Dockum contact.

Following placement of the well casing, fine-grained sand (e.g., 20/40 silica sand) shall be placed in the annulus to form a filter pack. Sand shall be placed from total depth to approximately one foot above the top of the well screen followed by approximately one foot of transitional sand (i.e., 100-mesh sand). For wells installed in five to eight feet of alluvium, the filter sand shall extend between 6 and 12 inches above the top of the well screen followed by 6 to 12 inches of transitional sand. The wells shall be completed by placing a grout mixture from the top of the transitional sand to the top of the borehole. The grout mixture may be gravity placed if the wells are less than 50 feet deep and contain no formation water; if they are greater than 50 feet deep or contain formation water, the grout shall be placed using the same procedures as the deep wells. The grout mixture shall consist of a high solids (~20 to 30%) bentonite grout mixed to the manufacturer's specification. The top of the well shall be cemented with concrete and set with aboveground well protection. No water shall be used in the construction of the well, except in the grout mixture, which shall be pre-mixed above ground prior to placement in the annulus to avoid any free water entering the well or annulus during well construction.

2.2.2.c Neutron Probe Access Tubes

Neutron probe access tubes also shall be installed at two locations near the Phase 1A landfill liner to allow moisture content monitoring in the vadose zone and enable collection of a representative sample of any fluid that may accumulate or migrate at or above the stratigraphic boundary between the Upper and Lower Dockum stratigraphic units and below the stratigraphic boundary between the alluvium and the Upper Dockum. The locations of the two neutron probe access tubes are shown in Figure 2. NPAT-1 is located immediately north of the Phase 1A Cell. The base of this cell shall slope to the north with a leachate collection sump constructed at the north end. NPAT-1 shall allow for monitoring of soil moisture as close as practicable to the Phase 1A Cell sump. NPAT-2 is located immediately west of the Phase 1A cell, to allow for monitoring of soil moisture to the west of the permitted unit. The top of the Upper Dockum dips to the west in the vicinity of NPAT-2.

Neutron probe access tubes shall be constructed with the same care as monitoring wells to ensure functionality and to prevent fluid contamination. Neutron probe access tubes shall be

constructed using PVC, low carbon steel, stainless steel casing, or other suitable material. Flush-threaded or welded tubing is preferred to coupled tubing, to minimize wall thickness for better transmission of neutrons. To allow use of various models of neutron probes, 2.5- to 3.0-inch tubing diameter shall be used. During installation, a dummy probe shall be used to check the access tubes for bends or dents before and after installation is complete. The top of the access tubes shall be cemented with concrete and set with aboveground well protection. No water shall be used in the installation of the access tubes, except in the concrete mixture. Finally, a desiccant shall be suspended beneath the well cap to keep the access tube free of moisture.

The neutron probe access tubes are used to collect representative moisture content information with the neutron probe. Therefore, the access tubes shall be installed in a manner that minimizes disturbance to the surrounding soils and minimizes moisture migration along the tube/soil interface.

To determine the moisture content of soil surrounding the neutron probe access tubes, a calibration is needed between instrument counts and soil moisture. During installation of the neutron probe access tubes, the neutron moisture meter shall be used to profile the moisture content. The moisture profile shall be compared with laboratory soil moisture data from samples collected during drilling, so a correlation can be made between neutron counts and moisture content for each major lithology type encountered. An accurate geologic log is required for the calibration. The soil samples collected during drilling shall be preserved and transported in sealed, moisture-proof containers (e.g., plastic bags, glass jars) in accordance with ATSM D4220.

At least 60 days prior to the planned installation of the neutron probe access tubes, the Permittee shall submit a work plan for the installation of the neutron probe access tubes to NMED for approval. The work plan shall include specifications for access tubes material, access tubes installation methodology, and soil samples collection and neutron probe calibration procedures.

2.2.2.d VZMS Construction Information

Vadose zone monitoring wells will be drilled using air-rotary drilling methods or other method approved by NMED. During drilling, VZMS construction information shall be recorded on boring logs and well construction forms by the field geologist for each well and shall, at a minimum, contain the following information. The information also shall be provided on final detailed well construction drawings presenting depth of well construction material emplacement and well dimensions.

i. Name of geologist, site location, and date of activity.

ii. Description and identification of drilling and sampling equipment.

iii. Name of drilling contractor.

iv. Soils description using the Unified Soil Classification System.

v. Description of soil texture, color, density, odors, and other appropriate descriptions.

vi. Description of soil or rock type.

vii. Depth and thickness of groundwater (saturated zones) if encountered.

viii. Total depth of the boring and well to within 0.1 foot with respect to ground surface, and total well depth to within 0.01 foot with respect to top of casing (marked).

ix. All well construction details:

- casing material specifications and size, and reference material certifications;
- screen slot size and depth from the top of casing and ground surface to both top and bottom of screened interval;
- casing and screen joint type;
- filter pack material source and grain size analysis;
- filter pack placement methodology;
- sealant material sources, types, and mix design;
- surface seal and protective casing design; and
- well location horizontal and vertical coordinates.

x. Explanation of any introduced water and a reference to its source and its chemical analysis.

xi. Reference to any non-anthropogenic fluids encountered during construction.

xii. Well development procedures, should they be required:

- equipment and methods used;
- total daily amounts of fluids removed;
- recovery rates;
- turbidity; and
- static fluid surface elevation measurements.

xiii. Aquifer test results, including hydraulic conductivity, for any well containing groundwater.

Three borings drilled for deep vadose zone monitoring wells shall be continuously cored. Core shall be collected during drilling of VZMW-1D and VZMW-4D located on the east side of the Phase 1A landfill and VZMW-7D located west of the Phase 1A landfill as the southeast corner of the stormwater detention basin. VZMW-7D shall be the boring drilled into, and screened within, the Lower Dockum. The primary purpose of the coring is to evaluate the possible existence of fractures or faults beneath the Facility. Should these borings yield insufficient core to accurately determine the lithology and geologic structure, additional core may be collected from other borings. All geologic core shall be labeled as to depth, photographed, boxed, stored, and be stored for possible inspection for the operating life of the Facility. The core samples shall be maintained as part of the Operating Record.

Following monitoring well installation, a licensed surveyor using a benchmark of known elevation as a reference point shall survey each vadose zone monitoring well and neutron probe access tube. A reference mark shall be made at the top of each well casing and surveyed for horizontal coordinates (±0.1 foot) and height above mean seal level (±0.01 foot). Then the depth of the well shall be measured and recorded to an accuracy of 0.01 foot relative to the top of casing, the well pad and the ground surface. Any deviations from this Work Plan shall be documented and justified.

2.2.3 Decontamination

The drill rig and equipment used for installing the vadose zone monitoring wells for the landfill Phase 1A cell shall be decontaminated prior to drilling and between boreholes. Decontamination procedures are described below.

Drilling equipment that comes into direct contact with subsurface soils or groundwater shall be decontaminated between each boring by removing adherent soil, steam cleaning and/or scrubbing with an anionic detergent in potable water followed by a double rinse with purified (deionized) water.

Investigation derived waste (IDW) shall be managed in accordance with the waste analysis plan (WAP), Permit Attachment F.

2.2.4 Well Development

Based upon previous investigations, groundwater is not anticipated in many of the vadose zone monitoring wells; therefore, well development should not be necessary. Isolated zones of perched groundwater may be encountered in the two deep vadose zone monitoring wells drilled at the locations of borings WW-1 and PB-14. The protocols for well development provided

below shall be followed for all vadose zone monitoring wells where groundwater is encountered. In the event that groundwater is encountered during the installation of monitoring wells, NMED must be contacted within 24 hours of the event.

If groundwater is encountered in a well, the well shall be developed to remove fine material from the formation and filter pack surrounding the well. Following well construction, the cement grout shall be allowed to cure for approximately one week, after which development shall consist of bailing and surging until relatively clear water (i.e., groundwater with low turbidity) is produced. Each well shall be surged and bailed using a development rig equipped with a winch and a 3-inch-diameter steel bailer. The volume of water removed may range from one casing volume for low-recharge wells (i.e., those that do not fully recharge within 12 hours) to six or more casing volumes.

3 BASELINE LIQUID CHARACTERIZATION

Potential sources for water detected in the vadose zone monitoring wells and sumps include the following:

i. Non-leachate liquids:

- rainwater;
- stormwater detention pond fluids;
- consolidation water from prepared subgrade or geosynthetic clay liner (GCL); and
- pipeline leaks from the facility water supply.

ii. Leachate fluids (originating within the regulated unit):

- fluids that have migrated through waste from the landfill; and
- stormwater runoff collected in the landfill contaminated water basin.

Potential sources for organic vapors detected in the vadose zone monitoring wells and sumps include:

i. leachate fluids (originating within the regulated unit); and

ii. organic vapors emanating from within the regulated unit.

A baseline liquid characterization program shall be conducted within three months of activating the Facility, and through ongoing monitoring during Facility operations, to evaluate the water quality characteristics of sources of non-leachate fluids that could accumulate in sumps or vadose zone monitoring wells. Additionally, leachate fluids shall be evaluated as part of the

WAP and shall include sampling and analysis of each of the leachate fluid types listed above. The potential characteristics of leachate fluids shall be evaluated after a sufficient amount of waste materials have been placed in the landfill and landfill leachate has been collected. These data shall be used to distinguish leachate fluids from non-leachate fluids that could accumulate in sumps or vadose zone monitoring wells during operation, according to the methods discussed in Section 6.4. Analyses of leachate fluids originating within the regulated unit also shall be used to identify the organic compounds that are expected to exist and potentially migrate in a vapor phase.

The baseline characterization program shall be conducted on samples of non-leachate fluids to produce preliminary chemical profiles for these waters. Samples of non-leachate fluids shall be analyzed according to the program described in Table I-1. These data shall be used to develop a water quality profile representative of each potential non-leachate fluid source.

A sample of the potential consolidation water shall be analyzed as part of the baseline characterization program. The sample shall be obtained by running a permeability test (ASTM D 5084) on a representative sample of the clay liner and/or GCL. The extract from that test shall then be analyzed according to Table I-1.

Water representative of the potential non-leachate fluid sources shall be used in conjunction with drill cuttings from both the Upper and Lower Dockum Units to establish a chemical baseline using the Synthetic Precipitation Leaching Procedure (SPLP) (U.S. EPA SW-846 method 1312;). The SPLP shall be used to test a minimum of three samples representative of the lithologies (e.g., mudstone, siltstone, and sandy siltstone) of both the Upper and Lower Dockum Units using each distinct non-leachate fluid type. If the previously discussed water profiling reveals that the different non-leachate fluids each have distinct profiles, each water type shall be used to conduct the SPLP tests; otherwise, water representative of the combined non-leachate fluids will be used. Cuttings shall be collected for use in these tests during installation of the vadose zone monitoring wells. The extract from these tests shall be analyzed according to the methods described in Table I-1. These data will provide an indication of the chemical profile (in terms of major ion chemistry, radiochemistry and trace metals) of water that would occur as a result of Dockum sediments being subjected to non-leachate fluid sources. Certain constituents listed in Table I-1, such as volatile organic compounds, are not expected to be detected during these tests; however, their absence will be confirmed in case any natural organic materials (e.g., hydrocarbons) exist in the geologic materials.

Additionally, the samples of the Dockum cuttings collected during drilling shall be used as part of a background study to determine background concentrations of naturally occurring metals and radionuclides in soil, as listed in Table I-1.

After initial vadose zone fluids are sampled and tested, an assessment shall be completed to determine whether the vadose zone fluids may be adversely affected by well construction

materials. The assessment shall be completed within six months of monitoring well construction, provided that sufficient vadose zone fluids are available to perform the assessment.

4 MONITORING PROCEDURES

4.1 Monitoring Frequency

Following installation, monitoring for the presence of fluids shall be performed daily for the vadose zone sump below the LCRS and LDRS sumps and monthly for the vadose zone monitoring wells. The total depth of the vadose zone wells also shall be measured each time the wells are monitored. Table I-2 presents a summary of the monitoring program for the facility.

During the operating life of the Facility, each vadose zone monitoring well, neutron probe access tube, and the landfill vadose zone sump shall be inspected according to the schedule in Table I-2.

In conjunction with monitoring for the presence of water, monitoring for organic vapor shall be conducted in each vadose zone monitoring well and the landfill vadose zone sump. During the post-closure care period, monitoring wells VZMW-1D, -2D, -3D, -4D, -10S, -11S, -12S, -13S and the landfill vadose zone sump shall be inspected and sampled semiannually. If evidence of leachate discharge to the vadose zone is noted during any sampling event, vadose zone monitoring frequency shall be increased as appropriate to reflect the apparent increased rate of leachate discharge to the subsurface.

4.2 Response Actions

The following response actions shall be conducted based on the outcome of each monitoring event.

- Liquids and organic vapor not present: no further action.
- Liquids present: the fluids will be sampled and analyzed. All remaining fluids will be removed and properly disposed.
- Organic vapors present above the trigger level (see Section 4.3): additional samples of soil vapors shall be collected and submitted for laboratory analysis.

If the source of water or organic vapors in the sumps or vadose monitoring wells is determined to be non-leachate fluids or vapors originating outside of the regulated unit, no further action will be conducted other than removing the liquid and mitigating the source, if possible (e.g., a break in the water supply system or an underground gas leak). As part of the source mitigation, a written plan for determining and mitigating the source of the fluids or organic vapors shall be submitted to NMED for approval within 15 business days of determining that the sampled liquid or organic vapors did not originate within the regulated unit.

If the source of water or organic vapors is determined to be leachate fluids or vapors originating within the regulated unit, corrective action steps shall be taken, as described in the applicable

permit module. Additionally, if the action leakage rate (ALR) is exceeded, corrective action or contingency steps shall be taken, as described in the applicable permit modules, to include an increase in the monitoring frequency to weekly until the ALR is reduced. All response actions shall be assessed by an independent New Mexico Professional Engineer. Reporting commitments are described in Section 6.4.

If fluids are detected in one of the shallow monitoring wells, the depth of the fluids shall be compared to the depth of the waste. This comparison will be one of the factors used to evaluate whether the source of the fluids could be from the waste disposal units.

Every two years, a groundwater sampling event shall be conducted for the constituents documented in 40 CFR § 264 Appendix IX. Due to the nature of the Facility being installed in the vadose zone, thep presence of water in the wells is not anticipated. However, if water is encountered, samples shall be collected from each monitoring well that contains sufficient water and the landfill vadose zone sump, if the sump contains sufficient water.

4.3 Monitoring Method

All sampling events shall be conducted using methods and procedures documented below.

The sumps shall be fitted with a dedicated transducer with a manual readout. Consequently, the readout will be recorded and documented manually at the frequency indicated in Table I-2.

The wells will not be fitted with transducers and so will be monitored visually and manually, as listed below:

i. a water level sounder shall be used to determine presence of water and, if water is present, to measure depth to water;

ii. if liquid is detected, an interface probe capable of detecting water as well as petroleum hydrocarbons, shall be lowered down the well and used to measure the depth of any water and/or the thickness of any petroleum hydrocarbons present; and

iii. if liquids are detected, a clean disposable bailer shall be lowered into the well to collect a sample of the fluid for visual inspection and confirmation of its presence prior to collecting any samples for laboratory analysis.

The water level sounder and interface probe shall be decontaminated prior to use at each well. The steps and results of each monitoring event shall be documented and the documentation shall be included in the Facility Operating Record.

Neutron probes shall be lowered down into the neutron probe access tubes and used to collect soil moisture data. Soil moisture changes with depth shall be assessed qualitatively by evaluating changes in neutron counts at a given depth relative to the background data and over time. Direct quantitative comparison between depths is not recommended due to variations in

density and composition of subsurface materials that are not accounted for when applying the standard calibration to all depths.

Organic vapor samples shall be collected from each vadose zone monitoring well and the landfill vadose zone sump using a vacuum pump or other sampling device.

Baseline concentrations shall be determined based on a minimum of eight measurements collected from each well prior to acceptance of waste in the landfill. The 95% UTL of the measurements in each well shall be calculated to establish the baseline organics concentrations in each monitoring well. The trigger level for collection of vapor samples for laboratory analysis shall be soil-vapor concentrations as detected by a properly calibrated photoionization detector (PID) equipped with a 11.2 electron volt (eV) lamp or other lamp energy level approved by NMED, or flame ionization detector (FID) at concentrations greater than ten parts per million (ppm) or concentrations greater than 100 ppm as detected by a properly calibrated combustible gas indicator above the corresponding baseline concentrations.

Soil vapor samples will first be screened for non-methane organic compounds (NMOC) and methane using instrumentation such as a PID, FID, and/or other gas detection instruments approved by NMED. The selection of the gas detection instrumentation and the energy level of the PID lamp will shall be based on the type and concentrations of organic compounds present in the landfill or identified in leachate fluids, if present. If field screening indicates the presence of NMOC greater than the trigger level, additional samples shall be collected and submitted for laboratory analysis. The soil vapor sampling procedures, and laboratory analytical methods shall be submitted to NMED for approval no later than 180 days after the collection of the first leachate sample or detection of vapor-phase contaminants at concentrations greater than the trigger level.

The procedures and schedule for inspection and maintenance of the VZMS sumps are described in the operations and maintenance manual included in the Permit Application. The wells shall be visually inspected for damage or malfunction at the time of each monitoring event. Any problems shall be communicated to the NMED and repaired in a timely manner.

4.4 Sample Collection

Consolidation water from prepared subgrade or GCL shall be sampled as part of baseline characterization if and when it accumulates. The most likely locations for consolidation water to accumulate are in the LDRS and VZMS sumps, as shown on Figure 4. As such, if liquid accumulates in the sumps prior to initial placement of waste in the landfill, it likely will represent consolidation water, provided there is no other significant source of fluids in the LDRS sump, such as rainwater. If fluid is observed after initial placement of waste in the landfill, it shall still

be sampled, but may not represent consolidation water. The exact nature of that fluid shall be determined at the time of occurrence.

If fluids are encountered in the sumps or vadose zone monitoring wells, samples shall be collected as described below. Each vadose zone monitoring sump shall be equipped with a bladder pump. Samples shall be collected using the minimal flow rate if sufficient volume exists in the sump. Laboratory analyses of samples shall be completed by an off-site chemical analytical laboratory, as described in the WAP.

Groundwater is not anticipated in the on-site vadose zone monitoring wells based on results from previous hydrogeologic investigations at the site. Perched groundwater may be encountered at the two off-site locations where VZMS wells will be installed at the locations of borings WW-1 and PB-14. In the event groundwater is encountered during well installation, the wells shall be initially sampled approximately one to two weeks after installation and development, otherwise the wells will be sampled, whenever liquid appears in the wells.

Static water levels shall be measured in the wells using an interface probe prior to sampling. Measurements shall be made to an accuracy 0.01 foot relative to the surveyed reference point on the well casing. The interface probe shall be decontaminated between each well using a non-phosphate biodegradable detergent and fresh tap water followed by a distilled or deionized water rinse. New chemical-resistant disposable sample gloves shall be used while collecting samples at each sump or well.

Following water level measurement all well purging, sampling and analyses of field and laboratory samples shall be conducted in accordance with the applicable portions of Permit Section 8. A Vapor and Groundwater Sampling and Analysis Work Plan shall be submitted to the NMED for review and approval no less than 60 days prior to the commencement of monitoring well installation.

5 LABORATORY ANALYSIS

5.1 Analytical Methods

Table I-1 summarizes the analytical program for the baseline liquid characterization program, as well as for water detected in vadose zone monitoring wells and sumps. Analytical detection limits will meet the most stringent of the following three criteria:

i. applicable state or federal drinking water standards;

ii. universal treatment standards (UTS) contained at 20.4.1.800 NMAC (incorporating 40 CFR § 268, Subpart D); and

iii. lowest detection limits specified at EPA publication SW-846 (most recent edition).

This analytical program is designed to "fingerprint" fluids associated with the landfill operations so that if water or organic vapors are detected in the vadose zone sumps or monitoring wells, the source of that water or organic vapors can be determined. As such, it may become justifiable to revise the vadose zone sump and monitoring well analytical program based on the results of the baseline liquid characterization program. NMED's approval will be obtained prior to making any changes to the program.

All laboratory procedures must be conducted in accordance with Permit Section 8.5.

5.2 Data Review, Validation, and Verification Requirements

All analytical laboratory data shall be presented in accordance with SW-846 [i.e., EPA SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (most recent edition, e.g., U.S. EPA, 2011a)], documentation packages that provide the same level of detail as EPA Contract Laboratory Program (CLP) protocol (U.S. EPA, 2011b) and Permit Section 8.5.

A tabular key will be provided with the package that relates field/laboratory sample numbers to: (1) QA and QC samples; (2) cooler receipt form(s); (3) reporting requirements for organic and inorganic analyses; (4) reporting of internal QC results (e.g., laboratory blanks, surrogate spike samples, matrix spike samples, laboratory duplicates and/or matrix spike duplicate pairs, and laboratory control standards); and (5) identification of field duplicates and all types of blanks. Actual chromatograms will be provided for all samples analyzed by gas chromatography (GC) methods.

At a minimum, data package verification shall include evaluation of sampling documentation and representativeness, technical holding time, instrument calibration and tuning, field and lab blank sample analyses, method QC sample results, field duplicates, compound identification and quantification, the presence of any elevated detection limits, and a summary of qualified data. All data will be flagged with appropriate qualifiers.

The data validation and verification procedures shall include: (1) an initial review or verification of the completeness of individual data packages for each sample delivery group; (2) validation of the data using guidelines tailored to the type of analyses performed (i.e., organics, inorganics, or radiochemical); (3) resolution of data discrepancies, where possible, by liaison with the responsible laboratory; (4) qualification of data by flagging with appropriate codes, with emphasis on data usability for decision-making purposes; and (5) preparation of sample delivery group specific data assessment summaries and a narrative report.

6 DATA MANAGEMENT

6.1 Field Documentation

Records of all field activities shall be kept in the facility operating record and the following items shall be used to document field activities:

i. field log book;

ii. boring logs and well construction diagrams;

iii. well or sump sampling logs; and

iv. chain of custody forms.

Field log books shall be maintained during the operating and post-closure period of the Facility and used to record details of work including daily activities, any deviations from sampling or quality assurance plans, and equipment calibration.

Geologic boring logs shall be produced by the field geologist during drilling activities. The logs shall be prepared under the direct supervision of a qualified geologist or geotechnical engineer. Field logs also shall be reviewed by the supervising geologist or engineer prior to finalization.

6.2 Data Analysis

Data analysis and reporting shall include tabular and graphical representation, graphical comparison between various parameters, and statistical analysis to determine whether fluids or organic vapors detected in the VZMS during the monitoring period originated within the regulated unit or not. Statistical procedures shall follow the methods described in Permit Attachment Q, Statistics for Release Determination. The application of data analysis methods is dependent on the data reported during monitoring of the VZMS, if any.

Using primarily the baseline characterizations and the leachate fluid analyses (WAP), chemical profiles of the water types as well as a suite of appropriate analytical indicator parameters shall be selected to be incorporated into the vadose zone monitoring program for leak detection during Facility operation. The indicator parameters both for fluids and organic vapors shall be based primarily on the leachate fluid analyses, while the non-leachate fluid profiles shall be based primarily on major ion chemistry established in the baseline, if available. Therefore, the indicator parameter list is expected to evolve as varying waste streams are accepted by the Facility. In addition, all hazardous chemicals ever received at the Facility shall be considered as indicator parameters.

Analytical data from samples of fluids detected in the VZMS shall be compared to the non-leachate fluids baseline characterizations and leachate fluids evaluations discussed in Section 3.

These comparisons shall be based on evaluating trilinear plots of major ion chemistry characterization for non-leachate parameters (bicarbonate, chloride, dissolved major cations [Na, K, Mg, Ca, Fe], total dissolved solids [TDS], and sulfate) and tabular and graphical summaries of metals/nonmetals, radionuclides, hydrocarbons, and other constituents. Through these evaluations, a correlation between the water types and concentration ranges of the monitoring sample to either the leachate fluids or non-leachate fluids characterization may be observed. If the monitoring sample data cannot be easily characterized as leachate fluid or non-leachate fluid, or if concentrations fall outside the ranges established during baseline characterization, the monitoring sample will be characterized using statistical methods. Statistical analysis will be used to determine statistically significant changes in the following non-leachate parameters: dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Ti, Zn) and radionuclides (gross alpha, gross beta, gamma emitters, total uranium, radium -226/-228, radon) over time. In this case, a tolerance or prediction interval statistical procedure will be applied unless a more appropriate statistical method is identified.

In order to apply these statistics, it may become necessary to collect additional baseline data for non-leachate fluids to establish a more concrete background profile. The need for additional baseline sampling and analysis will be evaluated at the time of occurrence and evaluation of fluids in the VZMS.

Analytical data for samples of organic vapors detected in the VZMS shall be compared to the indicator parameters for vapor-phase migration, which is a list of organic compounds that are expected to exist and potentially migrate in a vapor phase. This list shall be based on analyses of leachate fluids originating within the regulated unit, and is expected to evolve as varying waste streams are accepted by the facility. If the analytical data do not support the association of organic vapors with the regulated unit, additional investigation shall be performed to identify the source of organic vapors.

Solid wastes accepted by the facility, as well as leachate fluids, shall be sampled and analyzed separately and individually in accordance with the WAP. These data shall be used to develop a list of indicator parameters (i.e., waste constituents) to monitor for in the VZMS and will be used to determine if fluids or organic vapors detected in the VZMS did in fact originate within the regulated unit. Additionally, if based on these data it is not clear whether the fluids or organic vapors detected in the VZMS originated within the regulated unit, additional samples of any fluids present in the LCRS shall be collected and analyzed for major ions, metals, and organic compounds in accordance with Table I-1. These data will then be used to develop a chemical profile of the LCRS fluids at the time of occurrence of fluids in the VZMS, and shall be compared to the baseline non-leachate fluid profile(s) to aid in determining the source of fluids or organic vapors in the VZMS.

6.3 Data Reporting

Data shall be summarized and presented to NMED on a quarterly basis. All reports will be prepared under the supervision of a qualified geologist or professional engineer. The report shall include an executive summary that highlights any significant findings during the reporting period.

The first quarterly report shall contain the following information:

i. well construction diagrams and lithologic logs;

ii. list of indicator parameters for non-leachate fluids and associated computations;

iii. list of indicator parameters for initial leachate;

iv. list of indicator parameters for vapor-phase migration (list of organic compounds that are expected to exist and potentially migrate in a vapor phase) based on initial leachate;

v. VZMS analytical results collected during the first quarter;

vi. well inspection logs; and

vii. monitoring field logs with sampling information.

viii. a summary of well installation activities and descriptions of all field activities conducted

The main body of quarterly reports shall include discussions or summaries of the following topics:

1. monitoring and sampling methodology;
2. sample collection and preservation procedures;
3. indicator parameter lists, including non-leachate, leachate, and organic vapors parameters indicating any revisions and evaluations used to derive the indicator parameters;
4. current and historical analytical results;
5. monthly leachate chemistry results;
6. current and historical fluid levels;
7. VZMS inspection and maintenance results;

8. volumes of fluids removed from all monitoring points, including the LCRS and LDRS;
9. release assessment information in the form of a summaries of the field and laboratory analytical data
10. data tables presenting current and historical groundwater and vapor-phase field and laboratory analytical data;
11. significant historical changes in fluid levels or fluid chemistry (e.g., leachate fluids);
12. summary of 40 CFR § 264 Appendix IX results included in the previous biennial sampling event;
13. a cumulative list of chemicals managed in the landfill, as identified in the WAP;
14. maps illustrating Facility's waste management units and monitoring sump and well locations;
15. maps illustrating groundwater depth, gradient and flow direction (if appropriate);
16. map (plan view or cross-section) illustrating groundwater pathways (if appropriate);
17. graphs and/or tables depicting water quality;
18. maps depicting vapor-phase contaminant distribution(s)
19. laboratory documentation, chain of custody and QA/QC documentation;
20. copies of well and sump sampling logs and other pertinent documentation;
21. operation and maintenance report; and
22. conclusions and recommendations.

Biennial reports also shall be submitted that contain the following information:

- 40 CFR § 264 Appendix IX analysis; and
- any modification to the indicator parameter list based on 40 CFR § 264 Appendix IX analysis, including evaluations used to derive the indicator parameters.

If needed, special reports shall be submitted that contain the following information:

- release information;
- monthly reports, as long as there are leachate fluids in the VZMS; and

- non-leachate parameter list, including evaluations used to derive the indicator parameters.

If fluids or organic vapors are detected in either the sumps or wells, NMED shall be notified within 24 hours. Subsequently, an additional report (i.e., not a regularly scheduled quarterly report) shall then be submitted to NMED within 15 days of the detection fluid or organic vapors. This report shall include an assessment of the amount and source of the fluids or organic vapors; the possible size, location, and cause of the leak; and the seriousness of the any leak in terms of potential releases to the environment. It also shall include a summary of any immediate short or long term response actions to be taken. The report also shall include the following items:

- monitoring and sampling results from the sumps and wells (volumes/fluid levels and analytical results);
- a comparison to the baseline characterization results; and
- chemical analytical results for all fluids.

Within 30 days of fluid or organic vapors appearance, a report shall be submitted to NMED describing the effectiveness of the response actions. Monthly reports shall be submitted to NMED as long as fluids or organic vapors are present in the VZMS.

6.4 Data Storage

All completed data analyses and reports from this project will be stored electronically. Copies of the electronic data and hard copies of the data and laboratory reports shall be placed in the Facility Operating Record during the operating and post-closure periods.

7 HEALTH AND SAFETY

Field personnel shall be required to have current certification of 40-hour health and safety training per OSHA 29 CFR § 1910.120(e). Personnel shall adhere to proper health and safety protocols as described in a separate health and safety plan that will be prepared p prior to initiation of work plan activities and kept in the Facility Operating Record. The selected contractor also shall provide a health and safety plan relating to their operation (e.g., drilling equipment).

A designated Health and Safety Officer (HSO) shall be responsible for monitoring potentially hazardous situations during all field activities, ensuring that all personnel know the potential physical and chemical hazards and are trained in the proper use of personal protective equipment (PPE). It is anticipated that safety Level D will be the highest level of PPE necessary (i.e., work clothes, hard hats, steel-toed boots and safety glasses). The HSO will make the decision when it is necessary to upgrade to a higher level of PPE. The HSO will also conduct periodic air

monitoring (documented following Rule 1166-type requirements [SCAQMD, 2001]) and determine if conditions require an immediate termination of work.

8 REFERENCES

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Table I-1. Baseline Chemical Analyses

Analytes	Analytical Method	Sample Container(s)	Preservation Method/ Holding Time
General Water Quality			
Bicarbonate/carbonate (alkalinity)	SM 2320B	250-mL HDPE	4°C / 14 days
Dissolved major cations (Na, K, Mg, Ca, Fe)	EPA 6010B	500-mL HDPE	4°C; pH < 2 with HNO3 / 6 months
Dissolved major anions (F, Cl, Br, NO_2, NO_3, PO_4, SO_4)	EPA 300.0	500-mL HDPE	4°C/ 28 days
Total dissolved solids	SM 2540C	250-mL HDPE	4°C / 7 days
Sulfide	EPA 376.1/376.2	500-mL HDPE	4°C / Zn acetate, pH>9 with NaOH/7 days
Heavy Metals			
Dissolved metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, Zn)	EPA 6010B/6020	125-mL HDPE	4°C; pH < 2 with HNO3 / 6 months
Total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, Zn)	EPA 6010B/6020	500-mL HDPE	4°C; pH < 2 with HNO3 / 6 months
Total mercury (Hg)	EPA 7470/7471/ 245.2	500-mL HDPE	4°C; pH < 2 with HNO3 / 28 days
Radionuclides			
Gross alpha, gross beta, gamma emitters	EPA 900.0/ 901.0	1-L HDPE	4°C; pH < 2 with HNO3 / 6 months
Uranium, total	EPA 6020	500-mL HDPE	4°C; pH < 2 with HNO3 / 6 months
Radium 226/228	EPA 903.1/904.0/ 600	1-L HDPE	4°C; pH < 2 with HNO3 / 6 months
Radon	EPA 913.0	2 x 40-mL VOA vial	4°C / 4 days

Analytes	Analytical Method	Sample Container(s)	Preservation Method/ Holding Time
Organics			
Volatile organic compounds	EPA 8260B	3 x 40-mL VOA vial	4°C; pH < 2 with HCl / 14 days
Semivolatile organic compounds	EPA 8270C	1-L glass amber	4°C / 7 days extraction
Pesticides	EPA 8081/8141B	1-L glass amber	4°C / 7 days extraction
Polychlorinated biphenyls	EPA 8082	1-L glass amber	4°C / 7 days extraction
Perchlorate	EPA 314.1	125-mL wide-mouth HDPE	4°C / 28 days
Cyanide	EPA 335.3	1-L HDPE	4°C / 14 days
TPH-gasoline-range organics	EPA 8015M	3 x 40-mL VOA vial	4°C; pH <2 with HCl / 7 days extraction
TPH-diesel-range organics	EPA 8015M	500-mL glass amber	4°C; pH < 2 with HCl / 7 days extraction
TPH-oil-range organics	EPA 8015M	500-mL glass amber	4°C; pH < 2 with HCl / 7 days extraction
Oil & grease	EPA 9071/413.2	500-mL glass amber	4°C; pH < 2 with HCl / 7 days extraction
Soil Analyses			
Metals	EPA 200.7/6010C	125-mL CWM glass jar	4°C / 6 months
Radiochemistry	HASL-300 / Gamma spec	500-mL CWM glass jar	4°C / 6 months

VOA = Volatile organic analysis
CWM = Clear wide-mouth jar
HDPE = High density polyethyrene bottles
HCl = Hydrochloric acid

Table I-2. Monitoring Frequency

Time Period	Landfill		
	Sumps	Vadose Wells	Neutron Probes
Operation	Daily	Monthly	Monthly
Closure	Daily	Monthly	Monthly
Post-Closure	Semiannually	Semiannually	None

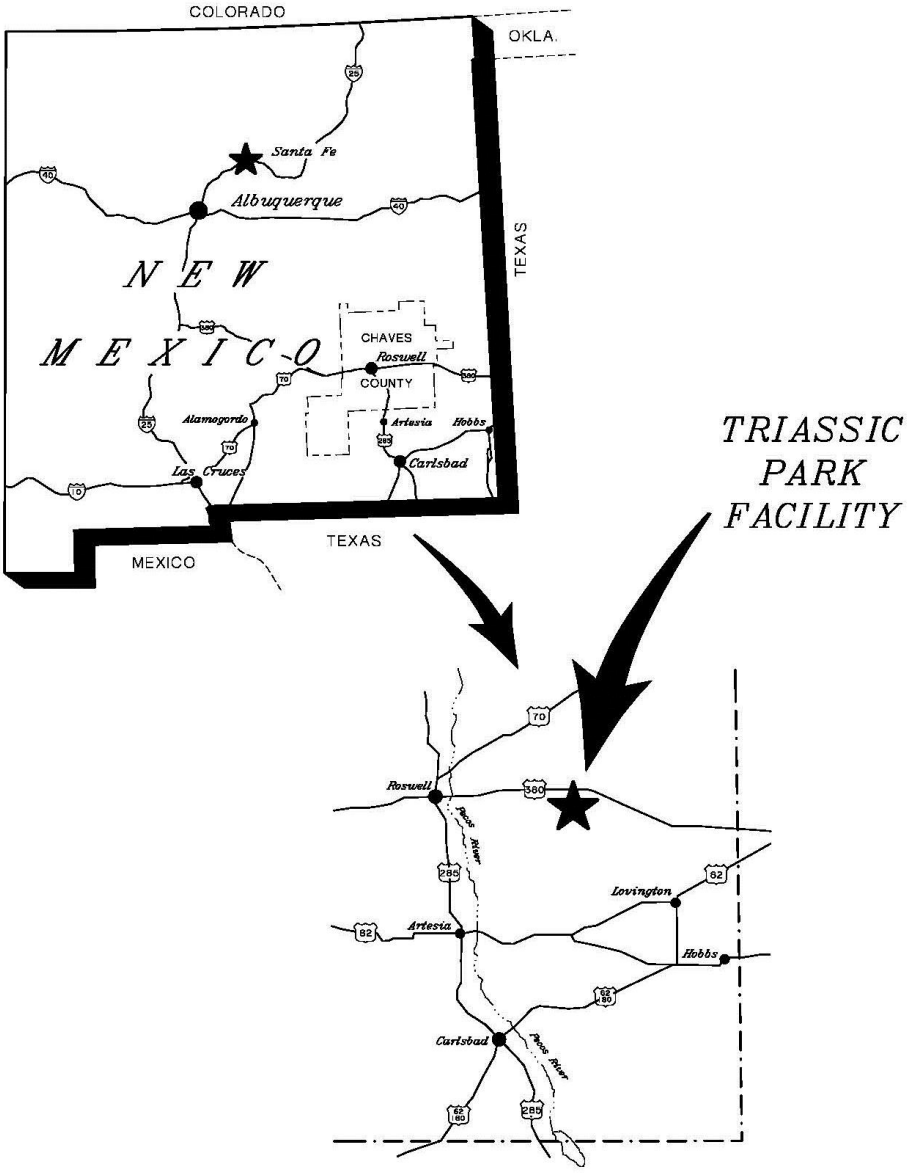


FIGURE 1: SITE LOCATION

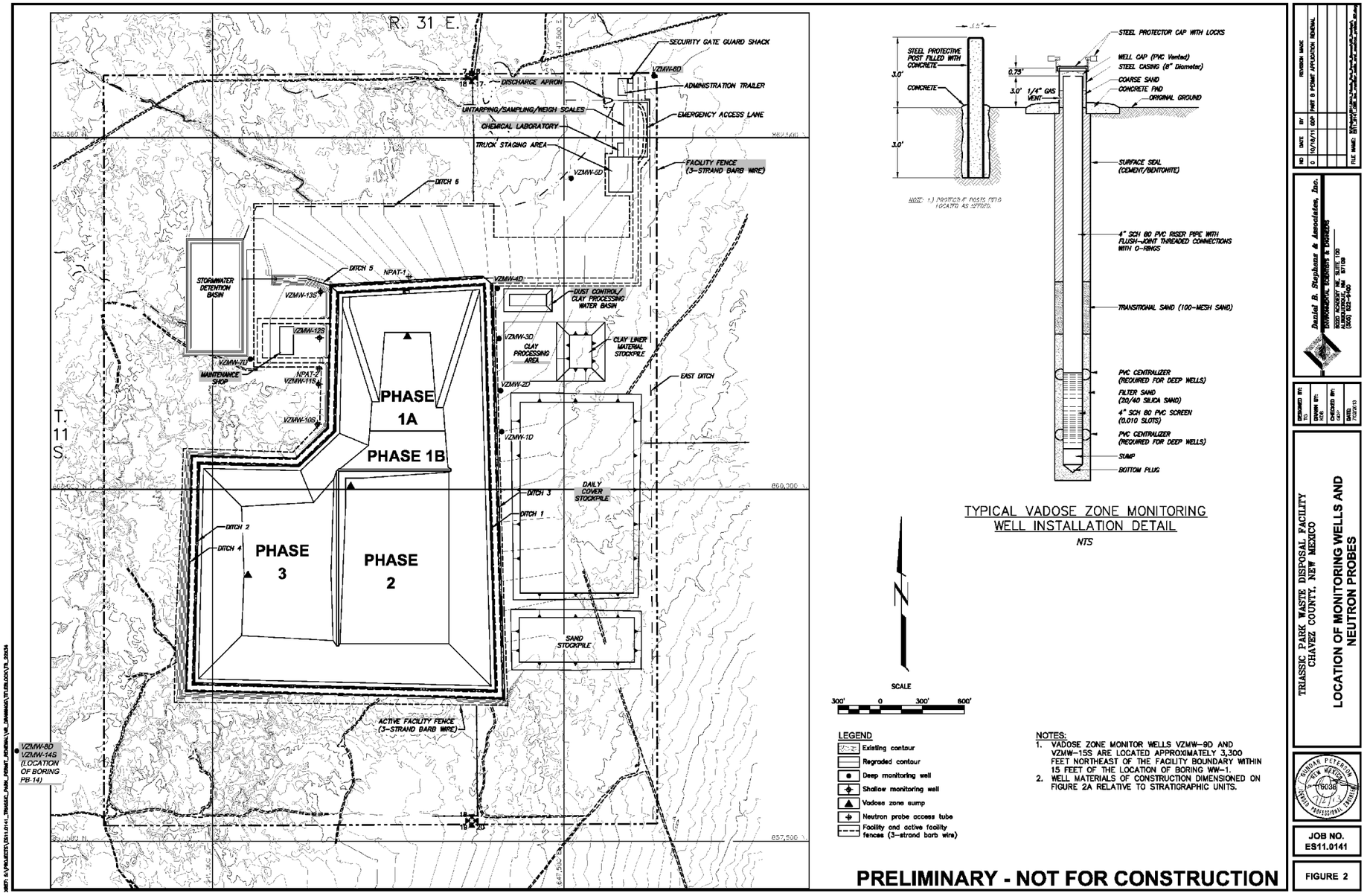
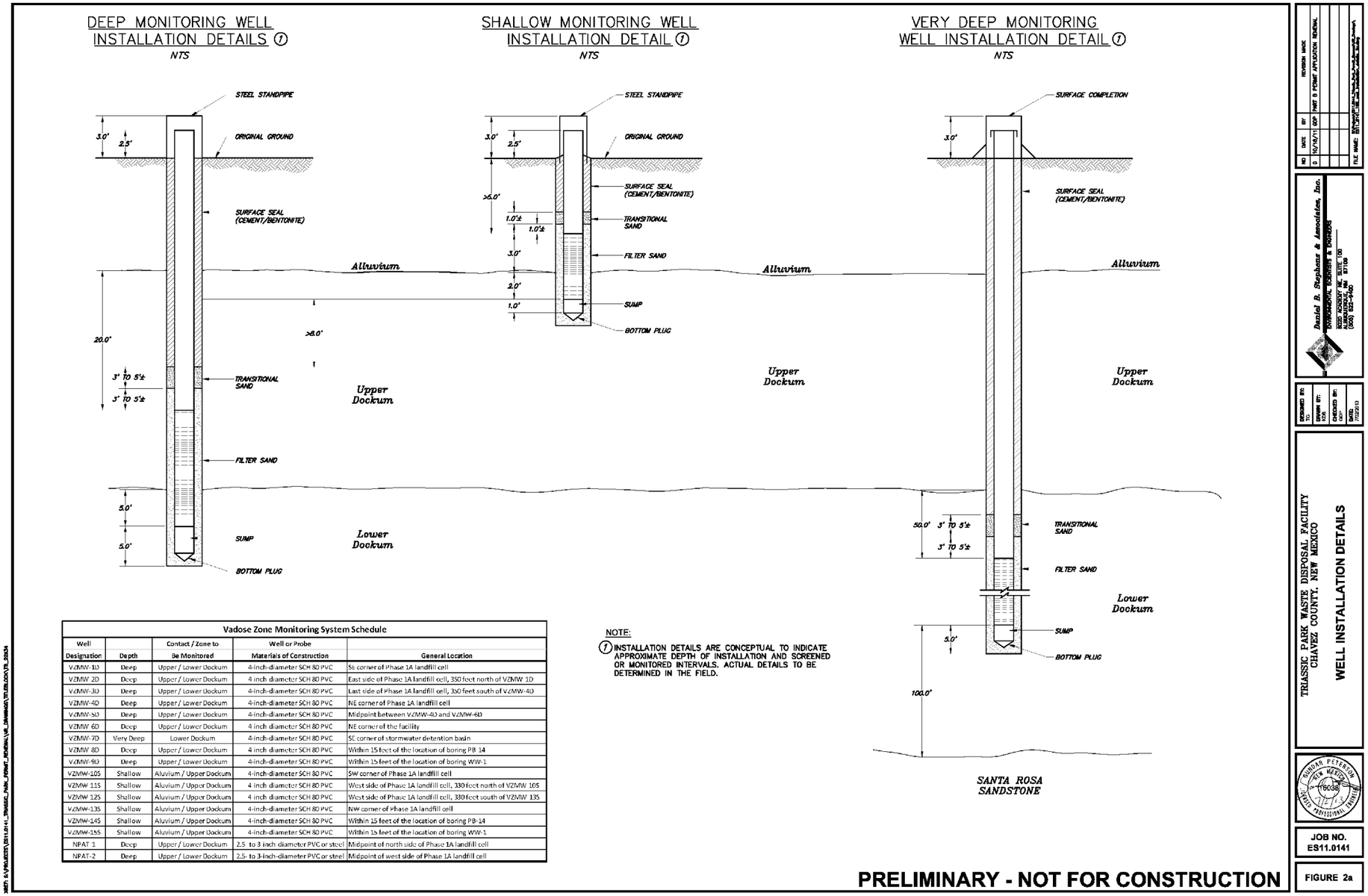


FIGURE I-2: LOCATION OF MONITORING WELLS AND NEUTRON PROBES



Vadose Zone Monitoring System Schedule				
Well Designation	Depth	Contact / Zone to Be Monitored	Well or Probe Materials of Construction	General Location
VZMW-1D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	SE corner of Phase 1A landfill cell
VZMW-2D	Deep	Upper / Lower Dockum	4 inch diameter SCH 80 PVC	East side of Phase 1A landfill cell, 350 feet north of VZMW-1D
VZMW-3D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	East side of Phase 1A landfill cell, 350 feet south of VZMW-4D
VZMW-4D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	NE corner of Phase 1A landfill cell
VZMW-5D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	Midpoint between VZMW-4D and VZMW-6D
VZMW-6D	Deep	Upper / Lower Dockum	4 inch diameter SCH 80 PVC	NE corner of the facility
VZMW-7D	Very Deep	Lower Dockum	4-inch-diameter SCH 80 PVC	SE corner of stormwater detention basin
VZMW-8D	Deep	Upper / Lower Dockum	4 inch diameter SCH 80 PVC	Within 15 feet of the location of boring PB-14
VZMW-9D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring WW-1
VZMW-10S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	SW corner of Phase 1A landfill cell
VZMW-11S	Shallow	Aluvium / Upper Dockum	4 inch diameter SCH 80 PVC	West side of Phase 1A landfill cell, 330 feet north of VZMW-10S
VZMW-12S	Shallow	Aluvium / Upper Dockum	4 inch diameter SCH 80 PVC	West side of Phase 1A landfill cell, 330 feet south of VZMW-13S
VZMW-13S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	NW corner of Phase 1A landfill cell
VZMW-14S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring PB-14
VZMW-15S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring WW-1
NPAT-1	Deep	Upper / Lower Dockum	2.5- to 3-inch-diameter PVC or steel	Midpoint of north side of Phase 1A landfill cell
NPAT-2	Deep	Upper / Lower Dockum	2.5- to 3-inch-diameter PVC or steel	Midpoint of west side of Phase 1A landfill cell

NOTE:
(7) INSTALLATION DETAILS ARE CONCEPTUAL TO INDICATE APPROXIMATE DEPTH OF INSTALLATION AND SCREENED OR MONITORED INTERVALS. ACTUAL DETAILS TO BE DETERMINED IN THE FIELD.

PRELIMINARY - NOT FOR CONSTRUCTION

REVISION MADE
NO. DATE BY REVISION MADE
0 10/14/11 GCP PART B PERMIT APPLICATION RENEWAL

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DESIGNED BY: TO
DRAWN BY: MS
CHECKED BY: GCP
DATE: 07/20/11

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO
WELL INSTALLATION DETAILS

JOB NO. ES11.0141
FIGURE 2a

FIGURE I-2(A): WELLS INSTALLATION DETAILS

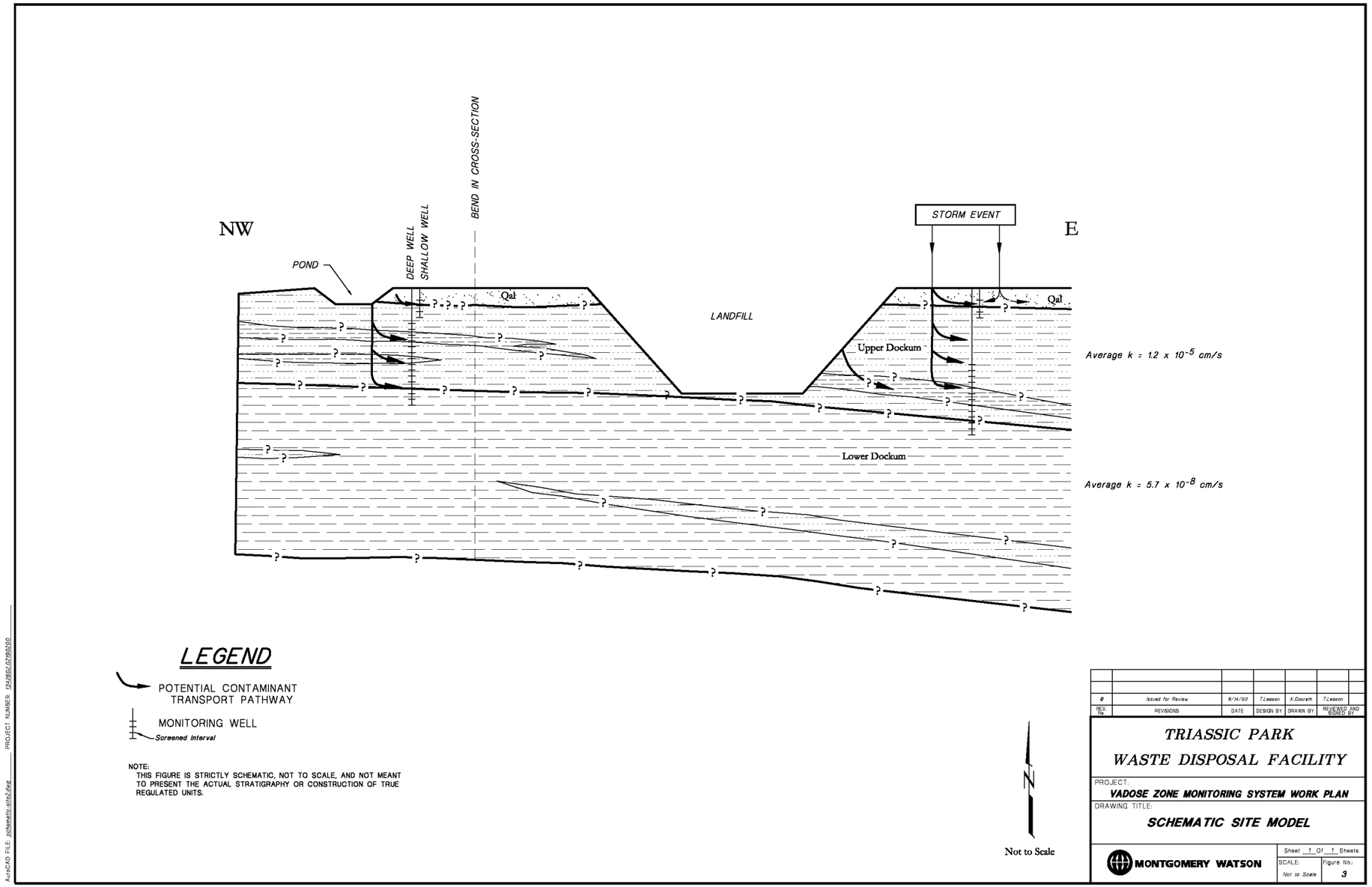


FIGURE I-3: SCHEMATIC SITE MODEL

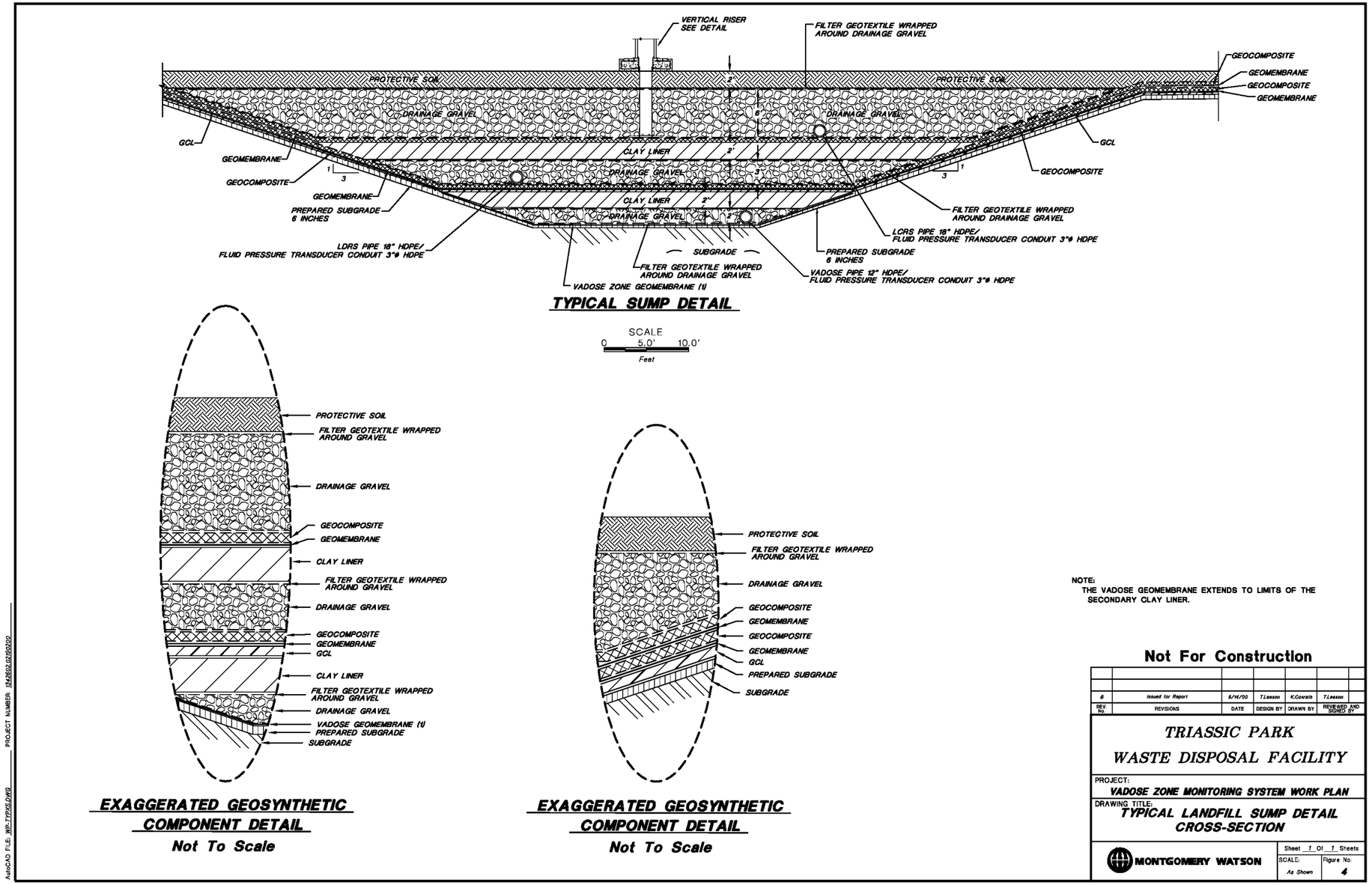
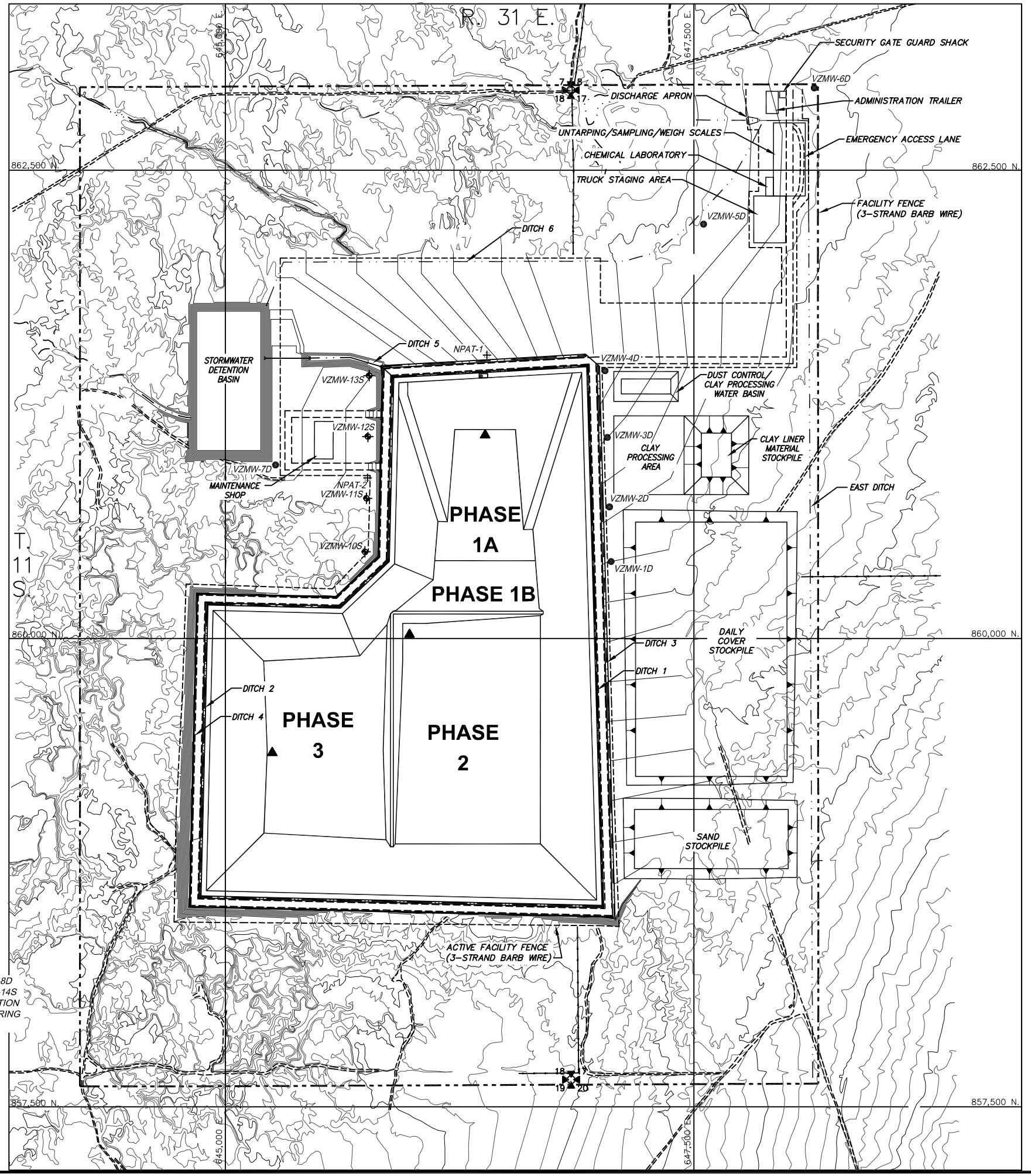
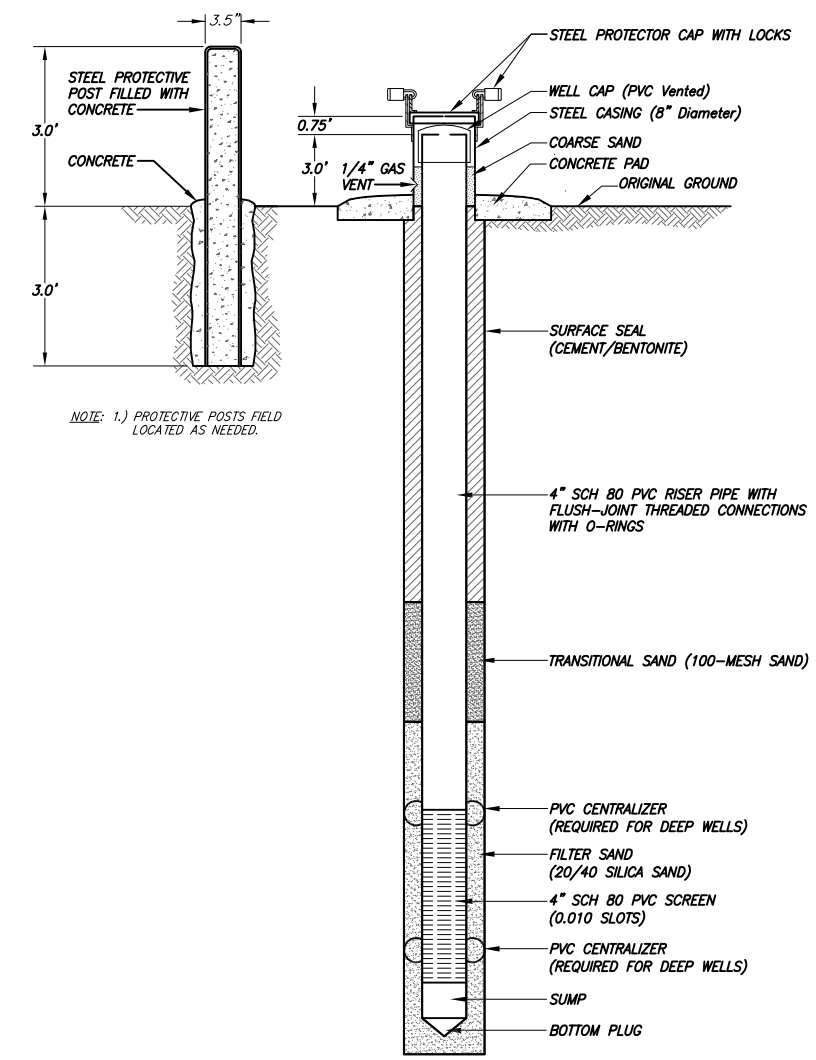


FIGURE I-4: TYPICAL LANDFILL SUMP DETAIL CROSS-SECTION





NOTE: 1.) PROTECTIVE POSTS FIELD LOCATED AS NEEDED.

TYPICAL VADOSE ZONE MONITORING WELL INSTALLATION DETAIL

NTS

SCALE

300' 0 300' 600'

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. VADOSE 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.
2. WELL MATERIALS OF CONSTRUCTION DIMENSIONED ON FIGURE 2A RELATIVE TO STRATIGRAPHIC UNITS.

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_LOBR_Site_Plan_Monitoring_Locations_Figure_02.dwg

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DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 7/02/2013

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

LOCATION OF MONITORING WELLS AND NEUTRON PROBES

SUNDAR PETERSON
NEW MEXICO
16038
7/2/13
LICENSED PROFESSIONAL ENGINEER

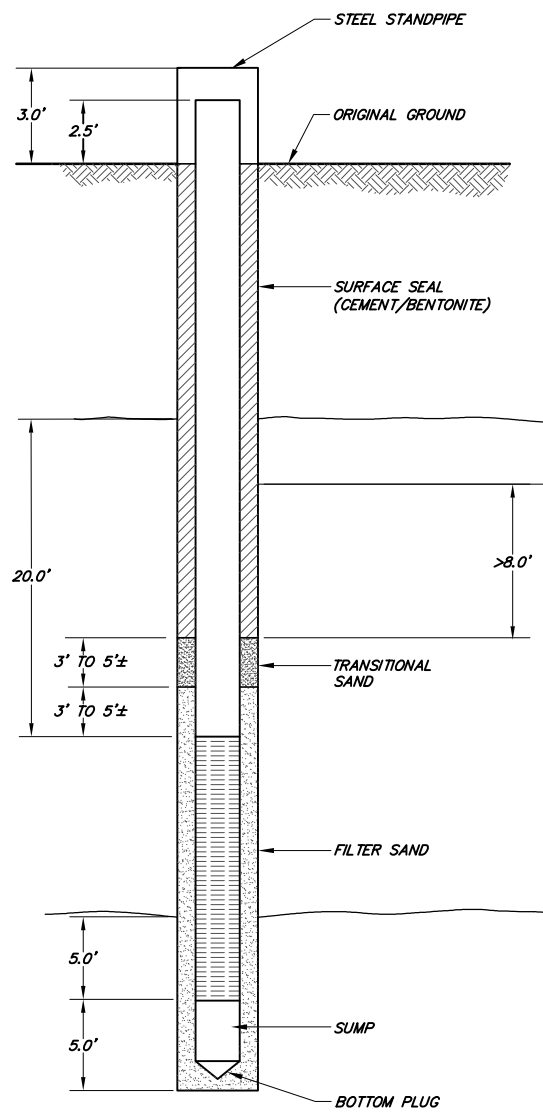
JOB NO. ES11.0141

FIGURE 2

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

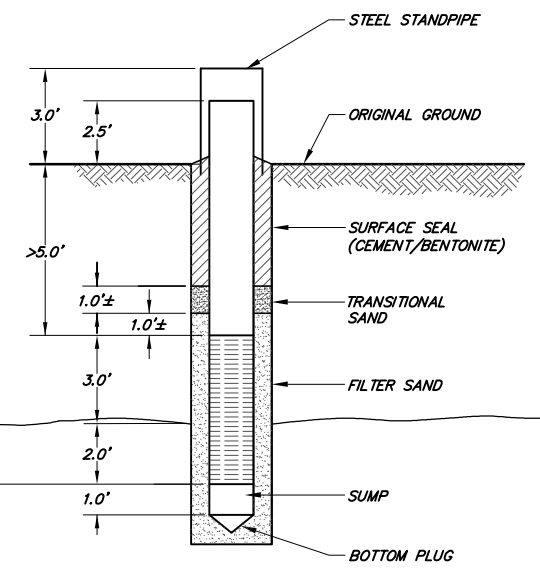
DEEP MONITORING WELL INSTALLATION DETAILS (1)

NTS



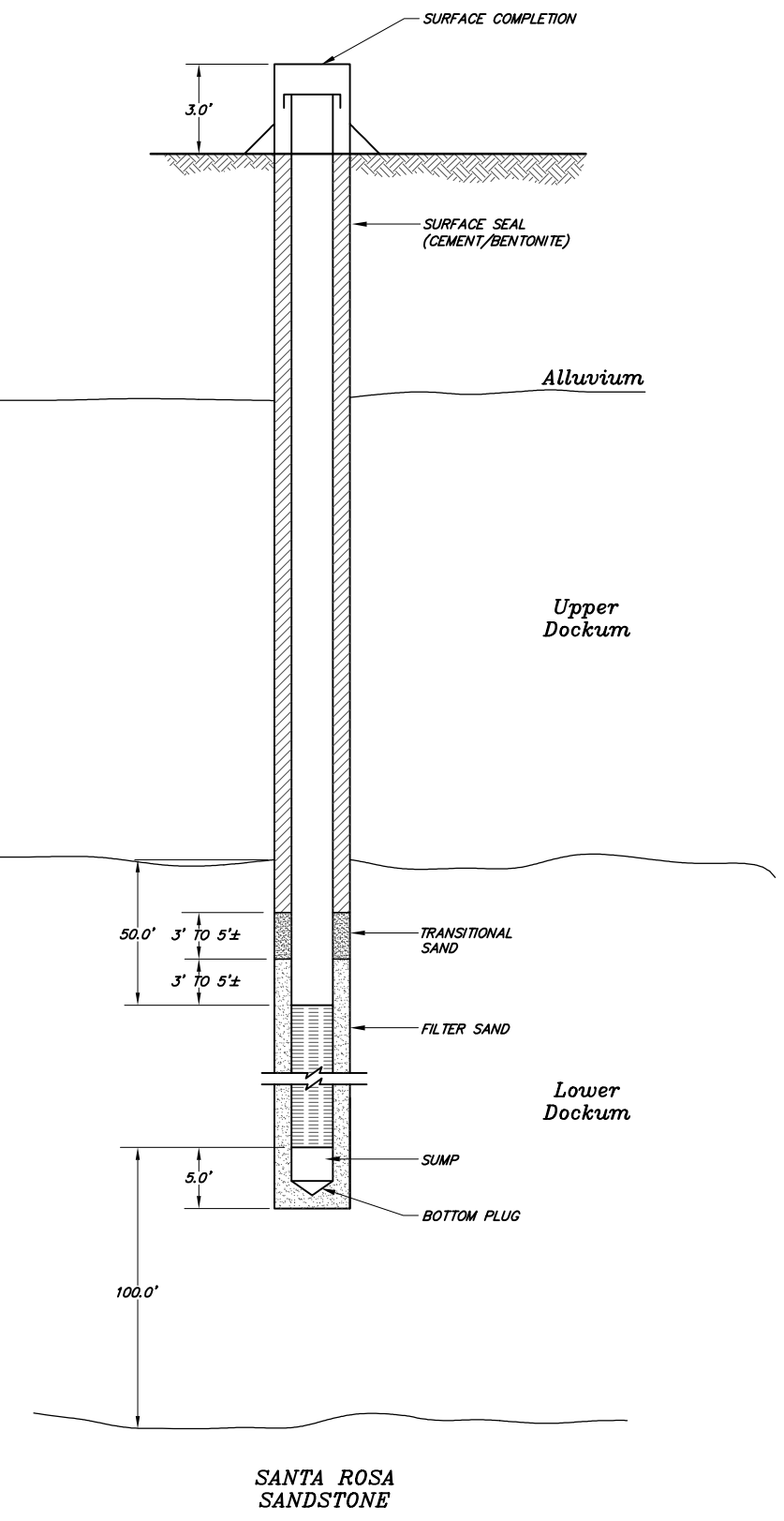
SHALLOW MONITORING WELL INSTALLATION DETAIL (1)

NTS



VERY DEEP MONITORING WELL INSTALLATION DETAIL (1)

NTS



NOTE:

(1) INSTALLATION DETAILS ARE CONCEPTUAL TO INDICATE APPROXIMATE DEPTH OF INSTALLATION AND SCREENED OR MONITORED INTERVALS. ACTUAL DETAILS TO BE DETERMINED IN THE FIELD.

Vadose Zone Monitoring System Schedule

Well Designation	Depth	Contact / Zone to Be Monitored	Well or Probe Materials of Construction	General Location
VZMW-1D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	SE corner of Phase 1A landfill cell
VZMW-2D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	East side of Phase 1A landfill cell, 350 feet north of VZMW-1D
VZMW-3D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	East side of Phase 1A landfill cell, 350 feet south of VZMW-4D
VZMW-4D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	NE corner of Phase 1A landfill cell
VZMW-5D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	Midpoint between VZMW-4D and VZMW-6D
VZMW-6D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	NE corner of the facility
VZMW-7D	Very Deep	Lower Dockum	4-inch-diameter SCH 80 PVC	SE corner of stormwater detention basin
VZMW-8D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring PB-14
VZMW-9D	Deep	Upper / Lower Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring WW-1
VZMW-10S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	SW corner of Phase 1A landfill cell
VZMW-11S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	West side of Phase 1A landfill cell, 330 feet north of VZMW-10S
VZMW-12S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	West side of Phase 1A landfill cell, 330 feet south of VZMW-13S
VZMW-13S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	NW corner of Phase 1A landfill cell
VZMW-14S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring PB-14
VZMW-15S	Shallow	Aluvium / Upper Dockum	4-inch-diameter SCH 80 PVC	Within 15 feet of the location of boring WW-1
NPAT-1	Deep	Upper / Lower Dockum	2.5- to 3-inch-diameter PVC or steel	Midpoint of north side of Phase 1A landfill cell
NPAT-2	Deep	Upper / Lower Dockum	2.5- to 3-inch-diameter PVC or steel	Midpoint of west side of Phase 1A landfill cell

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_VR_Well_Installation_Details.dwg

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DESIGNED BY: TG
DRAWN BY: KDB
CHECKED BY: GDP
DATE: 7/02/2013

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVEZ COUNTY, NEW MEXICO

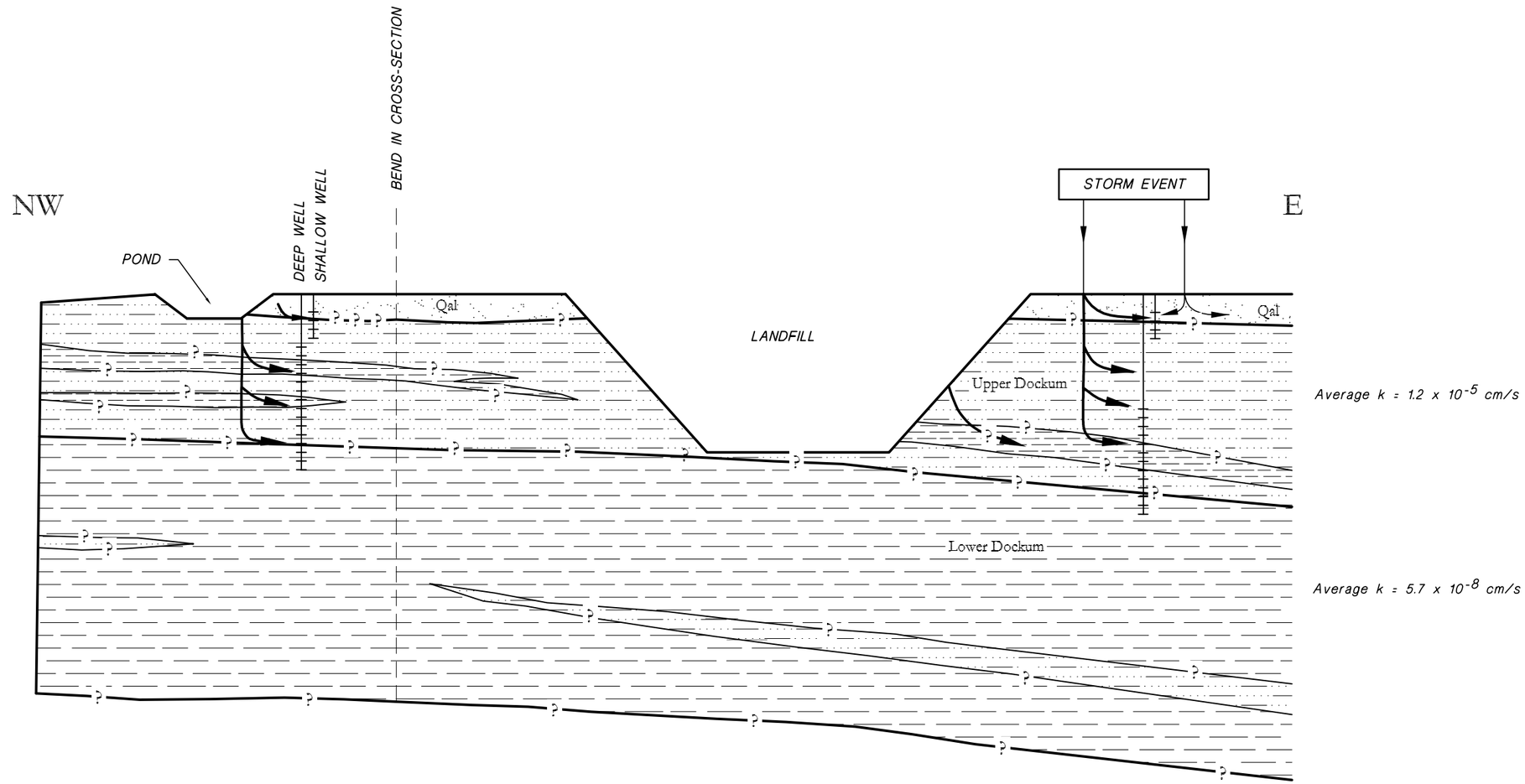
WELL INSTALLATION DETAILS

GUNDAR PETERSON NEW MEXICO 16038 7/2/13 LICENSED PROFESSIONAL ENGINEER

JOB NO. ES11.0141

FIGURE 2a

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



LEGEND

POTENTIAL CONTAMINANT TRANSPORT PATHWAY

MONITORING WELL

Screened Interval

NOTE:
THIS FIGURE IS STRICTLY SCHEMATIC, NOT TO SCALE, AND NOT MEANT TO PRESENT THE ACTUAL STRATIGRAPHY OR CONSTRUCTION OF TRUE REGULATED UNITS.

N

Not to Scale

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	6/14/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK WASTE DISPOSAL FACILITY

PROJECT:
VADOSE ZONE MONITORING SYSTEM WORK PLAN

DRAWING TITLE:
SCHEMATIC SITE MODEL

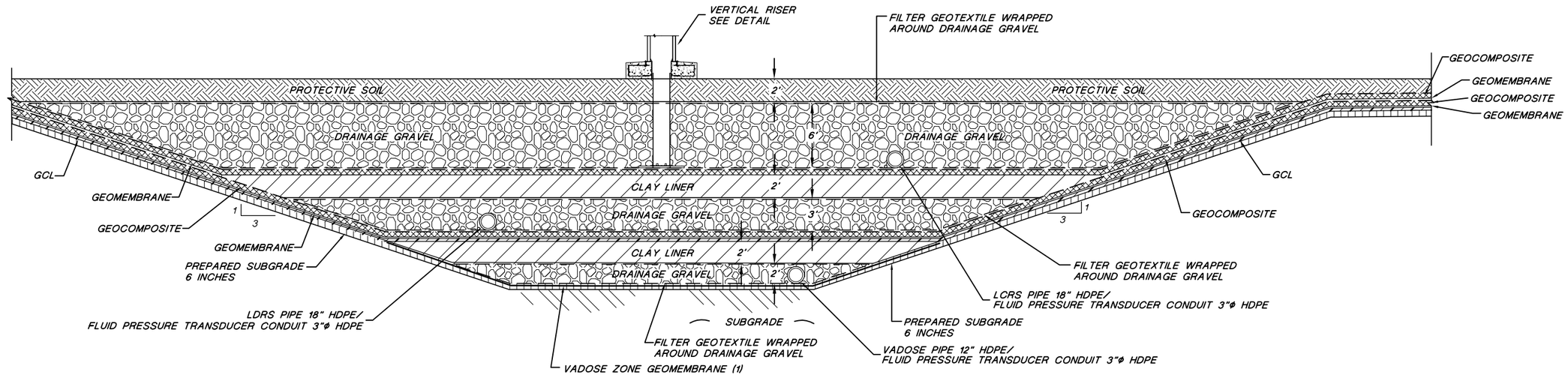
MONTGOMERY WATSON

Sheet 1 Of 1 Sheets

SCALE: Not to Scale

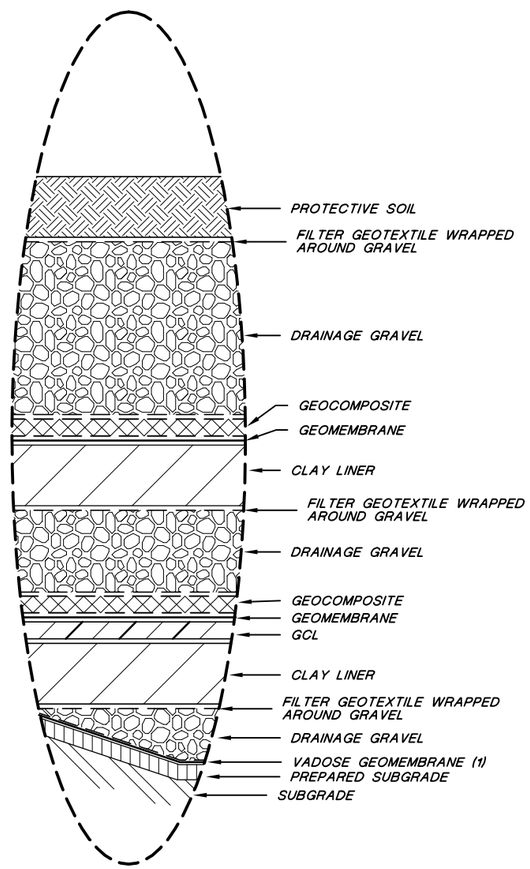
Figure No.: 3

AutoCAD FILE: schematic-site2.dwg PROJECT NUMBER: 1342602.02190200



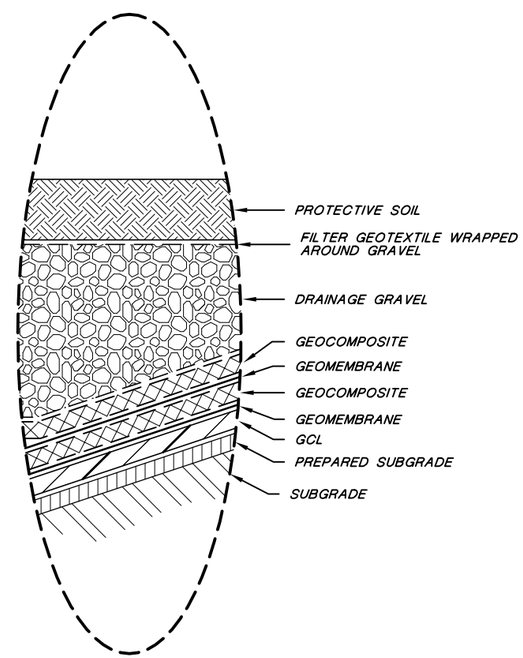
TYPICAL SUMP DETAIL

SCALE
0 5.0' 10.0'
Feet



EXAGGERATED GEOSYNTHETIC COMPONENT DETAIL

Not To Scale



EXAGGERATED GEOSYNTHETIC COMPONENT DETAIL

Not To Scale

NOTE:
THE VADOSE GEOMEMBRANE EXTENDS TO LIMITS OF THE SECONDARY CLAY LINER.

Not For Construction

REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Report	6/14/00	T.Leeson	K.Conrath	T.Leeson

TRIASSIC PARK
WASTE DISPOSAL FACILITY

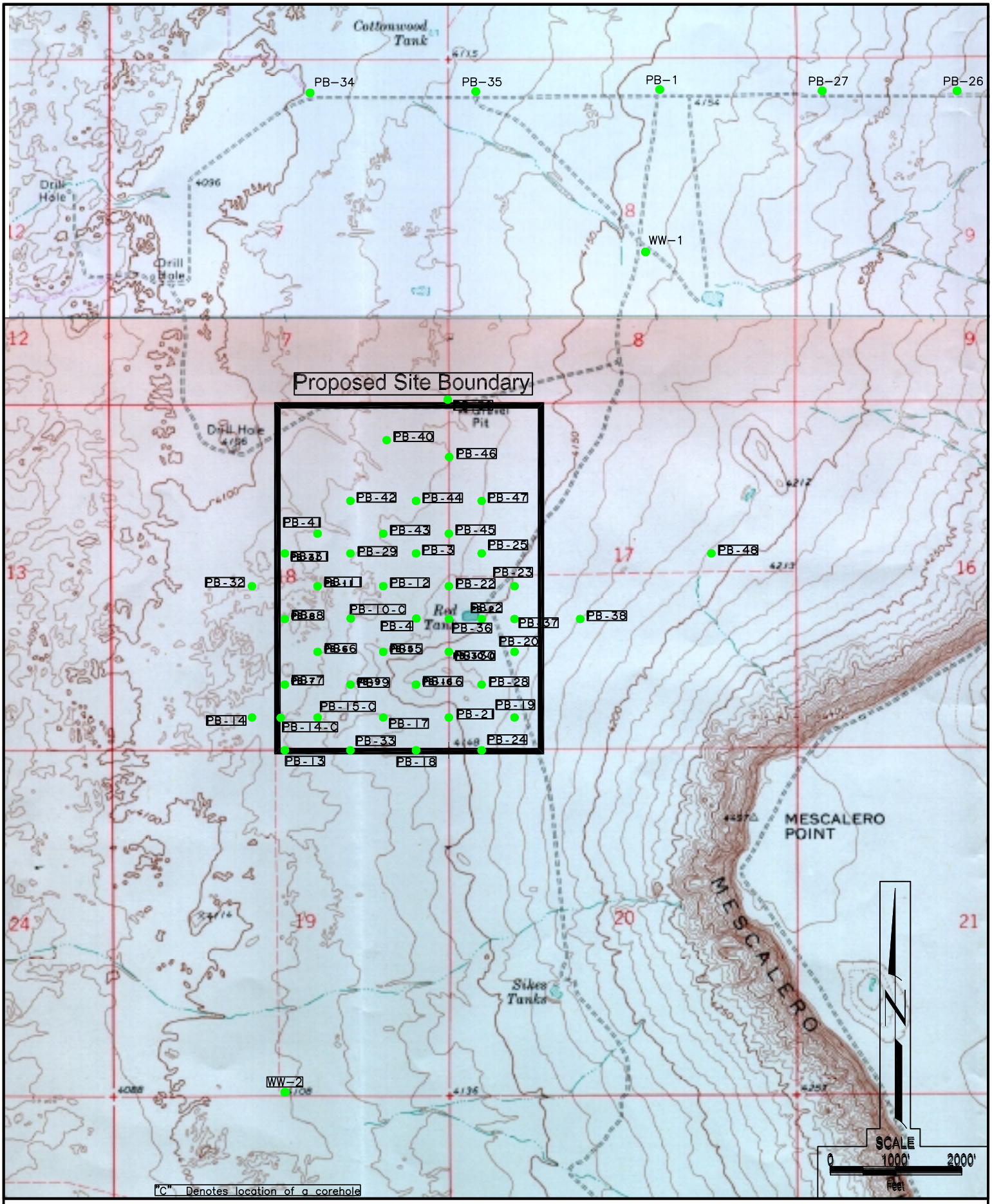
PROJECT:
VADOSE ZONE MONITORING SYSTEM WORK PLAN

DRAWING TITLE:
TYPICAL LANDFILL SUMP DETAIL CROSS-SECTION

MONTGOMERY WATSON

Sheet 1 Of 1 Sheets
SCALE: As Shown
Figure No: 4

AutoCAD FILE: WP-TYPXS.DWG PROJECT NUMBER: 1342602.02190200

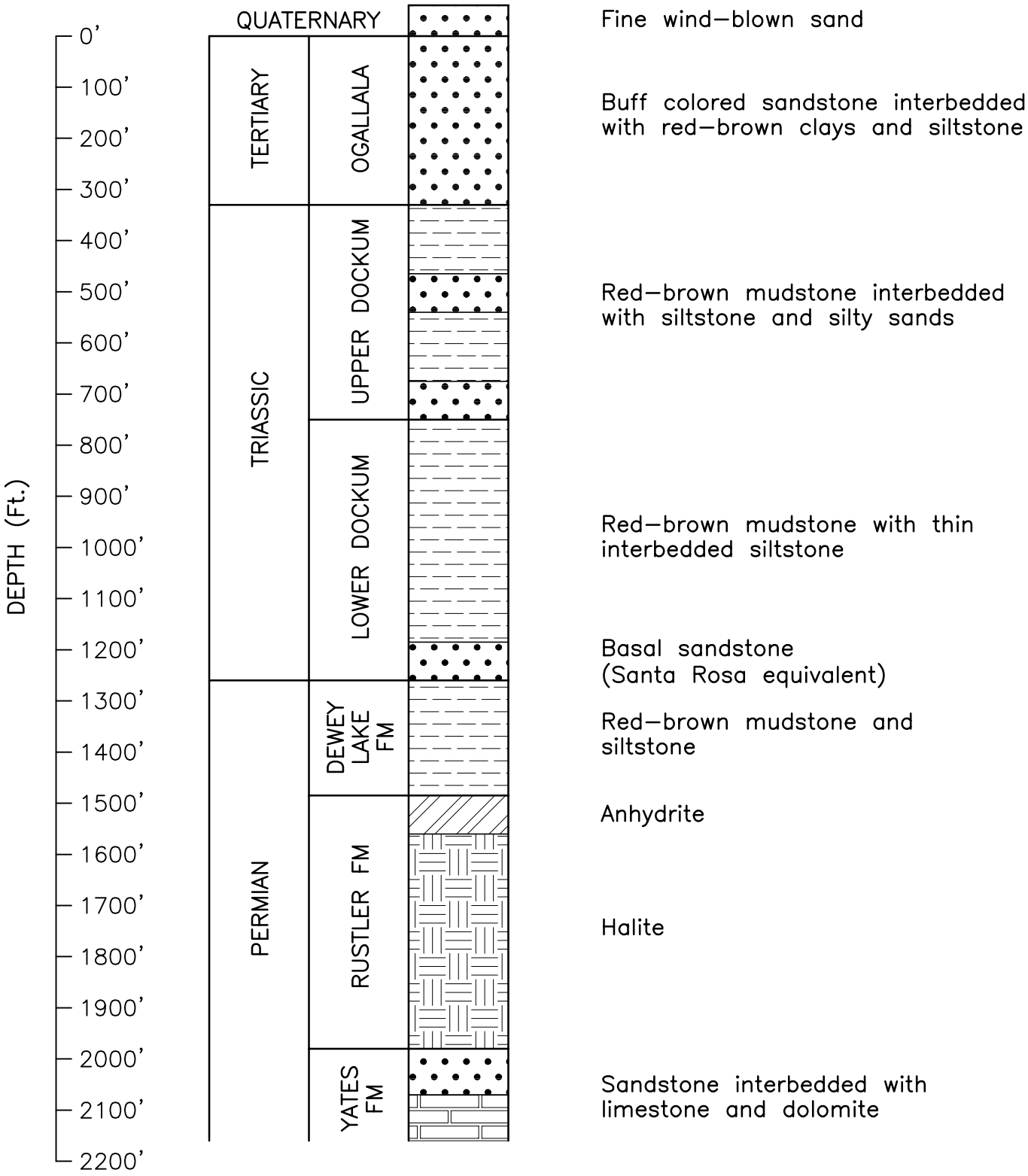


DRILL HOLE LOCATIONS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 1-1

AutoCAD FILE: *GAN-DHLOC.DWG*

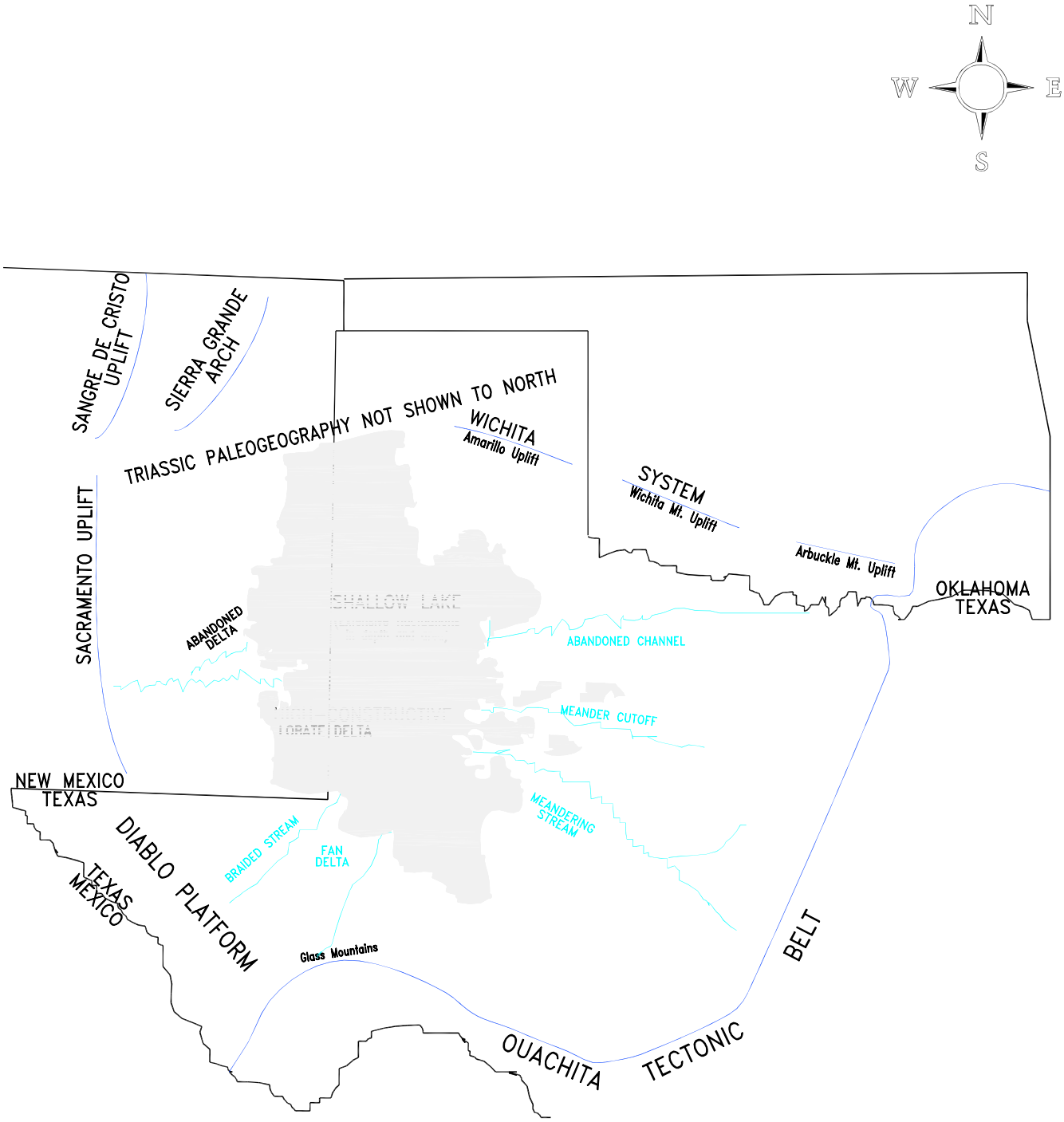


STRATIGRAPHIC COLUMN

Figure 3-1

TRIASSIC PARK WASTE DISPOSAL FACILITY

AutoCAD FILE: *GANDY-FIG3-1*



Scale: 1"=80 Miles

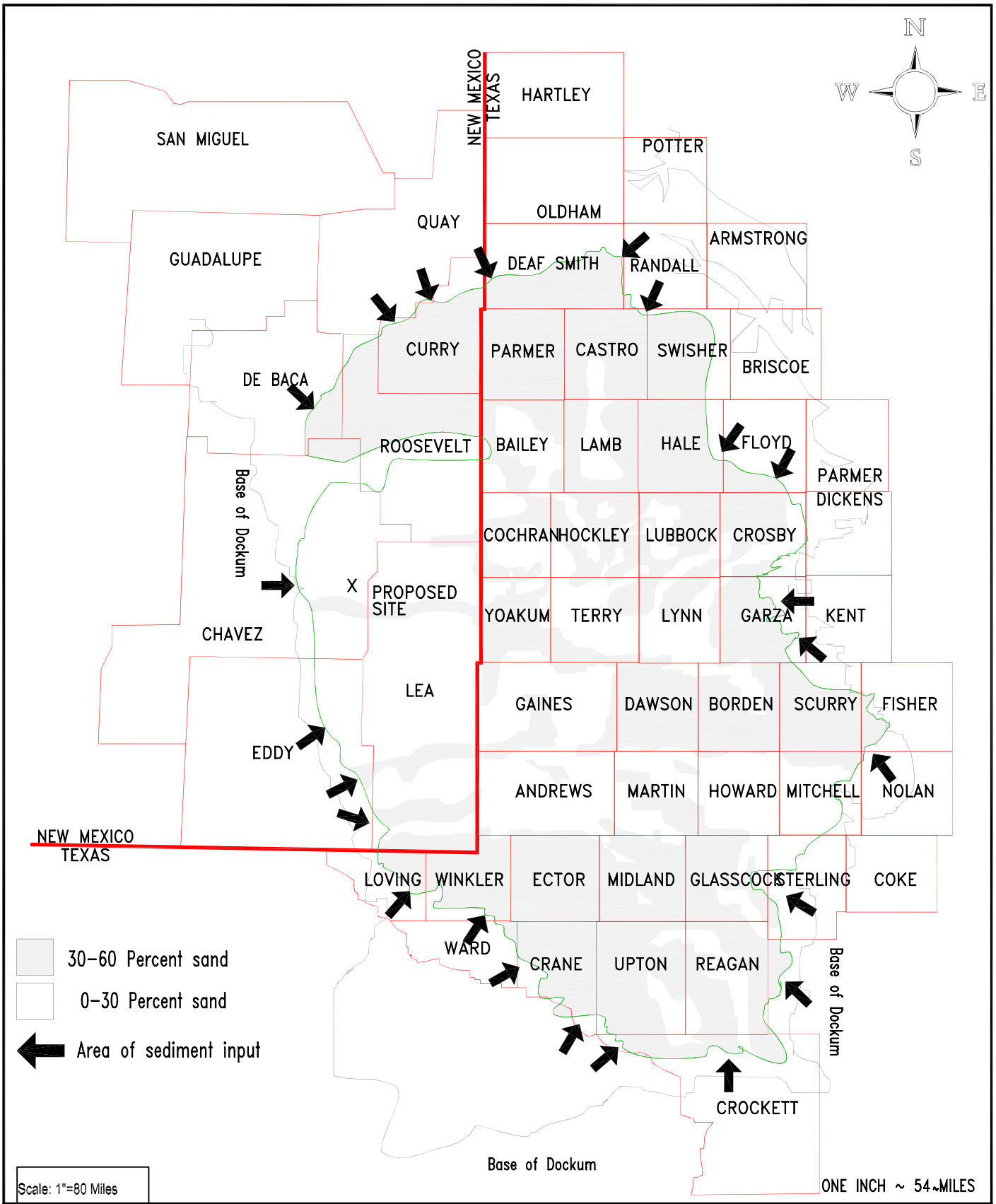
ONE INCH ~ 100 MILES

BASIN PALEOMAP FOR TRIASSIC PERIOD

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-2

AutoCAD FILE: *GANDY-FIG3-2*



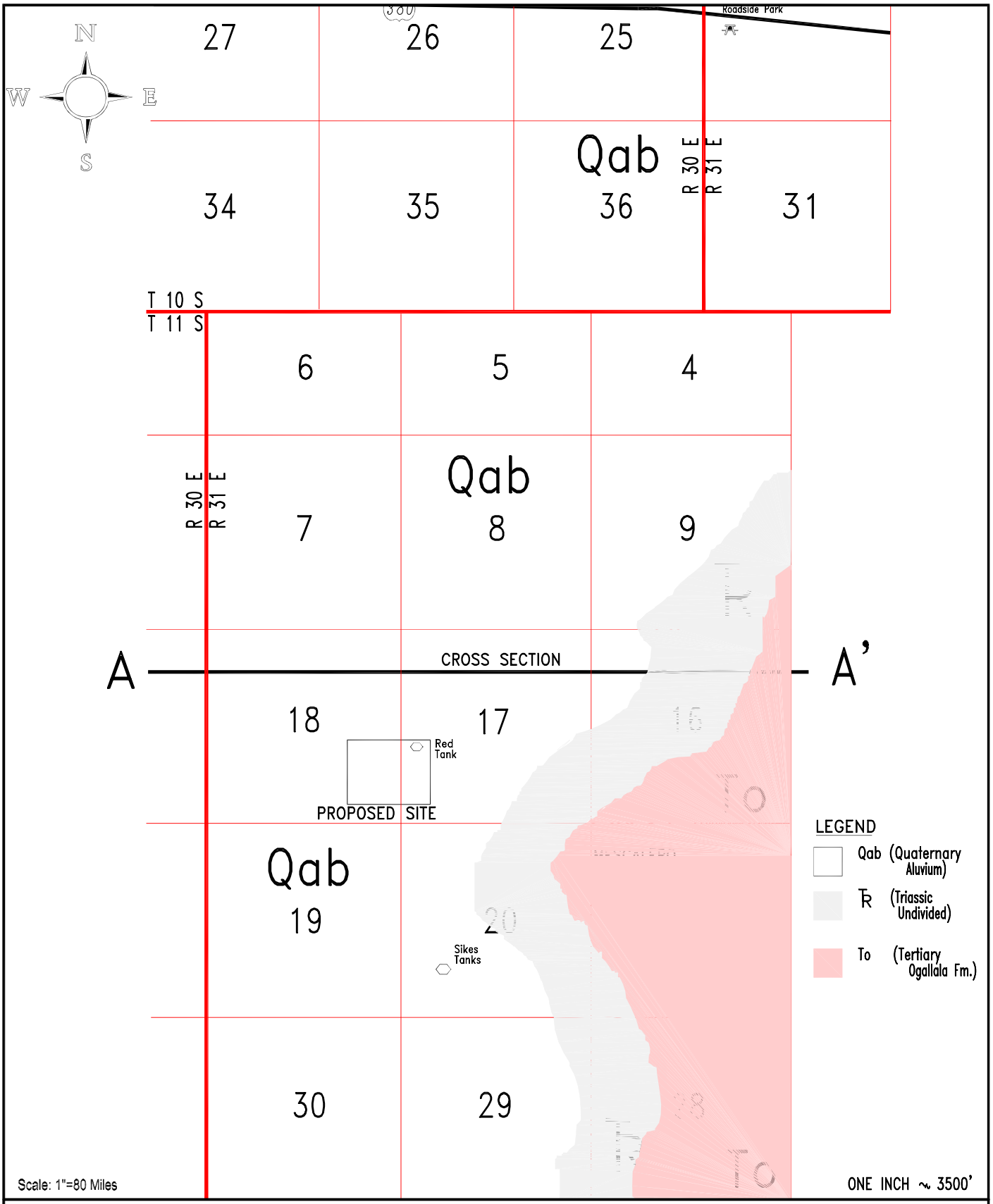
Scale: 1"=80 Miles

TRIASSIC PERIOD SAND ACCUMULATION IN PALEOBASIN

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-3

AutoCAD FILE: *GANDY-FIG3-3*



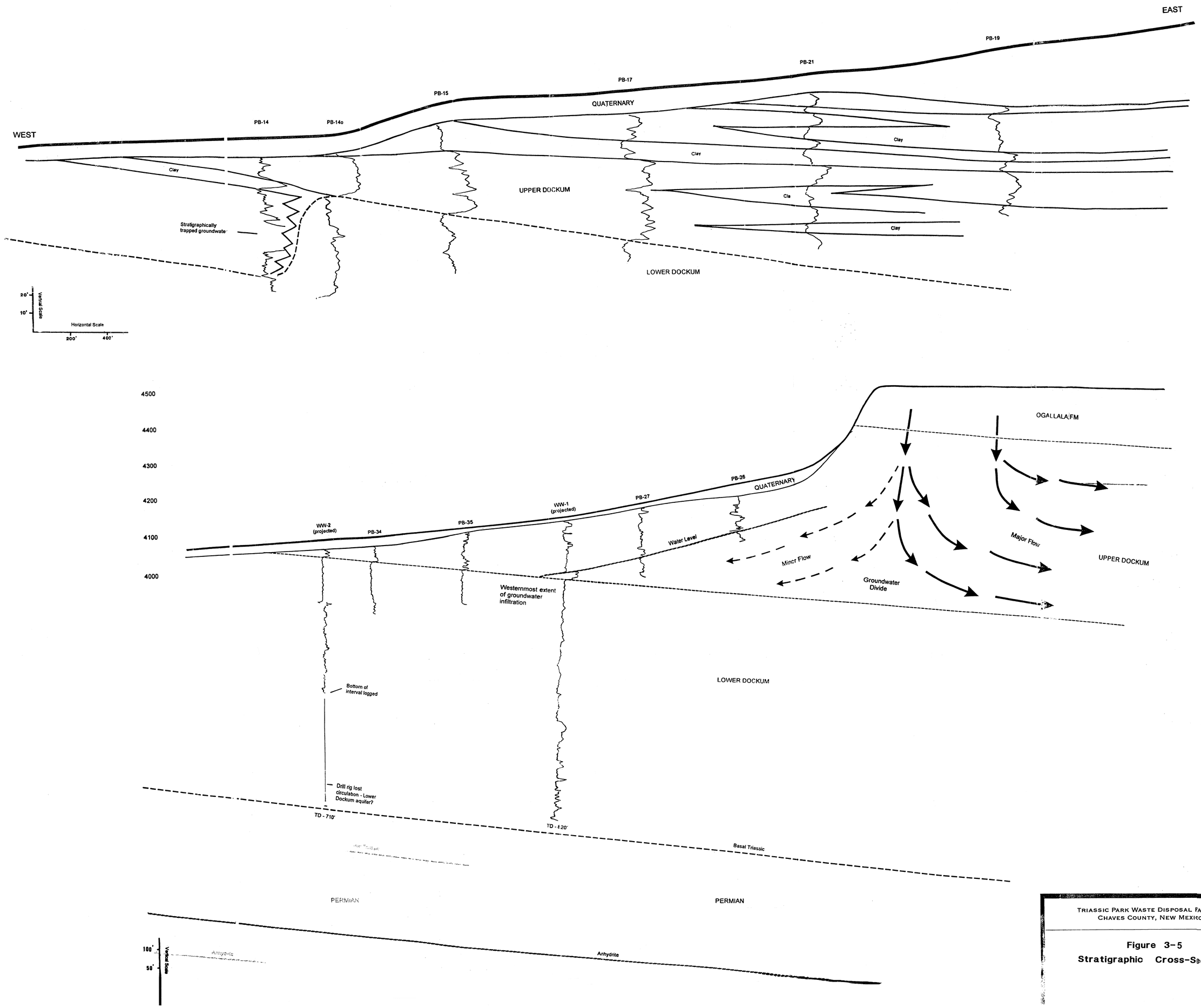
SURFACE GEOLOGY - PROJECT AREA

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-4

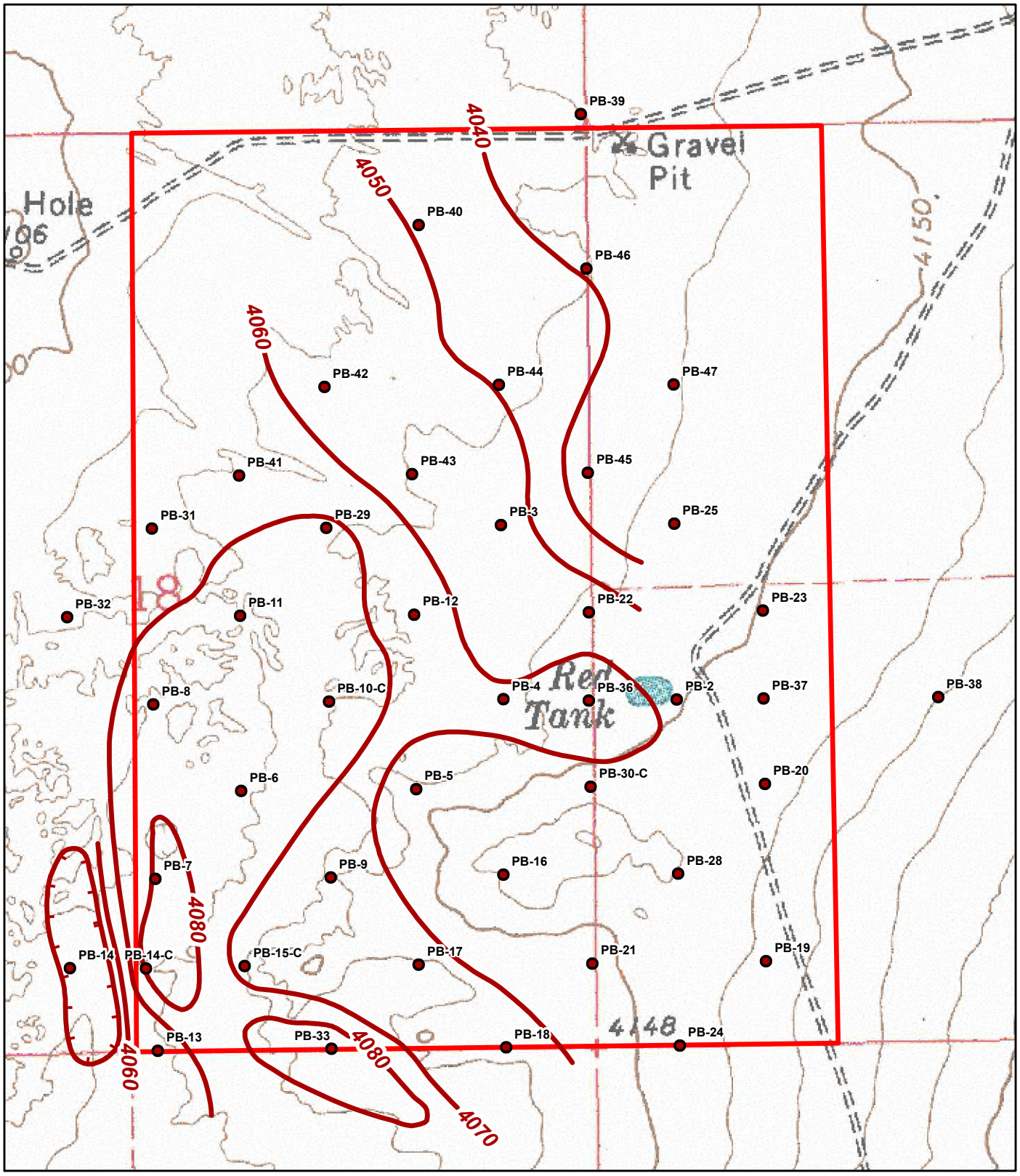
AutoCAD FILE: *GANDY-FIG3-4*

GANDY MARLEY PROJECT



TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVES COUNTY, NEW MEXICO

Figure 3-5
Stratigraphic Cross-Section



Legend

Proposed site boundary

Structural contour

PB-28 Borehole

N

0 400 800 Feet

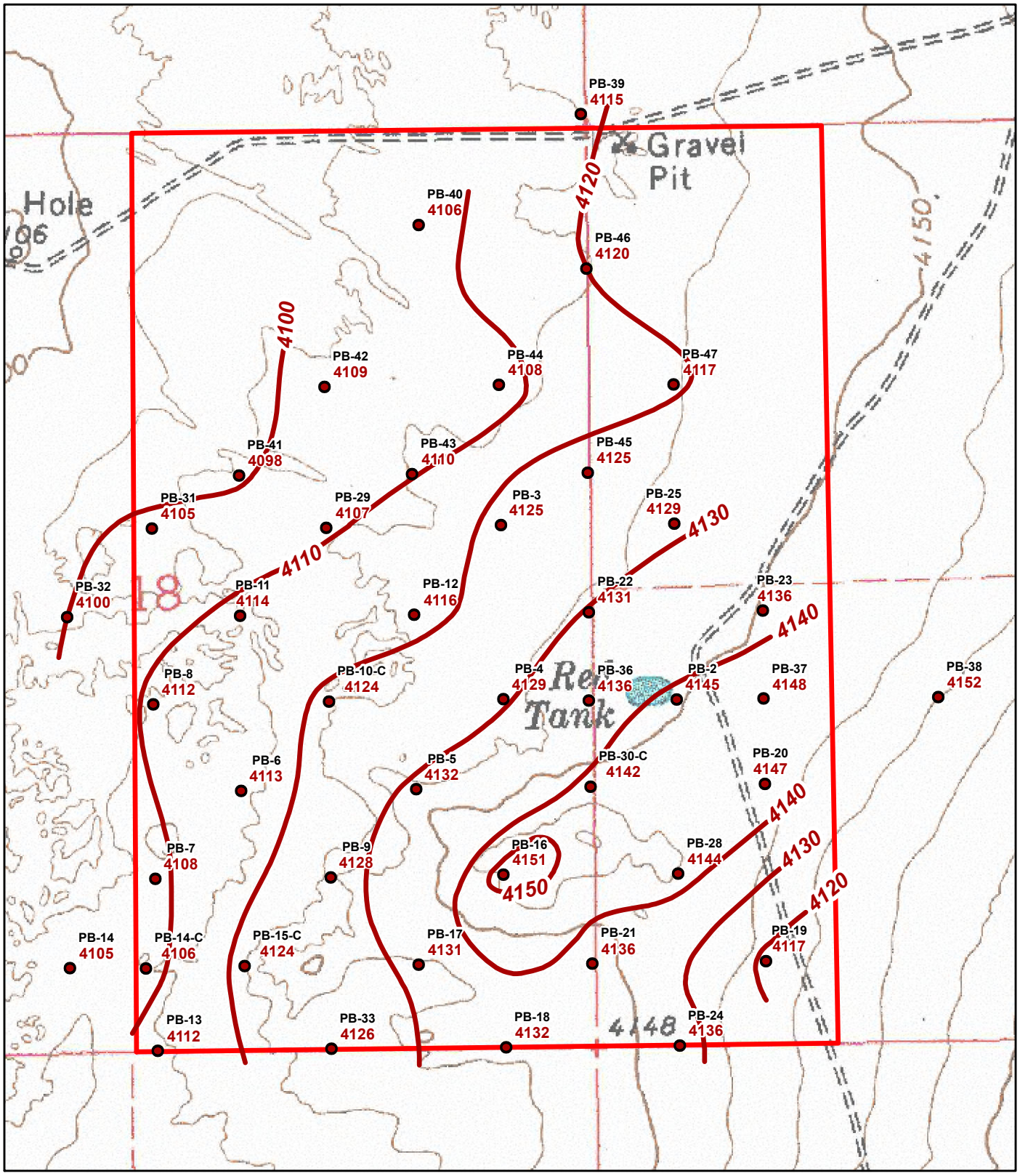
STRUCTURE CONTOUR TOP OF LOWER DOCKUM

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-6

S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\GIS\MXDS\FIGURES_06-13\FIG3-6_TOP_OF_LOWER_DOCKUM.MXD

6/26/2013



Legend

Proposed site boundary

Structural contour

PB-28 Borehole

N

0 400 800 Feet

STRUCTURE CONTOUR TOP OF UPPER DOCKUM

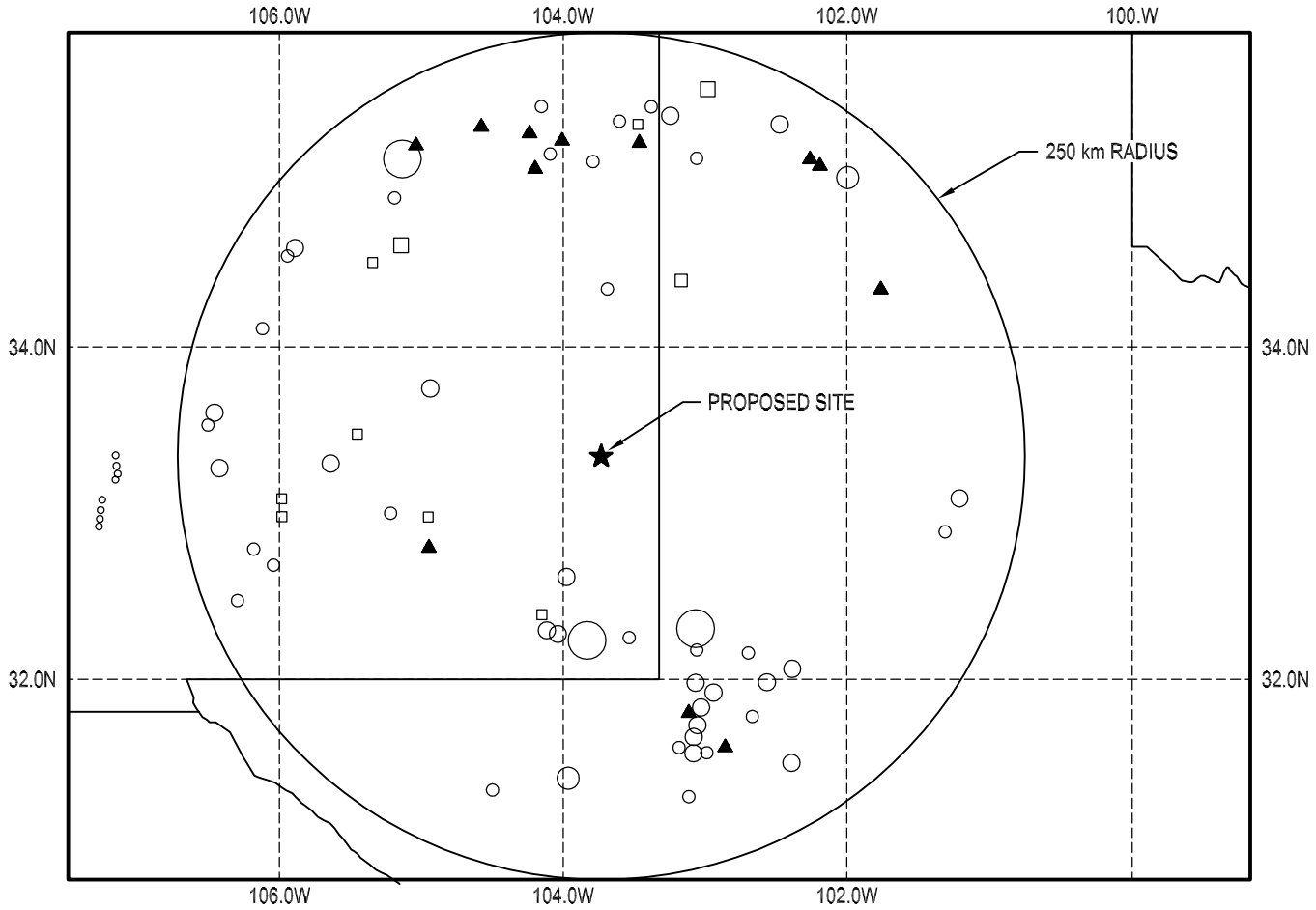
TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-6a

S:\PROJECTS\ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL\GIS\MXDS\FIGURES_06-13\FIG3-6A_TOP_OF_UPPER_DOCKUM.MXD

6/26/2013

SEISMICITY WITHIN 250 KM OF 33.367N 103.850W



102 EARTHQUAKES PLOTTED

MAGNITUDES

0.1-1.9 =	○	4.0-4.4 =	○
2.0-2.9 =	○	4.5-4.9 =	○
3.0-3.4 =	○	5.0-5.4 =	○
3.5-3.9 =	○	> 5.4 =	○

NO INTENSITY OR MAGNITUDE ▲

INTENSITIES

I-III	□	VII	□
IV	□	VIII	□
V	□	IX	□
VI	□	X-XII	□

National Geophysical Data Center/NOAA Boulder, Colorado 80303

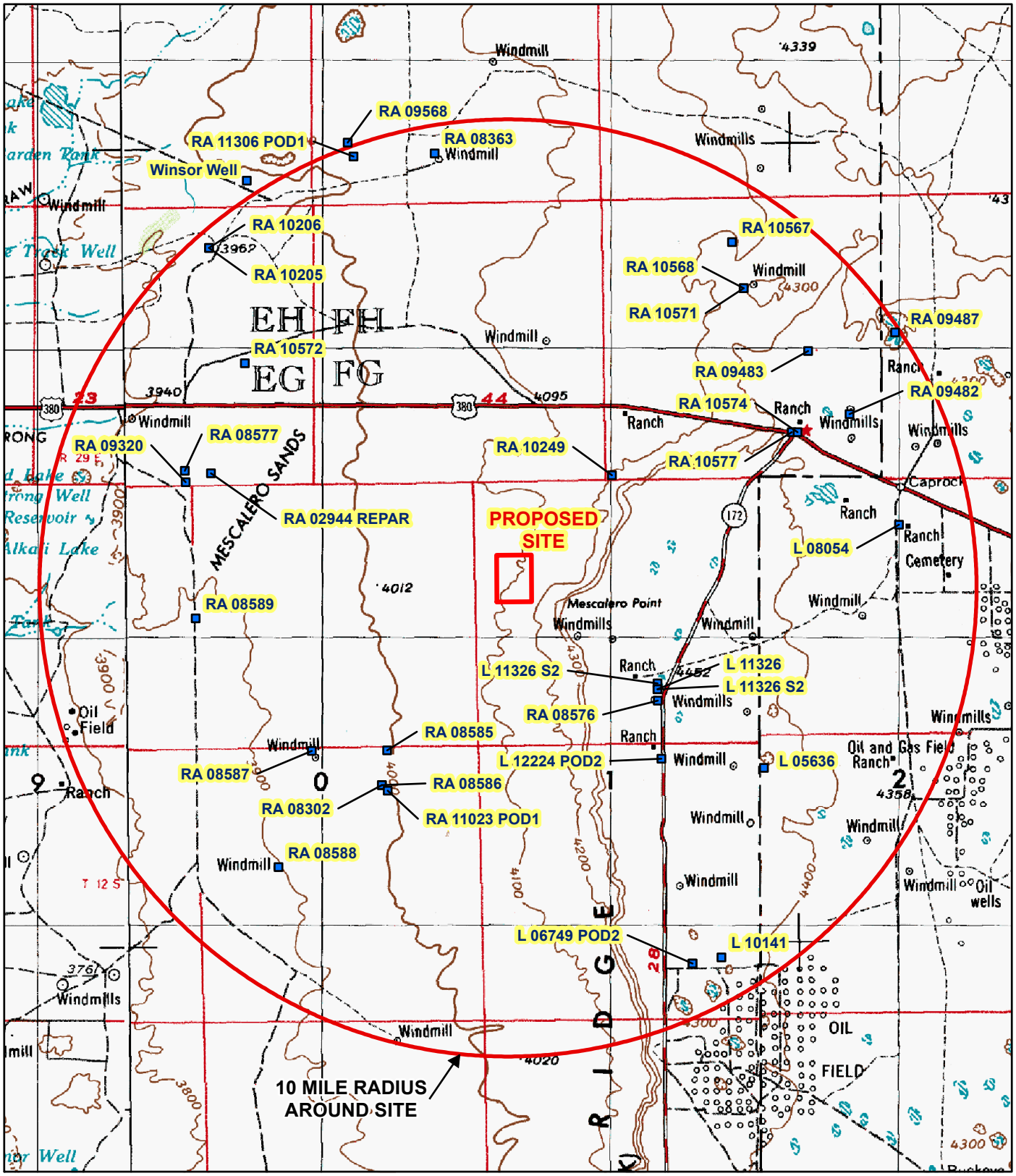
N

SEISMIC ACTIVITY MAP

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 3-7

AutoCAD FILE: *GANDY-FIG3-7*



0 1.5 3 Miles

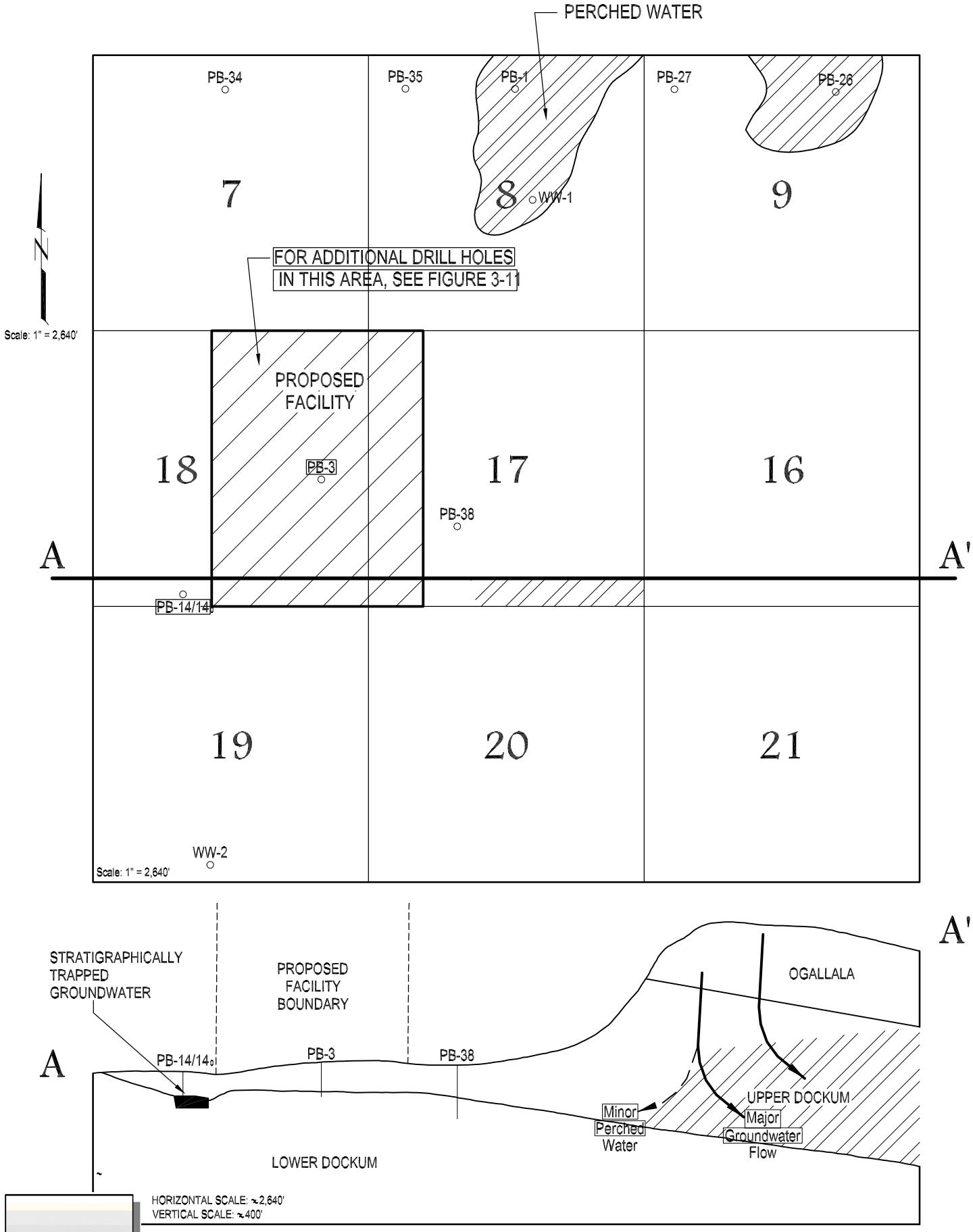
AREA TOPOGRAPHY AND WATER WELLS - 10 MILE RADIUS

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-1

S:/PROJECTS/ES11.0141_TRIASSIC_PARK_PERMIT_RENEWAL/GIS/MXDS/FIGURES/FIG_4-1_WELLS_10_MI.MXD

04/26/2012



UPPER DOCKUM - PERCHED WATER

TRIASSIC PARK WASTE DISPOSAL FACILITY

Figure 4-2

AutoCAD FILE: *GANDY-FIG4-2*