CHAPTER L

WIPP GROUND-WATER DETECTION MONITORING PROGRAM PLAN

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List of Abbreviations/Acronyms

ASER	Annual Site Environmental Report
AR/VR	Approval/Variation Request
Bell Canyon	Bell Canyon Formation
bgs	below ground surface
Castile	Castile Formation
cm	centimeter(s)
Culebra	Culebra Member of the Rustler Formation
CofC	Chain of Custody
°C	degree(s) Celsius
%C	percent completeness
DI	deionized
DMP	Detection Monitoring Program
DOE	U.S. Department of Energy
DQO	data quality objectives
EM	Environmental Monitoring
EPA	U.S. Environmental Protection Agency
ES&H	Environment, Safety, and Health Department
FEIS	Final Environmental Impact Statement
ft	foot (feet)
ft^2	square foot (square feet)
g/cm^3	gram per cubic centimeter
GWSP	Groundwater Surveillance Program
HWDU	hazardous waste disposal unit(s)
km	kilometer(s)
km^2	square kilometer(s)
$lb/in.^2$	pound(s) per square inch
LCS	laboratory control samples
LD	limit of detection
LWA	Land Withdrawal Act
m	meter(s)
M&DC	monitoring and data collection
m^2	square meter(s)
mg/L	milligram(s) per liter
mi	mile(s)
mi^2	square mile(s)
MOC	Management and Operating Contractor
MPa	megapascal(s)
mV	millivolt(s)
NIST	National Institute for Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PRS	Project Records Services

QA	Quality Assurance
QA/QC	quality assurance/quality control
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFA	request for analysis
RIDS	Records Inventory and Disposition Schedule
RPD	relative percent difference
Rustler	Rustler Formation
%R	percent recovery
Salado	Salado Formation
SC	specific conductance
SOP	Standard Operating Procedure
STLB	sample tracking logbook
TDS	total dissolved solids
TOC	total organic carbon
TOX	total organic halogens
TRU	transuranic
TSDF	treatment, storage, and disposal facilities
TSS	total suspended solids
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WLMP	WIPP Groundwater Level Monitoring Program
WQSP	Water Quality Sampling Program
µg/L	microgram(s) per liter
µm	micrometers

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CHAPTER L

WIPP GROUND-WATER DETECTION MONITORING PROGRAM PLAN

L-1 Introduction

The Waste Isolation Pilot Plant (**WIPP**) is a geologic repository for the disposal of transuranic (**TRU**) waste. The disposal horizon is located 2,150 feet (ft) (655 meters [m]) below the land surface in the bedded salt of the Salado Formation (hereinafter referred to as the Salado). At WIPP, water-bearing units occur both above and below the disposal horizon. Ground-water monitoring of the uppermost aquifer below the facility is not proposed at WIPP because that water-bearing unit (the Bell Canyon Formation) is not considered a credible pathway for a release from the repository. This is because the repository horizon and water-bearing sandstones of the Bell Canyon Formation are separated by over 2000 ft (610 m) of very low-permeability evaporite sediments (Appendices E1 and D6 of the RCRA Part B Permit Application (DOE, 1997b)). No natural credible pathway has been established for contaminant transport to aquifers below the repository horizon, as there is no hydrologic communication between the repository and underlying aquifer. The U.S. Environmental Protection Agency (**EPA**) concluded in 1990 that natural vertical communication does not exist based on their review of numerous studies (EPA, 1990). Furthermore, drilling boreholes for ground-water monitoring through the Salado and the Castile Formation (hereinafter referred to as the Castile) into the Bell Canyon aquifer would compromise the isolation properties of the repository medium.

Disposal of TRU mixed waste in the WIPP facility is subject to regulation under Title 20 of the New Mexico Administrative Code, Chapter 4, Part 1, Subpart V (20.4.1.500 NMAC). As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall demonstrate that the environmental performance standards for a miscellaneous unit, which are applied to the hazardous waste disposal units (**HWDUs**) in the underground, will be met.

Ground-water monitoring at WIPP in the past has focused on the Culebra member of the Rustler Formation (hereinafter referred to as the Culebra) because it represents the most significant hydrologic contaminant migration pathway to the accessible environment. The Culebra is the most significant water-bearing unit lying above the repository. Modeling of ground-water movement in the Culebra, based on the concept of a ground-water basin, is discussed in detail in Appendix D6, Section D6-2a(1), of the WIPP RCRA Part B Permit Application (DOE, 1997b).

The WIPP site is located in Eddy County in southeastern New Mexico (Figure L-1) within the Pecos Valley section of the southern Great Plains physiographic province (Powers et al., 1978). The site is 26 miles (mi) (42 kilometers [km]) east of Carlsbad, New Mexico in an area known as Los Medaños (the dunes). Los Medaños is a relatively flat, sparsely inhabited plateau with little water and limited land uses.

The WIPP site (Figure L-2) consists of 16 sections of Federal land in Township 22 South, Range 31 East. The 16 sections of Federal land were withdrawn from the application of public land laws by the WIPP Land Withdrawal Act (**LWA**), Public Law 102-579. The WIPP LWA transferred the responsibility for the administration of the 16 sections from the Department of Interior, Bureau of Land Management, to the U.S. Department of Energy (**DOE**). This law specified that mining and drilling for purposes other than support of the WIPP project are prohibited within this 16 section area with the exception of Section 31. Oil and gas drilling activities are restricted in Section 31 from the surface down to 6,000 feet.

This monitoring plan addresses requirements for sample collection, ground-water surface elevation monitoring, ground-water flow direction, data management, and reporting of ground-water monitoring data. It also identifies analytical parameters selected to assess ground-water quality, and establishes personnel responsibilities for the WIPP ground-water detection monitoring program (**DMP**). Because quality assurance is an integral component of the ground-water sampling, analysis, and reporting process, quality assurance/quality control (**QA/QC**) elements and associated data acceptance criteria are included in this plan.

Instructions for performing field activities that will be conducted in conjunction with this sampling and analysis plan are provided in field operating procedures, referenced throughout this plan. Procedures are required for each aspect of the ground-water sampling process, including ground-water surface elevation measurement, ground-water flow direction, sampling equipment installation and operation, field water-quality measurements, and sample collection. These procedures prescribe proper field sampling techniques. Samples will be collected by trained personnel under the supervision and direction of qualified engineers, scientists, or other technical personnel.

L-1a Geologic and Hydrologic Characteristics

L-1a(1) Geology

The WIPP site is situated within the Delaware Basin, which is part of the larger Permian Basin, located in the south-central region of North America. During the Permian period, which came to a close about 245 million years ago, ancient seas covered the basin. Their later evaporation resulted in the deposition of a thick sequence of evaporites. Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b) presents a detailed discussion of the regional geologic history. Three major evaporite-bearing formations were deposited in the Delaware Basin (see Figures L-3 and L-4):

- The Castile, which formed through evaporation of the Permian Sea, consists of interbedded anhydrites and halite. Its upper boundary is at a depth of about 2,825 ft (861 m) below ground surface (**bgs**), and its thickness at the WIPP facility is 1,250 ft (381 m) (see Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b)).

- The repository is located in the Salado, which overlies the Castile and resulted from prolonged desiccation that produced predominantly halite, with some carbonates, anhydrites, and clay seams. Its upper boundary is at a depth of about 850 ft (259 m) bgs, and it is about 2,000 ft (610 m) thick in the repository area (see Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b)).

- The Rustler Formation (hereinafter referred to as the Rustler) was deposited in a lagoonal environment during a major freshening of the basin and consists of carbonates, anhydrites, and halites. Its beds consist of clay and anhydrite and contain small amounts of brine. The Rustler's upper boundary is about 500 ft (152 m) bgs, and it ranges up to 350 ft (107 m) in thickness in the area (see Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b)).

These evaporite-bearing formations lie between two other formations significant to the geology and hydrology of the WIPP site. The Dewey Lake overlying the Rustler is dominated by nonmarine sediments and consists almost entirely of mudstone, claystone, siltstone, and interbedded sandstone (Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b)). This formation forms a 500-ft- (152-m) thick barrier of fine-grained sediments that retard the downward percolation of water into the evaporite units below.[1] The Bell Canyon Formation (hereinafter referred to as the Bell Canyon)—the first water-bearing unit below the repository (Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b))—is confined by the thick evaporite sequences of the Castile above. It consists of 1,200 ft (366 m) of interbedded sandstone, shale, and siltstone.

The Salado was selected to host the WIPP repository for several reasons. First, it is regionally extensive, underlying an area of more than 36,000 square mi (mi^2) (93,240 square kilometers [km^2]). Second, its permeability is extremely low. Third, salt behaves mechanically in a plastic manner under pressure (the pressure at the disposal horizon is more than 2,000 pounds per square inch [$lb/in.^2$] or 13.8 megapascals [MPa]) and eventually moves to fill any opening (referred to as creep). Fourth, any fluid remaining in small fractures or openings is saturated with salt, is incapable of further salt dissolution, and has probably remained in place for millions of years. Finally, the Salado lies between the Rustler and the Castile (Figure L-5), which contain very low permeability layers that help confine and isolate waste within and keep water outside of the WIPP repository (Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b)).

L-1a(2) Ground-water Hydrology

The general hydrogeology of the area surrounding the WIPP facility is described in this section starting with the first geologic unit below the Salado. Appendix D6 of the WIPP RCRA Part B Permit Application (DOE, 1997b) provides more detailed discussions of the local and regional hydrogeology. Relevant hydrological parameters for the various rock units above the Salado at WIPP are summarized in Table L-1.

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[1] While there may be some uncertainty over the amount of vertical recharge occurring within the Rustler, the issue is only of significance to long-term performance calculations in which releases from the repository occur through the creation of a migration pathway resulting from drilling (inadvertently) in the WIPP area. The consequences of vertical recharge are bounded in the modeling by assuming that under future climate conditions (which are assumed to be cooler and wetter), the ground-water surface elevation (water table) raises near ground surface, at which time the water table tends to mimic topography.

L-1a(2)(i) The Castile

The Castile is a basin-filling evaporite sequence of sediments surrounded by the Capitan Reef. The Castile represents a major regional ground-water aquitard that effectively prevents upward migration of water from the underlying Bell Canyon. Fluid present in the Castile is very restricted because evaporites do not readily maintain pore space, solution channels, or open fractures at depth. Drill-stem tests conducted in the Castile during construction of the WIPP facility found its permeability to be lower than detection limits; however, the hydraulic conductivity has been conservatively estimated to be less than 10^{-8} ft (3×10^{-9} m) per day. A description of the Castile brine reservoirs outside the WIPP area is provided in Appendix D6 of the RCRA Part B Permit Application (DOE, 1997b).

L-1a(2)(ii) The Salado

The Salado is an evaporite sequence that filled the remainder of the Delaware Basin and lapped extensively over the Capitan Reef and the back-reef sediments beyond. The Salado consists of approximately 2,000 ft (610 m) of bedded halite, with interbeds or seams of anhydrite, clay, and polyhalite. It acts hydrologically as a regional confining bed. The porosity of the Salado is very low and interconnected pores are probably nonexistent in halite at the depth of the disposal horizon. Fluids associated with the Salado occur mainly as very small fluid inclusions in the halite crystals and also occur between crystal boundaries (interstitial fluid) of the massive crystalline salt formation; fluids also occur in clay seams and anhydrite beds. Permeabilities measured from the surface in the area of the WIPP facility range from 0.01 to 25 microdarcies. The most reliable value, 0.3 microdarcy, was obtained from well DOE-2. The results of permeability testing at the disposal horizon are within the range of 0.001 to 0.01 microdarcy. As a comparison, the permeability of the Salado is roughly a thousand times less than that of a lower clay liner required of surface impoundments and landfills, assuming similar thicknesses.

L-1a(2)(iii) The Rustler

The Rustler has been the subject of extensive characterization activities because it contains the most transmissive hydrologic units overlying the Salado (specifically, the Culebra Member, hereafter referred to as the Culebra). Within the Rustler, five members have been identified. Of these, the Culebra is the most transmissive and has been the focus of most of the Rustler hydrologic studies.

The Culebra is the first continuous water-bearing zone above the Salado and is up to approximately 30 ft (9 m) thick. Water in the Culebra is usually present in fractures and is confined by overlying gypsum or anhydrite and underlying clay and anhydrite beds. The hydraulic gradient within the Culebra in the area of the WIPP facility is approximately 20 ft per mi (3.8 m per km) and becomes much flatter south and southwest of the site (Figure L-6). Culebra transmissivities in the Nash Draw range up to 1,250 square ft (ft^2) (116 square m [m^2]) per day; closer to the WIPP facility, they are as low as 0.007 to 74 ft^2 (0.00065 to 7.0 m^2) per day. The Culebra is hydrologically confined.

The two primary types of field tests that are being used to characterize the flow and transport characteristics of the Culebra are hydraulic tests and tracer tests.

The hydraulic tests consist of pump, injection, and slug testing of wells across the study area (e.g., Beauheim, 1987a). The most detailed hydraulic test data exist for the WIPP hydropads (e.g., H-19). The hydropads generally comprise a network of three or more wells located within a few tens of meters of each other. Long-term pumping tests have been conducted at hydropads H-3, H-11, and H-19 and at well WIPP-13 (Beauheim, 1987b, 1987c). These pumping tests provided transient pressure data both at the hydropad and over a much larger area. Tests often included use of automated data-acquisition systems, providing high-resolution (in both space and time) data sets. In addition to long-term pumping tests, slug tests and short-term pumping tests have been conducted at individual wells to provide pressure data that can be used to interpret the transmissivity at that well (Beauheim, 1987a). (Additional short-term pumping tests have been conducted in the Water Quality Sampling Program (**WQSP**) wells [Stensrud, 1995]). Detailed cross-hole hydraulic testing has recently been conducted at the H-19 hydropad (Kloska et al., 1995).

The hydraulic tests are designed to yield pressure data for estimation of hydrologic characteristics such as transmissivity, permeability, and storativity. The pressure data from long-term pumping tests and the interpreted transmissivity values for individual wells are used for input to flow modeling. Some of the hydraulic test data and interpretations are also important for the interpretation of transport characteristics. For instance, the permeability values interpreted from the hydraulic tests at a given hydropad are needed for interpretations of tracer test data at that hydropad.

There is strong evidence that the permeability of the Culebra varies spatially and varies sufficiently that it cannot be characterized with a uniform value or range over the region of interest to WIPP. The transmissivity of the Culebra varies spatially over six orders of magnitude from east to west in the vicinity of WIPP (see Figure D6-30 in the RCRA Part B Permit Application). Over the site, Culebra transmissivity varies over three to four orders of magnitude. Figure D6-30 shows variation in transmissivity in the Culebra in the WIPP region. Transmissivities have been calculated at 1×10^{-3} square feet per day (1×10^{-9} square meters per second) at well P-18 east of the WIPP site to 1×10^{3} square feet per day (1×10^{-3} square meters per second) at well H-7 in Nash Draw.

Transmissivity variations in the Culebra are believed to be controlled by the relative abundance of open fractures rather than by primary (that is, depositional) features of the unit. Lateral variations in depositional environments were small within the mapped region, and primary features of the Culebra show little map-scale spatial variability, according to Holt and Powers, 1988. Direct measurements of the density of open fractures are not available from core samples because of incomplete recovery and fracturing during drilling, but observation of the relatively unfractured exposures in the WIPP shafts suggests that the density of open fractures in the Culebra decreases to the east. Qualitative correlations have been noted between transmissivity and several geologic features possibly related to open-fracture density, including (1) the distribution of overburden above the Culebra, (2) the distribution of halite in other members of the Rustler, (3) the dissolution of halite in the upper portion of the Salado, and (4) the distribution of gypsum fillings in fractures in the Culebra.

Measured matrix porosities of the Culebra vary from 0.03 to 0.30. Fracture porosity values have not been measured directly, but interpreted values from tracer tests at the H-3, H-6, and H-11 hydropads vary from 5×10^{-4} to 3×10^{-3}. Data are insufficient to determine whether the average porosity of the matrix and fractures varies significantly on a regional scale.

Geochemical and radioisotope characteristics of the Culebra have been studied. There is considerable variation in ground-water geochemistry in the Culebra. The variation has been described in terms of different hydrogeochemical facies that can be mapped in the Culebra. A halite-rich hydrogeochemical facies exists in the region of the WIPP site and to the east, approximately corresponding to the regions in which halite exists in units above and below the Culebra, and in which a large portion of the Culebra fractures are gypsum filled. An anhydrite-rich hydrogeochemical facies exists west and south of the WIPP site, where there is relatively less halite in adjacent strata and where there are fewer gypsum-filled fractures. Radiogenic isotopic signatures suggest that the age of the ground water in the Culebra is on the order of 10,000 years or more (see, for example, Lambert, 1987; Lambert and Carter, 1987; and Lambert and Harvey, 1987).

The radiogenic ages of the Culebra ground water and the geochemical differences provide information potentially relevant to the ground-water flow directions and ground-water interaction with other units and are important constraints on conceptual models of ground-water flow. Previous conceptual models of the Culebra (see for example, Chapman, 1986; Chapman, 1988; LaVenue et al., 1990) have not been able to consistently relate the hydrogeochemical facies, radiogenic ages, and flow constraints (that is, transmissivity, boundary conditions, etc.) in the Culebra.

However, the Permittees have proposed a new conceptualization of ground-water flow that could explain observed geochemical facies and ground-water flow patterns. The new conceptualization, referred to as the ground-water basin model, offers a three dimensional approach to treatment of Supra-Salado rock units, and assumes vertical leakage (albeit very slow) between rock units of the Rustler exists (where hydraulic head is present).

Flow in the Culebra is considered transient. This differs from previous interpretations, wherein no-flow was assumed between Rustler units. The model assumes that the ground-water system is dynamic and is responding to the drying of climate that has occurred since the late Pleistocene period. The Permittees assumed that recharge rates during the late Pleistocene period were sufficient to maintain the water table near land surface, but has since dropped significantly. Therefore, the impact of local topography on ground-water flow was greater during wetter periods, with discharge from the Rustler to the west; flow is dominated by more regional topographic effects during drier times, with flow to a more southerly direction.

Four hydrogeochemical facies within the Culebra in the WIPP area (DOE, 1997a) have been identified:

- Zone A - saline (2-3 molal) NaCl brines, Mg/Ca ratio of 1.2 to 2;
- Zone B - dilute (<0.1 molal) CaSO4 - rich ground water;
- Zone C - variable composition (0.3-1.6 molal); Mg/Ca ratio 0.3 to 1.2; and
- Zone D - high salinities (3-7 molal); K/Na weight ratios (0.2).

Facies A ground-water flow is slow, has not changed over the last 14,000 years, and probably recharged more than 600,000 years ago. Vertical leakage occurs to Facies A, and both lateral and vertical ground-water flow rates are extremely low. Facies B occurs in an area with greater vertical fracturing in the Culebra, and therefore exhibits more vertical infiltration and more rapid lateral flow in the Culebra. Flow in Facies B is currently to the south (it may mix with Facies C water to the southeast) but was more toward the west during wetter climates; vertical infiltration from the Dewey Lake to the Culebra Facies B is assumed by the Permittees to have occurred during wetter climates in an area south of the WIPP site. Facies C water was not diluted to create Facies B water. Facies C occurs “in between” Facies A and B, and ground-water flow entered the Culebra prior to the climate change (to drier conditions) 14,000 years ago. Facies C ground-water flow is to the south at WIPP, where the Permittees theorized that it joins with a small amount of Facies A solute being transported from the east. Ground-water flow rate in Facies C is faster than in A but slower than in B, and the proposed recharge area from the Dewey Lake to the Culebra was to the northeast of the WIPP site. Facies C ground water infiltrated into the Dewey Lake and then interacted with anhydrite and halite along its path to the Culebra, wherein it mixed with smaller amounts of Facies A water. the Permittees concluded that the presence of anhydrite within Rustler units does not preclude slow downward infiltration (DOE, 1997a).

Previously, the Permittees and others believed the geochemistry of Culebra ground water was inconsistent with flow directions. This was based on the premise that Facies C water must transform to facies B water (e.g. become “fresher”), which is inconsistent with the observed flow direction. It is now believed that the observed geochemistry and flow directions can be explained with different recharge areas and Culebra travel paths (DOE, 1997a).

Head distribution in the Culebra (see Figure D6-31 in the RCRA Part B Permit Application (DOE, 1997b)) is consistent with ground-water basin modeling results indicating that the generalized ground-water flow direction in the Culebra is currently north to south. However, the fractured nature of the Culebra, coupled with variable fluid densities, can cause localized flow patterns to differ from general flow patterns.

Ground-water levels in the Culebra in the WIPP region have been measured for several decades. Water-level rises have been observed in the WIPP region and are possibly related to recovery from impacts caused by shaft installation, response to potash effluent discharge, or are unexplained, as discussed below. The extent of water-level rise observed at a particular well depends on several factors, but the proximity of the observation point to the potential cause of the water-level rise appears to be a primary factor.

In the vicinity of the WIPP site, water-level rises are believed to be caused by recovery from drainage into the shafts. Drainage into shafts has been reduced by a number of grouting programs over the years, most recently in 1993 around the Air Intake Shaft. Northwest of the site, in and near Nash Draw, water levels appear to fluctuate in response to effluent discharge from potash mines. Correlation of water-level fluctuation with potash mine discharge, however, cannot be proven definitively because sufficient data on the timing and volumes of discharge are not available. Water-level rises in the vicinity of the H-9 hydropad, about 6.5 miles south of the site, are thought to be caused by neither WIPP activities nor potash mining discharge. They remain unexplained. The Permittees continue to monitor ground-water levels throughout the region.

Inferences about vertical flow directions in the Culebra have been made from well data collected by the Permittees. Beauheim (1987a) reported flow directions towards the Culebra from both the underlying unnamed lower member of the Rustler and the overlying Magenta member of the Rustler over the WIPP site, indicating that the Culebra acts as a drain for the units around it. This is consistent with results of ground-water basin modeling. Recent simulations to enhance the conceptual understanding of the geohydrology of the Rustler can be found in Corbet and Knupp, 1996.

Use of water from the Culebra in the WIPP area is quite limited because of its varying yields and high salinity. The Culebra is not used for water supply in the immediate WIPP site vicinity. Its nearest use is approximately 7 mi (11 km) southwest of the WIPP facility, where salinity is low enough to allow its use for livestock watering (shown, for example, as Well H-8 in Figure L-7). However, the Permittees identified the Culebra as potential aquifer in the Compliance Certification Application (DOE, 1996b). Because of this, the Culebra will be the focus of future ground-water monitoring at WIPP as it is also the most transmissive continuous water-bearing zone at WIPP and is the most likely pathway for contaminant migration.

L-2 General Regulatory Requirements

Because geologic repositories such as the WIPP facility are defined under the Resource Conservation and Recovery Act (**RCRA**) as land disposal facilities and as miscellaneous units, the ground-water monitoring requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.600 through 264.603) shall be addressed. 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101) applies to miscellaneous unit treatment, storage, and disposal facilities (**TSDF**) only if ground-water monitoring is needed to satisfy 20.4.1.500 NMAC (incorporating 40 CFR §§264.601 through 264.603) environmental performance standards.

The New Mexico Environment Department (**NMED**) has concluded that ground-water monitoring in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264 Subpart F) at WIPP is necessary to meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.601 through 264.603).

L-3 WIPP Ground-water Detection Monitoring Program (DMP)—Overview

L-3a Scope

The Permittees have established a RCRA "Ground-water Detection Monitoring Program (DMP) Plan" to define and protect ground-water resources at WIPP. One of the objectives of the WIPP DMP is to establish, by means of ground-water sampling and analysis, an accurate and representative ground-water database that is scientifically defensible and demonstrates regulatory compliance. In addition, the DMP will be used to determine background or existing conditions of ground-water quality and quantity, including ground-water surface elevation and direction of flow, around the WIPP facility area.

This plan governs all ground-water sampling events conducted to meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101), and ensures that all such data are gathered in accordance with these and other applicable requirements. The ground-water quality data generated by monitoring activities will provide a comprehensive background database against which future analytical results can be compared during the DMP.

Ground-water monitoring at WIPP has been historically conducted by several programs including the WIPP Site Characterization Program, the WIPP WQSP, and recently the WIPP Ground-water Surveillance Program (**GWSP**). Ground-water quality and ground-water surface elevation data have been collected by these programs for over 12 years at WIPP. Data from the WQSP wells (which are widely distributed across the area, see Figure L-8) will be used to continually define changes in the area's potentiometric surface and ground-water flow directions. New monitoring wells included in the WIPP GWSP (WQSP wells 1-6a) were constructed to the specifications provided in the RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (EPA, 1986) and constitute the RCRA ground-water monitoring network specified in this DMP as required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101). These wells are being used to establish background ground-water quality, ground-water surface elevations and flow directions in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §§264.97(f) and (g) and 264.98(e)). Justification for the locations of these wells (3 upgradient and 4 downgradient) is presented below.

L-3b Current WIPP DMP

The WQSP wells 1 through 6a constitute the RCRA DMP for WIPP (Figure L-9 and Permit Attachment O, Figure A2-3) during detection monitoring as required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101). This monitoring plan is a continuation of the current WIPP GWSP, and these wells will serve as the monitoring locations during background water-quality characterization and the RCRA DMP (Figure L-9 and Permit Attachment O, Figure A2-3).

Wells WQSP-1, WQSP-2, and WQSP-3 were located directly upgradient of the WIPP shaft area. The locations of the three upgradient wells were selected to be representative of the flow vectors of ground water moving downgradient onto the WIPP site. Figure 34 of Davies, 1989, shows the simulation of direction and magnitude of ground-water flow. The upgradient wells were located based on the flow vectors resulting from this model simulation. The original WQSP observation wells, as well as those in the RCRA DMP, have been and will continue to be used as piezometer wells to support collection of ground-water surface elevation and ground-water flow modeling data to demonstrate regulatory compliance. Well location surveys for each of the seven wells were performed by the Permittees' survey personnel using the State Plane Coordinates-North American Datum Model 27 method. Results of the surveys are on file with the New Mexico State Engineers Department along with the associated extraction permits for each well.

WQSP-4, WQSP-5, and WQSP-6 were located downgradient of the WIPP shaft area in concert with the flow vectors shown by this model simulation. WQSP-6a was installed in the Dewey Lake Formation at the WQSP-6 location to assess ground-water conditions at this location. All three Culebra downgradient wells (WQSP-4, 5, and 6) were sited based on the greatest velocity magnitude of ground-water flow leaving the shaft area as shown on Figure 34 of Davies, 1989, and upgradient of the WIPP LWA boundary. WQSP-4 was also specifically located to monitor the zone of higher transmissivity around wells DOE-1 and H-11, which may represent faster flow path away from the WIPP shaft area to the LWA boundary (DOE, 1996b).

The Culebra has been selected for the focus of the DMP due to it being regionally extensive and exhibiting the most significant transmissivity of the water-bearing units at WIPP. The Culebra has been extensively studied during all past hydrologic characterization programs and found to be the most likely hydrologic pathway to the accessible environment or compliance point for any potential contamination.

The compliance point is defined in 20.4.1.500 NMAC (incorporating 40 CFR §264.95) as the vertical plane immediately downgradient of the hazardous waste management unit area (i.e., at the downgradient footprint of the WIPP repository). Permit Module V specifies the point of compliance as "the vertical surface located at the hydraulically downgradient limit of the Underground HWDUs that extends to the Culebra Member of the Rustler Formation." The RCRA ground-water monitoring network was not installed immediately downgradient of this plane. However, because the Underground HWDUs at WIPP are Subpart X units, and due to the relatively unique containment and transport aspects of the site, monitoring at the proposed locations will allow for detection of releases prior to release of these contaminants to the general public at the LWA boundary.

The DMP wells were located to intercept flow vectors downgradient away from the WIPP shafts area based on current density corrected potentiometric surfaces (Figure L-9). Based on natural contours of the potentiometric surface (Figure L-9) the selected well placement locations are downgradient of the general flow direction from the shaft area. Transport modeling of contaminant migration throughout the Culebra to the Land Withdrawal Act boundary suggests that travel times could be on the order of thousands of years if, under worst case conditions, hazardous constituents could migrate from the sealed repository. If contaminants were to migrate from the disposal facility, they would be detected by the DMP wells located midway between the shafts and LWA such that samples from wells could detect these contaminants long before they could reach the LWA boundary.

Potentiometric surfaces and ground-water flow directions defined prior to large-scale pumping in the WIPP area and the excavation of WIPP shafts suggests that flow was generally to the south-southeast from the waste disposal and shaft areas (Mercer, 1983; Davies, 1989). Recent (December 1996) potentiometric surface maps of the Culebra adjusted for density differences show very similar characteristics (Figure L-9). WQSP-4, WQSP-5, and WQSP-6 have been located downgradient of the waste emplacement areas according to present-day adjusted potentiometric surfaces.

Potentiometric surfaces that have not been corrected for density differences and that contain transient relics of previous pumping-drawdown events do not reflect accurate natural ground-water flow directions and should not be used to assess the adequacy of ground-water monitoring locations. Previous potentiometric surface maps showing a potentiometric low and hydrologic gradient toward the area between WQSP-3 and WQSP-4 had not been adjusted to freshwater head equivalents, and had also been influenced by the long-term pumping at well H-19. Hence, some historic maps may not represent natural Culebra flow directions or gradients, and appropriateness of the RCRA monitoring network cannot be definitively evaluated using these data.

L-3b(1) DMP Well Construction Specification

L-3b(1)(i) WQSP-1

Well WQSP-1 was drilled between September 13 and 16, 1994, to a total depth of 737 ft (225 m) bgs. The borehole was drilled through the Culebra and extends 15 ft (5 m) into the unnamed lower member of the Rustler. The well was drilled to a depth of 693 ft (211 m) bgs using compressed air as the drilling fluid. The interval from 693 to 737 ft (225 to 211 m) bgs (the total depth) was drilled using air mist with a foaming agent as the drilling fluid. WQSP-1 was drilled to 695.6 ft (212 m) bgs using a 9⅞-in. drill bit and was cored from 695.6 to 737 ft (212 to 225 m) bgs using a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core. After coring, WQSP-1 was reamed to 9⅞ in. (0.3 m) in diameter to total depth. WQSP-1 was cased from the surface to 737 ft (224.6 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-centimeter (cm)] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 702 to 727 ft (214 to 222 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 640 to 651 ft (195 to 198 m) bgs and with 8/16 Brady gravel from 651 to 737 ft (198 to 225 m) bgs. Based on core log results, the Culebra is located from 699 to 722 ft (213 to 220 m) bgs (see Figure L-10).

L-3b(1)(ii) WQSP-2

Well WQSP-2 was drilled between September 6 and 12, 1994, to a total depth of 846 ft (257.9 m) bgs. The borehole was drilled through the Culebra and extends 12.3 ft (3.7 m) into the unnamed lower member of the Rustler. The well was drilled to a depth of 800 ft (244 m) bgs with a 9⅞-in. drill bit using compressed air as the drilling fluid. The interval from 800 to 846 ft (244 to 258 m) bgs (the total depth) was drilled with a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core using air mist with a foaming agent as the drilling fluid. After coring, WQSP-2 was reamed to 9⅞ in. (0.3 m) in diameter to total depth. WQSP-2 was cased from the surface to 846 ft (258 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 811 to 836 ft (247 to 255 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 790 to 793 ft (241 to 242 m) bgs and with 8/16 Brady gravel from 793 to 846 ft (242 to 258 m) bgs. Based on core log results, the Culebra is located from 810.1 to 833.7 ft (247 to 254 m) bgs (see Figure L-11).

L-3b(1)(iii) WQSP-3

Well WQSP-3 was drilled between October 21 and 26, 1994, to a total depth of 880 ft (268 m) bgs. The borehole was drilled through the Culebra and extends 10 ft (3.1 m) into the unnamed lower member of the Rustler. The well was drilled to a depth of 880 ft (268 m) bgs using compressed air as the drilling fluid. The borehole was cleaned using air mist with a foaming agent. WQSP-3 was drilled to 833 ft (254 m) bgs using a 9⅞-in. drill bit and was cored from 833 to 879 ft (254 to 268 m) bgs using a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core. After coring, WQSP-3 was reamed to 9⅞ in. (0.3 m) in diameter to total depth of 880 ft (268 m) bgs. WQSP-3 was cased from the surface to 880 ft (268 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 844 to 869 ft (257 to 265 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 827 to 830 ft (252 to 253 m) bgs and with 8/16 Brady gravel from 830 to 880 ft (253 to 268 m) bgs. Based on core log results, the Culebra is located from 844 to 870 ft (257 to 265 m) bgs (see Figure L-12).

L-3b(1)(iv) WQSP-4

Well WQSP-4 was drilled between October 5 and 10, 1994, to a total depth of 800 ft (244 m) bgs. The borehole was drilled through the Culebra and extends 9.2 ft (2.8 m) into the unnamed lower member of the Rustler. The well was drilled to a depth of 740 ft (226 m) bgs with a 9⅞-in. drill bit using compressed air as the drilling fluid. The interval from 740.5 to 798 ft (225.7 to 243 m) bgs was cored with a 5¼-in. (0.13-m) core bit to cut 4-in.- (0.1-m) diameter core using air mist with a foaming agent as the drilling fluid. After coring, WQSP-4 was reamed to 9⅞ in. (0.3 m) in diameter to total depth of 800 ft (244 m) bgs. WQSP-4 was cased from the surface to 800 ft (244 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 764 to 789 ft (233 to 241 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 752 to 755 ft (229 to 230 m) bgs and with 8/16 Brady gravel from 755 to 800 ft (230 to 244 m) bgs. Based on core log results, the Culebra is located from 766 to 790.8 ft (233 to 241 m) bgs (see Figure L-13).

L-3b(1)(v) WQSP-5

Well WQSP-5 was drilled between October 12 and 19, 1994, to a total depth of 681 ft (208 m) bgs. The borehole was drilled through the Culebra and extends into the unnamed lower member of the Rustler. The well was drilled to a depth of 676 ft (206 m) bgs using compressed air as the drilling fluid. The borehole was cleaned using air mist with a foaming agent. WQSP-5 was drilled to 648 ft (198 m) bgs using a 9⅞-in. drill bit and was cored from 648 to 676 ft (198 to 206 m) bgs using a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core. After coring, WQSP-5 was reamed to 9⅞ in. (0.3 m) in diameter to total depth of 681 ft (208 m) bgs. WQSP-5 was cased from the surface to 681 ft (208 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 646 to 671 ft (197 to 205 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 623 to 626 ft (190 to 191 m) bgs and with 8/16 Brady gravel from 626 to 681 ft (191 to 208 m) bgs. Based on core log results, the Culebra is located from 648 to 674.4 ft (198 to 205.6 m) bgs (see Figure L-14).

L-3b(1)(vi) WQSP-6

Well WQSP-6 was drilled between September 26 and October 3, 1994, to a total depth of 616.6 ft (187.9 m) bgs. The borehole was drilled through the Culebra and extends 9.7 ft (3 m) into the unnamed lower member of the Rustler. The well was drilled to a depth of 367 ft (112 m) bgs using compressed air as the drilling fluid. The interval from 367 to 616 ft (112 to 188 m) bgs (the total depth) was drilled using brine as the drilling fluid. WQSP-6 was drilled to 568 ft (173 m) 4-in.- (0.1-m) ft bgs using a 9⅞-in. drill bit and was cored from 568 to 616 ft (173 to 188 m) bgs using a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core. After coring, WQSP-6 was reamed to 9⅞ in. (0.3 m) in diameter to total depth of 616.6 ft (188 m) bgs. WQSP-6 was cased from the surface to 616.6 ft (188 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval from 581 to 606 ft (177 to 185 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 567 to 570 ft (173 to 173.7 m) bgs and with 8/16 Brady gravel from 570 to 616.6 ft (174 to 188 m) bgs. Based on core log results, the Culebra is located from 582 to 606.9 ft (177 to 185 m) bgs (see Figure L-15).

L-3b(1)(vii) WQSP-6A

Well WQSP-6A was drilled between October 31 and November 1, 1994, to a total depth of 225 ft (69 m) bgs. It is located immediately west of WQSP-6. The borehole was drilled through a water-producing zone in the Dewey Lake Redbeds that had been previously encountered while drilling well WQSP-6. The well was drilled to a depth of 225 ft (69 m) bgs using compressed air as the drilling fluid. The borehole was cleaned using air mist with a foaming agent. WQSP-6A was drilled to 160 ft (49 m) bgs using a 9⅞-in. drill bit and was cored from 160 to 220 ft (49 to 67 m) bgs using a 5¼-in. core bit to cut 4-in.- (0.1-m) diameter core. After coring, WQSP-6A was reamed to 9⅞ in. (0.3 m) in diameter to total depth of 225 ft (69 m) bgs. WQSP-6A was cased from the surface to 225 ft (69 m) bgs with 5-in. (0.1-m) (0.28-in. [0.7-cm] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen from 190 to 215 ft (58 to 66 m) bgs. The annulus between the borehole wall and the casing/screen is packed with sand from 172 to 175 ft (52 to 53 m) bgs and with 8/16 Brady gravel from 175 to 225 ft (53 to 69 m) bgs (see Figure L-16).

L-4 Monitoring Program Description

The WIPP DMP has been designed to meet the ground-water monitoring requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101). The following sections of the monitoring plan specify the components of the DMP.

L-4a Monitoring Frequency

The seven RCRA monitoring wells have been sampled on a semiannual basis since their installation in 1995 to establish background ground-water quality in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §§264.97 and 264.98). This has included at least two full rounds of 20.4.1.500 NMAC (Incorporating 40 CFR §264) Appendix IX analysis for samples from each of the proposed RCRA detection monitoring wells. In addition, ground-water samples were collected from the DMP wells (from March 1997 until waste emplacement) at a frequency of four sample replicates collected semiannually from each well for the indicator parameters of pH, specific conductance (**SC**), total organic carbon (**TOC**), and total organic halogen (**TOX**) to further establish background ground-water quality until detection monitoring in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.98) becomes applicable. A total of four rounds of Appendix IX analysis will be conducted for samples from each well for use in background ground-water quality determinations.

Detection monitoring will start when the Permittees emplace waste and continue through the post-closure phase as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.90[c]). During detection monitoring, one sample and one sample duplicate will be collected semiannually from each well in the RCRA detection monitoring network. As shown in Table L-2, the DMP will continue to collect ground-water quality samples for all seven wells on a semiannual basis during the life of the DMP. 20.4.1.500 NMAC (incorporating 40 CFR §264.97[g][2]) provides that an alternate sampling frequency to that provided in 20.4.1.500 NMAC (incorporating 40 CFR §264.98) may be proposed by the Permittees. Given the nature and rate of ground-water flow in the area surrounding WIPP, collecting and analyzing one sample semiannually will be protective of human health and the environment because any hazardous constituent leaving the underground disposal facility will not have the potential to migrate beyond the ground-water monitoring network in a one-year time frame. Ground-water flow characteristics are presented in detail in Appendices D6 and E1 of the RCRA Part B Permit Application (DOE, 1997b).

Ground-water surface elevations will be monitored in each of the seven DMP wells on a monthly basis. The ground-water surface elevation in each DMP well will also be measured prior to each sampling event. Ground-water surface elevation measurements in the other existing WQSP well sites will also be monitored on a monthly basis to supplement the area water-level database and to help define regional changes in ground-water flow directions and gradients. The characteristics of the RCRA DMP (frequency, location) will be evaluated if significant changes are observed in the ground-water flow direction or gradient. If any change occurs which could affect the ability of the DMP to fulfill the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264 Subpart F), the Permittees shall promptly notify NMED in writing and apply for a permit modification, if appropriate.

L-4b Analytical Parameters

The analytes of interest measured to establish background ground-water quality prior to emplacement of waste include all indicator parameters and all other parameters listed in 20.4.1.500 NMAC (incorporating 40 CFR §264) Appendix IX. Field measurements of pH, SC, temperature, chloride, Eh, total iron, and alkalinity are also measured during background sampling .

The DMP will be initiated upon waste emplacement, at which time the semiannual samples will be analyzed for the parameters listed in Table L-3. This list includes the parameters of interest identified by the Permittees in the Waste Analysis Plan, Table C-3, of the RCRA Part B Permit Application (DOE, 1997b). Parameters to be analyzed by the contract laboratory such as specific conductance, total dissolved solids, total suspended solids, density, pH, total organic carbon, and total organic halogens were included as indicator parameters because of their universal commonality to ground water. Parameters such as chloride, alkalinity, calcium, magnesium, and potassium were included as matrix-specific general indicator parameters. Calcium, magnesium, potassium, chloride, and iron may be deleted during detection monitoring, with prior approval of NMED. Organic and inorganic compounds on the right hand side of Table L-3 were chosen because they will occur in the waste to be disposed at the WIPP facility. Additional parameters may be identified through the tentatively identified compound (**TIC**) process specified in the Waste Analysis Plan, Permit Attachment B. If compounds are identified, these will be added to the DMP list, unless the Permittees provide justification for their omission, and this omission is approved by NMED.

L-4c Ground-water Surface Elevation Measurement, Sample Collection and Laboratory Analysis

Ground-water surface elevations will be measured in each well prior to ground-water sample collection. Ground water will be extracted using serial and final sampling methods. Serial samples will be collected until ground-water field indicator parameters stabilize, after which the final sample for complete analysis will be collected. Final samples will then be analyzed for the DMP analytical suite.

L-4c(1) Ground-water Surface Elevation Monitoring Methodology

The WIPP ground-water level monitoring program (**WLMP**) is a subprogram of the DMP. The quality assurance activities of the WLMP are in strict accordance with WP 13-1, and the quality assurance implementing procedure specific to ground-water surface elevation monitoring is WIPP Procedure WP 02-EM1014[2]. Current versions of both WP 13-1 and WP 02-EM1014 are maintained in the WIPP Operating Record.

Ground-water surface elevation monitoring is in progress now and will continue through the post-closure care period specified in Permit Module VI. This section of the plan addresses the activities of the WLMP during the preoperational and operational phases of WIPP.

Collection of ground-water surface elevation data is required by 20.4.1.500 NMAC (incorporating 40 CFR §264.97(f)). These data also provide:

- Data collection as required by the Environmental Monitoring Plan.
- A means to fulfill commitments made in the Final Environmental Impact Statement (**FEIS**).
- A means to comply with future ground-water inventory and monitoring regulations.
- Input for making land use decisions, (i.e., designing long-term active and passive institutional controls for the site).
- Assistance in understanding any changes to readings from the water-pressure transducers installed in each of the shafts to monitor water conditions behind the liners.
- An understanding of whether or not the horizontal and vertical gradients of flow are changing over time.

The objective of the WLMP is to extend the documented record of ground-water surface elevation fluctuations in the Culebra and Magenta members of the Rustler in the vicinity of the WIPP facility and to meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.97(f)). Ground-water surface elevation data will be collected from each well of the RCRA DMP. Ground-water surface elevation data will also be collected from other Culebra wells, as well as monitoring wells completed in other water-bearing zones overlying and underlying the WIPP repository horizon (see Figure L-18) when access to those zones is possible. This includes, but is not limited to, the Bell Canyon, the Forty-niner, the contact zone between the Rustler and Salado, and the Dewey Lake.

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[2] WP 02-EM1014 “Groundwater Level Measurements” is a technical procedure that specifies the steps followed by Environmental Monitoring (**EM**) personnel for making manual ground-water level measurements in ground-water wells in the vicinity of the WIPP facility. The procedure provides general instructions including prerequisites, safety precautions, performance frequency, quality assurance, and records. Specific instructions are included for using the water level measurement electrical conductance probe and data management.

Ground-water surface elevation measurements will be taken monthly in at least one accessible completed interval at each available well pad. At well pads with two or more wells completed in the same interval, quarterly measurements will be taken in the redundant wells (well locations are shown in Figure L-18). Ground-water surface elevation measurements will be taken monthly at each of the seven DMP wells, as well as prior to each sampling event. If a cumulative ground-water surface elevation change of more than 2 feet is detected in any DMP well over the course of one year which is not attributable to site tests or natural stabilization of the site hydrologic system, the Permittees will notify NMED in writing and discuss the origin of the changes in the report specified in Permit Module V. Abnormal, unexplained changes in ground-water surface elevation may indicate changes in site recharge/discharge which could affect the assumptions regarding DMP well placement and constitute new information as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.41(a)(2)).

Ground-water surface elevation monitoring will continue through the post-closure care period specified in Permit Module VI. The Permittees may temporarily increase the frequency of monitoring to effectively document naturally occurring or artificial perturbations that may be imposed on the hydrologic systems at any point in time. This will be conducted in selected key wells by increasing the frequency of the manual ground-water surface elevation measurements or by monitoring water pressures with the aid of electronic pressure transducers and remote data-logging systems. The Permittees will include such additional data in the reports specified in Section L-5.

Interpretation of ground-water surface elevation measurements and corresponding fluctuations over time is complicated at WIPP by spatial variation in fluid density both vertically in well bores and areally from well to well. To monitor the hydraulic gradients of the hydrologic flow systems at WIPP accurately, actual ground-water surface elevation measurements will be monitored at the frequencies specified in Table L-2, and the densities of the fluids in the well bores will be measure annually. When both of these parameters are known, equivalent freshwater heads will be calculated. The concept of freshwater head is discussed in Lusczynski (1961).

A discussion explaining the calculation of freshwater heads from mid-formation depth at WIPP can be found in Haug, et al. (1987). Freshwater heads are useful in identifying hydraulic gradients in aquifers of variable density such as those existing at the WIPP site. Freshwater head at a given point is defined as the height of a column of freshwater that will balance the existing pressure at that point (Lusczynski, 1961).

Measured ground-water surface elevation data can be converted to equivalent freshwater head from knowledge of the density of the borehole fluid, using the following formula.

$$p = \rho g h$$

where

p = freshwater head (pressure)
ρ = average specific gravity of the borehole fluid (unitless)
g = freshwater density (mass/volume)
h = fluid column height above the datum (length)

If the freshwater density is assumed to be 1.000 gram per cubic centimeter (g/cm3), then the equivalent freshwater head is equal to the fluid column height times the average borehole fluid density (expressed as specific gravity).

L-4c(1)(i) Field Methods and Data Collection Requirements

To obtain an accurate ground-water surface elevation measurement, a calibrated water-level measuring device will be lowered into a test well and the depth to water recorded from a known reference point. When using an electrical conductance probe, the depth to water will be determined by reading the appropriate measurement markings on the embossed measuring tape when the alarm is activated at the surface. WIPP Procedure WP 02-EM1014 specifies the methods to be used in obtaining groundwater-level measurements. A current revision of this procedure will be maintained in the WIPP Operating Record.

L-4c(1)(ii) Ground-water Surface Elevation Records and Document Control

All incoming data will be processed in a timely manner to assure data integrity. The data management process for ground-water surface elevation measurements will begin with completion of the field data sheets. Date, time, tape measurement, equipment identification number, calibration due date, initial of the field personnel, and equipment/comments will be recorded on the field data sheets. If, for some unexpected reason, a measurement is not possible (i.e., a test is under way that blocks entry to the well bore), then a notation as to why the measurement was not taken will be recorded in the comment column. Personnel will also use the comment column to report any security observations (i.e., well lock missing).

Data recorded on the field data sheets and submitted by field personnel will be subject to guidelines outlined in WIPP Procedures WP 02-EM3001[3] and WP 02-EM1014[4]. Current copies

[3] WP 02-EM3001 "Administrative Processes for Environmental Monitoring Programs" is a management control procedure to provide the administrative guidance to be used by Environmental Monitoring (EM) personnel to maintain quality control (QC) associated with EM sampling activities and to assure that data acquired under the WIPP Environmental Monitoring Program are valid. The precautions and limitations portion of this procedure assure that only qualified personnel acquire samples under the EM program, that cross contamination of sampling equipment is prevented, and that sample hold times are not exceeded. The Performance portion of the procedure provides step-by-step instructions for Quality Assurance/Quality Control (QA/QC) implementation, the use of data sheets and sample tracking logbooks, sample tacking from collection to submittal, and actions to take if sample results indicate the potential for exceeding a regulatory limit.

of these procedures are maintained within the WIPP Operating Record. These procedures specify the processes for administering and managing such data. The data will be entered onto a computerized work sheet. The work sheet will calculate ground-water surface elevation in both feet and meters relative to the top of the casing and also relative to mean sea level. The work sheet will also adjust ground-water surface elevations to equivalent freshwater heads.

A check print will be made of the work sheet printout. The check print will be used to verify that data taken in the field was properly reported on the database printout. A minimum of 10 percent of the spreadsheet calculations will be randomly verified on the check print to ensure that calculations are being performed correctly. If errors are found, the work sheet will be corrected. The data contained on the computerized work sheet will be translated into a database file. A printout will be made of the database file. The data each month will then be compiled into report format and transmitted to the appropriate agencies as requested by the Permittees. Ground-water surface elevation data and equivalent freshwater heads for all Culebra wells will be transmitted to NMED one month after data are collected.

A computerized database file will be maintained for all ground-water surface elevation data. Monthly and quarterly data will be appended into a yearly file. Upon verification that the yearly database is free of errors, it will be appended into the project database file. A printed copy of the current project database (through December of the preceding year) will be kept in the Environment, Safety and Health Department (**ES&H**) EM fire-resistant storage area.

L-4c(2) Ground-water Sampling

L-4c(2)(i) Ground-water Pumping and Sampling Systems

The water-bearing units at WIPP are highly variable in their ability to yield water to monitoring wells. The Culebra, the most transmissive hydrologic unit in the WIPP area, exhibits transmissivities that range many orders of magnitude across the site area and is the primary focus of the DMP.

The ground-water pumping and sampling systems used to collect a ground-water sample from the seven new DMP wells will provide continuous and adequate production of water so that a representative ground-water sample can be obtained. The wells used for ground-water quality sampling vary in yield, depth, and pumping lift. These factors affect the duration of pumping as well as the equipment required at each well.

The type of pumping and sampling system to be used in a well depends primarily on the aquifer characteristics of the Culebra and well construction. The DMP wells will be individually equipped with dedicated submersible pumping assemblies. Each well has a specific type of

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[4] WP 02-EM1014 "Groundwater Level Measurement", is a technical procedure which lists the equipment required and the operational checks necessary to perform groundwater level measurements. This procedure as well as WP 02-EM3001 also provides information on performing validation and verification of laboratory data.

submersible pump, matched to the ability of the well to yield water during pumping. The down hole submersible pumps will be controlled by a variable electronic flow controller to match the production capacity of the formation at each well.

The electronic flow controller allows personnel collecting samples to control the rate of discharge during well purging to minimize the potential for loss of volatiles from the sample. As recommended in the "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document" (EPA, 1986) the wells will be purged a minimum of three well bore volumes at a rate that will minimize the agitation of recharge water. This will be accomplished by monitoring formation pressure and matching the rate of discharge from the well as nearly as possible to the rate of recharge to the well. WIPP Procedure WP 02-EM1002[5] specifies the methods used for controlling flow rates and monitoring formation pressure. A current version of this document will be maintained in the WIPP Operating Record. Well purging requirements will be used in conjunction with serial sampling to determine when the ground-water chemistry stabilizes and is therefore representative of undisturbed ground water.

The DMP wells will be cased and screened through the production interval with materials that do not yield contamination to the aquifer or allow the production interval to collapse under stress (high epoxy fiberglass). Details of well construction are presented in Section L-3b(1). An electric, submersible pump installation without the use of a packer will be used in this instance. The largest amount of discharge from the submersible pump will take place from a discharge pipe. In addition to this main discharge pipe a dedicated Teflon® sample line, running parallel to the discharge pipe, will also be used. Flow through the pipe will be regulated on the surface by a flow control valve and/or variable speed drive controller. Cumulative flow will be measured using a totalizing flow meter. Flow from the discharge pipe will be routed to a discharge tank for disposal.

The dedicated Teflon® sampling line will be used to collect the water sample that will undergo analysis. By using a dedicated Teflon® sample line, the water will not be contaminated by the metal discharge pipe. The sample line will branch from the main discharge pipe a few inches above the pump. Flow from the sample line will be routed into the sample collection area. Flow through the sample collection line will be regulated by a flow-control valve. The sample line will be insulated at the surface to minimize temperature fluctuations.

<u>Pressure Monitoring Systems</u>

The DMP wells do not require the installation of a packer because sample biases due to well construction deficiencies are not present. However, pressures will be monitored using down hole

[5] WP 02-EM1002 "Electric Submersible Pump Monitoring System Installation and Operation" is a technical procedure that provides step-by-step instructions for acquiring ground-water samples using electric submersible pumps (ESPs). The procedure addresses the equipment in general, lists precautions and limitations which assure that only qualified individuals operate the equipment, prerequisite actions which assure the correct installation and operation. The procedure details how to install the various subsystems such as the surface discharge and pressure monitoring system and the pressure monitoring bubbler and how to start up and shut down the ESP.

automatic air line bubblers in the formation to maintain the water level above the pump intake. Pressure transducers may be used in line with bubblers to provide continual electronic monitoring through data acquisition systems. WIPP Procedure WP 02-EM1002 provides instructions for monitoring formation pressure using automatic airline bubblers in conjunction with pressure transducers and data acquisition systems. A current version of this document will be maintained in the WIPP Operating Record.

The mobile field laboratory provides a work place for conducting field sampling and analyses. The laboratory will be positioned near the wellhead, will be climate controlled, and will contain the necessary equipment, reagents, glassware, and deionized water for conducting the various field analyses.

Sampling Overview

Two types of water samples will be collected: serial samples and final samples. Serial samples will be taken at regular intervals and analyzed in the mobile field laboratory for various physical and chemical parameters (called field indicator parameters). The serial sample data will be used to determine whether the sample is representative of undisturbed ground water as a direct function of the stabilization of field indicator parameters and the volume of the water being pumped from the well. Interpretation of the serial sampling data will enable the Team Leader (see Section L-7) to determine when conditions representative of undisturbed ground water are attained in the pumped ground water.

Final samples will be collected when the serially sampled field indicator parameters have stabilized and are therefore representative of undisturbed ground water.

L-4c(2)(ii) Serial Samples

Serial sampling is the collection of sequential samples for the purpose of determining when the ground-water chemistry stabilizes and is therefore representative of undisturbed ground water. The Permittees will consider a serial sample representative of undisturbed ground water when the majority of field indicator parameter measurements have stabilized within ±5 percent of the average of analytical results for the field indicator parameter from the background ground-water quality for each DMP well. Nonstabilization of one or two field indicator parameters attributable to matrix interferences, instrument drift, or other unforeseen reasons will not preclude the collection of final samples, provided the volume of purged water exceeds three well bore volumes. The Permittees will report, in the operating record, any final samples collected when field indicator parameters were not stabilized, and will provide an explanation of why the sample was collected when field indicator parameters were not stabilized.

Serial samples will be collected and analyzed to detect and monitor the chemical variation of the ground water as a function of the volume of water pumped. Once serial sampling begins, the frequency at which serial samples are collected and analyzed will be left to the discretion of the Team Leader (see Section L-7), but will be performed a minimum of three times during a sampling round.

The Permittees will use appropriate field methods to identify stabilization of the following field indicator parameters: chloride, divalent cations (hardness), alkalinity, total iron, pH, Eh, temperature, specific conductance, and specific gravity.

Protocols for collection of serial samples are specified in WIPP Procedure WP 02-EM1006[6]. Analysis of serial samples are specified in WIPP Procedure WP 02-EM1005[7]. Current versions of these procedures will be maintained in the WIPP Operating Record.

The three field indicator parameters of temperature, Eh, and pH will be determined by either an "in-line" technique, using a self-contained flow cell, or an "off-line" technique, in which the samples will be collected from a Teflon® sample line at atmospheric pressure. The iron, divalent cation, chloride, alkalinity, specific conductance, and specific gravity samples will be collected from the Teflon® sample line at atmospheric pressure. Because of the lack of sophisticated weights and measures equipment available for field density assessments, field density evaluations will be expressed in terms of specific gravity, which is a unitless measure. Density is expressed as unit weight per unit volume.

New polyethylene containers will be used to collect the serial samples from the Teflon® sample line. Serial sampling water collected for solute and specific conductance determinations will be filtered through a 0.45 micrometers (μm) membrane filter using a stainless-steel, in-line filter holder. Filtered water will be used to rinse the sample bottle prior to serial sample collection. Unfiltered ground water will be used when determining temperature, pH, Eh, and specific gravity. Sample bottles will be properly identified and labeled.

The filtered sample collected for solute analyses will be immediately analyzed for iron and alkalinity because these two solution parameters are extremely sensitive to changes in the ambient water-sample pressure and temperature. A sample and duplicate of filtered water will be collected and analyzed for solute parameters (alkalinity, chloride, divalent cations, and iron). Temperature, pH, and Eh, when not measured in a flow cell, will be measured at the approximate time of serial sample collection. These samples will be collected from the unfiltered sample line.

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[6] WP 02-EM1006 "Final Sample and Serial Sample Collection" is a technical procedure that provides step-by-step instructions for acquiring ground-water samples from the WQSP wells and from privately-owned wells in the vicinity of WIPP. The procedure addresses the equipment in general, lists precautions and limitations which assure that only qualified individuals operate the equipment, and prerequisite actions which assure the data quality. The procedure addresses collection of samples from private wells, collection of serial ground-water samples, the collection of final samples for submittal to the laboratory, and data review by the monitoring task leader.

[7] WP 02-EM1005 "Groundwater Serial Sample Analysis" is a technical procedure that provides step-by-step instructions for on site analysis of ground water to determine ground-water stability prior tot he collection of final samples for analysis. The procedure addresses the equipment in general, lists precautions and limitations which assure that only qualified individuals operate the equipment, prerequisite actions which assure data quality. The procedure addresses the field measurement of Eh, pH, temperature, specific gravity, specific conductance, alkalinity, chloride, divalent cation, and total iron as indicators of ground-water stability.

Samples to be analyzed for chloride and divalent cations (after preservation with nitric acid and stored at 4°C) may be stored for one week prior to analysis with confidence that the analytical results will not be altered.

Upon completion of the collection of the last serial sample suite, the serial sample bottles accrued throughout the duration of the pumping of the well will be discarded. No serial sample bottles will be reused for sampling purposes of any sort. However, serial samples may be stored for a period of time depending upon the need. WIPP Procedure WP 02-EM1006 defines the protocols for the collection of final and serial samples. WIPP Procedure WP 02-EM1005 defines the protocols for serial sample analysis. Current versions of these procedures will be maintained in the WIPP Operating Record.

During the first two years of DMP well serial sampling, the first sample will be analyzed as soon as possible after the pump is turned on and daily thereafter for a period of four days or until the field indicator parameters (chloride, divalent cations, alkalinity, and iron) stabilize. Eh, pH, and SC will be continually monitored by using a flow cell with ion-specific electrodes and a real-time readout. When detection monitoring begins, the serial sampling process may be modified and the decision to collect final samples would then be based on the number of well bore volumes purged and results of the analysis of chloride, temperature, specific gravity, pH, Eh, and SC. Removal of serial sampling from the DMP will be accomplished through a permit modification and a modification to this plan.

L-4c(2)(iii) Final Samples

The final sample will be collected once the measured field indicator parameters have stabilized (refer to Section L-4(c)(2)(ii)). A serial sample will also be collected and analyzed for each day of final sampling to ensure that samples collected for laboratory analysis are still representative of stable conditions. Sample preservation, handling, and transportation methods will maintain the integrity and representativeness of the final samples.

Prior to collecting the final samples, the collection team shall consider the analyses to be performed so that proper shipping or storage containers can be assembled. Table L-4 presents the sample containers, volumes, and holding times for laboratory samples collected as part of the DMP.

The monitoring system will use dedicated pumping systems and sample collection lines from the sampled formation to the well head. Non-dedicated sample collection lines from the well head to the sample collection area will be discarded after each use.

Sample integrity will be ensured through appropriate decontamination procedures. Laboratory glassware will be washed after each use with a solution of nonphosphorus detergent and deionized (**DI**) water and rinsed in DI water. Sample containers will be new, certified clean containers that will be discarded after one use. Ground-water surface elevation measurement devices will be rinsed with fresh water after each use. Non-dedicated sample collection manifold assemblies will be rinsed with two gallons of fresh water, then rinsed with five gallons of 5 percent nitric acid solution and rinsed with five gallons of DI water after each use. The exposed ends will be capped off during storage. Prior to the next use of the sampling manifold, it will be rinsed a second time with DI water and a blank rinsate sample will be collected to verify decontamination.

Water samples will be collected at atmospheric pressure using either the filtered or unfiltered Teflon® sampling lines branching from the main sample line. Detailed protocols, in the form of procedures, assure that final samples will be collected in a consistent and repeatable fashion. WIPP Procedure WP 02-EM1006 defines the requirements for collection of final samples for analyses. A current version of this procedure will be maintained in the WIPP Operating Record.

Final samples will be collected in the appropriate type of container for the specific analysis to be performed. The samples will be collected in new and unused glass and plastic containers (refer to Table L-4). For each parameter analyzed, a sufficient volume of sample will be collected to satisfy the volume requirements of the analytical laboratory (as specified by laboratory Standard Operating Procedures [**SOPs**]). This includes an additional volume of sample water necessary for maintaining quality control standards. All final samples will be treated, handled, and preserved as required for the specific type of analysis to be performed. Details about sample containers, preservation, and volumes required for individual types of analyses are found in the applicable procedures generated, approved, and maintained by the contract analytical laboratory.

Before the final sample is taken, all plastic and glass containers will be rinsed with the pumped ground water, either filtered or unfiltered, dependent upon analysis protocol. When the rinsing procedure is completed the final sample will be collected.

Final samples will be sent to contract laboratories and analyzed for general chemistry, radionuclides, metals, and selected VOCs that are specific to the waste anticipated to arrive at WIPP. Table L-3 presents the specific analytes for the DMP.

WIPP has not accepted TRU mixed waste for disposal prior to issuance of a hazardous waste disposal permit, and previous WQSP sample analyses have shown that requested hazardous constituents have not been introduced to the ground water in the vicinity of WIPP by other activities. Appendix D18, Attachment A, of the RCRA Part B Permit Application (DOE, 1997b) presented analytical data obtained from WQSP wells 1-6 which indicated that, for the Appendix IX parameters analyzed for, none of the anticipated waste constituents presented on Table L-3 were present in sampled ground water at WIPP.

Duplicates of the final sample will be provided to WIPP oversight agencies as requested by the Permittees or NMED.

Resulting wastes are disposed of in accordance with the WIPP Procedure WP 02-RC.01[8]. A current version of this procedure will be maintained in the WIPP Operating Record.

L-4c(2)(iv) Sample Preservation, Tracking, Packaging, and Transportation

Many of the chemical constituents measured by the DMP are not chemically stable and require preservation and special handling techniques. Samples requiring acidification will be treated with either high purity hydrochloric acid, nitric acid, or sulfuric acid (ULTREX or equivalent), depending upon the standard method of treatment required for the particular parameter suite or as requested by contract laboratory SOPs (see Table L-4).

The contract laboratory receiving the samples will use procedures that prescribe the type and amount of preservative, the container material type, and the required sample volumes that shall be collected. This information will be recorded on the Final Sample Checklist for use by field personnel when final samples are being collected. The Permittees will follow the EPA "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document," Table 4-1 (EPA, 1986), if laboratory SOPs do not specify sample container, volume, or preservation requirements.

The sample tracking system at WIPP will use uniquely numbered chain of custody (**CofC**) Forms and request for analysis (**RFA**) Forms. The primary consideration for storage or transportation is that samples shall be analyzed within the prescribed holding times for the parameters of interest. WIPP Procedure WP 02-EM3001 provides instructions to ensure proper sample tracking protocol. A current revision of this procedure will be maintained within the WIPP Operating Record.

Insulated shipping containers packaged with crushed ice or reusable ice packs will be used to keep the samples cool during transport to the contract laboratory. Holding times for specific analytical parameters require samples to be shipped by express air freight. The coolers will be packaged to meet Department of Transportation and International Air Transportation Association commercial carrier regulations.

L-4c(2)(v) Sample Documentation and Custody

To ensure the integrity of samples from the time of collection through reporting date, sample collection, handling, and custody shall be documented. Sample custody and documentation procedures for EM sampling and analysis activities are detailed in WIPP Procedure WP 02-EM3001. These procedures will be strictly followed throughout the course of each sample

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[8] WP 02-RC.01 "Site-Generated, Non-Radioactive Hazardous Waste Management Plan" is a step-by-step procedure that defines site-generate non-radioactive hazardous waste (SGNRHW) and lists responsibilities of waste management organizations including the generator, waste handlers, sampling personnel, safety personnel, and compliance personnel. In addition, the procedure defines training requirements, container marking requirements, spill response, and list prohibitions. A Section of the procedure is focused on waste management practices including the management in satellite accumulation areas, the hazardous waste staging area for materials awaiting analysis, the establishment of accumulation times, and hazardous waste disposal.

collection and analysis event. A current revision of this procedure will be maintained in the WIPP Operating Record.

Standardized forms used to document samples will include sample identification numbers, sample labels, custody tape, the sample tracking log books, and the request for analysis/chain of custody (RFA and CofC) form. The forms are briefly defined in the following subsections.

All sample documentation will be completed for each sample and reviewed by the Team Leader or his/her designee for completeness and accuracy.

<u>Sample Numbers and Labels</u>

A unique sample identification number will be assigned to each sample sent to the laboratory for analysis. The Team Leader (see Section L-7) will assign the numbers prior to sample collection. The sample identification numbers will be used to track the sample from the time of collection through data reporting. Every sample container sent to the laboratory for analysis will be identified with a label affixed to it. Sample label information will be completed in permanent, indelible ink and will contain the following information: sample identification number with sample matrix type; sample location; analysis requested; time and date of collection; preservative(s), if any; and the sampler's name or initials.

<u>Custody Seals</u>

Custody seals will be used to detect unauthorized sample tampering from collection through analysis. The custody seals will be adhesive-backed strips that are destroyed when removed or when the container is opened. The seal will be dated, initialed, and affixed to the sample container in such a manner that it is necessary to break the seal to open the container. Seals will be affixed to sample containers in the field immediately after collection. Upon receipt at the laboratory, the laboratory custodian will inspect the seal for integrity; a broken seal will invalidate the sample.

<u>Sample Tracking Logbook</u>

A sample tracking logbook (**STLB**) form will be completed for each sample collected. The STLB will include the following information: C of C number; RFA No.; date sample(s) were sent to the lab; laboratory name; acknowledgment of receipt or comments; well name and round number. Sample codes will indicate the well location; the geologic formation where the water was collected from, the sampling round number; and the sample number. The code is broken down as follows:

WQ6[1]C[2]R2[3]N1[4]

[1] Well identification (e.g., WQSP-6 in this case)
[2] Geologic formation (e.g., the Culebra in this case)
[3] Sample round no. (Round 2)
[4] Sample no. (N1)

To distinguish duplicate samples from other samples, a "D" is added as the last digit to signify a duplicate. STLB information will be completed in the field by the sampling team and checked by the Team Leader. When samples are shipped, the STLB will remain in the custody of the EM Section for sample tracking purposes.

Request for Analysis and Chain of Custody

An RFA and CofC form will be completed during or immediately following sample collection and will accompany the sample through analysis and disposal. An example of the RFA and CofC form is presented in Figures L-17a and L-17b. The RFA and CofC form will be signed and dated each time the sample custody is transferred. A sample will be considered to be in a person's custody if: the sample is in his/her physical possession; the sample is in his/her unobstructed view; and/or the sample is placed, by the last person in possession of it, in a secured area with restricted access. During shipment, the carrier's air bill number serves as custody verification. Upon receipt of the samples at the laboratory, the laboratory sample custodian acknowledges possession of the samples by signing and dating the RFA and CofC. The completed original (top page) of the RFA and CofC will be returned to the Team Leader with the laboratory analytical report and becomes part of the permanent record of the sampling event. The RFA and CofC form also contains specific instructions to the laboratory for sample analysis, potential hazards, and disposal instructions.

L-4c(3) Laboratory Analysis

Analysis of samples will be performed by a commercial laboratory. Methods will be specified in procurement documents and will be selected to be consistent with EPA recommended procedures in SW 846 (EPA, 1996). Additional detail on analytical techniques and methods will be given in laboratory SOPs. Table L-3 presents the analytical parameters for the WIPP DMP.

The Permittees will establish the criteria for laboratory selection, including the stipulation that the laboratory follow the procedures specified in SW 846 and that the laboratory follow EPA protocols. The selected laboratory shall demonstrate, through laboratory SOPs, that it will follow appropriate EPA SW 846 requirements and the requirements specified by the EPA protocols. The laboratory shall also provide documentation to the Permittees describing the sensitivity of laboratory instrumentation. This documentation will be retained in the facility operating record and will be available for review upon request by NMED. Instrumentation sensitivity needs to be considered because of regulatory requirements governing constituent concentrations in ground water and the complexity of brines associated with the WIPP repository.

Once the initial qualification criteria, as specified above, have been met, the Permittees will select a laboratory based upon competitive bid. The selected laboratory will perform analytical work for the Permittees for a predetermined period of time, as specified in the contract between the Permittees and the selected laboratory. As this period of performance comes to an end, a new laboratory selection/competitive bid process will be initiated by the Permittees. The same or a different laboratory may be selected for the new contract period. The SOPs for the laboratory currently under contract will be maintained in a file in the operating record by the Permittees.

The Permittees will provide NMED with an initial set of applicable laboratory SOPs for information purposes, and provide NMED with any updated SOPs on an annual basis.

Data validation will be performed on behalf of the Permittees by the Management and Operating Contractor (**MOC**) Environmental Monitoring (**EM**). Data validation results are documented on an Approval/Variation Request (**AR/VR**) form (Procedure WP 15-PC3041). If no discrepancies are found in the data, the AR/VR form will be signed and the approved box will be checked. If however, discrepancies are found, the AR/VR form will be signed and the disapproved or approved-on-condition box will be checked and the form will be returned to the team leader accompanied by an attached report discussing the data validation results, any anomalies, and resolutions. Copies of the data validation report will be distributed to the EM Manager, QA Manager, the Team Leader, and the Contract Administrator. Copies of the data validation report will be kept on file in the EM records section for review upon request by NMED.

L-4d Calibration

L-4d(1) Sampling Equipment Calibration Requirements

The equipment used to collect data for the WQSP and this DMP will be calibrated in accordance with maintenance administrative procedures specified below. The EM Section will be responsible for calibrating needed equipment on schedule, in accordance with written procedures. The EM Section will also be responsible for maintaining current calibration records for each piece of equipment.

L-4d(2) Ground-water Surface Elevation Monitoring Equipment Calibration Requirements

The equipment used in taking ground-water surface elevation measurements will be maintained in accordance with WIPP Procedure WP 10-AD3029[9] A current revision of this procedure will be maintained in the WIPP Operating Record. The EM Section will be responsible for calibrating the needed equipment on schedule in accordance with written procedures. The EM Section will also be responsible for maintaining current calibration records for each piece of equipment.

L-4e Statistical Analysis of Laboratory Data

As required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.97 and 264.98), data collected to establish background ground-water quality and as part of the DMP will be evaluated using appropriate statistical techniques. The following specifies the statistical analysis to be performed

[9] WP 10-AD3029 “Calibration and Control of Monitoring and Data Collection Equipment” provides the step-by-step protocols for the establishment and maintenance of a master database of monitoring and data collection (**M&DC**) equipment, the recall process for equipment needing calibration, the performance of calibrations, the management of calibration results to determine the adequacy of recall frequencies, functional testing of M&DC equipment, and reporting including out-of-tolerance reporting and expired calibration reporting. In addition, the procedure provides step-by-step process for the storage of calibrated M&DC equipment and the use of rental equipment.

by the DMP. Statistical analysis of DMP data will conform to EPA guidance "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities" (EPA, 1989) and "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance" (EPA, 1992).

L-4e(1) Temporal and Spatial Analysis

Environmental parameters vary with space and time. The effect of one or both of these two factors on the expected value of a point measurement will be statistically evaluated through spatial analysis and time series analysis. These methods often require extensive sampling efforts that may exceed the practical limits of the DMP sampling procedures.

Spatial analysis may have limited use DMP during the operational period, although the effect of spatial auto-correlation on the interpretation of the data will be considered for each parameter. Spatial variability will be accounted for by the use of predetermined key sampling locations. Data analysis will be performed on a location-specific basis, or data from different locations will be combined only when the data are statistically homogeneous. Statistical homogeneity will be determined by evaluating mean values and variances from the residuals from the individual well data.

Time series analysis plays a more important role in data analysis for the DMP. Parameters will be reported as time series, either in tabular form or as time plots. For key time series parameters, these plots will be in the form of control charts on which control levels will be identified based on preoperational database, fixed standards, control location databases, or other standards for comparison. Where significant seasonal changes in the expected value of the parameter are identified in the preoperational database or in the control locations, corrections in the control levels which reflect the seasonal change will be made and documented.

L-4e(2) Distributions and Descriptive Statistics

For data sets which include more than ten data points that are homogeneous in space and time (including seasonal homogeneity) and have less than ten percent missing data, a test for conformance to the normal distribution will be performed. The test for normality of the data will be performed in accordance with the methodologies presented in "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance" (EPA, 1992).

If normality is not met, the data will be log-transformed (or transformed using a suitable mathematical transformation, e.g., square root) and retested for normality. If the transformed data fit a normal distribution, the original data will be accepted as having lognormal or an otherwise mathematically-transformed normal distribution. If normality is still not found, two courses may be taken. One will be to continue to test the fit to standard families of distributions, such as the gamma, beta, and Weibull, with proper modifications to subsequent analyses based on these results. The other course will be to use nonparametric methods of data analysis.

For data sets smaller than ten, but homogeneous and complete, the lognormal distribution will be assumed. Data sets with more than ten percent missing data will be analyzed using nonparametric methods. Nonhomogeneous data sets will be subdivided into homogeneous sets and each of these analyzed individually.

Descriptive statistics will be calculated for each homogeneous data set. At a minimum, these include a central value and a range of variation. The central value is the arithmetic mean of the untransformed data if the data are not censored at either end. If the data are censored, either a trimmed mean or the median will be used as the central value (which may be within the censored range). If the data set is greater than ten and is uncensored, the standard deviation will be calculated and used as a basis for the reported range in variation. If these criteria are not met, the range between the 0.25 and 0.75 cartelist will be used.

L-4e(3) Data Anomalies

Data anomalies include data points reported as being below the limit of detection (**LD**) or otherwise censored over a specific range of values, missing data points occurring randomly in the data set, and outliers that cannot be ascribed to a known source of variation.

Whenever possible, sample values which are reported below detection limits will be incorporated into the database as sample values measured at one-half the detection limit for statistical analysis. When values are not available, alternative methods of analysis, as specified in previous sections, will be used. In particular, the use of nonparametric statistics will be required.

Missing data points comprising less than 10 percent of the data set do not significantly affect data analyses. Results based on data in which more than 10 percent is missing will be identified as such at the time of reporting. Consideration of the potential effect of missing data shall be made when the majority of the data are missing from a discrete time span.

Formal testing for outliers will only be done in accordance with EPA guidance. The methodologies specified in Section 8.2 of the "Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities" (EPA, 1989) will be used to check for outliers.

If an outside source of variation is not identified to account for outliers in a data set, it will be included in the data set and all subsequent analyses. If the inclusion of such outliers is found to affect the final results of the analyses significantly, both results (with and without outliers) will be reported.

L-4e(4) Comparisons and Reporting

Prior to waste receipt, measurements will have been made of each background ground-water quality parameter and constituent specified in Table L-3 at every DMP ground-water monitoring well during each of the four background sampling events. If any background ground-water quality parameter or constituent has not been measured prior to waste receipt, measurements will be made for those parameters or constituents in hydraulically upgradient DMP ground-water monitoring wells for a sequence of four sampling events. Following completion of the four sampling events, the arithmetic mean and variance shall then be calculated by the field supervisor or designee for each well. These measurements will then serve as a background value against which statistical values for subsequent sampling events during detection monitoring will be compared. Statistical analysis and comparison will be accomplished using one of the five statistical tests specified in 20.4.1.500 NMAC (incorporating 40 CFR §264.98(h)), which may include Cochran's Approximation to the Behrens-Fisher students' t-test at the 0.01 level of significance (described in Appendix IV to 20.4.1.500 NMAC (incorporating 40 CFR §264). If the comparisons show a significant increase at any monitoring site (as defined in 20.4.1.500 NMAC (incorporating 40 CFR §264.98(f)), the well shall be resampled and an analysis performed as soon as possible, in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.98(g)(2)). The results of the statistical comparison will be reported annually in the Annual Site Environmental Report (**ASER**), and will be reported to NMED as required under 20.4.1.500 NMAC (incorporating 40 CFR §264.98(g)).

L-5 Reporting

L-5a Laboratory Data Reports

Laboratory data will be provided in electronic and hard copy reports to the Permittees. Laboratory data reports will be forwarded to the Team Leader (see Section L-7) and NMED and will contain the following information for each analytical report:

- A brief narrative summarizing laboratory analyses performed, date of issue, deviations from the analytical method, technical problems affecting data quality, laboratory quality checks, corrective actions (if any), and the project manager's signature approving issuance of the data report.

- Header information for each analytical data summary sheet including: sample number and corresponding laboratory identification number; sample matrix; date of collection, receipt, preparation and analysis; and analyst's name.

- Analytical parameter, analytical result, reporting units, reporting limit, analytical method used.

- Results of QC sample analyses for all concurrently analyzed QC samples.

All analytical results will be provided to NMED.

L-5b Statistical Analysis and Reporting of Results

Analytical results from semi-annual ground-water sampling activities will be compared and interpreted by the Team Leader through generation of statistical analyses as specified in Section L-4e. The Team Leader will perform statistical analyses; the results will be included in the ASER in summary form, and will also be provided to NMED as specified in Permit Module V.

L-5c Annual Site Environmental Report

Data collected from this DMP will be reported to NMED as specified in Permit Module V, and to the EM Manager and NMED in the ASER. The ASER will include all applicable information that may affect the comparison of background ground-water quality and ground-water surface elevation data through time. This information will include but is not limited to:

- Well configuration changes that may have occurred from the time of the last measurement (i.e., plug installation and removal, packer removal and reinstallation, or both; and the type and quantity of fluids that may have been introduced into the test wells).
- Any pumping activities that may have taken place since publication of the last annual report (i.e., ground-water quality sampling, hydraulic testing, and shaft installation or grouting activities).
- Radionuclide-specific data collected during the previous year.

The DMP data used in generating the ASER will be maintained as part of the WIPP operating record and will be provided to NMED for review as specified in the permit.

L-6 Records Management

Records generated during ground-water sampling and ground-water surface elevation monitoring events will be maintained in the form project files in the EM section. Project records will include, but are not limited to:

- Sampling and Analysis Plans (**SAP**)
- SOPs
- STLBs
- RFA and CofC forms
- Contract Analytical Laboratory Data Reports
- Variance Logs and Nonconformance Reports
- Corrective Action Reports.

These and all raw analytical records generated in conjunction with ground-water sampling and ground-water surface elevation monitoring will be stored in fire resistant cabinets in the EM section according to the Records Inventory and Disposition Schedule (**RIDS**) and will be made available for inspection upon request. The following records will be transmitted to the Permittees' Project Records Services (**PRS**) for long-term storage in accordance with the RIDS:

- Instrument maintenance and calibration records
- QC sample data
- Control charts and calculation

- Sample tracking and control documentation
- Raw analytical results.

L-7 Project Organization and Responsibilities

L-7a Environmental Monitoring Manager

The EM Manager will be responsible for the overall design and implementation of the DMP. The EM Manager will develop and approve specific procedures all DMP activities, and will review and approve programmatic reports. The EM Manager will provide oversight of appropriate levels of cooperation and consultation between the EM Section and the State of New Mexico regarding environmental monitoring and will revise the QA section of the DMP, if necessary, and submit revisions as permit modifications as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.42).

The EM Manager and staff will be responsible for achieving and maintaining quality in the DMP. All DMP data will be reviewed and approved by the EM Manager, or designee, prior to release.

The EM Manager will establish minimum qualification criteria and training requirements for all DMP personnel. The EM Manager will assure that position descriptions for assigned DMP personnel are adequately prepared. The EM Manager and/or Team Leader will assure that training is performed on an individual basis to maintain an acceptable level of proficiency by all new or temporary DMP staff and by all permanent GWSP staff. The EM Manager will assure that documents detailing all staff training are current and properly filed. Copies of training records will be on file for the Permittees in the MOC Technical Training Section.

The EM Manager will appoint a DMP Team Leader and Field Team, and assign the following responsibilities specified below.

L-7b Team Leader

The Team Leader will coordinate and oversee field sampling activities, ensuring that sampling and associated procedures will be followed and that QA/QC and safety guidelines will be met. The Team Leader will direct the DMP per written approved procedures, and initiate the review of programmatic plans and procedures. The Team Leader will review and evaluate sample data, prepare and review programmatic reports, and assure that appropriate samples will be collected and analyzed. The Team Leader will assure that adequate technical support is provided to the Quality Assurance (**QA**) Department, when required during audits of vendor facilities. Any nonconformances or project changes will be immediately communicated to the Team Leader.

L-7c Field Team

The field team members will consist of one or more scientists, engineers, or technicians, who will be responsible for sample collection, handling, shipping, and preparation and maintenance of appropriate data sheets, and completion of sample tracking documentation under the direction of the Team Leader, in accordance with this DMP and associated field procedures. The field team will inspect, maintain, and ensure proper calibration of equipment prior to use at each site, while ensuring that site health and safety requirements will be met at all times. The field team will communicate any nonconformances, malfunctions, or project changes to the Team Leader immediately.

L-7d Safety Manager

The Safety Manager will be responsible for ensuring that the necessary requirements for the health and safety of personnel associated with sampling and analysis activities are met. The cognizant manager will be responsible for ensuring that field team members operate in a safe manner and personnel have appropriate training. The Safety Manager will ensure that periodic health and safety assessments are conducted and that the cognizant manager will initiate corrective actions where deficiencies are identified.

L-7e Analytical Laboratory Management

Sample collection containers supplied by the laboratory will be certified as clean by either the laboratory or their supplier. The Permittees will supply containers for radiological samples. The analytical laboratory will be responsible for performing analyses in accordance with this DMP Plan and regulatory requirements. The laboratory will maintain documentation of sample handling and custody, analytical results, and internal QC data. Additionally, the laboratory will analyze QC samples in accordance with this plan and its own internal QC program for indicators of analytical accuracy and precision. Data generated outside laboratory acceptance limits will trigger an investigation and, if appropriate, corrective action, as directed by the EM Manager. The laboratory will report the results of the environmental sample and QC sample analyses and any necessary corrective actions that were performed. In the event that more than one analytical laboratory is used (e.g., for different analyses), each one will have the responsibilities specified above.

L-7f Quality Assurance (QA) Manager

The QA Manager will provide independent oversight of the DMP, via the assigned cognizant QA engineer, to verify that quality objectives are defined and achieved. The QA Manager will ensure objective, independent assessments of the DMP quality performance and the quality performance of the contract analytical laboratory. The QA Manager has been delegated authority on behalf of the Permittees by the MOC General Manager and will have access to work areas, identify quality problems, initiate or recommend corrective actions, verify implementation of corrective actions, and ensure that work will be controlled or stopped until adequate disposition of an unsatisfactory condition has been implemented.

L-8 Quality Assurance Requirements

Specific Quality Assurance (**QA**) requirements for WIPP are defined in WIPP document WP 13-1. A current revision of this document will be maintained in the WIPP Operating Record. Requirements specific to the DMP are presented in this section.

L-8a QA Program—Overview

The QA program was developed to assure that integrity and quality will be maintained for all samples collected and that equipment and records will be maintained in accordance with EPA guidance. The QA Program identifies data quality objectives (**DQO**), processes for assuring sample quality, and processes for generating and maintaining quality records.

L-8b DQOs

DQOs are qualitative and quantitative statements that specify the quality of data required to support project decisions. DQOs will be established to ensure that the data collected will be of a sufficient and known quality for their intended uses. The overall DQO for this project will be to collect accurate and defensible data of known quality that will be sufficient to assess the concentrations of constituents in the ground water underlying the WIPP area. The data generated thus far by the DMP has been used to establish background ground-water quality. For the purpose of this DMP, DQOs for measurement data will be specified in terms of accuracy, precision, completeness, representativeness, and comparability. Measurements of data quality in terms of accuracy and precision will be derived from the analysis of QC samples generated in the field and laboratory. Appropriate QC procedures will be used so that known and acceptable levels of accuracy and precision will be maintained for each data set. This section defines the acceptance criteria for each QC analysis performed. The following subsections define each DQO.

L-8b(1) Accuracy

Accuracy is the closeness of agreement between a measurement and an accepted reference value. When applied to a set of observed values, accuracy is a combination of a random component and a common systematic error (bias) component. Measurements for accuracy will include analysis of calibration standards, laboratory control samples, matrix spike samples, and surrogate spike samples. The bias component of accuracy is expressed as percent recovery (%R). Percent recovery is expressed as follows:

$$\%R = \frac{(measured\ sample\ concentration)}{true\ concentration} \times 100$$

L-8b(1)(i) Accuracy Objectives for Field Measurements

Field measurements will include pH, SC, temperature, Eh, and static ground-water surface elevation. Field measurement accuracy will be determined using calibration check standards.

Thermometers used for field measurements will be calibrated to the National Institute for Standards and Technology (**NIST**) traceable standard on an annual basis to assure accuracy. Accuracy of ground-water surface elevation measurements will be checked before each measurement period by verifying calibration of the device within the specified schedule. WIPP document WP 13-1 outlines the basic requirements for field equipment use and calibration. WIPP Procedure WP 10-AD3029 contains instructions that outline protocols for maintaining current calibration of ground-water surface elevation measurement instrumentation. A current revision of this document or procedure will be maintained in the WIPP Operating Record.

L-8b(1)(ii) Accuracy Objectives for Laboratory Measurements

Analytical system accuracy will be quantified using the following laboratory accuracy QC checks: calibration standards, laboratory control samples (**LCS**), laboratory blanks, matrix and surrogate spike samples. Single LCSs and matrix spike and surrogate spike sample analyses will be expressed as %R. Laboratory analytical accuracy is parameter dependent and will be prescribed in the laboratory SOP.

L-8b(2) Precision

Precision is the agreement among a set of replicate measurements without assumption or knowledge of the true value. Precision data will be derived from duplicate field and laboratory measurements. Precision will be expressed as relative percent difference (**RPD**), which is calculated as follows:

$$RPD = \frac{|(measured\ value\ sample\ 1 - measured\ value\ sample\ 2)|}{average\ of\ \ measured\ samples\ 1 + 2} \times 100$$

L-8b(2)(i) Precision Objectives for Field Measurements

Precision of field measurements of water-quality parameters will meet or exceed required reporting levels. SC, pH, temperature, and optionally Eh will be measured during well purging and after sampling. SC measurements will be precise to ±10% pH to 0.10 standard unit, and temperature to 0.10 degrees Celsius (°C), Eh to 10 millivolts (mV).

L-8b(2)(ii) Precision Objectives for Laboratory Measurements

Precision of laboratory analyses will be assessed by performing the same analyses twice on LCSs with each analytical batch assessed at a minimum frequency of 1 in 20 ground-water samples for nonradiological parameters and 1 in 10 for radiological parameters. The laboratory will determine analytical precision control limits by performing replicate analyses of control samples. Precision measurements will be expressed as RPD. Laboratory analytical precision is also parameter dependent and will be prescribed in laboratory SOPs.

L-8b(3) Contamination

In addition to measurements of precision and bias, QC checks for contamination will be performed. QC samples including trip blanks, field blanks, and method blanks will be analyzed to assess and document contamination attributable to sample collection equipment, sample handling and shipping, and laboratory reagents and glassware. Trip blanks will be used to assess volatile organic compound (**VOC**) sample contamination during shipment and handling and will be collected and analyzed at a frequency of 1 sample per sample shipment. Field blanks will be used to assess field sample collection methods and will be collected and analyzed at a minimum frequency of one sample per 20 samples (five percent of the samples collected). Method blanks will be used to assess contamination resulting from the analytical process and will be analyzed at a minimum frequency of one sample per 20 samples, or five percent of the samples collected. Evaluation of sample blanks will be performed following U.S. EPA "National Functional Guidelines for Organic Data Review" (EPA, 1991) and "Functional Guidelines for Evaluating Inorganics Analyses" (EPA, 1988). Only method blanks will be analyzed via wet chemistry methods. The criteria for evaluating method blanks will be established as follows: If method blank results exceed reporting limits, then that value will become the detection limit for the sample batch. Detection of analytes of interest in blank samples may be used to disqualify some samples, requiring resampling and additional analyses on a case-by-case basis.

L-8b(4) Completeness

Completeness is a measure of the amount of usable valid data resulting from a data collection activity, given the sample design and analysis. Completeness may be affected by unexpected conditions that may occur during the data collection process.

Occurrences that reduce the amount of data collected include sample container breakage in the laboratory and data generated while the laboratory was operating outside prescribed QC limits. All attempts will be made to minimize data loss and to recover lost data whenever possible. The completeness objective for noncritical measurements (i.e., field measurements) will be 90 percent and 100 percent for critical measurements (i.e., compliance data). If the completeness objective is not met, the WIPP EM Manager will determine on behalf of the Permittees the need for resampling on a case-by-case basis. Numerical expression of the completeness (**%C**) of data is as follows:

$$\%C = \frac{number\ of\ accepted\ samples}{total\ number\ of\ samples\ collected} \times 100$$

L-8b(5) Representativeness

Representativeness is the degree to which sample analyses accurately and precisely represent the media they are intended to represent. Data representativeness for this DMP will be accomplished through implementing approved sampling procedures and the use of validated analytical methods. Sampling procedures will be designed to minimize factors affecting the integrity of the samples. Ground-water samples will only be collected after well purging criteria have been met. The analytical methods selected will be those that will most accurately and precisely represent the true concentration of analytes of interest.

L-8b(6) Comparability

Comparability is the extent to which one data set can be compared to another. Comparability will be achieved through reporting data in consistent units and collection and analysis of samples using consistent methodology. Aqueous samples will consistently be reported in units of measures dictated by the analytical method. Units of measure include:

- Milligrams per liter (mg/L) for alkalinity, inorganic compounds and metals
- Micrograms per liter (µg/L) for VOCs.

Ground-water surface elevation measurements will be expressed as equivalent freshwater elevation in feet above mean sea level.

L-8c Design Control

The ground-water monitoring system was designed and will be maintained to meet specifications established in 20.4.1.500 NMAC (incorporating 40 CFR §§264 Subpart F and 264.601 through 264.603).

L-8d Instructions, Procedures, and Drawings

Provisions and responsibilities for the preparation and use of instructions and procedures at WIPP are outlined in WIPP document WP 13-1. Any activities performed for ground-water monitoring that may affect ground water will be performed in accordance with documented and approved procedures which comply with the Permit and the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264 Subpart F).

Technical procedures, as specified elsewhere in this DMP, have been developed for each quality-affecting function performed for ground-water monitoring. The technical procedures unique to the DMP will be controlled by the ES&H at WIPP. The procedures are sufficiently detailed and include, when applicable, quantitative or qualitative acceptance criteria.

Procedures were prepared in accordance with requirements in WIPP document WP 13-1. A current revision of this document will be maintained in the WIPP Operating Record.

L-8e Document Control

Document controls will ensure that the latest approved versions of procedures will be used in performing ground-water monitoring functions and that obsolete materials will be removed from work areas.

L-8f Control of Work Processes

Process control requirements, defined in WIPP document WP 13-1 are met, and will continue to be met, for this DMP. A current revision of this document will be maintained in the WIPP Operating Record.

L-8g Inspection and Surveillance

Inspection and surveillance activities will be conducted as outlined in WIPP document WP 13-1. The QA Department will be responsible for performing the applicable inspections and surveillance on the scope of work. EM section personnel will be responsible for performance checks as defined in applicable procedures and determined for the Permittees by MOC metrology laboratory personnel. Performance checks for the DMP will determine the acceptability of purchased items and assess degradation that occurs during use. A current revision of this document will be maintained in the WIPP Operating Record.

L-8h Control of Monitoring and Data Collection Equipment

WIPP document WP 13-1 outlines the basic requirements for control and calibrating monitoring and data collection (**M&DC**). M&DC equipment shall be properly controlled, calibrated, and maintained according to WIPP Procedure WP 10-AD3029 to ensure continued accuracy of ground-water monitoring data. Results of calibrations, maintenance, and repair will be documented. Calibration records will identify the reference standard and the relationship to national standards or nationally accepted measurement systems. Records will be maintained to track uses of M&DC equipment. If M&DC equipment is found to be out of tolerance, the equipment will be tagged and it will not be used until corrections are made. A current revision of this document or procedure will be maintained in the WIPP Operating Record.

L-8i Control of Nonconforming Conditions

WIPP document WP 13-1 specifies the system used at WIPP for ensuring that appropriate measures are established to control nonconforming conditions. Nonconforming conditions connected to the DMP will be identified in and controlled by documented procedures. Equipment that does not conform to specified requirements will be controlled to prevent use. The disposition of defective items will be documented on records traceable to the affected items. Prior to final disposition, faulty items will be tagged and segregated. Repaired equipment will be subject to the original acceptance inspections and tests prior to use. A current revision of this document will be maintained in the WIPP Operating Record.

L-8j Corrective Action

Requirements for the development and implementation of a system to determine, document, and initiate appropriate corrective actions after encountering conditions adverse to quality at WIPP are outlined in WIPP document WP 13-1. Conditions adverse to acceptable quality will be documented and reported in accordance with corrective action procedures and corrected as soon as practical. Immediate action will be taken to control work performed under conditions adverse to acceptable quality and its results to prevent quality degradation. A current revision of this document will be maintained in the WIPP Operating Record.

L-8k Quality Assurance Records

WIPP document WP 13-1 outlines the policy that will be used at WIPP regarding identification, preparation, collection, storage, maintenance, disposition, and permanent storage of QA records. A current revision of this document will be maintained in the WIPP Operating Record.

Records to be generated in the DMP will be specified by procedure. QA and RCRA operating records will be identified. This will be the basis for the labeling of records as “QA” or “RCRA operating” on the EM RIDS.

QA records will document the results of the DMP implementing procedures and will be sufficient to demonstrate that all quality-related aspects are valid. The records will be identifiable, legible, and retrievable.

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TABLES

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TABLE L-1
HYDROLOGICAL PARAMETERS FOR ROCK UNITS ABOVE THE SALADO AT WIPP

Unit		Hydraulic Conductivity	Storage Coefficient	Transmissivity	Permeability	Thickness	Hydraulic Gradient
Santa Rosa		2×10^{-8} to 2×10^{-6} m/s (1) (2)	Specific capacity 0.029 to 0.041 ℓ/s/m	6×10^{-7} to 6×10^{-5} m^2/s (3)	10^{-10} m^2	0 to 91 m	0.001 (5)
Dewey Lake		10^{-8} m/s	Specific storage 1×10^{-5} (1/m) (2)	2.8×10^{-6} to 2.8×10^{-4} m^2/s (4)	5.01×10^{-17} m^2	152 m	0.001 (5)
Rustler	Forty-niner	1×10^{-13} to 1×10^{-11} m/s (anhydrite) 1×10^{-9} m/s (mudstone) (2)	Specific storage 1×10^{-5} (1/m) (2)	8×10^{-8} to 8×10^{-9} m^2/s	0 m^2	13 to 23 m	NA (6)
Rustler	Magenta	$1 \times 10^{-8.5}$ to $1 \times 10^{-6.5}$ m/s (2)	Specific storage 1×10^{-5} (1/m) (2)	4×10^{-4} to 1×10^{-9} m^2/s	6.31×10^{-14} m^2	7 to 8.5 m	3 to 6
Rustler	Tamarisk	1×10^{-13} to 1×10^{-11} m/s (anhydrite) 1×10^{-9} m/s (mudstone) (2)	Specific storage 1×10^{-5} (1/m) (2)	$<2.7 \times 10^{-11}$ m^2/s	0 m^2	26 to 56 m	NA (6)
Rustler	Culebra	$1 \times 10^{-7.5}$ to $1 \times 10^{-5.5}$ m/s (2)	Specific storage 1×10^{-5} (1/m) (2)	1×10^{-3} to 1×10^{-9} m^2/s	2.1×10^{-14} m^2	4 to 11.6 m	0.003 to 0.007 (5)
Rustler	Unnamed lower member	6×10^{-15} to 1×10^{-13} m/s 1.5×10^{-11} to 1.2×10^{-11} m/s (basal interval)	Specific storage 1×10^{-5} (1/m) (2)	2.9×10^{-10} to 2.2×10^{-13} m^2/s 2.9×10^{-10} to 2.4×10^{-10} m^2/s (basal interval)	0 m^2	29 to 38 m	NA (6)

Matrix characteristics relevant to fluid flow include values used in this table such as permeability, hydraulic conductivity, gradient, etc.)

Table Notes:

(1) The Santa Rosa Formation is not present in the western portion of the WIPP site. It was combined with the Dewey Lake Red Beds in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996), and the range of values entered here are those used in that study for the Dewey Lake/Triassic hydrostratigraphic unit.

(2) Values or ranges of values given for these entries are the values used in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996). Values are estimated based on literature values for similar rock types, adjusted to be consistent with site-specific data where available. Ranges of values include spatial variation over the WIPP site and differences in values used in different simulations to test model sensitivity to the parameter.

(3) The range of values given here for transmissivity of the Santa Rosa is estimated for the center of the site. Transmissivity is the product of the thickness of the productive interval times its hydraulic conductivity.

Thickness of the Santa Rosa is estimated to be 30 meters at the center of the WIPP site, and the range of derived transmissivities are based on the range of hydraulic conductivity values used by Corbet and Knupp (1996) for the combined Dewey Lake/Triassic unit.

(4) The range of values given here by transmissivity of the Dewey Lake is estimated for the center of the site. Transmissivity is the product of the thickness of the productive interval times its hydraulic conductivity. Thickness of the Dewey Lake is estimated to be 140 meters at the center of the WIPP site, and the range of derived transmissivities are based on the range of hydraulic conductivity values used by Corbet and Knupp (1996) for the combined Dewey Lake/Triassic unit.

(5) Hydraulic gradient is a dimensionless term describing change in the elevation of hydraulic head divided by change in horizontal distance. Values given in these entries are determined from potentiometric surfaces. The range of values given for the Culebra reflects the highest and lowest gradients observed within the WIPP site boundary. Values for the Dewey Lake and Santa Rosa are assumed to be the same as the gradient determined from the water table. Note that the Santa Rosa Formation is absent or above the water table in most of the controlled area, and that the concept of a horizontal hydraulic gradient is not meaningful for these regions.

(6) Flow in units of very low hydraulic conductivity is slow, and primarily vertical. The concept of a horizontal hydraulic gradient is not applicable.

Sources: Beauheim, 1986; Domenico and Schwartz, 1990; Domski, Upton, and Beauheim, 1996; Earlough, 1977.

TABLE L-2
WIPP GROUND-WATER DETECTION MONITORING PROGRAM SAMPLE COLLECTION AND GROUND-WATER SURFACE ELEVATION MEASUREMENT FREQUENCY

Installation	Frequency
Ground-water Quality Sampling	
DMP monitoring wells	Semiannually
All other WIPP surveillance wells	On special request only
Ground-water Surface Elevation Monitoring	
DMP monitoring wells	Monthly and prior to sampling events
All other WIPP surveillance well sites	Monthly
Redundant wells at all other WIPP surveillance well sites	Quarterly

TABLE L-3
ANALYTICAL PARAMETER LIST FOR THE WIPP DETECTION MONITORING PROGRAM

Background Ground-water Quality	**Operational Detection Monitoring Ground-water Quality**
Indicator Parameters pH, SC, TOC, TOH, TDS, TSS, density Parameters Listed in 20.4.1.500 NMAC (incorporating 40 CFR §264) Appendix IX, Calcium, Magnesium, Potassium Field Analyses pH, SC, temperature, chloride, Eh, alkalinity, total Fe, specific gravity	Indicator Parameters pH, SC, TOC, TOH, TDS, TSS, density Organic Parameters Chloroform 1,2-dichloroethane Carbon tetrachloride Chlorobenzene 1,1-dichloroethylene 1,1-dichloroethane Methylene chloride 1,1,2,2-tetrachloroethane Toluene 1,1,1-trichloroethane Cresols 1,2-dichlorobenzene 2,4-dinitrophenol Hexachloroethane Isobutanol Pyridine 1,1,2 Trichloroethane Trichlorofluoromethane Nitrobenzene 1,4-dichlorobenzene cis-1,2-dichloroethylene trans-1,2-dichloroethylene 2,4-dinitrotoluene Hexachlorobenzene Methyl ethyl ketone Pentachlorophenol Tetrachloroethylene Trichloroethylene Xylenes Vinyl Chloride Metals Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver Antimony Beryllium Nickel Thallium Vanadium Calcium Magnesium Potassium Field Analyses pH, SC, temperature, chloride, Eh, alkalinity, total Fe, specific gravity

Note: Because of the lack of sophisticated weights and measures equipment available for field density assessment, field density evaluations are expressed in terms of specific gravity, which is a unitless measure.

TABLE L-4
ANALYTICAL PARAMETER AND SAMPLE REQUIREMENTS

(10) PARAMETERS	(12) NO. OF BOTTLES	(13) VOLUME	(14) TYPE	(15) ACID WASH	(16) SAMPLE FILTER	(17) PRESERVATIVE	(18) HOLDING TIME
Indicator[1] Parameters: • pH • SC • TOC • TOX	 - - 4 3	 25 ml[2] 100 ml[2] 15 ml[2] 250 ml	 Glass Glass Glass Glass	 Field determined Field determined yes yes	 No? No No No	 Field determined Field determined HCl H_2SO_4, pH<2	 None None 28 days[2] 7 days[2]
General Chemistry	1	1 Liter	Plastic	Yes	No	HNO_3,4pH<2	not specified in DMP
Phenolics	1	1 Liter	Amber Glass	Yes	No	H_2SO_4, pH<2	not specified in DMP
Metals/Cations	2	1 Liter	Plastic	Yes	No	HNO_3, pH<2	6 months[2,3]
VOC	4	40 ml	Glass	No	No	HCL, ph<2	14 days[2]
VOC (Purgable)	2	40 ml	Glass	No	No	HCL, ph<2	14 days[2]
VOC (Non-Purgable)	2	40 ml	Glass	No	No	HCL, ph<2	14 days[2]
BN/As	1	½ Gallon	Amber Glass	Yes	No	None	
TCLP	1	1 Liter	Plastic	Yes	No	HNO_3, pH<2	7 days[2]
Cyanide (Total	1	1 Liter	Plastic	Yes	No	NaOH, pH>12	14 days[2]
Sulfide	1	250 ml	Amber Glass	Yes	No	NaOH + Zn Acetate	28 days[2]
Radionuclides	1	1 Gallon	Plastic Cube	Yes	Yes	HNO_3, pH<2	6 months[2]

1 = RCRA Detection Monitoring Analytes
2 = As specified in Table 4-1 of the RCRA TEGD
3 = Reduced holding time of 1 week for WIPP-specific Divalent cation 2 samples noted in the GMD

Note: Unless otherwise indicated, data are from DOE Procedure WP 02-EM1006 methods and are provided as information only.

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FIGURES

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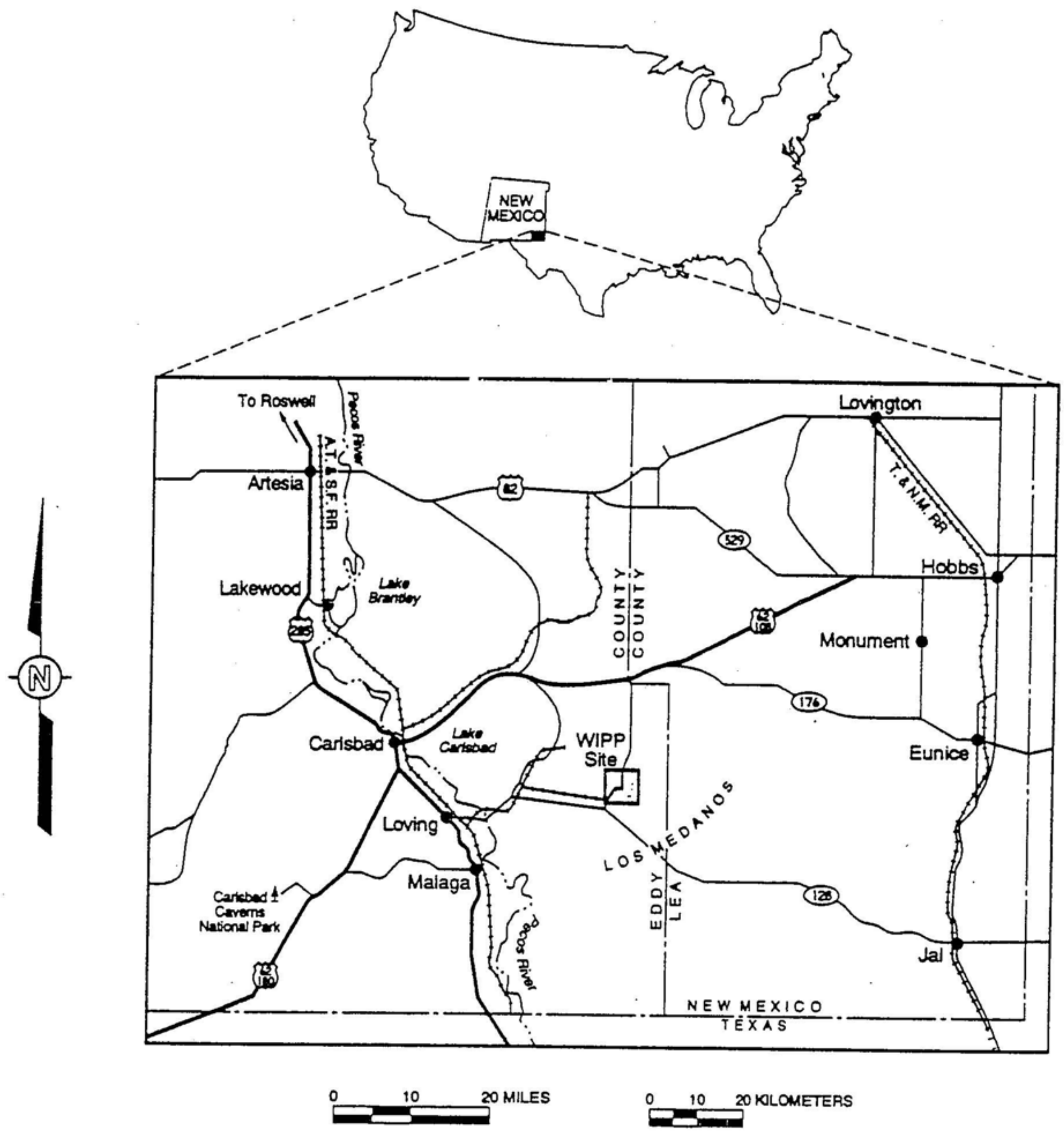


Figure L-1
General Location of the WIPP Facility

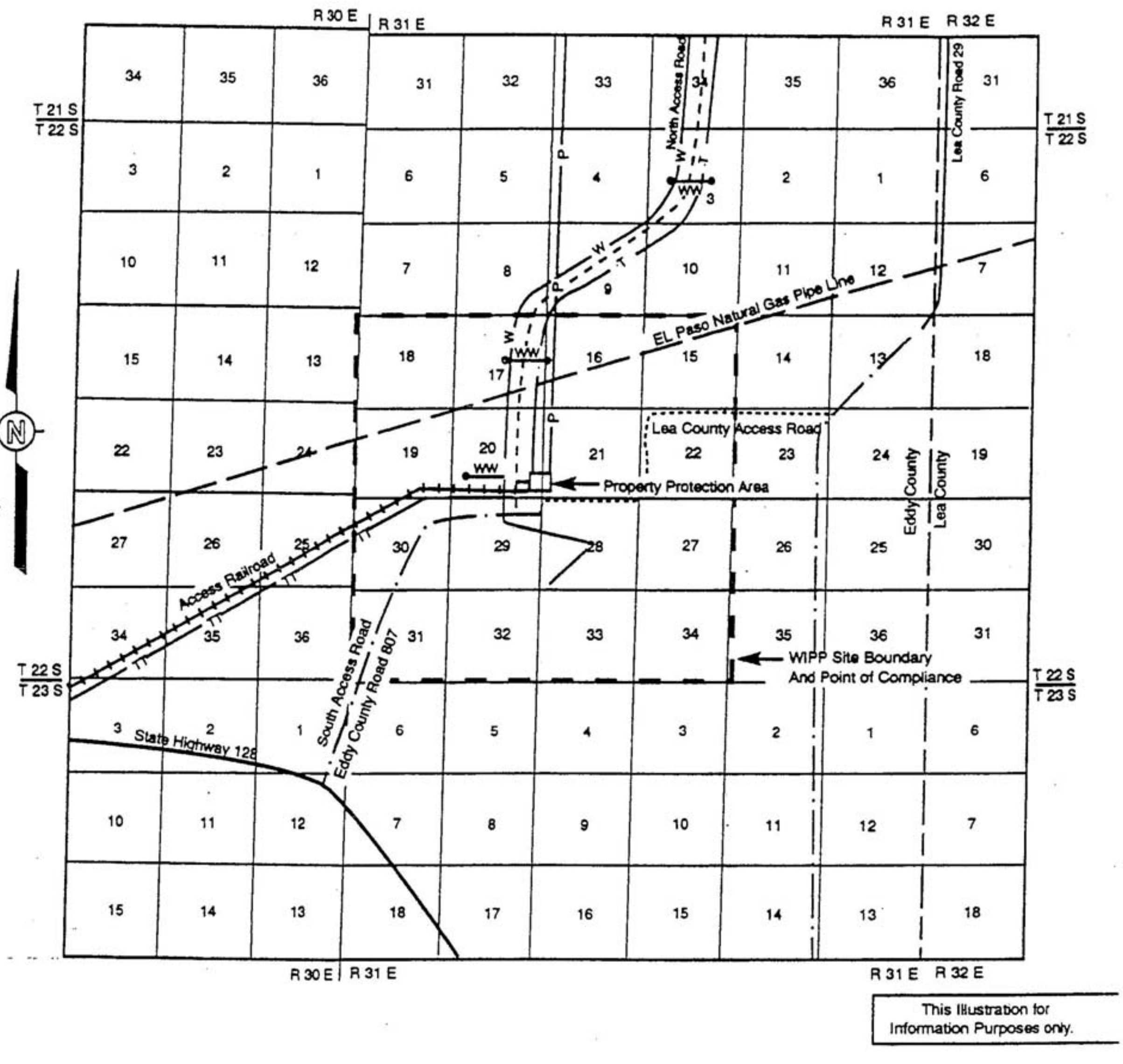
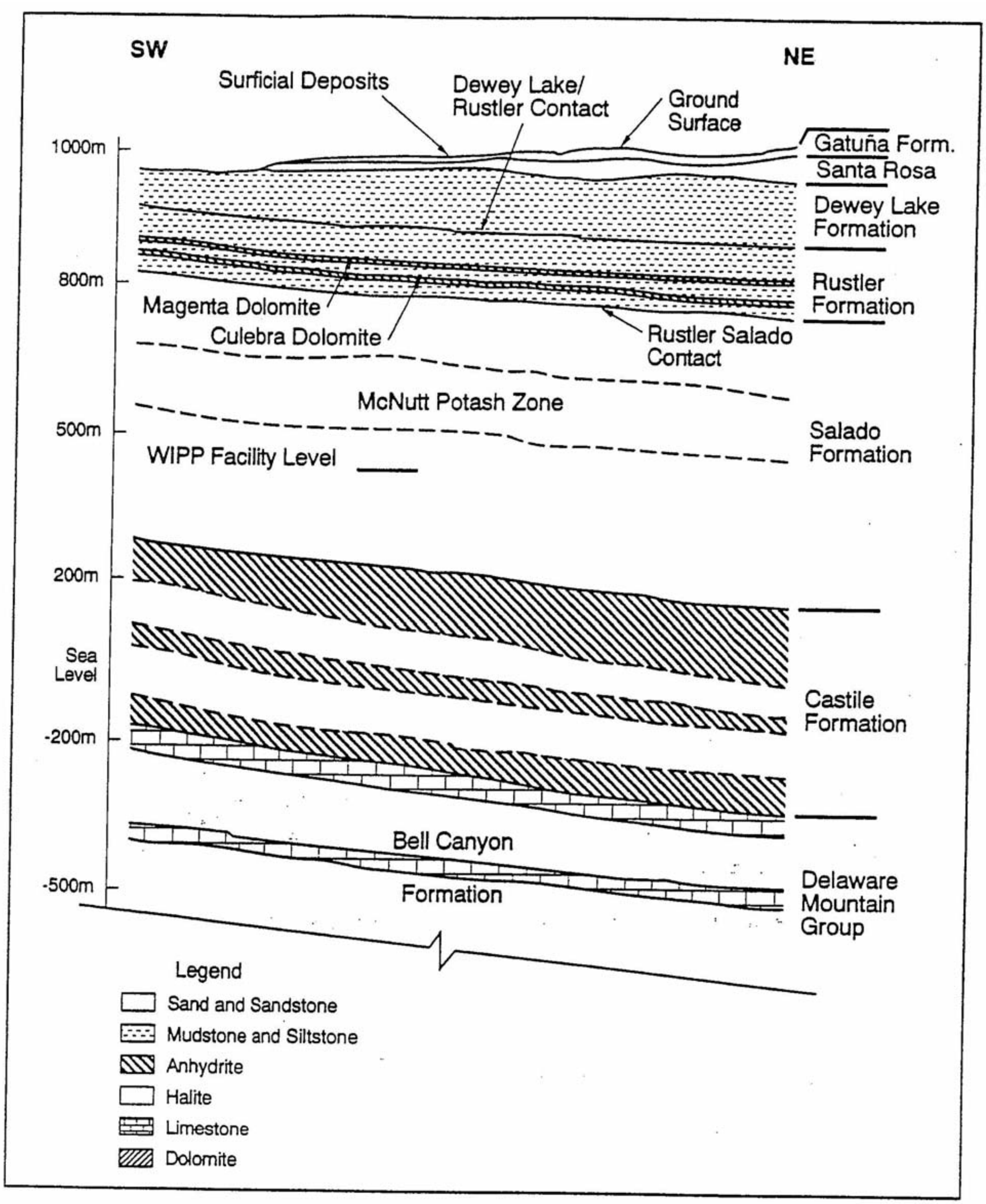


Figure L-2
WIPP Facility Boundaries Showing 16-Square-Mile Land Withdrawal Boundary

System	Series	Group	Formation	Member
Recent	Recent		Surficial Deposits	
Quater-nary	Pliesto-cene		Mescalero Caliche	
			Gatuña	
Tertiary	Mid-Pliocene		Ogallala	
Triassic		Dockum	Santa Rosa	
Permian	Ochoan		Dewey Lake	
			Rustler	Forty-niner
				Magenta
				Tamarisk
				Culebra
				Unnamed lower
			Salado	Upper
				McNutt Potash
				Lower
			Castile	
	Guadalupian	Delaware Mountain	Bell Canyon	
			Cherry Canyon	
			Brushy Canyon	

Figure L-3
Site Geologic Column

1


2 Figure L-4
3 Generalized Stratigraphic Cross Section above Bell Canyon Formation at WIPP Site

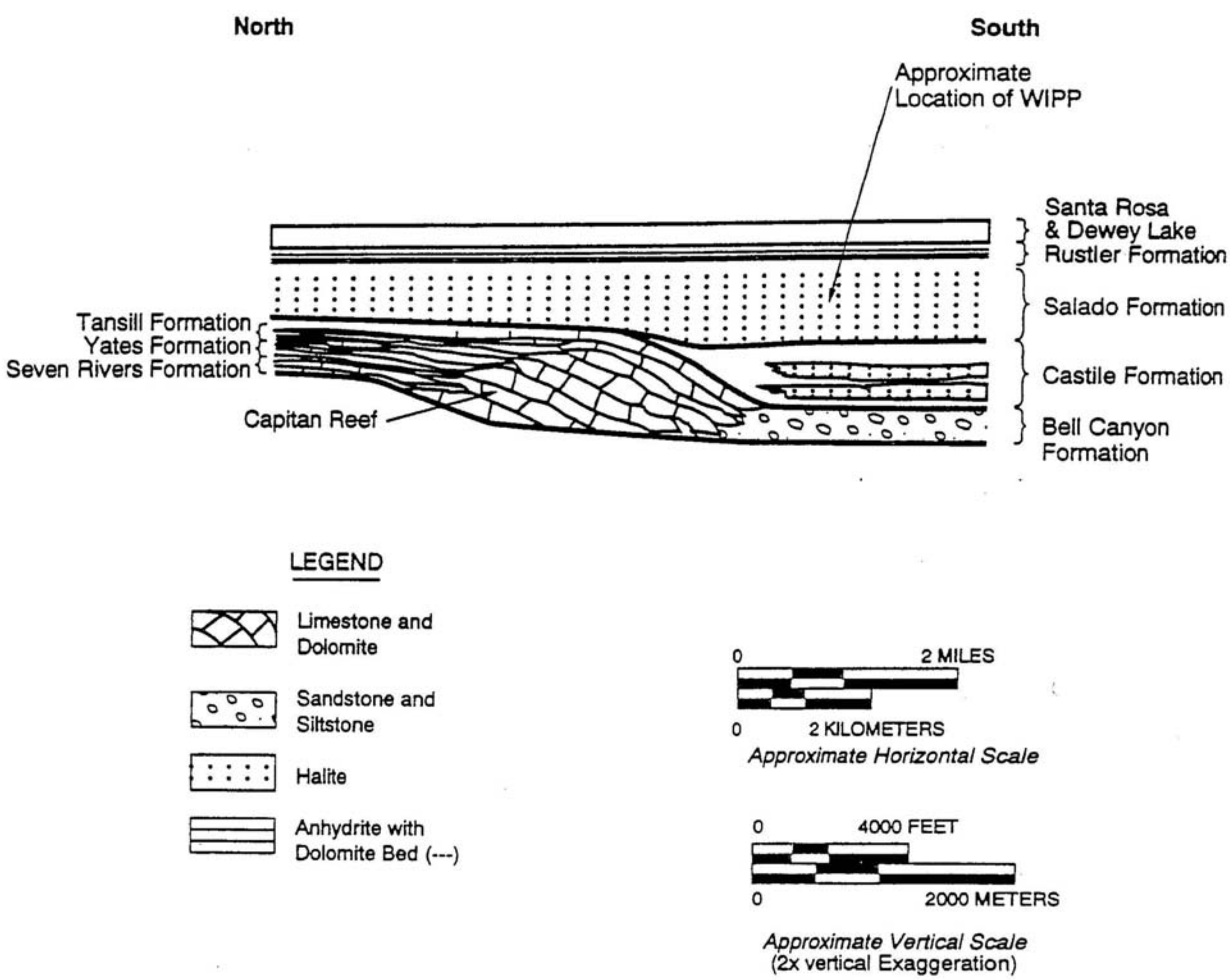
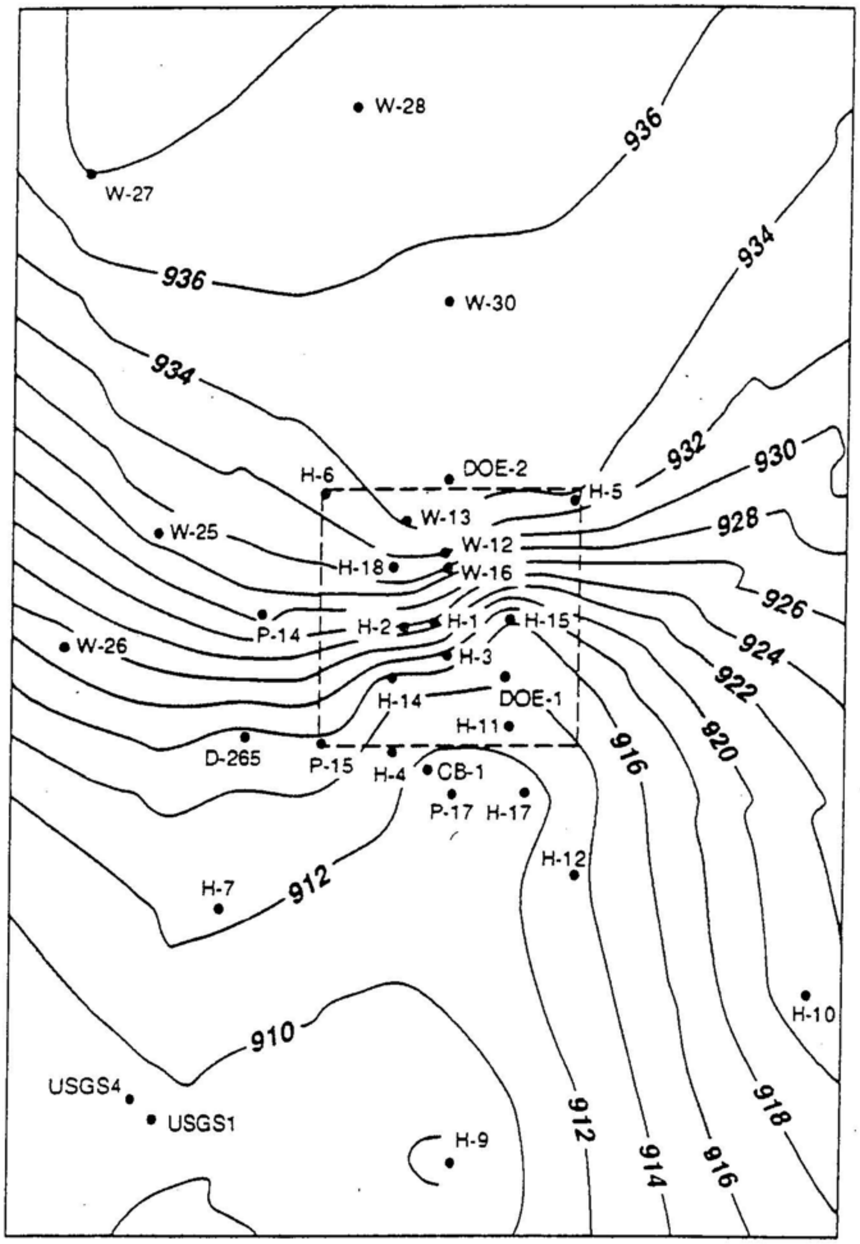
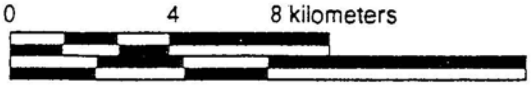


Figure L-5
Schematic North-South Cross Section Through the North Delaware Basin



Source: Jones et al. 1992. Figure 2-5



• Observation Well

Freshwater Heads in meters above mean sea level

Contour Interval: 2 meters

Figure L-6
Culebra Freshwater-Head Contour Surface

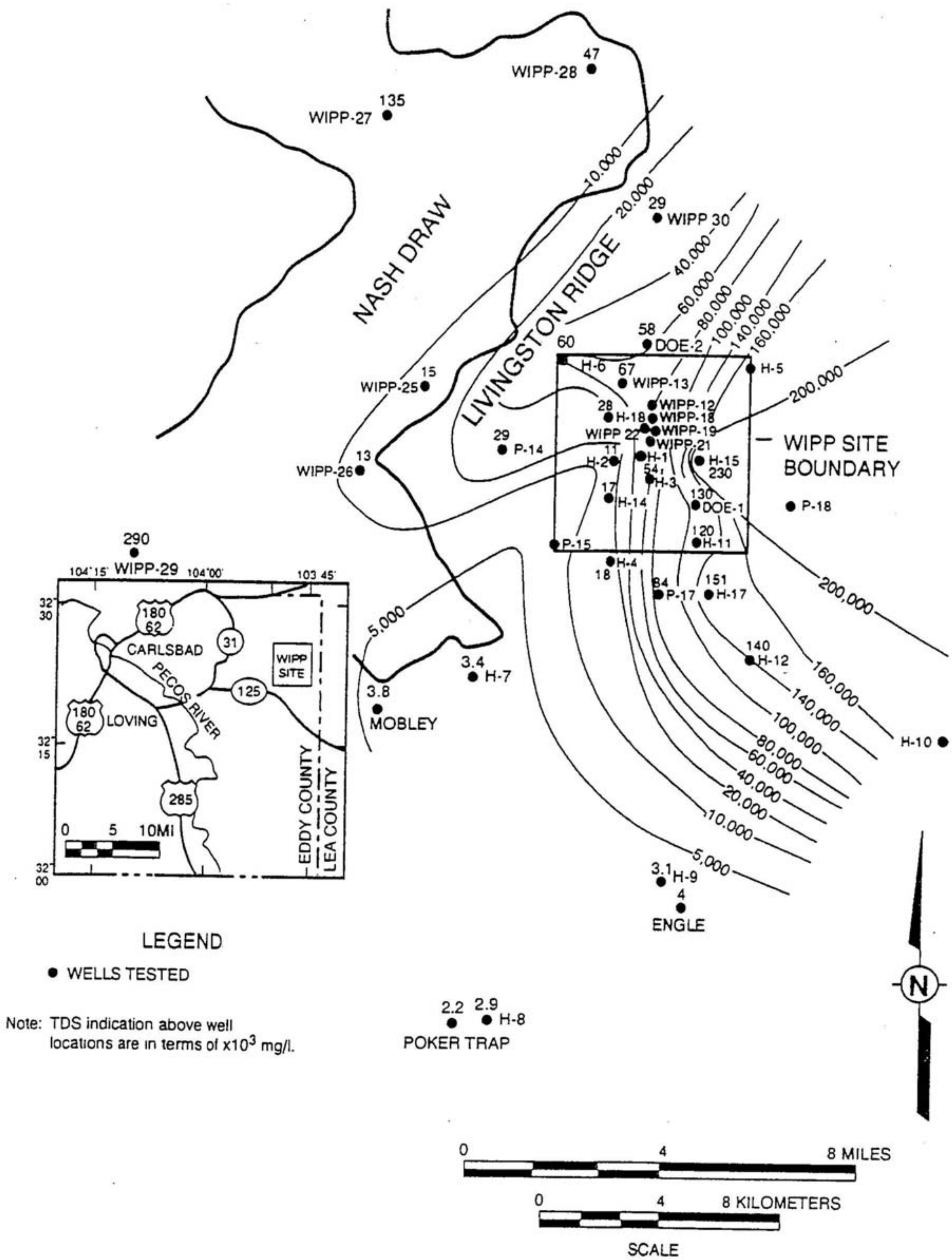


Figure L-7
Total Dissolved Solids Distribution in the Culebra

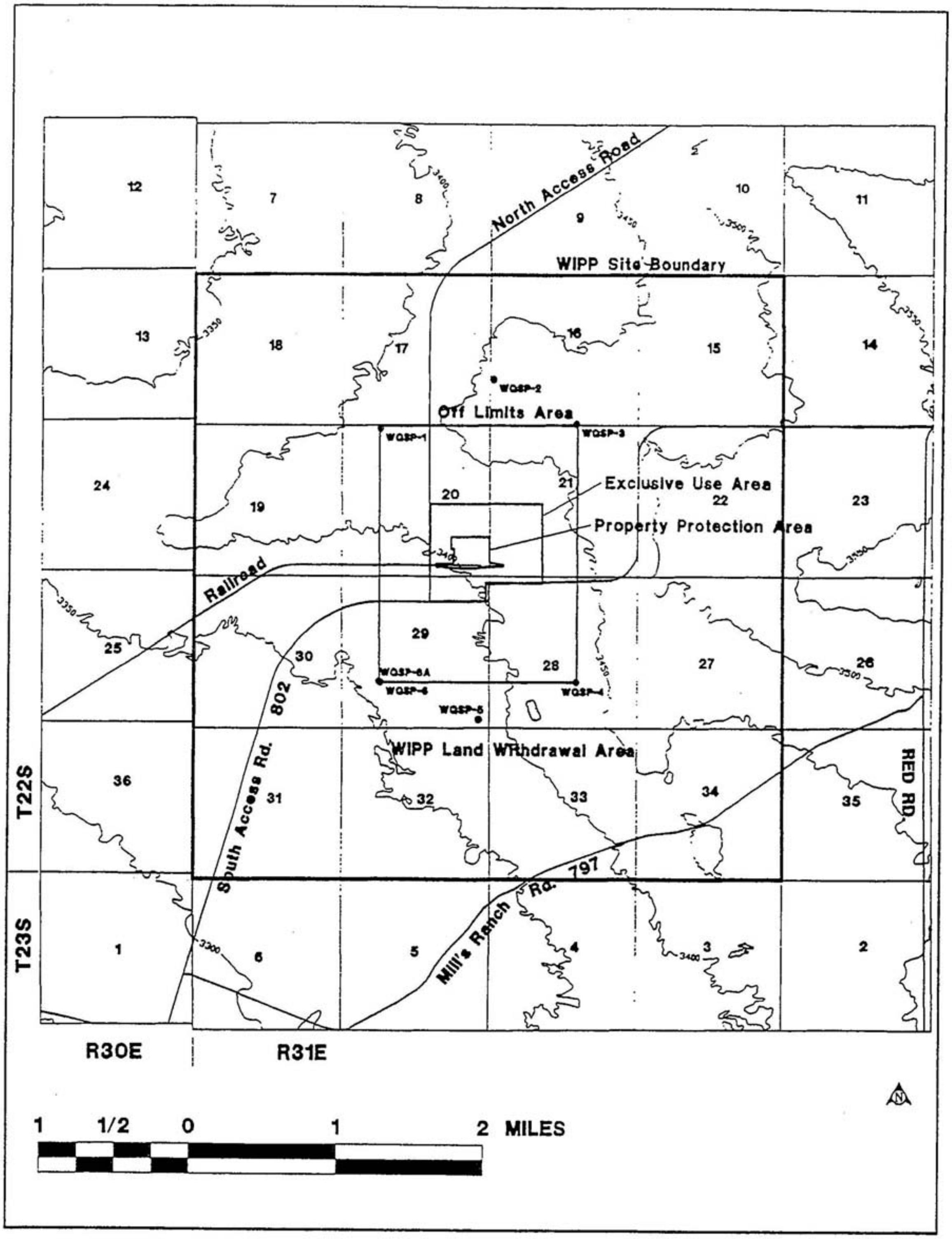


Figure L-8
WQSP Monitor Well Locations

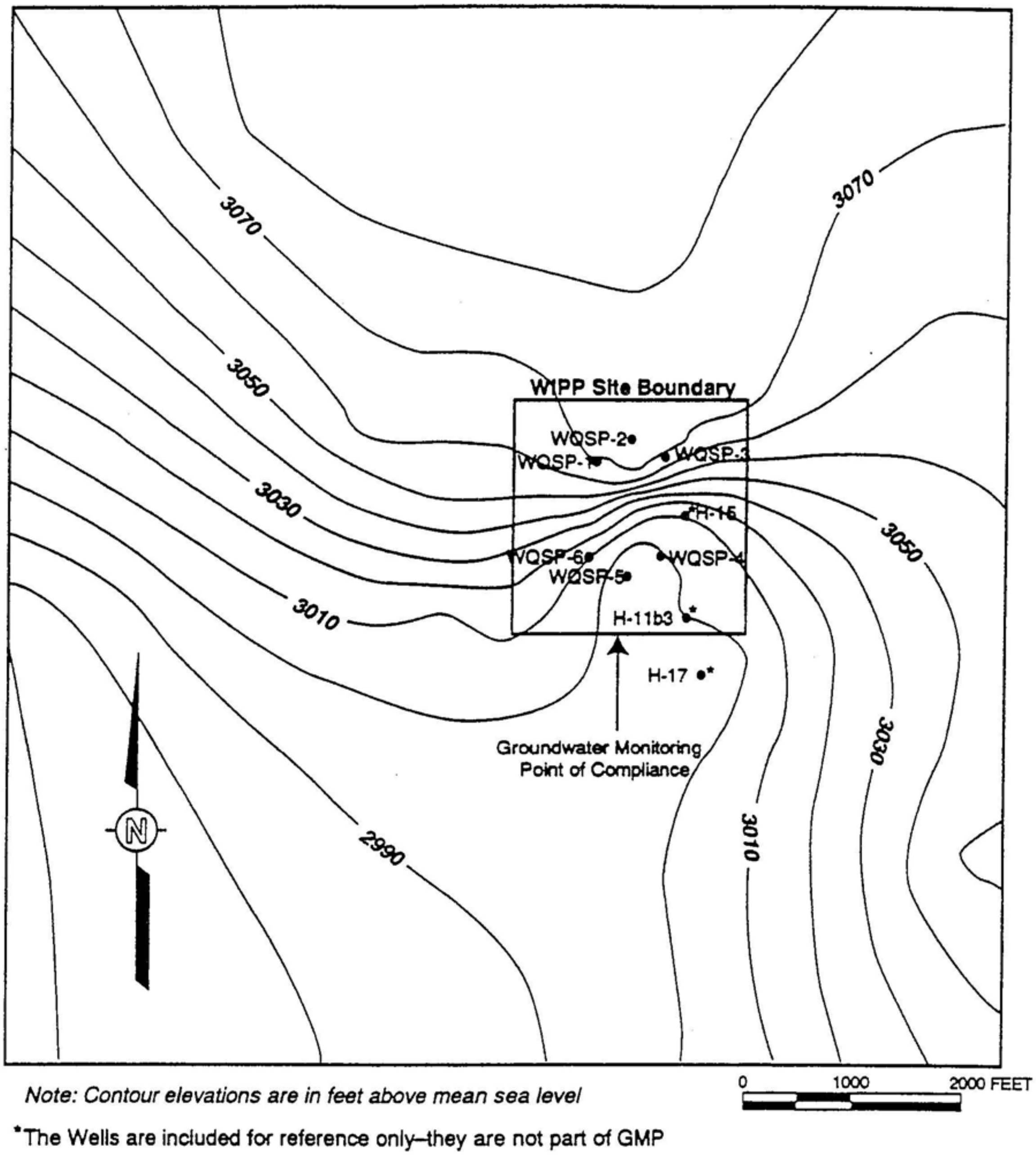


Figure L-9
WIPP DMP Monitor Well Locations and Potentiometric Surface of the Culebra Near the WIPP Site as of 12/96 (adjusted to equivalent freshwater head)

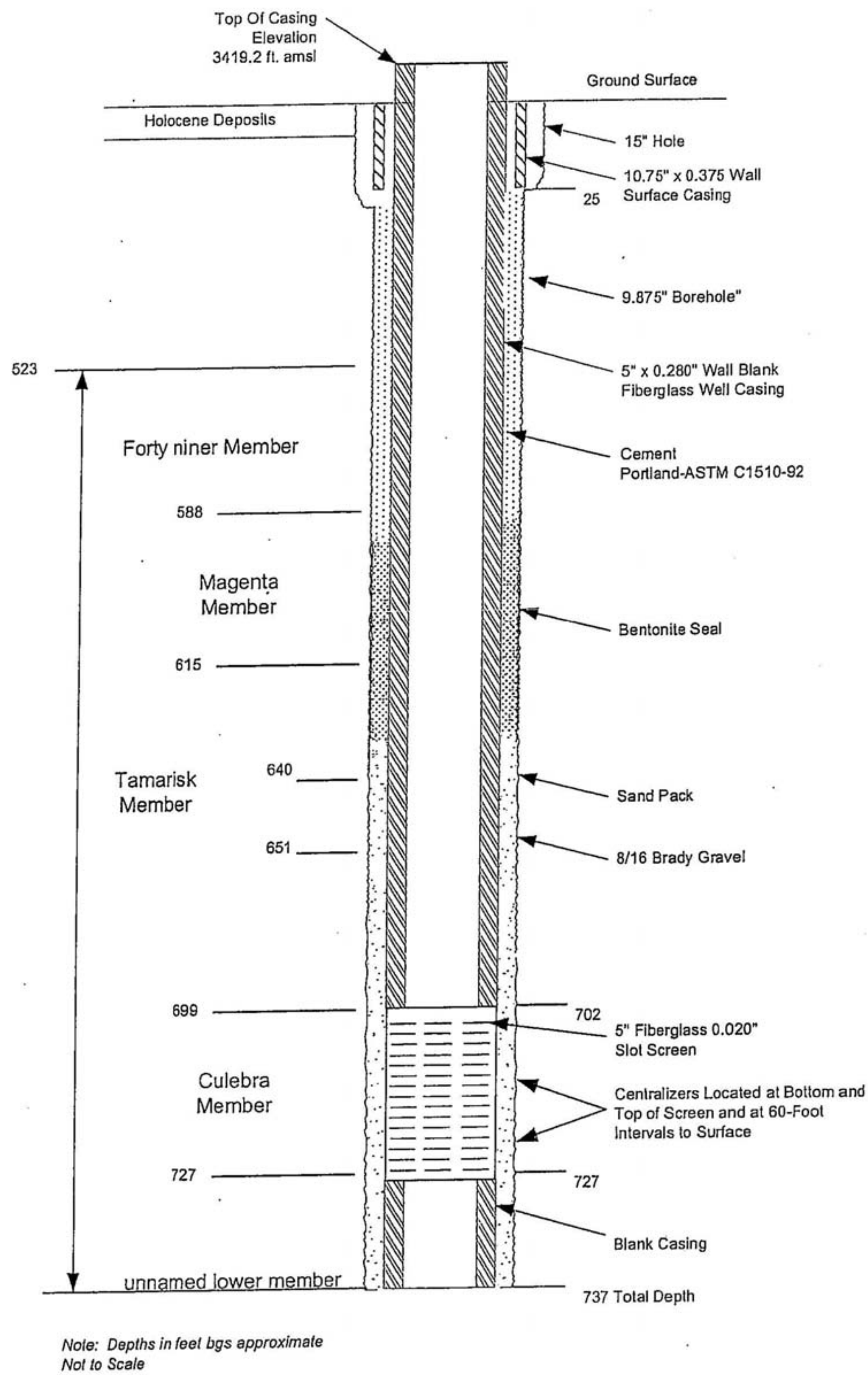


Figure L-10
As-Built Configuration of Well WQSP-1

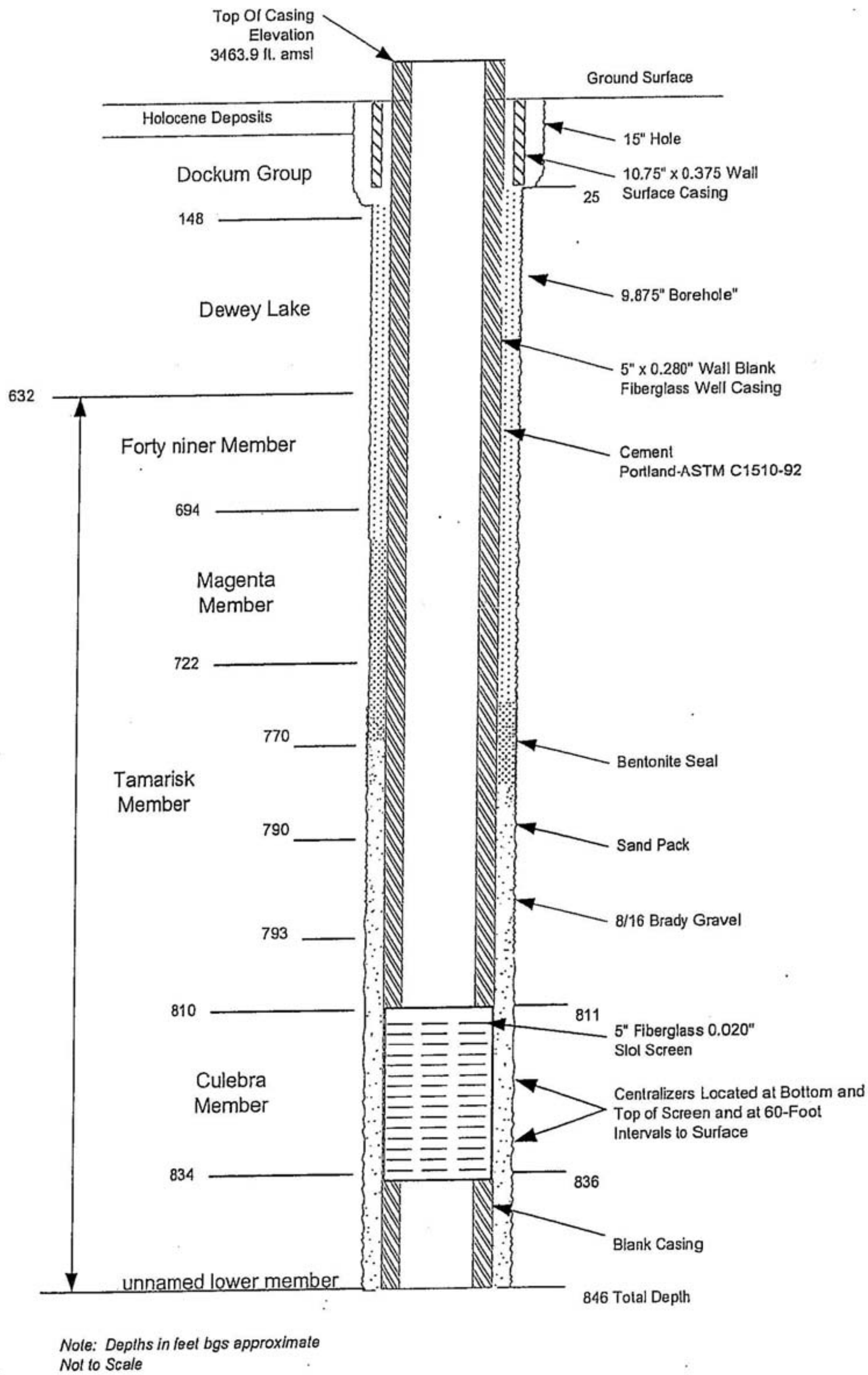
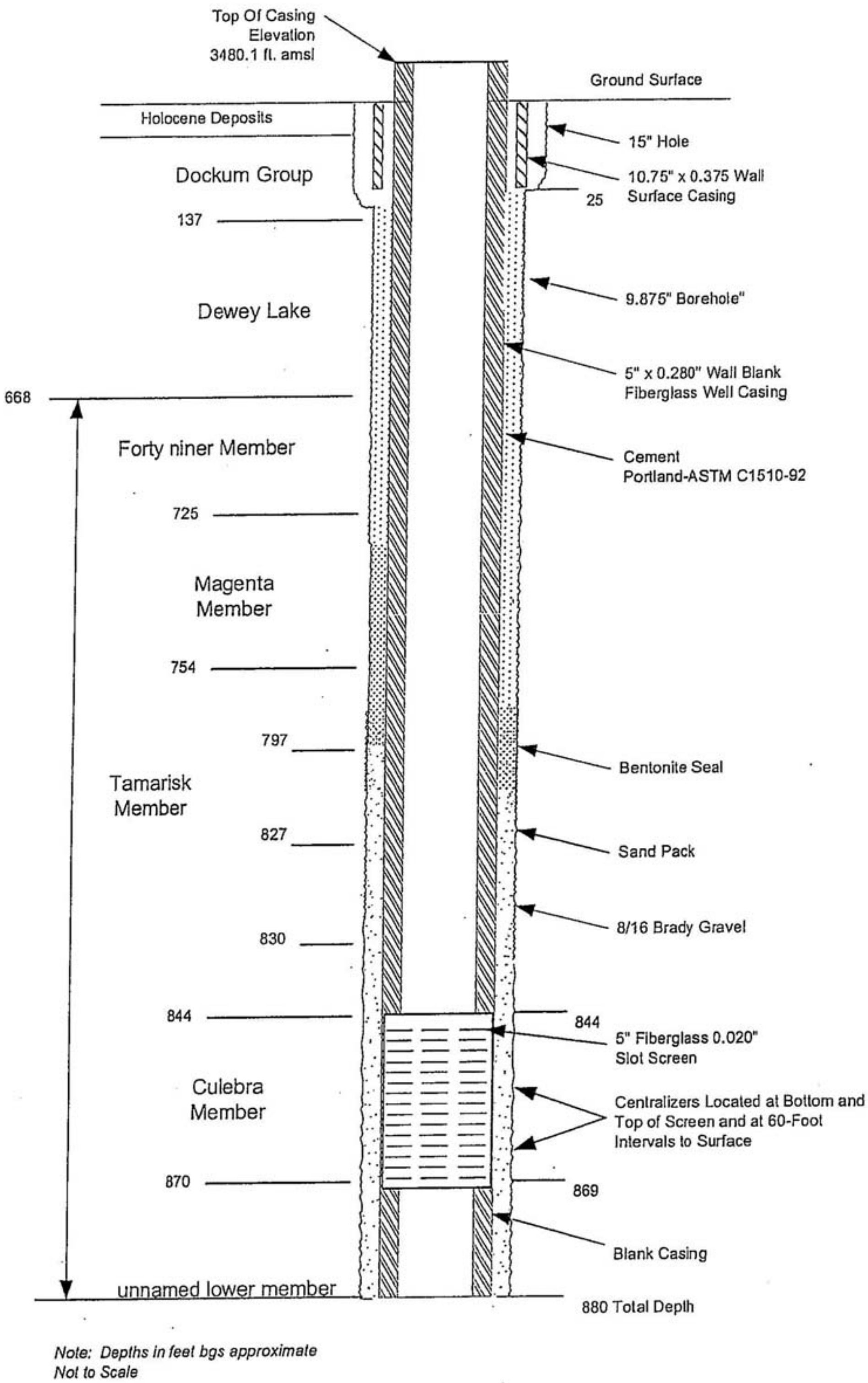
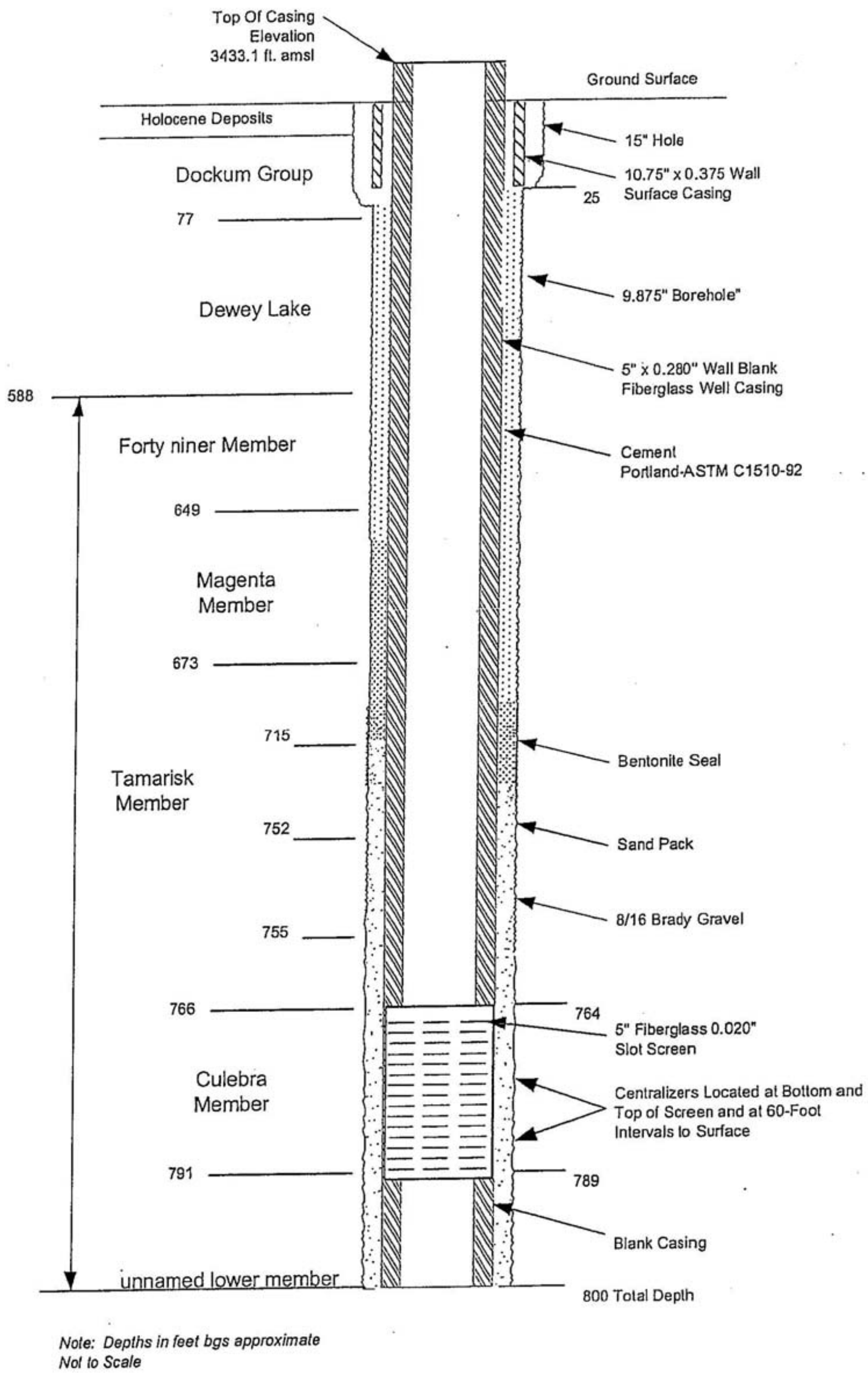


Figure L-11
As-Built Configuration of Well WQSP-2



1

2 Figure L-12
3 As-Built Configuration of Well WQSP-3



1

2 Figure L-13
3 As-Built Configuration of Well WQSP-4

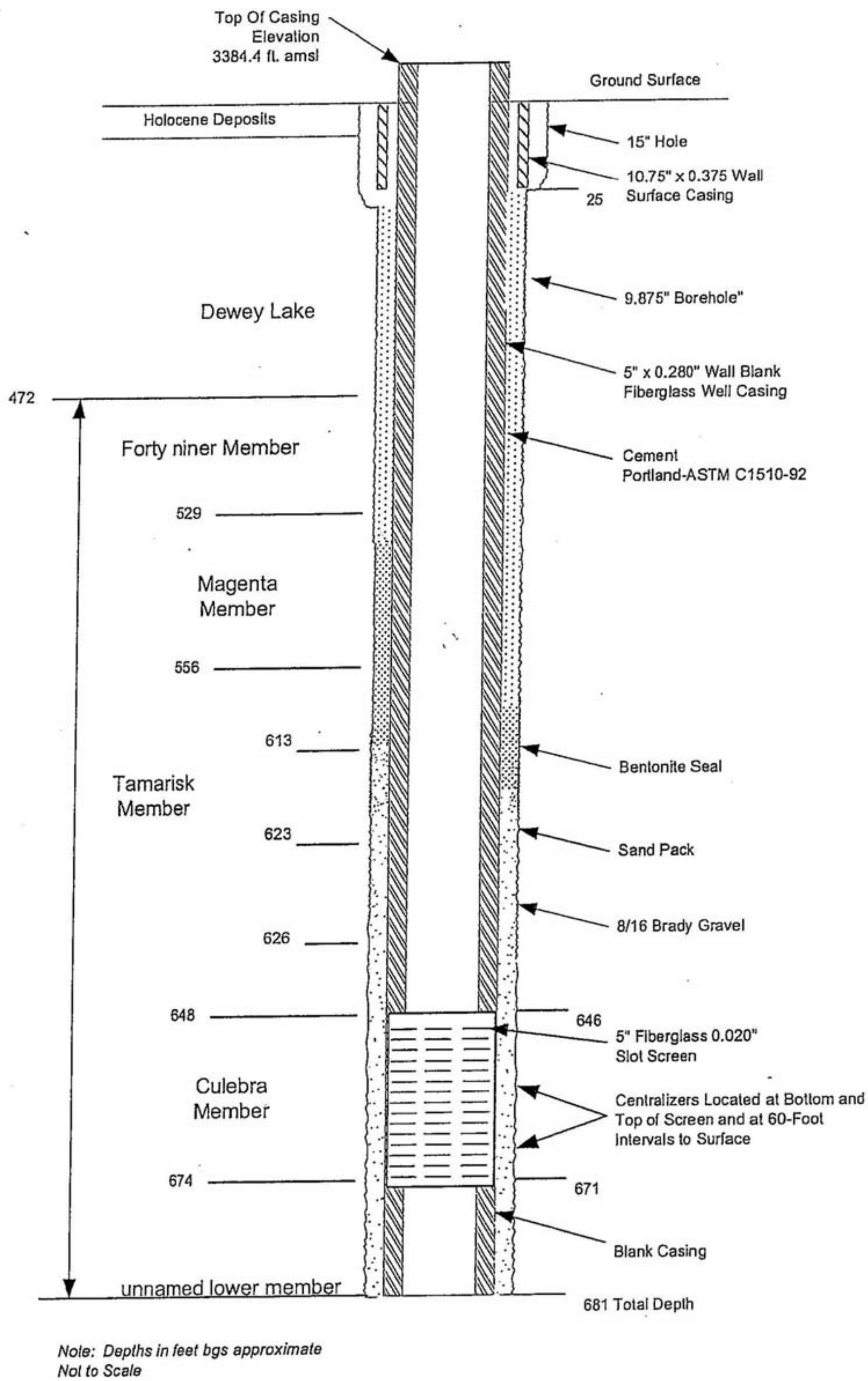


Figure L-14
As-Built Configuration of Well WQSP-5

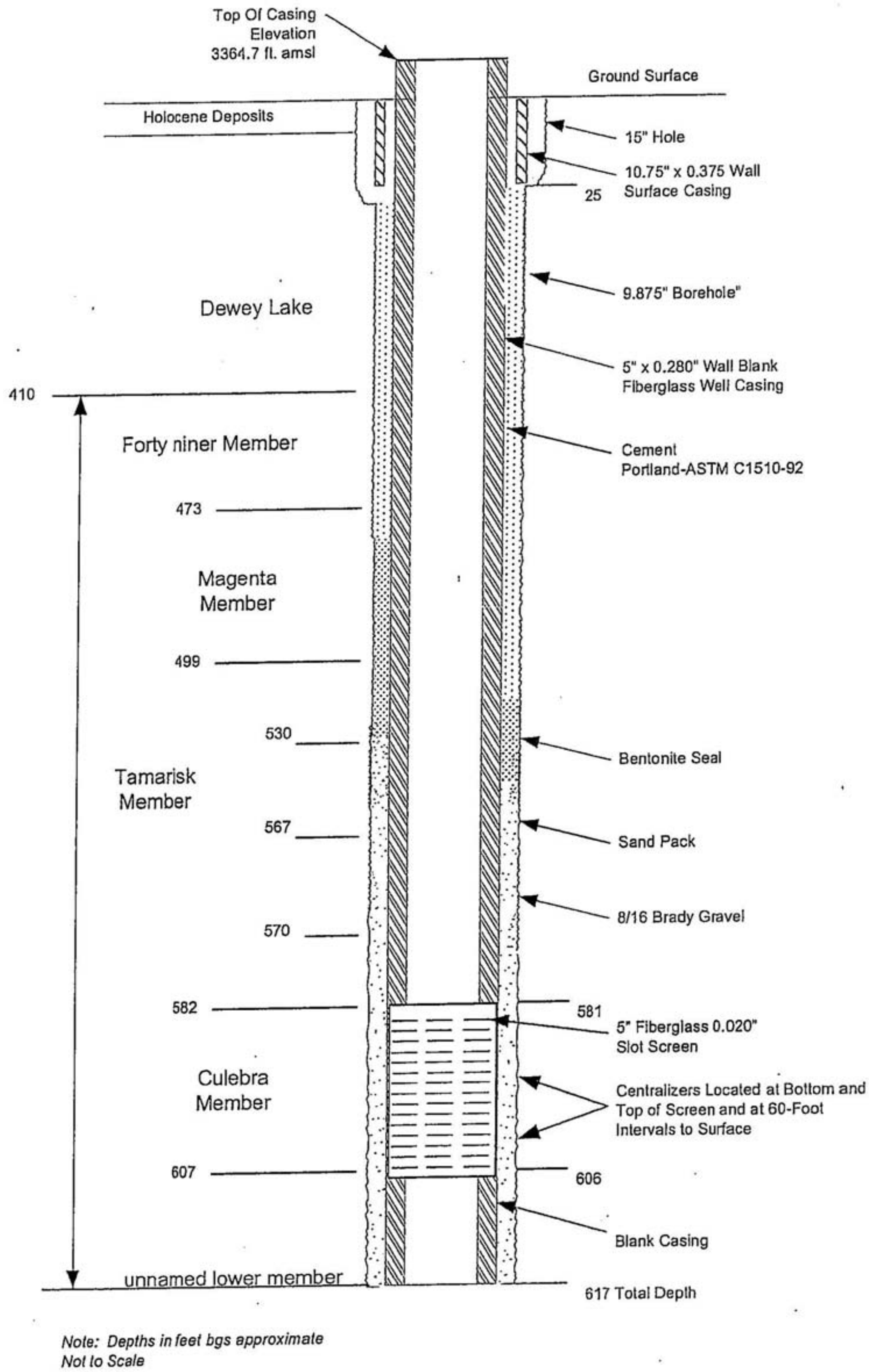


Figure L-15
As-Built Configuration of Well WQSP-6

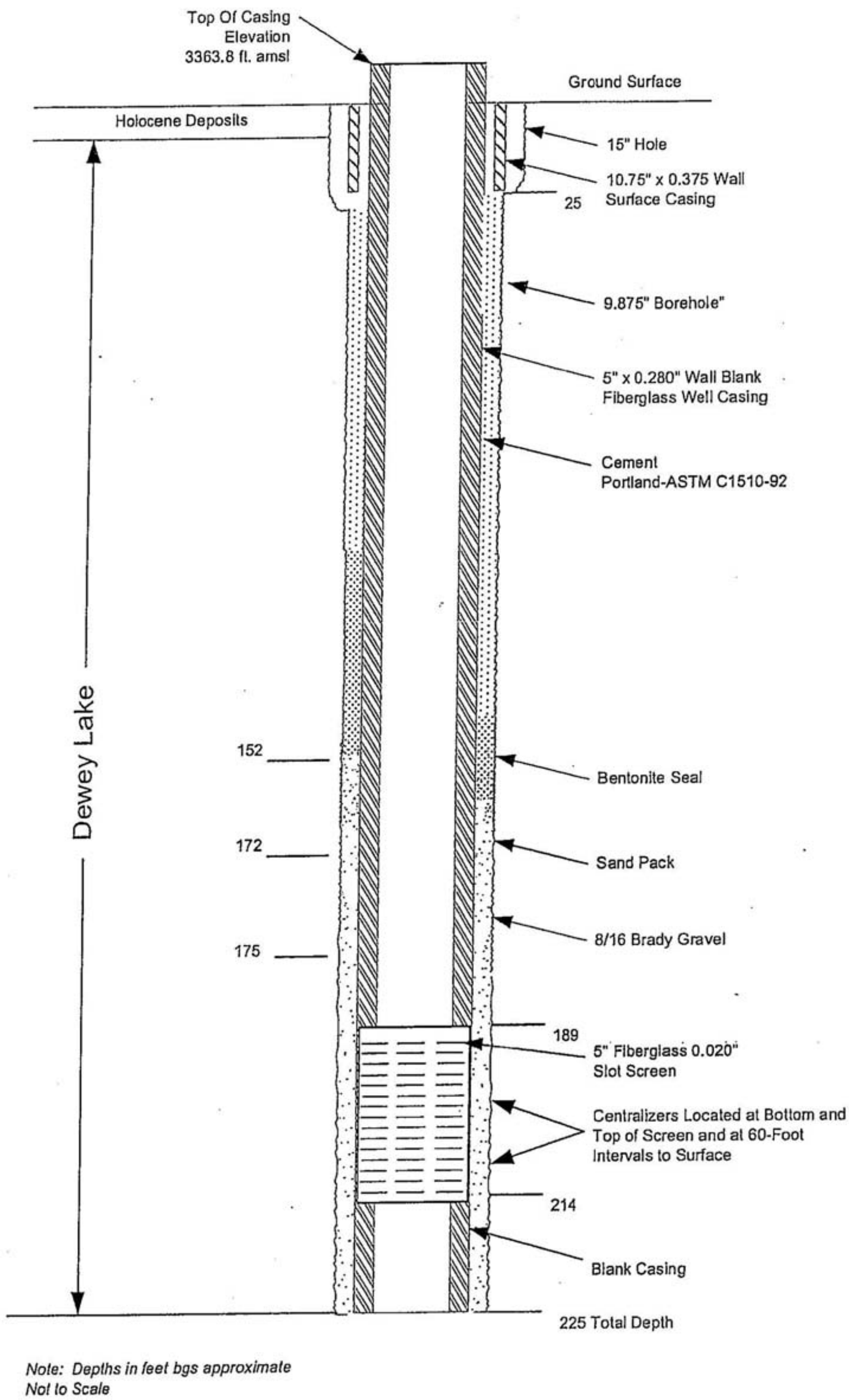


Figure L-16
As-Built Configuration of Well WQSP-6A

Chain of Custody Record

{MOC Name and Address}

C of C Control No. ____________

RFA Control No. ____________

SAMPLING PROGRAM ____________ LAB DESTINATION ____________

SAMPLE TEAM MEMBERS ____________ CARRIER/WAYBILL NO. ____________

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.

Special Instructions ____________

Possible Sample Hazards: ____________

Signatures: (Name, Company, Date and Time: ____________

1. Relinquished By: ____________
   Received By: ____________
2. Relinquished By: ____________
   Received By: ____________
3. Relinquished By: ____________
   Received By: ____________
4. Relinquished By: ____________
   Received By: ____________

WHITE - Original, to accompany samples YELLOW- Field Copy PINK- OTHER

Figure L-17a
Example Chain-of-Custody Record

REQUEST FOR ANALYSIS

{MOC Name and Address} ____________

____

____

____

R/A Control ____________

C/C Control No. ____________

Date Sample Shipped ____________

Lab Destination ____________

Laboratory Contact ____________

Send Lab Report To ____________

____

____

VOC Monitoring Program ____________

Purchase Order No. ____________

Date Report Required ____________

Project Contact ____________

Project Contact Phone No. ____________

Serial No.	Sample No.	C-of-C No.	Sample Type	Sample Pressure	Preservative	Contract-Specific Testing	Special Instructions

TURNAROUND TIME REQUIRED: (Rush must be approved by appropriate Manager) NORMAL ______ RUSH ____(Subject to rush surcharge)
POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or contain high levels of hazardous substances.)
NONHAZARD______ FLAMMABLE______SKIN IRRITANT______HIGHLY TOXIC______BIOLOGICAL______OTHER

SAMPLE DISPOSAL (Please indicate disposition of sample following analysis.) RETURN TO CLIENT______DISPOSAL BY LAB______ (Please Specify)

FOR LAB USE ONLY
RECEIVED BY ____________ DATE/TIME ____________

Figure L-17b
Example Request for Analysis

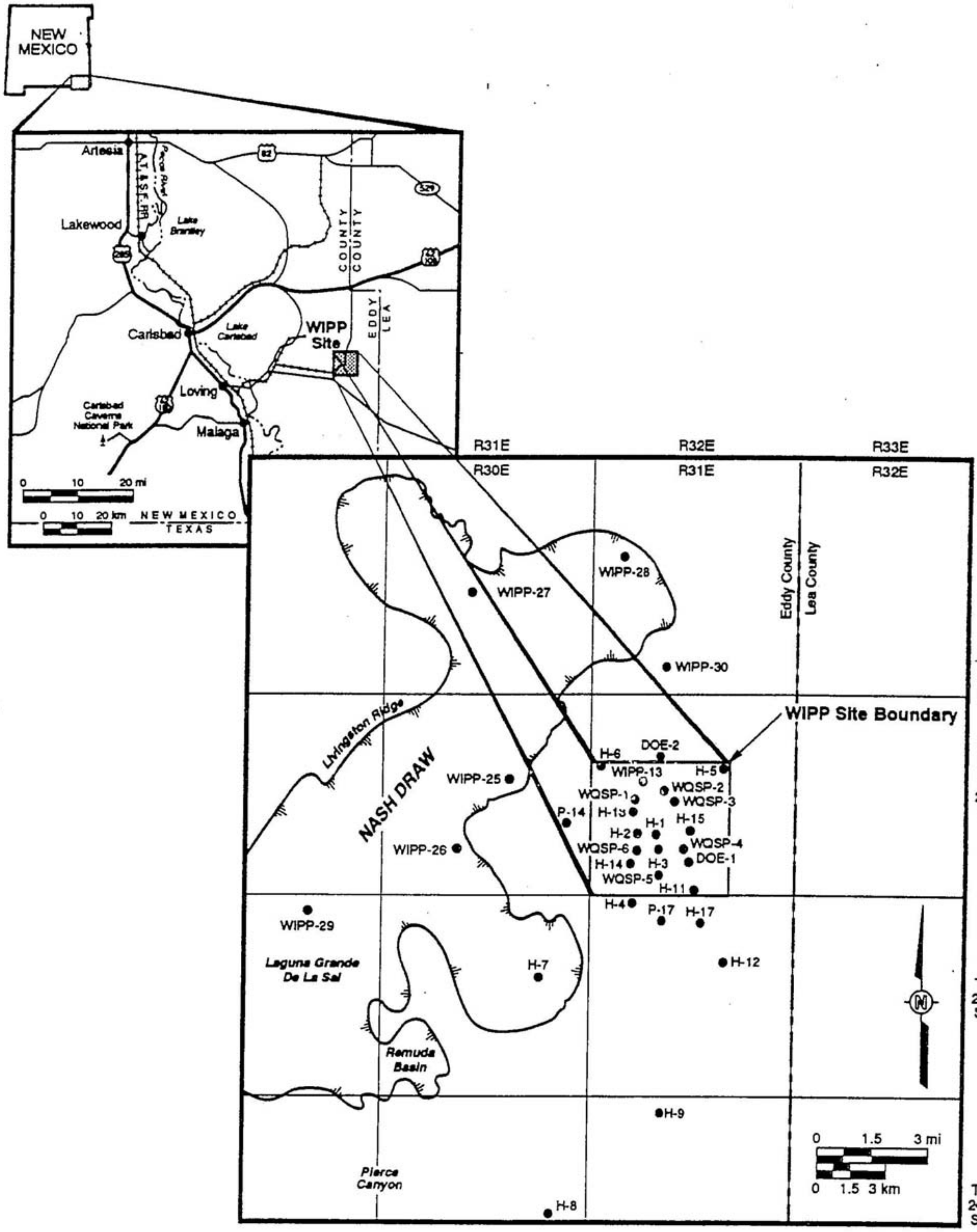


Figure L-18
Ground-water Surface Elevation Monitoring Locations