DOE/WIPP 04-2225

Waste Isolation Pilot Plant

2003 Site Environmental Report

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Processing and final preparation of this report was performed by the Waste Isolation Pilot Plant Management and Operating Contractor for the U.S. Department of Energy under Contract No. DE-AC04-01AL66444.

EXECUTIVE SUMMARY

The mission of Waste Isolation Pilot Plant (WIPP) is to safely and permanently dispose of transuranic (TRU) radioactive waste generated through the research and production of nuclear weapons and other activities related to the national defense of the United States (U.S.). In 2003, 7,696 cubic meters (m^3) of TRU waste was emplaced at WIPP. From the first receipt of waste in March 1999 through the end of 2003, 16,969 m^3 of TRU waste has been emplaced at WIPP.

The U.S. Department of Energy (DOE) Carlsbad Field Office (CBFO) and Washington TRU Solutions LLC (WTS) are dedicated to maintaining high quality management of WIPP environmental resources. DOE Order 450.1, *Environmental Protection Program* and DOE Order 231.1A, *Environment, Safety, and Health Reporting* require that the environment at and near DOE facilities be monitored to ensure the safety and health of the public and the environment. This *Waste Isolation Pilot Plant 2003 Site Environmental Report* (SER) summarizes environmental data from 2003 that characterize environmental management performance and demonstrate compliance with applicable federal and state regulations.

This report was prepared in accordance with DOE Order 231.1A, and Guidance for the Preparation of DOE Annual Site Environmental Reports (ASERs) for Calendar Year 2003 (DOE, 2004). This order and guidance require that DOE facilities submit an annual SER to the DOE Headquarters Office of the Assistant Secretary for Environment, Safety, and Health. The WIPP Hazardous Waste Facility Permit (HWFP) further requires that the SER be provided to the New Mexico Environment Department (NMED).

Environmental Program Information

It is the DOE's policy to conduct its operations at WIPP in compliance with all applicable environmental laws and regulations, and to protect human health and the environment. This is accomplished through a comprehensive management system consisting of radiological and nonradiological environmental monitoring and surveillance and environmental compliance. As part of this management system, the DOE collects data needed to detect and quantify potential impacts WIPP may have on the surrounding environment.

Environmental activities at WIPP include collecting and analyzing environmental samples for contaminants, and evaluating whether WIPP activities have caused significant negative environmental impacts. The *Waste Isolation Pilot Plant Environmental Monitoring Plan* (EMP) (DOE/WIPP 99-2194) outlines major environmental monitoring and surveillance activities at WIPP and WIPP's quality assurance/quality control (QA/QC) program as it relates to environmental monitoring.

WIPP's effluent monitoring and environmental surveillance programs are designed to ensure adequate protection of the public and the environment during DOE operations and that operations comply with the DOE and other applicable federal and state radiation standards and requirements. The Environmental Monitoring Program entails monitoring the pathways that radionuclides and other contaminants could take to reach the environment surrounding WIPP. Pathways monitored include air, groundwater, surface water, soils, sediments, vegetation, and game animals. The goal of the program is to determine if the local ecosystem has been impacted during the WIPP disposal phase and, if so, to evaluate the severity, geographic extent, and environmental significance of those impacts.

The *Waste Isolation Pilot Plant Land Management Plan* (LMP) (DOE/WIPP 93-004) was created in accordance with the WIPP Land Withdrawal Act of 1992 (LWA) (Public Law [Pub. L.] 102-579, as amended by Pub. L. 104-201). This plan identifies resource values, promotes multiple-use management, and identifies long-term goals for the management of WIPP lands. In accordance with the LMP, WIPP follows a land reclamation program and a long-range reclamation plan. WIPP also conducts oil and gas surveillance in the region surrounding the site as an active institutional control to protect WIPP realty from potential trespass.

The purpose of this report is to provide important information needed by DOE Headquarters to assess field environmental program performance and confirm compliance with environmental standards and requirements. This report conveys the DOE's environmental performance to stakeholders and members of the public living near the DOE WIPP site. The 2003 SER also outlines significant environmental programs and efforts of environmental merit at WIPP for 2003.

The following highlights are discussed in the 2003 SER:

- Implementation of the WIPP's Environmental Management System (EMS) within the framework of the Integrated Safety Management System (ISMS).

- Achievement of site-specific pollution prevention (P2) goals.

- Performance of radiation protection programs including controlling radiological doses and releases.

- Implementation of the WIPP's environmental performance measures program.

- Implementation of the WIPP's Groundwater Monitoring Program.

Environmental Management System

The WIPP EMS conforms to the International Organization for Standardization (ISO) 14001, *Environmental Management Systems – Specification With Guidance for Use* (ISO, 1996). WIPP's ISMS includes the EMS, and requires systematic planning, integrated execution, and evaluation of programs for public health, environmental protection, and compliance with applicable environmental protection requirements. WIPP identifies operational aspects with environmental impacts and develops objectives and targets from these to assure effective implementation of WIPP's environmental policy.

Pollution Prevention

Noteworthy P2 activities in 2003 included the implementation of two new pollution prevention opportunity assessment recommendations:

- Use of less hazardous chemical alternatives
- Recycling used fluorescent lamps.

Radiological Dose Assessment

The potential radiation dose to members of the public from WIPP operations has been calculated from WIPP effluent monitoring results and demonstrates compliance with federal regulations and the DOE's policy of keeping this dose as low as reasonably achievable.

Environmental Performance Measures

All environmental performance measures and commitments established for WIPP for FY2003 have been met and new performance goals are established for FY2004. WIPP's practice of establishing, implementing, tracking, trending, analysis, and reporting environmental performance measures is consistent with the ISMS fifth core function, Feedback and Continuous Improvement.

Groundwater Monitoring

In 2003, each of the seven water quality sampling wells was sampled twice. All analytical results from the samples were below regulatory limits. The analytical data set from each well was compared to the groundwater baseline that was established prior to WIPP being operational. All analytical values for the groundwater samples were within the statistical range established in the baseline. Therefore, all HWFP requirements were met and no exceedance notifications to the NMED or the EPA were required in 2003.

Environmental Compliance

WIPP is required to comply with applicable federal and state laws and DOE orders. In order to accomplish and document compliance, the following submittals, required on a routine basis, were prepared in 2003:

NMED Submittals

A. Hazardous Waste Facility Permit (HWFP)

2002 Site Environmental Report
Annual Volatile Organic Compounds (VOCs) Monitoring and Ventilation Report
Quarterly Solid Waste Management Unit (SWMU) Activities Progress Report
Biennial Treatment, Storage, and Disposal (TSDF) Report
Waste Minimization Report
Detection Monitoring Program Statistical Comparison Report
Round 16 Water Quality Sampling Program (WQSP) Groundwater Report
Round 17 WQSP Groundwater Report
Geotechnical Analysis Report
Monthly Water Level Results Report

B. New Mexico Water Quality Act

Quarterly Discharge Monitoring Reports

Environmental Protection Agency (EPA) Submittals

2003 Annual Change Report

Other correspondence and regulatory submittals were made in 2003 and are described in Chapter of this report.

Federal Acquisition and Recycling

In 1995, WIPP adopted a systematic and cost-effective affirmative procurement plan for the promotion and procurement of products containing recovered materials. Affirmative procurement is designed to "close the loop" in the waste minimization recycling process by supporting the market for materials collected through recycling and salvage operations. WIPP continued its recycling program in 2003.

Internal Environmental Compliance Assessments

The Environmental Assessment Plan (EAP) (WP 02-EC.13) plays a major role in the overall program for environmental protection activities at WIPP. The EAP defines the internal environmental compliance assessment process used to determine if facility activities protect human health and the environment; these activities are in compliance with applicable federal, state, and local requirements; with permit conditions and requirements; and best management practices. During 2003, WTS performed three internal environmental compliance assessments as follows:

- Clean Water Act Compliance
- Environmental Monitoring and Sample Control
- Off-site waste disposal process

Volatile Organic Compound Monitoring

In 2003, VOC samples were collected twice weekly. The measured VOC concentrations upstream and downstream of the active waste disposal area and the differences between the sampling stations were very small relative to the concentrations of concern. There were no significant releases of VOCs detected from the waste in Panel 1 or Panel 2, which opened in March of 2003. There were no Tentatively Identified Compounds that exceeded concentrations that would warrant further investigation. All HWFP requirements were met and no exceedance notifications to the NMED were required in 2003.

Environmental Radiological Program Information

Radionuclides present in the environment, whether naturally occurring or from human-made sources, contribute to radiation doses to humans. Therefore, environmental monitoring at nuclear facilities is imperative for characterizing radiological conditions, and for detecting releases and determining their effects, should they occur. WIPP monitors air, surface and groundwater, soils, sediments, and biota in the vicinity of WIPP. Plutonium-238, $^{239+240}$Pu, ^{241}Am, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{234}U, ^{235}U, and ^{238}U are monitored because they are components of TRU waste. Potassium-40 is monitored because of possible enhancement in southeastern New Mexico due to potash mining. Radionuclide concentrations observed were very small. These data indicate that there has been no impact to the public or the environment due to WIPP operations in 2003.

Dose Limits

A good understanding of the risks associated with high-radiation doses was achieved from more than 50 years of extensive research conducted on the effects of radiation on humans and the environment. However, there is still uncertainty as to what risks are incurred from low radiation dose and dose rates, so models are used to predict these risks.

The regulatory basis for WIPP radiological monitoring is in Title 40 *Code of Federal Regulations* (CFR) §191.03(b), which specifies that the annual dose to any member of the public may not exceed 25 millirem (mrem) to the whole body and 75 mrem to any critical organ. In addition, WIPP voluntarily complies with 40 CFR §61.92, which establishes that the emissions of radionuclides shall not exceed an effective dose equivalent (EDE) of 10 mrem per year to a member of the public.

Background Radiation

Radiation is and has been a natural part of the environment since the beginning of time. There are several sources of naturally occurring radiation: cosmic and cosmogenic radiation (from outer space and the earth's atmosphere), terrestrial radiation (from the earth's crust), and internal radiation (naturally occurring radioactive material in our bodies). In addition to natural radioactivity, small amounts of radioactivity from above-ground nuclear weapons tests and from the 1986 Chernobyl nuclear accident are present in the environment. A significant potential source of radiation in the environment near and at the WIPP site is Project Gnome. Under Project Gnome, a nuclear device was detonated in bedded salt on December 10, 1961, approximately 9 km (5.4 mi) from the WIPP site. The Project Gnome shot vented into the atmosphere; therefore, environmental samples taken at WIPP may contain residual contamination from this occurrence. Together, natural radiation and residual fallout are called "background" radiation. All living organisms are constantly exposed to background radiation. Exposure to radioactivity from weapons testing fallout is quite small compared to natural radioactivity and continually gets smaller as radionuclides decay. The average annual dose received by a member of the public from naturally occurring radionuclides is approximately 3 mSv (millisievert) (300 mrem) (NCRP [National Council on Radiation Protection and Measurements], 1987b).

Dose from Air Emissions

Title 40 CFR §191.03(b) set limits for doses to members of the public due to emissions of radionuclides to the ambient air. To determine the potential radiation dose received by members of the public from WIPP, WIPP used the mission monitoring and compliance procedures for DOE facilities (40 CFR Part 61.93[a]), which requires the use of CAP88-PC to calculate the effective dose equivalent to members of the public. CAP88-PC dose calculations are based on the assumption that exposed people remain at home during the entire year and all vegetables, milk, and meat consumed are home produced. Thus, this dose calculation is a maximum potential dose which encompasses dose from inhalation, plume submersion, deposition, and ingestion of air-emitted radionuclides.

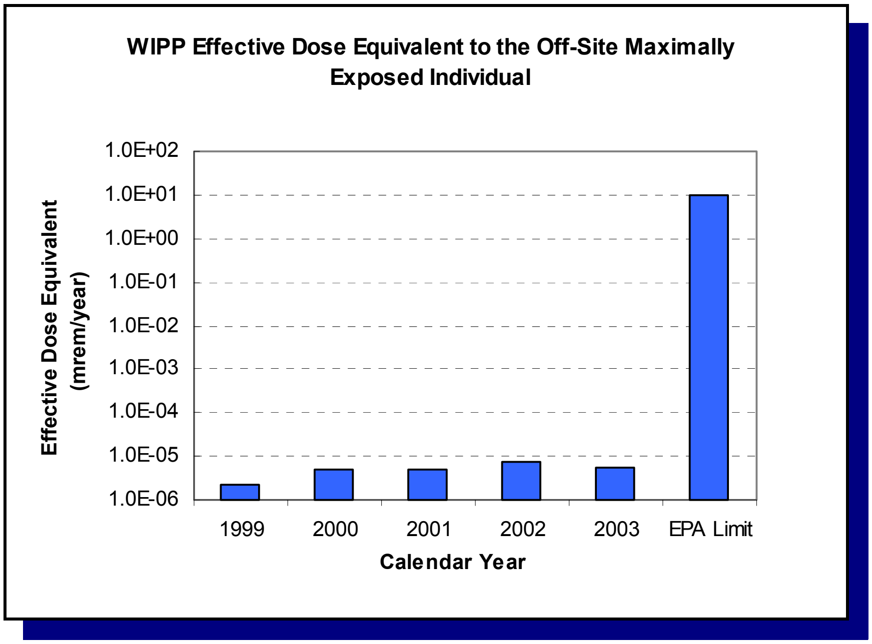
Total Potential Dose from WIPP Operations

The potential dose to an individual from the ingestion of WIPP-related radionuclides transported in water is nonexistent. Drinking water for communities near WIPP comes from groundwater sources that are too far away to be affected by potential WIPP contaminants.

Game animals sampled during 2003 were mule deer, quail, and fish. The only radionuclides detected were not different from baseline levels. Therefore, no dose from WIPP-related radionuclides have been received by any individual from this pathway during 2003.

The only measurable dose potential from WIPP operations is through the air pathway. Concentrations of radionuclides in air emissions, based on effluent monitoring results, accounted for the dose from WIPP operations during 2003. These concentrations did not exceed background ambient air levels and resulted in an EDE to the maximally exposed individual near WIPP of 5.43×10^{-6} millirem (mrem)/year.

The following figure and table show EDEs from 1999 through 2003. Note that these EDE are more than six orders of magnitude below the EPA limit specified in 40 CFR §61.92.



Comparison of Effective Dose Equivalents to EPA Limit

Year	Annual Dose (mrem/yr)	Percent of EPA Limit
1999	2.23E-06	22.3 millionth
2000	5.18E-06	51.8 millionth
2001	4.96E-06	49.6 millionth
2002	7.61E-06	76.1 millionth
2003	5.43E-06	54.3 millionth

Dose to Nonhuman Biota

Dose limits that cause no deleterious effects on populations of aquatic and terrestrial organisms have been suggested by the NCRP and the International Atomic Energy Agency. These absorbed dose limits are:

- Aquatic Animals 10 mGy/d (milli Gray/day), (1 rad/d)
- Terrestrial Plants 10 mGy/d (1 rad/d)
- Terrestrial Animals 1 mGy/d (0.1 rad/d)

The DOE requires discussion of radiation doses to nonhuman biota in the annual SER using the DOE Technical Standard, DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. This standard requires an initial screening phase using conservative assumptions.

This guidance was used to screen radionuclide concentrations observed around WIPP during 2003. The screening results indicate that radiation in the environment surrounding WIPP does not have a deleterious effect on populations of plants and animals.

Release of Property Containing Residual Radioactive Material

There was no release of radiologically contaminated materials or property in 2003. Preventing the release of contaminated materials or property at WIPP is accomplished through implementation of institutional controls.

Quality Assurance

The fundamental objective of a QA program is to ensure that high-quality measurements are produced and reported from the analytical laboratory. The defensibility of data generated by laboratories must be based on sound scientific principles, method evaluations, and data verification and validation. The WIPP Laboratories, of Carlsbad, New Mexico; Air Toxics, Ltd., of Folsom, California; and Trace Analysis, of Lubbock, Texas, were the contract laboratories that performed the radiological and nonradiological analyses for WIPP environmental samples. Verification of quality practices by these laboratories through audits and assessments, combined with their acceptable performance in various interlaboratory comparison programs, continues to ensure the quality of the data provided by these laboratories.

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ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACAA	Accelerated Corrective Action Approach
AEA	Atomic Energy Act
amsl	above mean sea level
ANOVA	Analysis of Variance
ANSI	American National Standards Institute
AOC	Area of Concern
ASTM	American Society for Testing and Materials
BCG	biota concentration guide
bgl	below ground level
BLM	U.S. Department of the Interior, Bureau of Land Management
Bq	becquerel
Bq/L	becquerels per liter
Bq/m^3	becquerels per cubic meter
CAA	Clean Air Act
CAO	Carlsbad Area Office (now Carlsbad Field Office)
CAP88	computer code for calculating both dose and risk from radionuclide emissions
CBFO	Carlsbad Field Office
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEMRC	Carlsbad Environmental Monitoring and Research Center
CFR	*Code of Federal Regulations*
CH	contact-handled
Ci	curie
cm	centimeter
COD	chemical oxygen demand
DOE	U.S. Department of Energy
DP	Discharge Plan
DPM	disintegration per minute
E	East
EAP	Environmental Assessment Plan
EDE	effective dose equivalent
EEG	Environmental Evaluation Group
Eh	Intensity Factor
EH	DOE Environment, Safety, and Health
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EMP	WIPP Environmental Monitoring Plan
EMS	Environmental Management System

EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERA	Environmental Resource Associates
ft	foot/feet
ft^3	cubic feet
FEL	From the East Line
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLPMA	Federal Land Policy and Management Act
FNL	From the North Line
FSL	From the South Line
FWL	From the West Line
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
g	gram
GET	General Employee Training
gpd	gallons per day
Gy	Gray
HEPA	high-efficiency particulate air (filter)
HWDU	Hazardous Waste Disposal Unit
HWFP	Hazardous Waste Facility Permit
IAEA	International Atomic Energy Agency
in.	inch
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
kg	kilogram
km	kilometer
km^2	square kilometers
L	liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LEPC	Local Emergency Planning Committee
LMP	Land Management Plan
LUR	Land Use Request
LVAS	Low Volume Air Sampler
LWA	Land Withdrawal Act

m	meter
m^3	cubic meters
mBq	millibecquerel
MDC	Minimum Detectable Concentration
MDL	Method Detection Limit
MeV	million electron volts
mg	milligram
mg/L	milligram per liter
mi	mile(s)
mi^2	square miles
ml	milliliter
MOU	Memorandum of Understanding
MP	Management Policy
mrem	millirem
MRL	Method Reporting Limit
MSDS	material safety data sheet
mSv	millisievert
mSv/yr	millisievert per year
N	North
N/A	not applicable
N/C	not collected
NCRP	National Council for Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMIMT	New Mexico Institute of Mining and Technology
NMSA	New Mexico Statutes Annotated
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NQA	Nuclear Quality Assurance
NR	not reported
NRC	U.S. Nuclear Regulatory Commission
NRIP	National Institute of Standards and Technology Radiochemistry Intercomparison Program
NWPA	Nuclear Waste Policy Act
oz	ounce
P2	pollution prevention
PCB	polychlorinated biphenyl
pCi	picoCuries
pCi/L	picoCuries per liter

PIP	production injection packer
ppbv	parts per billion by volume
PPOA	Pollution Prevention Opportunity Assessment
Pub. L.	Public Law
QA	quality assurance
QAP	Quality Assurance Program
QC	quality control
R	Range
RCRA	Resource Conservation and Recovery Act
RER	Relative Error Ratio
RFI	RCRA Facility Investigation
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RL	Reporting Limit
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
S	South
SAA	Satellite Accumulation Area
SARA	Superfund Amendments and Reauthorization Act
SD	Standard Deviation (Also, Soil Deep)
SDWA	Safe Drinking Water Act
SEIS-II	Second Supplemental Environmental Impact Statement
SER	site environmental report
SERC	State Emergency Response Commission
SI	Soil Intermediate
SMA	Special Management Area
SNL	Sandia National Laboratories
SOW	Statement of Work
SS	Soil Surface
SSW	Shallow Subsurface Water
SU	Standard Unit
SWMR	Solid Waste Management Regulation
SWMU	Solid Waste Management Unit
T	Township
TDS	Total Dissolved Solid
TOC	Total Organic Compound
TOH	Total Organic Halogens
TPU	Total Propagated Uncertainty
TRU	transuranic (waste)
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TSS	Total Suspended Solids
TWBIR	TRU Waste Baseline Inventory Report

U.S.	United States
U.S.C.	*United States Code*
UST	underground storage tank
UTLV	Upper Tolerance Limit Value
VOC	Volatile Organic Compound
W	West
WIPP	Waste Isolation Pilot Plant
WLWA	WIPP Land Withdrawal Area
WQSP	WIPP Groundwater Quality Sampling Program
WRES	Washington Regulatory and Environmental Services
WTS	Washington TRU Solutions LLC

Symbols

σ	sigma
°C	Degrees Celsius
°F	Degrees Fahrenheit
M	Molar
µCi	microCurie
µg	microgram
µmhos	micromhos
%	Percent
[RN]	Radionuclide concentration

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CHAPTER 1 - INTRODUCTION

The purpose of this report is to provide information needed by the DOE to assess WIPP's environmental performance and to convey that performance to stakeholders and members of the public. This report has been prepared in accordance with DOE Order 231.1A and DOE guidance. This report documents WIPP's environmental monitoring programs and their results for 2003.

The WIPP Project is authorized by the DOE National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (Pub. L. 96-164). After more than 20 years of scientific study and public input, WIPP received its first shipment of waste on March 26, 1999.

Located in southeastern New Mexico, WIPP is the nation's first underground repository permitted to safely and permanently dispose of TRU radioactive and mixed waste (as defined in the WIPP LWA) generated through the research and production of nuclear weapons and other activities related to the national defense of the United States. TRU waste is defined in the WIPP LWA as radioactive waste containing more than 100 nanocuries (3,700 becquerels [Bq]) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years. Exceptions are noted as high-level waste, waste that has been determined not to require the degree of isolation required by the disposal regulations, and waste the U.S. Nuclear Regulatory Commission (NRC) has approved for disposal. Most TRU waste is contaminated industrial trash, such as rags and old tools, and sludges from solidified liquids; glass; metal; and other materials from dismantled buildings.

A TRU waste is eligible for disposal at WIPP if it has been generated in whole or in part by one or more of the activities listed in the Nuclear Waste Policy Act of 1982 (42 *United States Code* [U.S.C.] §10101, et seq.), including naval reactors development, weapons activities, verification and control technology, defense nuclear materials production, defense nuclear waste and materials by-products management, defense nuclear materials security and safeguards and security investigations, and defense research and development. The waste must also meet the WIPP Waste Acceptance Criteria.

When TRU waste arrives at WIPP, it is transported into the Waste Handling Building. The waste containers are removed from the shipping containers, placed on the waste hoist, and lowered to the repository level of 655 m (2,150 ft; approximately 0.5 mi) below the surface. Next, the containers of waste are removed from the hoist and placed in excavated storage rooms in the Salado Formation, a thick sequence of evaporite beds deposited approximately 250 million years ago (Figure 1.1). After each panel has been filled with waste, specially designed closures are emplaced. When all of WIPP's panels have been filled, at the conclusion of WIPP operations, seals will be placed in the shafts. Salt under pressure is relatively plastic, and mine openings will be allowed to creep closed for final disposal, encapsulating and isolating the waste.

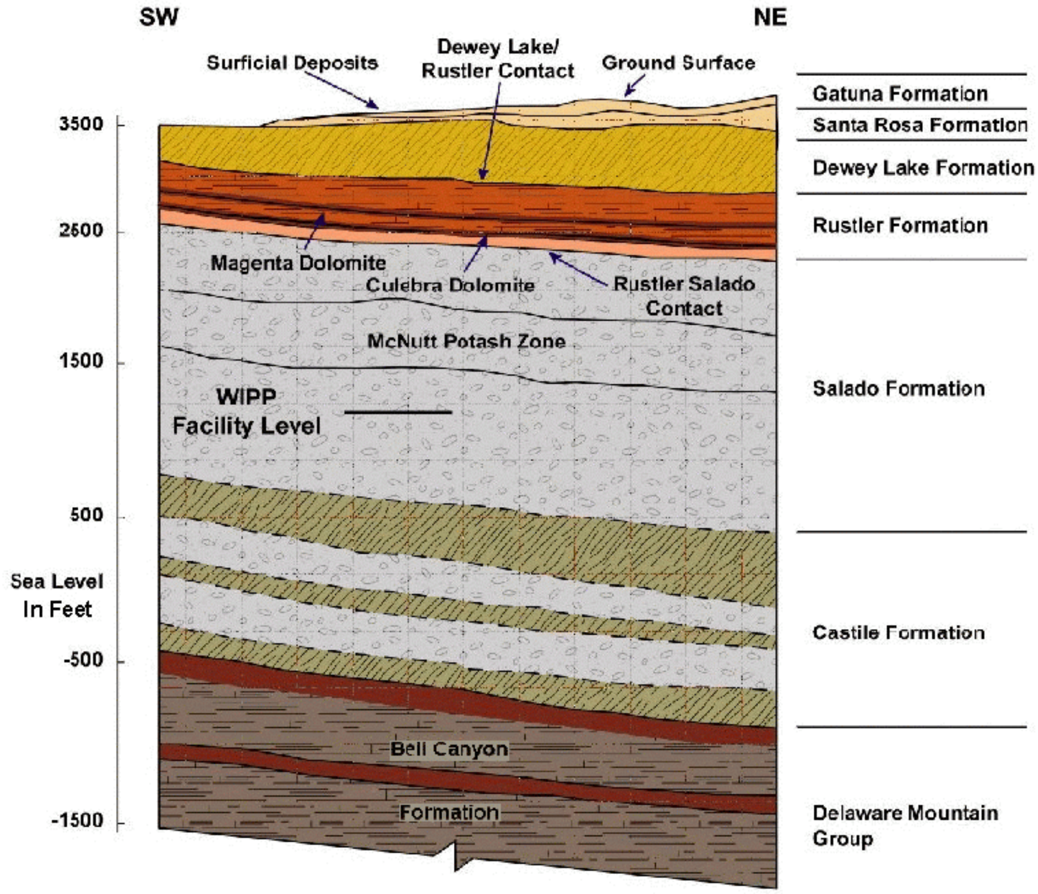

Figure 1.1 - WIPP Stratigraphy

1.1 WIPP's Mission

Current radioactive waste storage facilities at 23 locations across the United States were never intended to provide permanent disposal. WIPP's mission is to provide for the safe, permanent, and environmentally sound disposal of TRU radioactive waste left from research, development, and production of nuclear weapons. Over the 35 years' operational lifetime, WIPP is expected to receive approximately 37,000 shipments of waste from locations across the United States.

1.2 WIPP's History

Government officials and scientists initiated the WIPP site selection process in the 1950s. At that time, the National Academy of Sciences conducted a nationwide search for stable geological formations to contain wastes for thousands of years. In 1955, after extensive study, salt deposits were recommended as a promising medium for the disposal of radioactive waste.

Salt deposits were selected as the host for the planned disposal of nuclear waste for several reasons. Most deposits of salt are found in stable geological areas with very little earthquake activity, assuring the stability of a waste repository. Salt deposits also demonstrate the absence of water that could move waste to the surface. Water, if it had been or were present, would have dissolved the salt beds. In addition, salt is relatively easy to mine. Finally, rock salt heals its own fractures because it is relatively plastic. This means salt formations will slowly and progressively move in to fill mined areas and will safely seal radioactive waste from the environment.

Government scientists searched for an appropriate site for the disposal of radioactive waste throughout the 1960s, and finally tested the area of southeastern New Mexico in the early 1970s. Salt formations at WIPP were deposited in thick beds during the evaporation of an ancient ocean, the Permian Sea. These geologic formations consist mainly of sodium chloride, the same substance as table salt. However, at WIPP, the salt is not granular, but is in the form of solid rock. The main salt formation at WIPP is approximately 610 m (2,000 ft) thick, and begins 259 m (850 ft) below the earth's surface. Formed about 225 million years ago during the Permian Age, the large expanses of uninterrupted salt beds provide a repository that has been stable for more than 200 million years. This proven stability over such a long time span offers the predictability that the salt will remain stable for the comparatively short 10,000-year period that WIPP is mandated to demonstrate isolation of the waste from the human environment.

In 1979, Congress authorized the construction of WIPP, and the DOE constructed the facility during the 1980s. In late 1993, the DOE created the Carlsbad Area Office (CAO) (now CBFO) to lead the TRU waste disposal efforts. The CBFO coordinates the TRU program at waste-generating sites and national laboratories.

In 1999, WIPP received its first waste shipment. On March 25, the first waste bound for WIPP departed Los Alamos National Laboratory in New Mexico; it arrived at WIPP the following morning, and the first wastes were placed underground later that day. On April 27, the first out-of-state shipment arrived at WIPP, from the Idaho National Engineering and Environmental Laboratory. Later in the year, on October 27, the Secretary of the NMED issued a WIPP HWFP, which allows WIPP to manage, store, and dispose of CH TRU mixed waste. Mixed waste is waste contaminated by both hazardous and radioactive substances. "Contact-handled mixed waste" is TRU mixed waste with a surface dose rate less than 200 mrem per hour. The surface dose rate is the measurable amount of radioactivity from neutrons and gamma rays at the external surface of the container.

1.3 Site Description

Located in Eddy County in the Chihuahuan Desert of southeastern New Mexico (Figure 1.2), the WIPP site encompasses approximately 41.1 square kilometers (km^2), or 16 square miles (mi^2). This part of New Mexico is relatively flat and is sparsely inhabited, with little surface water. The site is 42 km (26 mi) east of Carlsbad in a region known as Los Medaños (the Dunes).

The WIPP LWA was signed into law on October 30, 1992, transferring the administration of federal land from the U.S. Department of the Interior to the DOE. With the exception of facilities within the boundaries of the posted 5.7 km^2 (2.2 mi^2) Off-Limits Area, the surface land uses remain largely unchanged from pre-1992 uses, and are managed in accordance with accepted practices for multiple land use. However, mining and drilling for purposes other than those which support WIPP are prohibited within the WIPP site. The WIPP site boundary extends a minimum of 1.6 km (1 mi) beyond any of the WIPP underground developments.

The majority of the lands in the immediate vicinity of WIPP are managed by the U.S. Department of the Interior's Bureau of Land Management (BLM). Land uses in the surrounding area include livestock grazing; potash mining; oil and gas exploration and production; and recreational activities such as hunting, camping, hiking, and bird watching. The region is home to diverse populations of animals and plants.

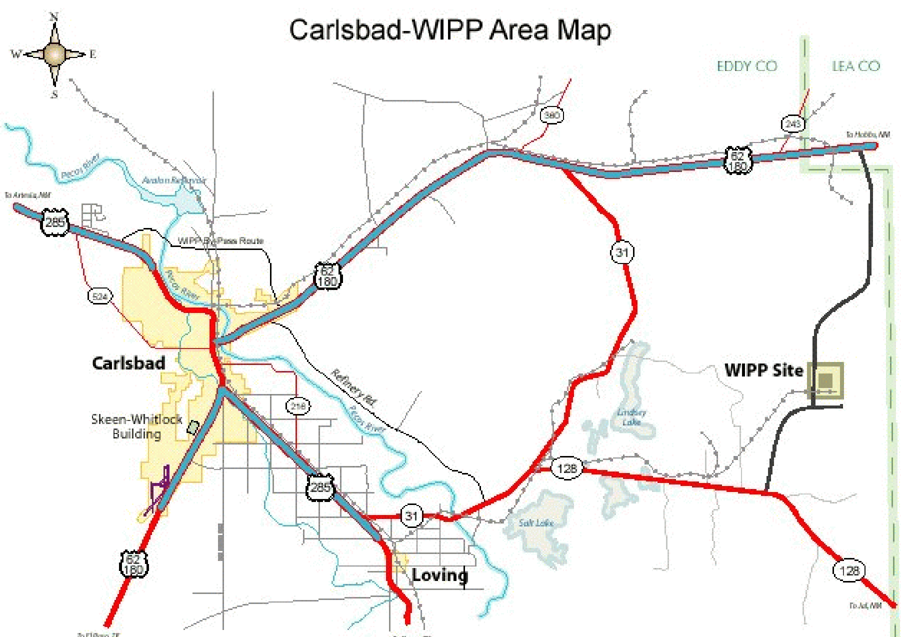

Figure 1.2 - WIPP Location (Scale: 1" = 10 miles)

1.3.1 WIPP Property Areas

Five property areas are defined within WIPP's boundary (Figure 1.3).

Property Protection Area

The interior core of the facility encompasses approximately 0.129 km^2 (0.05 mi^2) (≈35 acres) surrounded by a chain link fence. This area is under tight security and uniformed security personnel are on duty 24 hours a day.

Exclusive Use Area

The Exclusive Use Area was originally comprised of 1.12 km^2 (0.432 mi^2) (≈277 acres). During the construction of the North Salt Pile Infiltration Controls in 2003, this area was increased by approximately 0.08 km^2 (20 acres) to 1.2 km^2 (297 acres). It is surrounded by a five-strand barbed wire fence and is restricted exclusively for the use of the DOE and its contractors and subcontractors in support of the project. In addition, this area is defined as the point of closest public access for the purpose of analyzing accident consequences to the general public in the *Waste Isolation Pilot Plant Contact-Handled (CH) Documented Safety Analysis* (DOE/WIPP 95-2065). This area is marked by DOE warning (e.g., "no trespassing") signs and is patrolled by WIPP security personnel to prevent unauthorized activities or uses.

Off-Limits Area

The Off-Limits Area is an area where unauthorized entry and introduction of weapons and/or dangerous materials are prohibited. The Off-Limits Area includes 5.7 km^2 (2.2 mi^2) (≈1,421 acres). Pertinent prohibitions are posted at consistent intervals along the perimeter. Grazing and public thoroughfare will continue in this area unless these activities present a threat to the security, safety, or environmental quality of WIPP. This sector is patrolled by WIPP security personnel to prevent unauthorized activity or use.

WIPP Land Withdrawal Area

The WIPP site boundary delineates the perimeter of the 41.4 km^2 (16 mi^2) (≈10,240 acres) WIPP Land Withdrawal Area (WLWA). This tract includes properties outlying the Property Protection Area, the Exclusive Use Area, and the Off-Limits Area. This sector is designated as a Multiple Land Use Area, and is managed accordingly.

Special Management Areas

Certain properties used in the operation of WIPP (e.g., reclamation sites, well pads, roads) are, or may be, identified as Special Management Areas (SMA) in accordance with the LMP. An SMA designation is made due to values, resources, and/or circumstances that meet criteria for protection and management under special management designations. Unique resources of value that are in danger of being lost or damaged, areas where ongoing construction is occurring, fragile plant and/or animal communities, sites of archaeological significance, locations containing safety hazards, or sectors that may receive an unanticipated elevated security status would be suitable for designation as an SMA. Accordingly, the subject sector would receive special management emphasis under this stipulation. SMAs will be posted against trespass and will be safeguarded commensurate with applicable laws governing property protection. WIPP security personnel patrol these areas to prevent unauthorized access or use.

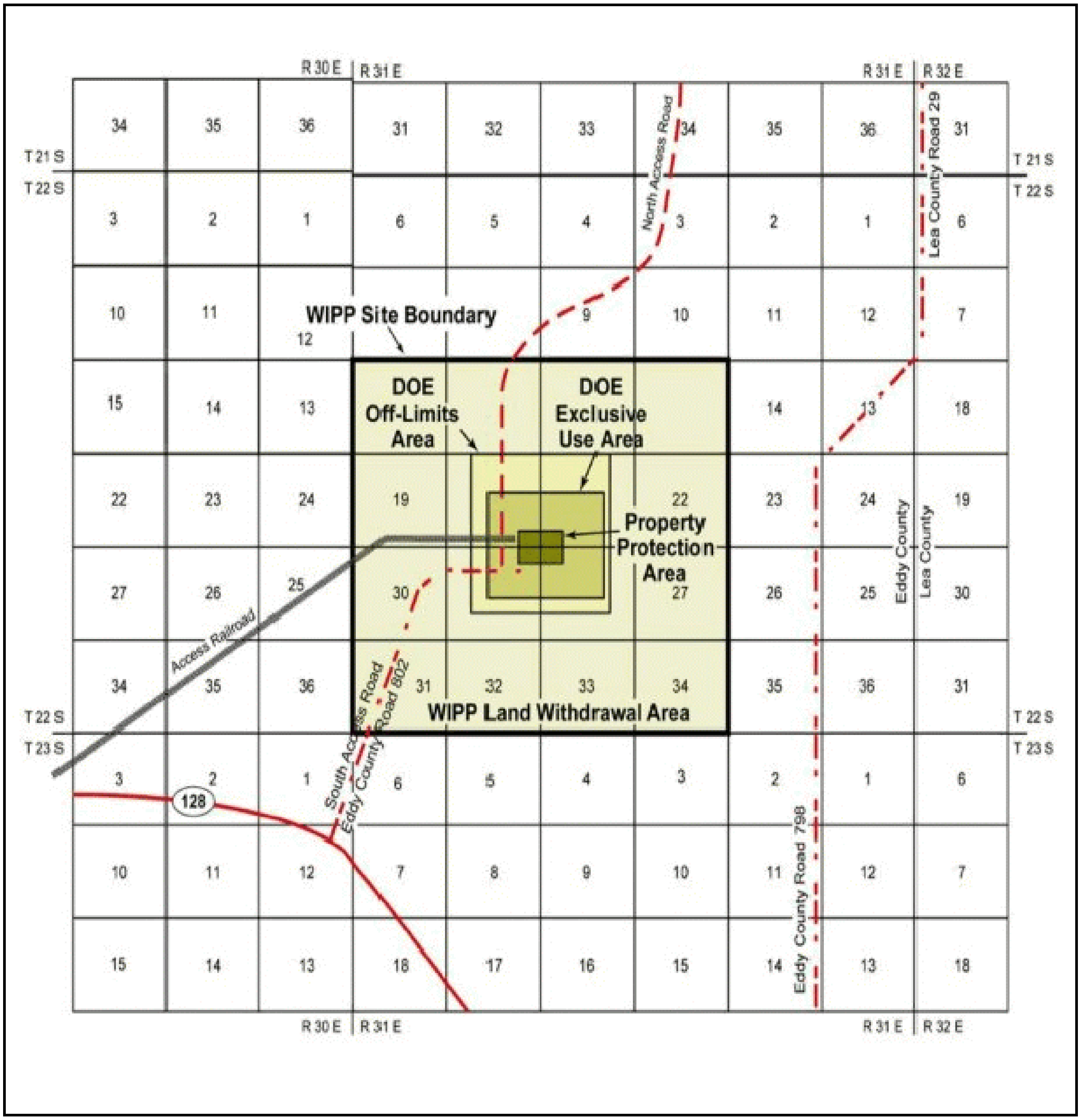

Figure 1.3 - WIPP Property Areas (Scale: 1/2" = 1 mile)

1.3.2 Population

Approximately 26 residents live within 16 km (10 mi) of the WIPP site. The population within 16 km (10 mi) of WIPP is associated with ranching, oil and gas exploration/ production, and potash mining. There are two nearby ranch residences, Smith Ranch and Mills Ranch, which are monitored as part of the Environmental Monitoring Program.

The majority of the local population within 80.5 km (50 mi) of WIPP is concentrated in and around the communities of Carlsbad, Hobbs, Eunice, Loving, Jal, Lovington, and Artesia, New Mexico. The estimated population within this radius is 100,944. The nearest community is the village of Loving (current estimated population 1,326), 29 km (18 mi) west-southwest of WIPP. The nearest major populated area is Carlsbad, 42 km (26 mi) west of WIPP. The current estimated population of Carlsbad is 25,625.

1.4 Environmental Performance

The DOE's Environmental Protection Program (DOE Order 450.1) describes the DOE's commitment to environmental protection and pledges to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources. It also commits that the DOE will meet or exceed compliance with applicable environmental requirements.

In 2003, WIPP maintained compliance with applicable environmental laws, regulations, and permit conditions. Furthermore, analyses from the Environmental Monitoring Program have demonstrated that WIPP has not had a negative impact on the environment.

1.5 Organization of This SER

This report is organized as follows:

- Chapter 2 contains environmental program information.
- Chapter 3 presents a summary of WIPP's compliance with environmental laws and regulations.
- Chapter 4 contains radiological program information.
- Chapter 5 describes the nonradiological program with the exception of groundwater monitoring.
- Chapter 6 presents site hydrology, groundwater monitoring, and public drinking water protection.
- Chapter 7 contains information on Quality Assurance.

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CHAPTER 2 - ENVIRONMENTAL PROGRAM INFORMATION

The DOE's policy is to conduct its operations in compliance with applicable environmental laws and regulations, and to safeguard the integrity of the southeastern New Mexico environment. This is accomplished via programs that implement radiological and nonradiological environmental monitoring, environmental compliance, and land management activities, which include reclamation of disturbed lands. Environmental monitoring includes collecting and analyzing environmental samples from various media and evaluating whether WIPP activities have caused any negative environmental impacts.

2.1 Environmental Monitoring Plan

WIPP's EMP outlines the program for monitoring the environment at the WIPP site, including the major environmental monitoring and surveillance activities at WIPP. The EMP also discusses the WIPP QA/QC program as it relates to environmental monitoring. The purpose of the EMP is to outline how WIPP's effect on the local ecosystem is to be evaluated. Effluent and environmental monitoring provide data necessary to demonstrate compliance with applicable environmental protection regulations. The EMP sampling schedule is provided in Table 2.1.

The EMP describes the monitoring of naturally occurring and specific anthropogenic (human-made) radionuclides. The geographic scope of radiological sampling is based on projections of potential release pathways from the waste stored at WIPP. The EMP also describes monitoring of VOCs, groundwater chemistry, and other nonradiological environmental parameters, and collection of meteorological data.

Table 2.1 - Sampling Schedule for the WIPP Environmental Monitoring Program

Type of Sample	Number of Sampling Locations	Sampling Frequency
Liquid effluent	1	Semiannual
Liquid effluent	4	(DP 831 permit[a]) Semiannual[b]
Airborne effluent	3	Periodic/Confirmatory
Meteorology	2	Continuous
Atmospheric particulate	7	Weekly
Vegetation	6	Annual
Beef/Deer/Game Birds/Rabbits	Sitewide	Annual
Soil	6	Annual
Surface water	14	Annual
Groundwater	7	Semiannual
Fish	3	Annual
Sediment	12	Annual
Aerial photography	Sitewide	As needed
Volatile organic compounds (VOCs)	2	Semiweekly

[a] Monitoring compliance with the Discharge Permit (DP-831).
[b] Reporting requirement changed from quarterly to semiannual in 2003. Three reports were issued in 2003.

2.2 WIPP Environmental Monitoring Program

The DOE conducts effluent monitoring and environmental surveillance to verify that the public and the environment are protected during WIPP operations, and to ensure operations comply with applicable federal and state requirements.

WIPP's Environmental Monitoring Program directs monitoring of air, surface water, groundwater, sediments, soils, and biota (e.g., vegetation, select mammals, game birds, and fish). Environmental monitoring activities are performed in accordance with procedures that govern how samples are to be taken, preserved, and transferred. Procedures also direct the verification and validation of environmental sampling data.

In addition to monitoring for radionuclides contained in WIPP wastes, background radiation (naturally occurring radioactivity and radioactivity associated with worldwide fallout from historic weapons testing) is also monitored.

The atmospheric pathway, which can lead to the inhalation of radionuclides, has been determined to be the most likely exposure pathway to the public from WIPP. Therefore, airborne particulate sampling for alpha-emitting radionuclides is emphasized. Air sampling results are used to trend environmental radiological levels and determine if there has been a deviation from established baseline concentrations. The geographic scope of radiological sampling is based on projections of potential release pathways for the types of radionuclides in WIPP wastes, and includes Carlsbad, New Mexico, and nearby ranches.

Nonradiological environmental monitoring activities at WIPP consist of sampling and analyses designed to detect and quantify impacts of construction and operational activities. Ecological monitoring focuses on nonradiological effects of WIPP, such as impacts to wildlife habitat.

WIPP has collected radiological and nonradiological environmental data. Studies are considered during environmental evaluations. The following are examples of investigations conducted prior to WIPP waste receipt:

- The WIPP Biology Program began in 1975 with site monitoring studies of climate, soils, vegetation, arthropods, and vertebrates.

- Investigations of site geohydrology were conducted by the U.S. Geological Survey at the request of the DOE from 1976 to 1980. Afterwards, SNL took over the program and is still continuing it.

The goal of the WIPP Environmental Monitoring Program is to determine if the local ecosystem has been impacted during the predisposal and disposal phases of WIPP, and, if so, to evaluate the severity, geographic extent, and environmental significance of those impacts. The program fulfills the environmental monitoring requirements of DOE Order 450.1.

2.3 Land Management Programs

On October 30, 1992, the WIPP LWA became law. This act transferred the responsibility for the management of the WLWA from the Secretary of the Interior to the Secretary of Energy. In accordance with Sections 3(a)(1) and (3) of the act, these lands:

> . . . are withdrawn from all forms of entry, appropriation, and disposal under the public land laws . . . are reserved for the use of the Secretary of Energy . . . for the construction, experimentation, operation, repair and maintenance, disposal, shutdown, monitoring, decommissioning, and other activities associated with the purposes of WIPP as set forth in Section 213 of the DOE National Security and Military Application of the Nuclear Energy Act of 1980 (Pub. L. 96-164; 93 Stat. 1259, 1265), and this Act.

The DOE developed the LMP as required by Section 4 of the WIPP LWA. The LMP identifies resource values, promotes multiple-use management, and identifies long-term goals for the management of WIPP lands until the culmination of the decommissioning phase. This plan was developed in consultation and cooperation with the BLM and the state of New Mexico. Changes or amendments to the plan require the involvement of the BLM, the state of New Mexico, and affected stakeholders.

The LMP encourages direct communication among stakeholders, including federal and state agencies, involved in managing the resources within, or activities impacting the areas adjacent to, the WLWA. It sets forth cooperative arrangements and protocols for addressing WIPP-related land management actions. Commitments contained in current permits, agreements, or concurrent Memorandums of Understanding (MOUs) with other agencies will be respected when addressing and evaluating land use management activities and future amendments that affect the management of WIPP lands.

2.3.1 Land Use Requests

Parties who wish to conduct activities that may impact lands under the jurisdiction of WIPP, but outside the secured fence area of the facility designated as the Property Protection Area, are required by the LMP to prepare a Land Use Request (LUR).
A LUR consists of a narrative description of the project, a completed environmental review, and a map depicting the location of the proposed activity. The LUR, and associated National Environmental Policy Act (NEPA) checklists, are used to determine if applicable regulatory requirements have been met prior to the approval of a proposed project. A LUR may be submitted to the land use coordinator by any WIPP organization or outside entity wishing to complete any construction, right-of-way, pipeline easement, or similar action within the WIPP boundary or on lands used in the operation of WIPP, under the jurisdiction of the DOE. During 2003, 18 LURs were submitted for review and approval; all met applicable criteria and were approved.

On October 5, 2003, the most significant of the 18 LURs was submitted in support of infiltration controls for the north salt tailings pile. The intent of the LUR was to provide for phased installation of infiltration controls consisting of:

- Reshaping and capping the existing salt tailings pile.
- Reshaping and lining the existing salt pile evaporation pond and runoff ditches.
- Clearing approximately 13 acres of undisturbed land north of the existing pile.
- Relocating a portion of the storm water diversion berm approximately 460 feet (ft) further north.
- Excavating and constructing a salt storage extension consisting of two lined salt storage cells (A & B) and a new, lined evaporation basin.
- Clearing, excavating, and lining existing storm water retention basin immediately west of the Property Protection Area.
- Enlarging and lining two existing stormwater retention ponds immediately south of the Property Protection Area.
- Relocating a portion of the Exclusive Use Area's fence around the relocated berm. This action increased the size of the Exclusive Use Area by approximately 20 acres.

On October 23, 2003, equipment was mobilized and work was initiated. As of December 31, 2003, the stormwater diversion berm had been completed. Clearing work to accommodate cells A & B was finished, with 90 percent completion of the salt storage extension pond. Work was initiated to remove the old diversion berm and the contractor began reshaping the north slope of the existing salt pile.

2.3.2 Wildlife Population Monitoring

Southeastern New Mexico is home to an abundant array of plants and wildlife. In 1995, the U.S. Department of the Interior, Fish and Wildlife Service, provided an updated list of threatened and endangered species for Eddy and Lea Counties, New Mexico. Included were 18 species that may be present on WIPP lands. A comprehensive evaluation in support of the second Supplemental Environmental Impact Statement (SEIS-II) (DOE/EIS-0026-S-2, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*) was conducted in 1996 to determine the presence or absence of threatened or endangered species in the vicinity of WIPP and WIPP's effect on these species. Results indicated that activities associated with the operation of WIPP had no impact on any threatened or endangered species. WIPP continues to consider resident species when planning activities that may impact their habitat in accordance with the Joint Powers Agreement with the state of New Mexico and 50 CFR Part 17.

2.3.3 Reclamation of Disturbed Lands

Without an active reclamation program for disturbed areas, the establishment of stable ecological conditions in arid environments may require decades or centuries to achieve, depending on the disturbance and environmental conditions present. Reclamation activities are intended to reduce soil erosion, increase the rate of plant colonization and succession, and provide habitat for wildlife in disturbed areas. Reclamation ultimately serves to mitigate the effects of WIPP-related activities on affected plant and animal communities. The objective of the reclamation program is to reclaim lands used in the operation of WIPP that are no longer commissioned for WIPP operations.

WIPP follows a reclamation program and a long-range reclamation plan in accordance with the LMP and specified permit conditions. As locations are identified for reclamation, WIPP personnel reclaim these areas by using the best acceptable reclamation practices. Seed mixes used reflect those species indigenous to the area with priority given to those plant species which are conducive to soil stabilization, wildlife, and livestock needs.

2.3.4 Oil and Gas Surveillance

The oil and gas industry is well established in southeastern New Mexico. Nearly all phases of oil and gas activities have occurred in the vicinity of WIPP, including seismic exploration, exploratory drilling, field development (comprised of production and injection wells), and other activities associated with hydrocarbon extraction.

One aspect of the WIPP land withdrawal, unique to most DOE facilities, was the intent to maintain a multiple land use concept in the management of the property. However, to prevent compromising the present or projected waste disposal areas of the repository, all drilling and mining on the WIPP site unrelated to WIPP and its operation have been prohibited. Two mineral leases were not appropriated by the federal government. Both leases are located in Section 31 of Township (T) 22 South (S), Range (R) 31 East (E), and can be accessed from outside the WLWA. The EPA, in its Final Certification Decision (60 FR 27399), determined that the DOE did not need to acquire these leases to protect the repository.

Oil and gas activities within 1.6 km (1 mi) of the WIPP boundary are routinely monitored in accordance with the LMP to identify new activities associated with oil and gas exploration and production, including:

- Drilling
- Survey staking
- Geophysical exploration
- Pipeline construction
- Work-overs
- Changes in well status
- Anomalous occurrences (e.g., leaks, spills, accidents, etc.)

During 2003, WIPP surveillance teams conducted 24 scheduled surveillances and more than 100 field inspections.

Field personnel drove onto approximately 91 well locations, within one mile of the WIPP boundary, as an active institutional control to inspect for conditions that may compromise WIPP properties. Surveillances were conducted as needed, usually in response to reports of flow line leaks. During 2003, no major leaks or occurrences were observed. Minor incidents, such as small leaks, were encountered and courtesy notifications were provided to the well operators. Without exception, operators responded immediately, or within a few hours.

Proposed new well locations, staked within one mile of the WIPP, are field verified. This ensures that the proposed location is of sufficient distance from the WIPP boundary to protect the WIPP from potential trespass. If a well is within 330 ft of the WIPP boundary, the operator is required to submit daily deviation surveys to the WIPP Land Use Coordinator to assess the horizontal drift of the well bore. During 2003, daily logs were transmitted to WIPP for four new wells. Deviation calculations showed that there were no conditions to warrant suspicion of trespass.

CHAPTER 3 - COMPLIANCE SUMMARY

WIPP is required to comply with applicable federal and state laws and DOE orders. Regulatory requirements are incorporated into facility plans and implementing procedures. The primary method for maintaining compliance with environmental requirements is through the use of documented procedures, routine training of facility personnel, and ongoing self-assessments.

3.1 Compliance Overview

In 2003, WIPP maintained compliance with applicable federal and state environmental regulations. The following sections describe the site compliance posture for 2003. Section 3.2 contains a listing of environmental statutes/regulations applicable to WIPP. Section 3.3 describes significant accomplishments and ongoing compliance activities relative to the regulations pertinent to WIPP's operation. A detailed breakdown of WIPP's compliance with environmental regulations is available in the *Waste Isolation Pilot Plant Biennial Environmental Compliance Report* (DOE/WIPP 04-2171).

3.2 Compliance Status

A summary of WIPP's compliance with major environmental regulations is presented below. A list of WIPP permits appears in Appendix B.

3.2.1 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. §9601), or Superfund, establishes a comprehensive federal strategy for responding to, and establishing liability for, releases of hazardous substances from a facility to the environment. Any spills of hazardous substances that exceed a reportable quantity must be reported to the National Response Center under the provisions of CERCLA and 40 CFR Part 302. Hazardous substance cleanup procedures are specified in the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR Part 300). No release sites have been identified at WIPP that would require cleanup under the provisions of CERCLA.

<u>Superfund Amendments and Reauthorization Act of 1986</u>

WIPP is required by the Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III (42 U.S.C. §§1101, et seq.) (also known as the Emergency Planning and Community Right-to-Know Act [EPCRA]) to submit (1) a list of hazardous chemicals present at the facility in excess of 10,000 pounds for which a Material Safety Data Sheet (MSDS) is required, (2) an Emergency and Hazardous Chemical Inventory Form (Tier II Form), which identifies the inventory of hazardous chemicals present during the preceding year , and (3) notification to the State Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) of any accidental releases of hazardous chemicals in excess of reportable quantities. The list of hazardous chemicals and the Tier II Form are also submitted to the fire departments with jurisdiction over the facility.

Section 313, "Toxic Chemical Release Report," identifies requirements for facilities to submit a toxic chemical release report to the EPA and the resident state if toxic chemicals are used at the facility in excess of established threshold amounts.

The list of chemicals provides external emergency responders with information they may need when responding to a hazardous chemical emergency at WIPP. The Tier II Form, due on March 1 of each year, provides information to the public about hazardous chemicals above threshold planning quantities that a facility has on-site at any time during the year. WIPP submits the Tier II Form annually to each fire department with which the CBFO maintains an MOU and to the LEPC and SERC. The list of chemicals is a one-time notification unless new chemicals in excess of 10,000 pounds, or new information on existing chemicals, is received. WIPP made the last notification in 1999. The Toxic Chemical Release Report, due July 1, was required at WIPP for the first time for calendar year 2003. The Toxic Chemical Release Report was submitted to the EPA and to the SERC. Table 3.1 presents the 2003 EPCRA reporting status. A response of "yes" indicates that the report was required and submitted.

Table 3.1 - Status of EPCRA Reporting

EPCRA Section	Description of Reporting	Status
Sections 302-303	Planning Notification	Yes
Section 304	EHS[a] Release Notification	Not Required
Sections 311-312	MSDS[b]/Chemical Inventory	Yes
Section 313	TRI Reporting	Yes

[a] Extremely Hazardous Substance
[b] Material Safety Data Sheet

Accidental Releases of Reportable Quantities of Hazardous Substances

During 2003, there were no releases of hazardous substances exceeding the reportable quantity limits.

3.2.2 Federal Acquisition, Recycling, and Pollution Prevention

In July 1995, WIPP adopted a systematic and cost-effective affirmative procurement plan for the promotion and procurement of products containing recovered materials. Affirmative procurement is designed to "close a loop" in the waste minimization and recycling processes by supporting the market for materials collected through recycling and salvage operations.

Affirmative procurement programs are mandated by the Resource Conservation and Recovery Act (RCRA), which requires federal procuring departments to establish material preference programs targeted to purchase recycled materials. Executive Order 13101 and EPA guidelines in 40 CFR Part 247, provide additional guidance for implementing affirmative procurement programs at federal facilities.

Affirmative procurement programs must include four elements: (1) a preference program, (2) a promotion program, (3) an estimation, certification, and verification procedure, and (4) annual review and monitoring procedures. WIPP's affirmative procurement program is defined in WP 02-EC.07, Waste Isolation Pilot Plant Affirmative Procurement Plan.

3.2.3 Resource Conservation and Recovery Act

The RCRA (42 U.S.C. §6901, et seq) was enacted in 1976. Implementing regulations were promulgated first in May 1980. This body of regulations ensures that hazardous waste is managed and disposed of in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 prohibit land disposal of hazardous waste unless treatment standards are met first. The amendments also emphasize waste minimization.

The NMED is authorized by the EPA to implement the hazardous waste program in New Mexico pursuant to the New Mexico Hazardous Waste Act (New Mexico Statutes Annotated [NMSA] §§74.4-1 through 74.4-14, 1978). The technical standards for hazardous waste treatment, storage, and disposal facilities are outlined in 20.4.1.500 New Mexico Administrative Code (NMAC) (incorporating 40 CFR Part 264). The hazardous waste management permitting program is administered through 20.4.1.900 NMAC (incorporating 40 CFR Part 270).

WIPP was issued the HWFP on October 27, 1999. The operating conditions set forth in the HWFP were effective November 26, 1999. The HWFP authorized WIPP to receive, store, and dispose of CH TRU mixed waste. Two storage units (the Parking Area Container Storage Unit and the Waste Handling Building Container Storage Unit) and three Underground Hazardous Waste Disposal Units (HWDUs 1, 2, and 3) are permitted for the management of CH TRU waste.

In 2003, 16 HWFP modifications were submitted to the NMED in accordance with 20.4.1.900 NMAC (incorporating 40 CFR Part 270), including eight Class 1 notifications, seven Class 2 requests, and one Class 3 request. The Class 1 notifications made necessary corrections/updates to information in the HWFP, such as equipment locations, key personnel names, and equipment upgrades. The Class 2 requests provided operational flexibility, including disposal of waste with additional hazardous waste numbers, disposal of TRU waste containing polychlorinated biphenyls (PCBs), removal of obsolete emergency equipment, and deletion of headspace gas analysis for specific waste types. The Class 3 request will provide for the construction and use of additional hazardous waste disposal units.

The NMED proposed a modification to the HWFP on November 26, 2003. This agency-initiated modification proposed to restrict waste coming to WIPP to those waste streams that appeared in the 1995 TRU Waste Baseline Inventory Report (TWBIR) unless a permit modification is approved to add a non-TWBIR waste stream.

Title 40 CFR Part 280 addresses underground storage tanks (USTs) containing petroleum products or hazardous chemicals. Requirements for UST management pertain to the design, construction, installation, and operation of USTs, as well as notification and corrective action requirements in the event of a release and actions required for out-of-service USTs. The NMED has been authorized by the EPA to regulate USTs. WIPP maintains two USTs registered with the NMED.

One NMED RCRA regulatory inspection took place at the WIPP site during 2003, on May 6 and 7. No violations were noted and the inspection report was closed.

Hazardous Waste Generator Compliance

Nonradioactive hazardous waste is currently generated through normal facility operations, and is managed in Satellite Accumulation Areas and a "less-than-90-day" storage area. Hazardous waste generated at WIPP is characterized, packaged, labeled, and manifested to off-site treatment, storage, and disposal facilities in accordance with the requirements codified in 40 CFR Part 262.

WIPP Solid Waste Management Units and Areas of Concern

Module VII of the HWFP contains corrective action requirements for the WIPP SWMUs and Areas of Concern (AOCs). The HWFP identified fifteen SWMUs requiring a RCRA Facility Investigation (RFI), three SWMUs not requiring a RFI (the Hazardous Waste Management Units), and eight AOCs in the 41.1 km^2 (16 mi^2) WLWA. The SWMUs and eight AOCs identified in the HWFP are associated with natural resource exploration activities prior to the development of WIPP, or early WIPP mineral assessment and geologic studies to support facility construction. There was no SWMU classification change during 2003.

Program Deliverables and Schedule

WIPP is in compliance with the HWFP reporting requirements contained in Module VII, Table 1 RFI/CMS (Corrective Measures Study) Schedule of Compliance. In 2003, WIPP continued to submit quarterly progress reports.

The *WIPP Sampling and Analysis Plan for Solid Waste Management Units and Areas of Concern* (DOE/WIPP 00-2014) addresses the current permit requirements for an RFI of SWMUs and AOCs. It uses the results of previous investigations performed at WIPP and expands the investigations as required by the HWFP. As an alternative to the RFI specified in Module VII of the HWFP, current NMED guidance identifies an Accelerated Corrective Action Approach (ACAA) that may be used for all SWMUs and AOCs. This ACAA is used to replace the standard RFI Work Plan and Report sequence for all current SWMUs and AOCs with a more flexible decision-making approach. The ACAA process allows a facility to proceed on an accelerated time line. The ACAA process can be entered either before or after an RFI Work Plan. According to the NMED's guidance, a facility can prepare an RFI Work Plan or ACAA for any SWMU or AOC. The NMED recognized that WIPP was using the ACAA in lieu of the standard RFI in 2001. The required RFI work plan was superseded by the ACAA and the ACAA is used as a basis for a No Further Action (NFA) petition.

The ACAA process was used to produce an NFA report and petition, which was submitted to the NMED in October 2002. If an NFA determination is granted, WIPP will prepare an HWFP modification request to remove the 15 SWMUs and 8 AOCs from the HWFP.

3.2.4 National Environmental Policy Act

The NEPA (42 U.S.C. §§4321-4335) requires the federal government to use all practicable means to consider potential environmental impacts of proposed projects as part of the decision-making process. The NEPA also dictates that the public shall be allowed to review and comment on proposed projects that have the potential to significantly affect the environment.

NEPA requirements are detailed in the Council on Environmental Quality regulations in 40 CFR Parts 1500 through 1508. The DOE codified its requirements for implementing the council's regulations in 10 CFR Part 1021. Title 10 CFR §1021.331 requires that, following completion of each environmental impact statement and its associated Record of Decision (ROD), the DOE shall prepare a mitigation action plan that addresses mitigation commitments expressed in the ROD. To fulfill this DOE order requirement, the CBFO issued the 2003 Annual Mitigation Report for the Waste Isolation Pilot Plant in July 2003.

Day-to-day operational compliance with the NEPA at WIPP is achieved through implementation of a NEPA compliance plan and procedure. One hundred and eleven projects were reviewed and approved through the NEPA screening process in 2003. These projects were primarily routine maintenance of equipment and equipment upgrades at the WIPP site.

3.2.5 Clean Air Act

The Clean Air Act (CAA) (42 U.S.C. §7401, et seq.) provides for the preservation, protection, and enhancement of air quality. Both the state of New Mexico and the EPA have authority for regulating compliance with portions of the CAA. Radiological effluent monitoring in compliance with EPA requirements is discussed in Section 3.2.16.

The CAA established National Ambient Air Quality Standards for six "criteria" pollutants: sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. The initial 1993 WIPP air emissions inventory was developed as a baseline document to calculate maximum potential hourly and annual emissions of both hazardous and criteria pollutants. Based on the current air emissions inventory, WIPP operations do not exceed the 10-ton-per-year emission limit for any individual hazardous air pollutant or the 25-ton-per-year limit for any combination of hazardous air pollutant emissions, or the 10-ton-per-year emission limit for total suspended particulate. Proposed facility modifications are reviewed to determine if they will create new air emission sources and require permit applications.

Based on the initial 1993 air emissions inventory, the WIPP site is not required to obtain federal CAA permits. WIPP, in consultation with the NMED Air Quality Bureau, working in concert with data provided in the first air emissions inventory, was required to obtain a New Mexico Air Quality Control Regulation 702, Operating Permit (recodified in 2001 as 20.2.72 NMAC, "Construction Permits") for two backup diesel generators at the site. There have been no activities or modifications to the operating conditions of the diesel generators that would require reporting under the conditions of the permit.

3.2.6 Clean Water Act

The Clean Water Act (33 U.S.C. §§1251 through 1376) establishes provisions for the issuance of permits for discharges into waters of the United States. The regulation defining the scope of the permitting process is contained in 40 CFR §122.1(b)(1), which states that "The NPDES [National Pollutant Discharge Elimination System] program requires permits for the discharge of 'pollutants' from any 'point source' into 'waters of the United States.'"

WIPP does not have any discharges into waters of the United States and is not subject to regulation under the NPDES program. All wastewaters generated at WIPP are managed in on-site evaporation ponds that have no discharges to surface water or groundwater.

3.2.7 New Mexico Water Quality Act

The New Mexico Water Quality Act (§§74-6-1, et seq., NMSA 1978) created the New Mexico Water Quality Control Commission and tasked the commission with the development of regulations to protect New Mexico ground and surface water. New Mexico water quality regulations for ground and surface water protection are contained in 20.6.2 NMAC.

On January 16, 1992, the NMED issued the original discharge permit (DP-831) for the WIPP sewage treatment facility in accordance with these regulations. A Discharge Plan Renewal, submitted to the NMED on June 6, 2002, was approved on April 29, 2003. The Discharge Plan permits the disposal of up to 23,000 gallons per day (gpd) of sewage effluent, 2,000 gpd of nonhazardous water to Evaporation Pond B, 8,000 gpd of nonhazardous brine water to the H-19 Evaporation Pond, and 100 gallons per year of neutralized acid to the domestic wastewater lagoons.

A Notice of Intent (NOI) was submitted to the NMED on October 30, 2002, for the following activities:

- Changes to the shape and addition of a liner to the existing salt pile
- Construction of a new lined stockpile and evaporation pond north of the WIPP facility

The NMED notified WIPP on December 30, 2002, that a Discharge Plan, as defined in 20.6.2.7 NMAC, was required for the WIPP salt pile operations. The discharge plan modification application was submitted to the NMED on April 25, 2003, and approved on December 22, 2003. The existing salt pile evaporation pond has been lined with a polyethylene liner during this reporting period. Two stormwater retention ponds on the south side and one stormwater retention basin on the east side of the WIPP Property Protection Area will be lined in the future in accordance with the approved DP-831 permit modification.

In 2003, the DOE submitted four quarterly discharge monitoring reports to the NMED to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in the discharge plan.

3.2.8 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (42 U.S.C. §300f, et seq.) provides the regulatory strategy for protecting public water supply systems and underground sources of drinking water. New Mexico's drinking water regulations are contained in 20.7.10 NMAC, which adopts, by reference, 40 CFR Part 141, "National Primary Drinking Water Regulations," and 40 CFR Part 143, "National Secondary Drinking Water Regulations." Water is supplied to WIPP from wells owned by the city of Carlsbad's municipal water supply system.

WIPP qualifies for a reduced monitoring schedule under 40 CFR §141.86(d)(4), and is required to sample for lead and copper every three years. WIPP last sampled drinking water in July 2002. All samples were below action levels as specified by New Mexico monitoring requirements for lead and copper in tap water. The next lead and copper sampling period will be in July 2005.

Bacterial samples were collected and reported to NMED monthly throughout 2003. All bacteriological/analytical results were below the SDWA regulatory limits.

3.2.9 National Historic Preservation Act

The National Historic Preservation Act (NHPA) (16 U.S.C. §470, et seq.) was enacted to protect the nation's cultural resources and establish the National Register of Historic Places. During 2003, nine archaeological investigations were conducted to assess cultural resources for the construction of new monitoring wells and the salt pile infiltration controls. No archeological sites or artifacts were encountered.

3.2.10 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) (15 U.S.C. §2301, et seq.) was enacted to provide information about all chemicals and to control the production of new chemicals that might present an unreasonable risk of injury to health or the environment. The TSCA authorizes EPA to require testing of old and new chemical substances. The TSCA also provides the EPA authority to regulate the manufacturing, processing, import, use, and disposal of chemicals.

PCBs are one of the compounds regulated by the TSCA. The PCB storage and disposal regulations are listed in the applicable subparts of 40 CFR Part 761. An Initial Report requesting authorization to store and dispose of waste contaminated with PCBs, in accordance with the chemical waste landfill provisions of 40 CFR §761.75, was submitted to EPA Region VI on March 22, 2002. This Initial Report included requests for waivers to the technical requirements for hydrological conditions, surface and groundwater monitoring, and leachate collection. WIPP conducts groundwater monitoring in accordance with the HWFP. On May 15, 2003, the EPA Region VI approved the disposal of waste containing PCBs per the Initial Report. To date, no waste containing PCBs above the TSCA regulatory threshold of 50 ppm has been shipped to the site.

3.2.11 Federal Insecticide, Fungicide, And Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. §§136, et seq.) authorizes the EPA to regulate the registration, certification, use, storage, disposal, transportation, and recall of pesticides. FIFRA authorizes the EPA to establish regulations and procedures regarding the disposal or storage of packages and containers of pesticides and the disposal or storage of excess amounts of such pesticides. The FIFRA regulations are found in 40 CFR Parts 150-189.

All applications of restricted-use pesticides at WIPP are conducted by commercial pesticide contractors who are required to meet federal and state standards. These contractors store and dispose of pesticides off-site. General-use pesticides are stored according to label instructions. Used, empty cans are discarded by WIPP personnel into Satellite Accumulation Area (SAA) containers and managed as hazardous waste.

3.2.12 Endangered Species Act

The Endangered Species Act (16 U.S.C. §§1531, et seq.) was enacted in 1973 to prevent the extinction of certain species of animals and plants. This act provides strong measures to help alleviate the loss of species and their habitats, and places restrictions on activities that may affect endangered and threatened animals and plants to help ensure their continued survival. With limited exceptions, this act prohibits activities that could impact protected species, unless a permit is granted from the U.S. Fish and Wildlife Service (FWS). A biological assessment and "formal consultation," followed by the issuance of a "biological opinion" by the FWS, may be required for any species that is determined to be in potential jeopardy.

To ensure that WIPP environmental protection programs are current in their consideration of sensitive and protected species, a threatened and endangered species survey was conducted from August to November 1996. No threatened or endangered species were found within the WIPP LWA boundaries during the 1996 survey. The DOE has determined that activities associated with the operation of WIPP will have no impact on any threatened or endangered species. Considerations pertaining to protected species are implemented in accordance with the LMP during the deliberation and administration of projects conducted on WIPP lands.

3.2.13 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. §§703 through 712) is intended to protect birds that have common migratory flyways between the United States and Canada, Mexico, Japan, and Russia. The act makes it unlawful "at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, or attempt to take, capture, or kill . . . any migratory bird, any part, nest, or eggs of any such bird" unless specifically authorized by the Secretary of the Interior by direction or through regulations permitting and governing these actions.

Under the Migratory Bird Treaty Act, the CBFO is required to consult annually with the FWS with respect to impacts on migratory game birds and crows resulting from the hunting activities permitted on WIPP lands. Hunting privileges for the public within the WIPP withdrawal area are subject to regulations implementing the Migratory Bird Treaty Act (50 CFR Part 20), which regulate the harvest of migratory birds by specifying the mode of harvest, hunting seasons, and possession limits. There were no migratory birds taken at WIPP during 2003.

3.2.14 Federal Land Policy And Management Act

The objective of the Federal Land Policy and Management Act (FLPMA; 43 U.S.C. §§1701-1785) is to ensure that:

> *. . . public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use.*

Title II under FLPMA, *Land Use Planning; Land Acquisition and Disposition*, directs the Secretary of the Interior to prepare and maintain an inventory of all public lands and to develop and maintain, with public involvement, land-use plans regardless of whether subject public lands have been classified as withdrawn, set aside, or otherwise designated. The DOE developed the WIPP LMP, which is described in Section 2.3.

Under Title V, *Rights-of-Way*, the Secretary of the Interior is authorized to grant, issue, or renew rights-of-way over, upon, under, or through public lands. To date, several right-of-way reservations and land-use permits have been granted to the DOE. Examples of right-of-way permits include those obtained for a water pipeline, an access road, a caliche borrow pit, and a sampling station. Each "facility" (road, pipeline, railroad, etc.) is maintained and operated in accordance with the stipulations provided in the respective right-of-way reservation. Areas that are the subject of a right-of-way reservation are reclaimed and revegetated consistent with the terms of the right-of-way.

3.2.15 Federal Facilities Compliance Act

The Federal Facilities Compliance Act (FFCA) of 1992 (42 U.S.C. §§6912, 6939c and 6961) amended Section 6001 of the Solid Waste Disposal Act and was designed to bring federal facilities (including those under the DOE) into full compliance with RCRA. The FFCA waives the government's sovereign immunity, allowing fines and penalties to be imposed for RCRA violations at DOE facilities. In addition, the Act requires that the DOE facilities provide comprehensive data to the EPA and state regulatory agencies on mixed-waste inventories, treatment capacities, and treatment plans for each site. The Act ensures that the public will be informed of waste treatment options and encourages active public participation in the decisions affecting federal facilities. The FFCA does not require disposal plans. Furthermore, the waste that is disposed of at WIPP is not required to meet the land disposal restriction treatment.

3.2.16 Atomic Energy Act

The Atomic Energy Act (AEA) of 1954, as amended (42 U.S.C. §§2011, et seq.), initiated a national program for research, development, and use of atomic energy for both national defense and domestic civilian purposes. The authority of the EPA to establish generally applicable standards for the protection of the public and the environment from radiation is derived from the AEA, as amended, and the Nuclear Waste Policy Act of 1982 (NWPA) (42 U.S.C. §10101, et seq.), the Reorganization Plan No. 3 of 1970, and the WIPP LWA. The EPA oversees WIPP's protection of the public and the environment from radiation in accordance with standards found in 40 CFR Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes."

Title 40 CFR 191 Subpart A, "Environmental Standards for Management and Storage," sets the operational term requirements limiting annual radiation doses to members of the public from management and storage operations at disposal facilities operated by the DOE and not regulated by either the NRC or by agreement states. The annual dose equivalent, to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from management and storage may not exceed 25 millirem (mrem) to the whole body and 75 mrem to any other critical organ. The results of environmental monitoring and dose calculations have shown no releases of radionuclides that may affect the public. WIPP has conducted periodic confirmatory sampling since receipt of waste began in March 1999. Results of the monitoring program demonstrate compliance with the dose limits discussed above.

The EPA conducts an annual inspection of the monitoring programs that are conducted in accordance with 40 CFR Part 191, Subpart A; and 40 CFR §194.42. The EPA issued guidance for implementation of Subpart A, which includes methods for dose calculation, modeling, and reporting. The DOE operates to an implementation plan for compliance with 40 CFR 191, Subpart A.

The EPA has certification authority for Subparts B and C of 40 CFR Part 191. As required by the WIPP LWA in Section 8(d)(2), the EPA certified, on May 18, 1998 (63 FR 27353), that the WIPP facility complied with 40 CFR Part 191, Subparts B and C, and met the containment, individual protection, and groundwater protection requirements. The DOE is required to submit a recertification application to the EPA every five years during the operational period.

The WIPP LWA requires the EPA to establish criteria to use in certifying that the DOE will comply with the radioactive waste disposal standards of 40 CFR Part 191, Subparts B and C. These criteria are found in 40 CFR Part 194. Title 40 CFR Part 194 requires that DOE notify EPA if there are changes that may affect the WIPP certification. The DOE submits an annual change report to the EPA in November of each year.

3.2.17 DOE Orders

The DOE uses a system of orders, notices, directives, and policies to implement its programs under the AEA and to ensure compliance with the requirements of the AEA. An assessment process is in place to assure compliance with environmental safety and health-related orders.

3.2.17.1 DOE Order 151.1B, *Comprehensive Emergency Management System*

This order establishes requirements for emergency planning, categorization, preparedness, response, notification, public protection, and readiness assurance activities. The applicable requirements of this order are implemented through the WIPP emergency management program, the emergency response program, the training program, the emergency readiness program, the records management program, and the RCRA Contingency Plan.

3.2.17.2 DOE Order 225.1A, *Accident Investigation*

The objective of this order is to prescribe requirements for conducting investigations of certain accidents occurring at DOE operations and sites; prevent the recurrence of such accidents; and contribute to improved environmental protection and safety and health of DOE employees, contractors, and the public. This order is implemented through the WIPP's Root Cause Analysis procedure.

3.2.17.3 DOE Order 231.1A, *Environment, Safety and Health Reporting*

This order specifies collection and reporting of information on environment, safety and health that is required by law or regulation, or that is essential for evaluating DOE operations and identifying opportunities for improvement needed for planning purposes within the DOE. The order specifies the reports that must be filed, the persons or organizations responsible for filing the reports, the recipients of the reports, the format in which the reports must be prepared, and the schedule for filing the reports. This order is implemented at WIPP through the environmental monitoring plan, the annual SER, the hazardous and universal waste management plan, the HWFP reporting and notifications compliance plan, the radiation safety manual, the dosimetry program, the fire protection program, and WIPP procedures.

3.2.17.4 DOE Order 414.1B, *Quality Assurance*

This order provides DOE policy, sets forth principles, and assigns responsibilities for establishing, implementing, and maintaining programs, plans, and actions to ensure quality achievement in DOE programs. This order is implemented through the WIPP's QA program documents.

3.2.17.5 DOE Order 435.1, *Radioactive Waste Management*

The objective of this order is to ensure that all DOE radioactive waste, including TRU waste that is disposed at the WIPP site, is managed in a manner that is protective of workers and the public. In the event that a conflict exists between any requirements of this order and the WIPP LWA regarding their application to WIPP, the requirements of the LWA prevail. The WIPP implements the requirements of this order through the Waste Acceptance Criteria, and procedures governing the management and disposal of site-generated radioactive waste.

3.2.17.6 DOE Order 450.1, *Environmental Protection Program*

This order emphasizes stewardship practices that are protective of the environment, other natural resources, and cultural resources, and requires integration of Environmental Management Systems into Integrated Safety Management Systems to meet or exceed compliance with applicable federal, state, and local laws and regulations. This order is implemented through the existing site EMS and ISMS programs, as well as procedures.

3.2.17.7 DOE Order 451.1B, *National Environmental Policy Act Compliance Program*

This order establishes DOE requirements and responsibilities for implementing the NEPA, the Council on Environmental Quality Regulations Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and the DOE NEPA Implementing Procedures (10 CFR Part 1021). This order is implemented at WIPP by adherence to a screening procedure. The screening procedure is used to evaluate environmental impacts associated with proposed activities and to determine if additional analyses are required.

3.2.17.8 DOE Order 5400.5, *Radiation Protection of the Public and the Environment*

This order, along with portions of Order 231.1A, establishes standards and requirements for operations of the DOE and its contractors with respect to protecting members of the public and the environment against undue risk from radiation. Activities and analyses describing compliance with the applicable requirements of the order are contained in DOE/WIPP 95-2065. Monitoring activities to document compliance with the order are described in the WIPP ALARA (as low as reasonably achievable) program manual, the EMP, the records management program, and the radiation safety manual.

3.2.18 Executive Order 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition*

This executive order requires that federal agencies incorporate waste prevention and recycling into operations, demand recycled/recovered materials, purchase environmentally preferable products, track purchases of EPA-designated guideline items, develop and implement affirmative procurement programs, and establish goals for solid waste prevention and recycling. Sections 3.2.2, 3.3.2, and 3.3.3 of this chapter discuss compliance with this order.

3.2.19 Executive Order 13148, *Greening the Government Through Leadership in Environmental Management*

This executive order requires development of environmental management systems, environmental compliance audit programs, reporting under EPCRA, reduction of toxic releases and off-site transfers of toxic chemicals, reduction of the use of toxic chemicals, hazardous substances, and pollutants, and generation of hazardous and radioactive waste, reductions in ozone-depleting substances, and environmentally and economically beneficial landscaping. Sections 3.2.1, 3.2.2, 3.3.2, and 3.3.3 of this chapter discuss compliance with this order.

3.3 Other Significant Accomplishments and Ongoing Compliance Activities

3.3.1 Environmental Compliance Assessment Program

Internal assessment of activities at the WIPP facility are periodically performed to evaluate the processes in place to comply with applicable environmental regulatory requirements. The environmental assessments are performed pursuant to the Environmental Assessment Plan (EAP) (WP 02-EC.13).

Environmental assessment is a systematic, documented verification process for objectively evaluating whether specific environmental activities, events, conditions, management systems, or information conform to applicable regulatory requirements and internal processes. Assessments, in general, provide information about the overall effectiveness of the EMS.

The following is a summary of the internal assessments performed in 2003.

An assessment of Clean Water Act Compliance was conducted on March 24 through 27, March 31, and April 8, 2003. All areas assessed were determined to be in compliance with applicable requirements. There was no discernable pattern or trend indicating a weakness in the programmatic implementation of water-related regulatory requirements. Concerns noted during the assessment pertained to record retention, inadequate procedures and clarification of discharges described in DP-831.

An assessment was performed on May 12 through June 13, 2003, to evaluate the adequacy and effective implementation of the EMP. It was determined that the EMP is adequately defined and effectively implemented. Concerns were identified related to periodic document review, departure from some procedure requirements and lack of identification and completion of quality records.

An assessment of off-site waste disposal was performed on November 24 through December 15, 2003. The assessment was conducted at the WIPP site. The assessment evaluated procedures and processes controlling disposal of waste generated by WTS or WTS subcontractors supporting operation of the WIPP. The assessment included the evaluation of the adequacy, implementation, and effectiveness of programs and procedures to comply with the New Mexico Solid Waste Act, as implemented through the New Mexico Solid Waste Management Regulations (SWMRs) contained within 20.9.1, NMAC and DOE Order 450.1. Concerns were identified related to departure from some procedure requirements and adequacy of control over waste vendor selection. There was no evidence of regulatory noncompliance discovered during the assessment.

3.3.2 Integrated Safety Management System/Environmental Management System

WIPP is committed to achieving the highest standards of environmental quality, and to providing a safe and healthful workplace for its employees, contractors, and the surrounding communities. WIPP is likewise committed to protecting the surrounding environment, including wildlife and plant species and habitats, and cultural, historical, and archaeological resources. To accomplish its mission successfully, WIPP has implemented an EMS as required by DOE Order 450.1. In this order, the DOE directs that facilities must integrate their ISMS and EMS.

The Environmental Management System Description (WP 02-EC.0) describes the EMS at WIPP. The document also serves as a road map for the implementation of the EMS and clarifies how ISMS/EMS integration is achieved. The WIPP EMS conforms to ISO 14001 (ISO, 1996), which requires an organization's top management, through its environmental policy, to commit to (1) continual improvement of its environmental activities, (2) the prevention of pollution, and (3) compliance with applicable legal requirements.

Policy

The WTS General Manager issued MP 1.14 to communicate senior management's commitment to the WIPP environmental policy and to establish performance expectations. This policy constitutes the framework of the WIPP EMS and addresses compliance with applicable environmental laws, regulations, and DOE orders. It also stresses the importance of pollution prevention and presents a commitment to continually improve environmental and safety performance.

The environmental policy is available to employees on the WIPP Q&MIS® (Quality and Manufacturing Integrated Systems) electronic document control system. The WIPP environmental policy is available to the public by calling the WIPP Information Center at 1-800-336-9477 or from the WIPP Internet Homepage at www.wipp.ws.

Planning and Analysis

DOE Order 450.1, Section 4.a.(1) requires that an ISMS include an EMS that provides for systematic planning, integrated execution, and evaluation of programs for public health, environmental protection, P2, and compliance with applicable environmental protection requirements. Identification of an organization's operational aspects, the resultant environmental impacts, and the significance of those impacts begins the planning cycle. This step is the basis for subsequently establishing objectives and targets, focusing training priorities, and ensuring that the environmental policy is successfully implemented.

WIPP has documented a list of current aspects and impacts in Attachment 1 of WP 02-EC.0. WIPP managers review these environmental aspects and update objectives and targets if necessary, on an annual basis. This is done when planning the next fiscal year's activities so the aspects will be considered for appropriate funding.

Objectives and Targets

WIPP has established environmental objectives and targets that support the site's environmental policy. Since WIPP is a TRU waste disposal facility, many of its objectives are associated with the operation of the site. WIPP has site-specific goals that support the accomplishment of DOE pollution prevention and energy efficiency goals.

Implementation and Operation

Successful implementation of an EMS needs the support of all employees. EMS responsibilities are not confined to the environmental department. Operations and other functional areas have significant EMS responsibilities. Management provides resources essential to the implementation and control of the EMS, including training, funding, human resources, specialized skills, and technology.

Employees are trained so that work may be performed safely and within approved controls. Work at WIPP is conducted in accordance with the WIPP Conduct of Operations Manual (WP 04-CO) and its implementing procedures. The Conduct of Operations process is implemented by requiring that work be performed in accordance with thorough and clear procedures. Additionally, adequate training must be provided, and roles and responsibilities must be clearly defined.

WIPP has a comprehensive Conduct of Maintenance process to ensure that mechanical systems are functional and perform as intended when needed. WIPP also has a comprehensive emergency response plan in the unlikely event of a radiological or nonradiological accident or environmental release. Response scenarios have been developed for both on-site and off-site events. Drills and exercises are conducted periodically to test the procedures and response personnel.

Corrective Actions

WIPP uses established procedures to investigate nonconformance, to mitigate the impact of any nonconformance, and to develop and implement corrective and preventive actions. An automated system is used to track corrective action commitments, and to provide a status of these commitments to senior management.

Self-Assessment Procedures

Internal environmental compliance assessments are conducted according to the EAP. The EAP defines the assessment process used to evaluate compliance with applicable environmental requirements, and to develop and implement corrective actions that will prevent reoccurrence of identified deficiencies. Environmental assessment is performed to determine if WIPP activities (1) are protective of human health and the environment; (2) are in compliance with applicable local, state, and federal environmental regulations, DOE orders and guidance, WIPP environmental permits; and (3) embody good management practices.

Management Review Process

To ensure that the WIPP EMS remains suitable, adequate, and effective, an annual report that evaluates the EMS is submitted to WTS senior management. The report includes information from both compliance and EMS assessments/audits, facility changes, and progress toward meeting the site's objectives and targets. When appropriate, the report includes recommendations regarding the need for changes to the Environmental Management Policy, as well as suggested changes to the list of environmental aspects/impacts, and/or environmental objectives/targets.

EMS Performance Measures

Site responsibilities for the P2 program are an integral part of the WIPP EMS. The DOE Secretary of Energy has prescribed that waste streams from routine operations be decreased as follows by FY 2005:

Hazardous	90 percent
Low-level radioactive	80 percent
Low-level mixed radioactive	80 percent
TRU	80 percent
Sanitary	75 percent

The wastes generated in 2003, and the percent relative to the 1993 baseline (2000 baseline for radioactive and mixed wastes) are listed in Table 3.2.

Table 3.2 - 2003 WIPP Waste Volumes and Reduction Goals for FY 2005

Waste Type	Baseline (Metric Tons)	2003 Actual (Metric Tons)	% Baseline
RCRA (Hazardous)	5.14	6.19	120
RCRA Leaded Brine (1995 baseline)	58.63	0.23	4.5
Low-level radioactive (2000 baseline)	0.8	0.51	63.8
Low-level mixed radioactive (2000 baseline)	0.02	0.08	400
Sanitary	1,224	97.69	8
Medical	0.03	0.06	N/A, No required waste stream reduction

The Secretary of Energy's new goals for fiscal year (FY) 2005 and beyond are to recycle 45 percent of sanitary wastes from all operations by FY 2005 and 50 percent by FY 2010, based on the 1993 baseline.

The WIPP baseline for leaded brine was established in 1995, since this is when WIPP brines first tested as hazardous for lead. Low-level and low-level mixed radioactive wastes were not generated at the WIPP facility until 2000, when the WIPP Laboratories started routine analyses. The WIPP Laboratories were in start-up mode, and the waste generation continued to increase through August 2003, at which time the laboratory moved to a different location. Subsequent to 2003, generation of low-level and low-level mixed radioactive waste at the WIPP facility is anticipated to be essentially zero.

The increase in mining activities in 2002 and 2003 required increased washing activities for mining equipment. The wash water was a RCRA hazardous waste, which caused the increase above the baseline.

3.3.3 Pollution Prevention

WIPP's P2 program focuses primarily on reducing the generation of the following waste streams: leaded brine, sanitary waste, RCRA waste, low-level mixed waste, and low-level radioactive waste. Other waste minimization efforts at WIPP include recycling items such as used oil, pallets, scrap metal, fire extinguishers, wet batteries, ethylene glycol, Safety-Kleen solvent, computer equipment, aluminum cans, toner cartridges, and paper.

Pollution Prevention Activities

Two Pollution Prevention Opportunity Assessments (PPOAs) were prepared in 2003:

- PPOA 03-001 – *Chemical List Approved for Use*. This PPOA addressed routinely purchased chemicals and established a list of alternatives that were safer for the environment.

- PPOA03-002 – *Management of Used Fluorescent Lamps*. This PPOA assessed the management of used lamps at DOE owned and leased buildings in Carlsbad. Lamps from these facilities are now recycled through permitted waste disposal vendors.

In 2003, WIPP continued its mandatory recycling program. Table 3.3 identifies the volume of materials recycled at WIPP in 2003.

Table 3.3 - Materials Recycled at WIPP in 2003

Recycled Material	2003 Actual (Metric Tons)
Paper	37.05
Aluminum cans	0.36
Cardboard	8.74
Toner cartridges	1.89
Wooden Pallets	0
Oil	4.00
Fluorescent bulbs/high-pressure sodium bulbs	0.51
Wet batteries	2.46
Silver	0.00
Ethylene glycol (RCRA)	0.36
Scrap metal	52.51
Plastic	0.54
Computer equipment	3.50
Total Sanitary and RCRA Materials Recycled	111.92
Total Sanitary and RCRA Materials Generated	200.73
PERCENT RECYCLED	55.8

3.3.4 Environmental Training

WIPP has a comprehensive environmental training program administered by the Technical Training Section as described in the WIPP Training Program (WP 14-TR.01). Technical Training has adopted a DOE-approved methodology of Tabletop Job and Needs Analysis, and Tabletop Training Program Design to determine content and training program design based on defined job requirements. All employees receive initial and periodic refresher General Employee Training (GET). The GET addresses general site information, safety, environmental, radiation protection, emergency response, and other issues.

Specific training requirements and qualification standards have been developed for personnel whose work has the potential to create a significant impact on the environment. Workers who will perform waste handling, TRU and hazardous waste management, mining, maintenance, and other waste management and permit compliance tasks must successfully complete the required training and, in many cases, those workers must also meet certain qualifications before they may begin unsupervised work in those areas. EMS information has been integrated into GET, Hazardous Waste Worker, Hazardous Waste Supervisor, Hazardous Waste Responder, and Radiation Worker training programs and the associated refresher courses.

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CHAPTER 4 - ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

DOE Order 450.1 states that the DOE must "conduct environmental monitoring, as appropriate, to support the site's ISMS, to detect, characterize, and respond to releases from DOE activities; assess impacts; estimate dispersal patterns in the environment; characterize the pathways of exposures and doses to members of the public; characterize the exposures and doses to individuals, to the population; and to evaluate the potential impacts to the biota in the vicinity of the DOE activity."

Radionuclides present in the environment, whether naturally occurring or human-made, contribute to radiation doses to humans. Therefore, environmental monitoring around nuclear facilities is imperative to characterize radiological conditions, corroborate releases, and determine their effects, should they occur.

The WIPP Environmental Monitoring Program requires the monitoring of air, groundwater, surface water, soils, sediments and biota to characterize the radiological environment around the WIPP facility. This program is carried out in accordance with the EMP (DOE/WIPP 99-2194). The radiological monitoring portion of this plan meets the requirements contained in DOE/EH-00173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring*. The WIPP Effluent Monitoring Program requires the monitoring of air from the underground storage areas and the Waste Handling Building to detect potential releases of radiation from WIPP activities.

The radiological environment near WIPP includes natural radioactivity, global fallout and, potentially, radioactive contamination remaining from Project Gnome. Under Project Gnome, a nuclear device was detonated underground in bedded salt on December 10, 1961. The test site for Project Gnome was located approximately 9 km (5.4 miles) southwest of the WIPP site. The Project Gnome shot vented into the atmosphere. Therefore, environmental samples in the vicinity of the WIPP site may contain small amounts of fission products from fallout and residual contamination from Project Gnome in addition to natural radioactivity.

Natural background radiation, global fallout, and remaining radioactive contamination from Project Gnome together comprise the radiological baseline for WIPP. A report entitled *Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant* (DOE/WIPP 92-037) summarizes the radiological baseline data obtained at and near the WIPP site during the period from 1985 through 1989, prior to the time that WIPP became operational. Radioisotope concentrations in environmental media sampled under the current ongoing environmental monitoring program are compared with this baseline to gain information regarding annual fluctuations.

Environmental media sampled in the current environmental monitoring program include airborne particulates, soil, surface water, groundwater, sediments and animal and vegetable biota. These samples are analyzed for ten radionuclides, including natural uranium (^{234}U, ^{235}U, and ^{238}U); ^{40}K; actinides expected to be present in the waste (^{238}Pu, $^{239+240}$Pu, and ^{241}Am), and major fission products (^{137}Cs, ^{60}Co, and ^{90}Sr). Environmental levels of these radionuclides can provide corroborating information on which to base conclusions regarding releases from WIPP operations, in the event of potential radionuclide releases detected by the WIPP effluent monitoring system.

Radionuclides were considered "detected" in a sample if the measured concentration or activity was greater than the total propagated uncertainty (TPU) at the 2 sigma level (2 sigma TPU or 2 x TPU) and greater than the minimum detectable concentration (MDC). This methodology was patterned after that described in *Hanford Decision Level for Alpha Spectrometry Bioassay Analyses Based on the Sample-Specific Total Propagated Uncertainty* (MacLellan, 1999). The MDC was determined by the analytical laboratories based on the natural background radiation, the analytical technique, and inherent characteristics of the analytical equipment. The MDC represents the minimum concentration of a radionuclide detectable in a given sample using the given equipment and techniques with a specific statistical confidence (usually 95 percent). TPU is an estimate of the uncertainty in the measurement due to all sources, including counting error, measurement error, chemical recovery error, detector efficiency, randomness of radioactive decay and any other sources of uncertainty. Measurements of radioactivity are actually probabilities due to the random nature of the disintegration process. A sample is decaying as it is being measured, so no finite value can be assigned. Instead, the ranges of possible activities are reported by incorporating the total propagated uncertainties of the method. Sample results are also normalized with the instrument background and/or the method blank. If either of those measurements have greater activity ranges than the actual sample, it is possible to get negative values on one end of the reported range of activities. Additional information on the equations used is contained in Appendix D.

The WIPP Laboratories perform these analyses for all radiological samples. The WIPP Laboratories use highly sensitive radiochemical analysis and detection techniques that result in very low detection limits. This allows detection of radionuclides at levels far below those of environmental and human health concern. The MDCs attained by the WIPP Laboratories are below the recommended MDCs specified in ANSI N13.30, which provides performance criteria for radiobioassay.

Comparisons of radionuclide concentrations were made between years and locations using the statistical procedure, ANOVA [Analysis of Variance] for those data sets containing sufficient "detects" to make such comparisons statistically meaningful. When this or other statistical tests were used, the p-value was reported. The p-value is the probability under the null hypothesis of observing a value as unlikely or more unlikely than the value of the test statistic. In many cases, scientists have accepted a value of $p < 0.05$ as indicative of a difference between samples. However, interpretation of p requires some judgment on the part of the reader and individual readers may choose to defend higher or lower values of p as their cutoff value. For this report, $p < 0.05$ was used.

<u>Effluent Monitoring</u>

The purpose of effluent monitoring is to determine whether radionuclides are being released from WIPP operations into the environment. The WIPP facility has three effluent emission points that could release airborne radionuclides to the atmosphere. A monitoring station has been established for each emission point, designated Stations A, B, and C. Each station employs one or more fixed air samplers, collecting particulate from the effluent air stream using a Versapore filter. Instruments at Station A sample the unfiltered underground exhaust air. Samples collected at Station B represent the underground exhaust air after HEPA (high-efficiency particulate air) filtration and, sometimes, nonfiltered air during maintenance. Samples collected at Station C represent the air from the Waste Handling Building after HEPA filtration. For each sampling event, chain-of-custody forms are initiated to track and maintain an accurate written record of filter sample handling and treatment from the time of sample collection through laboratory procedures to disposal.

In the effluent monitoring program, four radionuclides are analyzed for that are considered to have the highest potential to deliver a dose to an off-site receptor. These radionuclides are ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and ^{90}Sr.

Environmental Monitoring

The purpose of radiological environmental monitoring is to accurately measure radionuclides in the ambient environmental media. This allows for a comparison of sample data to results from previous years and to baseline data, to determine what, if any, impact WIPP is having on the surrounding environment. WIPP's radiological monitoring includes sampling and analysis of air, groundwater, surface water, sediment, soil and biota for ten radionuclides. For each sampling event, chain-of-custody forms are initiated to track and maintain an accurate written record of sample handling and treatment from the time of sample collection through delivery to the laboratory.

The radionuclides analyzed in the environmental monitoring program are ^{238}Pu, $^{239+240}$Pu, ^{241}Am, ^{234}U, ^{235}U, ^{238}U, ^{137}Cs, ^{60}Co, ^{40}K, and ^{90}Sr. Isotopes of plutonium and americium were analyzed because they are the most significant alpha-emitting radionuclides among the constituents of TRU wastes received at the WIPP site. Uranium isotopes were analyzed because they are prominent alpha-emitting radionuclides in the natural environment.

Strontium-90, ^{60}Co, and ^{137}Cs are analyzed to demonstrate the ability to quantify these beta and gamma-emitting contaminants should they appear in the TRU waste stream. Potassium-40, a natural gamma-emitting radionuclide which is ubiquitous in the earth's crust, was also monitored because of its possible enhancement due to the deposition of tailings from local potash mining.

4.1 Effluent Monitoring

4.1.1 Sample Collection

During 2003, 345 filter samples were collected from Station A for a total air volume sampled of 29,921 m^3 (1,068,621 ft^3). Because only a small fraction of the air released through Station A is sampled, the activity on the filter is normalized to the total air flow through Station A. Fifty-five filter samples were collected from Station B for a total air volume sampled of 30,506 m^3 (1,089,492 ft^3), and 52 filter samples were collected from Station C for a total air volume sampled of 11,194 m^3 (399,783 ft^3). The activity on the filters for Stations B and C is also normalized to the total airflow through these stations.

During transport from the field, the filters are placed in protective containers with their field data sheets, stored zip lock bags, and placed in a fire-proof, locked cabinet. After 72 hours for the short-lived progeny of radon to decay, the filter samples are transmitted via chain-of-custody to the WIPP Laboratories.

The filter samples were composited each quarter for Stations B and C. Because of the large number of samples from Station A, these samples were composited monthly. Samples were analyzed radiochemically for ^{241}Am, ^{238}Pu, $^{239+240}$Pu, and ^{90}Sr, the components of the CH waste at WIPP expected to produce 98 percent of the potential radiation dose to humans.

4.1.2 Sample Preparation

Monthly and quarterly filter samples were composited. The composites were transferred into a Pyrex beaker, spiked with appropriate tracers (^{243}Am, and ^{242}Pu), and heated in a Muffle furnace at 250°C (482°F) for two hours, followed by two hours at 375°C (707°F) and six hours at 525°C (977°F).

The ash was cooled, transferred quantitatively into a Teflon beaker by rinsing with concentrated nitric acid, and heated with concentrated hydrofluoric acid until completely dissolved. Hydrofluoric acid was removed by evaporating to dryness.

Approximately 25 ml (milliliters) (0.845 fluid oz [ounce]) of concentrated nitric acid and one gram (0.0353 oz) of boric acid were added, heated, and finally evaporated to dryness. The residue was dissolved in 8 M (molar) nitric acid for gamma spectrometry and determinations of ^{90}Sr and alpha-emitting radionuclides.

4.1.3 Determination of Individual Radionuclides

Gamma-emitting radionuclides were measured in the air filters by gamma spectrometry. Strontium-90 and alpha-emitting radionuclides were determined by sequential separation and counting. Determination of actinides involved co-precipitation, ion exchange separation, and alpha spectrometry.

4.1.4 Results and Discussion

Out of 20 total composite samples, three monthly composite samples had detectable radioactivity (Table 4.1), which occurred during the months of January and September 2003 for ^{241}Am, and during the month of August 2003 for $^{239+240}$Pu. Six composite samples had concentrations greater than the MDC, but less than the 2 sigma TPU. For ^{241}Am, these occurred during the months of March and October 2003 at Station A, and during the fourth quarter at Station C. Similar occurrences happened during June 2003 at Station A for ^{238}Pu, and for $^{239+240}$Pu during the month of December 2003, and the fourth quarter at Station B. The June 2003 monthly composite sample at Station A had a concentration of ^{241}Am greater than the 2 sigma TPU, but less than the MDC. This is not "detectable" radioactivity. For the remaining 11 samples, the WIPP Laboratories reported an activity less than 2 sigma TPU and the MDC.

In addition to the monthly composite analyses (Table 4.1), the WIPP Laboratories also performed a quarterly composite isotopic analysis of the Station A secondary filter samples, which were collected during the months of April, May, and June 2003. This analysis was performed because two entities (Environmental Evaluation Group [EEG] and the Carlsbad Environmental Monitoring and Research Center [CEMRC]) samples had detectable radioactivity ($^{239+240}$Pu) for June 2003 (EEG) and that quarter (CEMRC) (EEG, 2004; CEMRC, 2004). For $^{239+240}$Pu, the WIPP Laboratories reported the following sampling concentration in Disintegration per Minute (DPM) per sample: Activity: 6.26×10^{-2}, 2×TPU: 4.28×10^{-2}; and MDC: 4.85×10^{-2}. The WIPP Laboratories results are converted from DPM/sample to becquerels (Bq)/sample by multiplying the laboratory results by 0.016667. The $^{239+240}$Pu result was considered "detectable" in the composite analysis because the measured concentration or activity was greater than the 2 sigma TPU and greater than the MDC. Although this activity cannot be combined directly with monthly composite results to obtain an overall source term, estimates show that its inclusion would not appreciably change the dose to the maximally exposed individual.

Additional sampling was routinely performed in the underground using fixed air samplers and continuous air monitors. Evaluation of the samples from both indicate that there were no detectable releases that exceeded the 10 mrem per year limit and the 0.1 mrem per year limit for periodic confirmatory sampling in accordance with the provisions of 40 CFR §61.94, from the WIPP facility. Results from 2003 sampling are contained in DOE/WIPP 02-2171.

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2003

Nuclide	Activity	2 × TPU[a]	MDC[b]	Activity	2 × TPU	MDC	Activity	2 × TPU	MDC
	Station A			Station B			Station C		
	1st Quarter								
^{241}Am	See below [c]			1.35×10^{-4}	2.72×10^{-4}	3.66×10^{-4}	0.00×10^{0}	N/A[d]	9.88×10^{-4}
^{238}Pu				0.00×10^{0}	N/A[d]	6.77×10^{-4}	0.00×10^{0}	N/A[d]	8.25×10^{-4}
$^{239+240}$Pu				5.00×10^{-4}	7.14×10^{-4}	6.77×10^{-4}	0.00×10^{0}	N/A[d]	3.03×10^{-4}
^{90}Sr				2.91×10^{-2}	2.94×10^{-2}	4.92×10^{-2}	1.50×10^{-3}	2.90×10^{-2}	5.11×10^{-2}
	2nd Quarter								
^{241}Am	See below			2.89×10^{-4}	5.81×10^{-4}	1.06×10^{-3}	3.85×10^{-4}	6.77×10^{-4}	1.19×10^{-3}
^{238}Pu				1.62×10^{-4}	3.26×10^{-4}	4.37×10^{-4}	0.00×10^{0}	N/A[d]	9.21×10^{-4}
$^{239+240}$Pu				0.00×10^{0}	N/A[d]	4.37×10^{-4}	1.25×10^{-4}	2.51×10^{-4}	3.39×10^{-4}
^{90}Sr				1.34×10^{-2}	2.23×10^{-2}	3.89×10^{-2}	1.57×10^{-2}	2.13×10^{-2}	3.67×10^{-2}

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2003

Nuclide	Activity	2 × TPU[a]	MDC[b]	Activity	2 × TPU	MDC	Activity	2 × TPU	MDC
				3rd Quarter					
^{241}Am				2.31×10^{-4}	3.29×10^{-4}	8.46×10^{-3}	1.10×10^{-4}	2.21×10^{-4}	2.98×10^{-4}
^{238}Pu		See below		5.25×10^{-4}	7.51×10^{-4}	7.07×10^{-4}	0.00×10^{0}	N/A[d]	4.37×10^{-4}
$^{239+240}$Pu				2.61×10^{-4}	5.25×10^{-4}	7.07×10^{-4}	-1.61×10^{-4}	3.23×10^{-4}	1.19×10^{-3}
^{90}Sr				1.37×10^{-2}	2.13×10^{-2}	3.60×10^{-2}	-1.22×10^{-2}	2.25×10^{-2}	3.85×10^{-2}
				4th Quarter					
^{241}Am				6.51×10^{-4}	1.15×10^{-3}	2.02×10^{-3}	4.22×10^{-4}	4.29×10^{-4}	2.87×10^{-4}
^{238}Pu		See below		1.21×10^{-4}	4.18×10^{-4}	8.84×10^{-4}	-1.59×10^{-4}	2.26×10^{-4}	7.14×10^{-4}
$^{239+240}$Pu				3.60×10^{-4}	4.22×10^{-4}	3.25×10^{-4}	0.00×10^{0}	N/A[d]	2.15×10^{-4}
^{90}Sr				-7.73×10^{-3}	2.30×10^{-2}	4.00×10^{-2}	-5.48×10^{-3}	2.34×10^{-2}	4.07×10^{-2}
			Station A	**1st Quarter**		**Monthly[c]**			
		January			**February**			**March**	
^{241}Am	6.85×10^{-4}	5.70×10^{-4}	3.09×10^{-4}	6.77×10^{-4}	9.66×10^{-4}	1.58×10^{-3}	6.99×10^{-4}	7.10×10^{-4}	4.74×10^{-4}
^{238}Pu	3.43×10^{-4}	4.88×10^{-4}	4.63×10^{-4}	1.25×10^{-4}	2.50×10^{-4}	3.37×10^{-4}	0.00×10^{0}	N/A[d]	4.40×10^{-4}
$^{239+240}$Pu	1.71×10^{-4}	3.43×10^{-4}	4.63×10^{-4}	1.24×10^{-4}	2.49×10^{-4}	3.37×10^{-4}	1.62×10^{-4}	3.26×10^{-4}	4.40×10^{-4}
^{90}Sr	-3.27×10^{-3}	2.86×10^{-2}	5.07×10^{-2}	-1.77×10^{-3}	3.11×10^{-2}	5.40×10^{-2}	-4.37×10^{-3}	3.21×10^{-2}	5.59×10^{-2}
			Station A	**2nd Quarter**		**Monthly**			
		April			**May**			**June**	
^{241}Am	5.31×10^{-6}	2.88×10^{-4}	3.89×10^{-4}	1.88×10^{-4}	3.77×10^{-4}	5.07×10^{-4}	7.51×10^{-4}	7.22×10^{-4}	9.25×10^{-4}
^{238}Pu	-1.71×10^{-4}	3.42×10^{-4}	1.25×10^{-3}	0.00×10^{0}	N/A[d]	3.52×10^{-4}	3.54×10^{-4}	4.14×10^{-4}	3.19×10^{-4}
$^{239+240}$Pu	0.00×10^{0}	N/A[d]	4.59×10^{-4}	1.30×10^{-4}	2.61×10^{-4}	3.52×10^{-4}	4.70×10^{-4}	5.81×10^{-4}	8.66×10^{-4}
^{90}Sr	-4.29×10^{-3}	3.18×10^{-2}	5.55×10^{-2}	7.77×10^{-3}	3.19×10^{-2}	5.44×10^{-2}	1.22×10^{-2}	2.39×10^{-2}	4.18×10^{-2}
			Station A	**3rd Quarter**		**Monthly**			
		July			**August**			**September**	
^{241}Am	3.89×10^{-3}	5.81×10^{-3}	9.51×10^{-3}	0.00×10^{0}	N/A[d]	4.55×10^{-4}	4.96×10^{-4}	4.51×10^{-4}	2.69×10^{-4}
^{238}Pu	0.00×10^{0}	N/A[d]	3.92×10^{-4}	-2.50×10^{-4}	3.56×10^{-4}	1.16×10^{-3}	-1.72×10^{-4}	3.44×10^{-4}	1.26×10^{-3}
$^{239+240}$Pu	2.88×10^{-4}	4.11×10^{-4}	3.92×10^{-4}	5.00×10^{-4}	5.03×10^{-4}	3.38×10^{-4}	1.71×10^{-4}	5.92×10^{-4}	1.26×10^{-3}
^{90}Sr	1.14×10^{-2}	2.47×10^{-2}	4.33×10^{-2}	-8.03×10^{-3}	2.18×10^{-2}	3.70×10^{-2}	-5.14×10^{-3}	2.28×10^{-2}	3.85×10^{-2}
			Station A	**4th Quarter**		**Monthly**			
		October			**November**			**December**	
^{241}Am	3.49×10^{-4}	4.07×10^{-4}	3.16×10^{-4}	1.00×10^{-4}	2.01×10^{-4}	3.00×10^{-4}	1.29×10^{-4}	4.48×10^{-4}	9.51×10^{-4}
^{238}Pu	1.34×10^{-4}	2.69×10^{-4}	3.89×10^{-4}	0.00×10^{0}	N/A[d]	3.27×10^{-4}	0.00×10^{0}	N/A[d]	6.51×10^{-4}
$^{239+240}$Pu	0.00×10^{0}	N/A[d]	3.89×10^{-4}	0.00×10^{0}	N/A[d]	8.33×10^{-4}	3.53×10^{-4}	3.57×10^{-4}	2.39×10^{-4}
^{90}Sr	-1.01×10^{-2}	2.74×10^{-2}	4.77×10^{-2}	-3.70×10^{-3}	3.89×10^{-2}	3.04×10^{-2}	-9.47×10^{-3}	2.43×10^{-2}	4.26×10^{-2}

[a] Total propagated uncertainty
[b] Minimum detectable concentration
[c] Station A - composited monthly due to the large number of samples
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

4.2 Airborne Particulates

4.2.1 Sample Collection

Weekly airborne particulate samples were collected from seven locations around WIPP (Figure 4.1) using low volume air samplers (LVAS). Locations were selected based on the prevailing wind direction. Location codes are shown in Appendix C. Each week at each sampling location, approximately 600 m^3 (21,187 ft^3) of air was filtered through a 4.7-cm (1.85-in.) diameter glass microfiber filter using a low-volume continuous air sampler.

4.2.2 Sample Preparation

Weekly air particulate samples were composited for each quarter. The composites were transferred into a Pyrex beaker, spiked with appropriate tracers (^{243}Am, and ^{242}Pu), and heated in a Muffle furnace at 250°C (482°F) for two hours, followed by two hours at 375°C (707°F) and six hours at 525°C (977°F).

The ash was cooled, transferred quantitatively into a Teflon beaker by rinsing with concentrated nitric acid, and heated with concentrated hydrofluoric acid until completely dissolved. Hydrofluoric acid was removed by evaporating to dryness.

Approximately 25 ml (milliliters) (0.845 oz [ounce]) of concentrated nitric acid and one gram (0.0353 oz) of boric acid were added, heated, and finally evaporated to dryness. The residue was dissolved in 8 M (molar) nitric acid for gamma spectrometry and determinations of ^{90}Sr and alpha-emitting radionuclides.

4.2.3 Determination of Individual Radionuclides

Gamma-emitting radionuclides were measured in the air filters by gamma spectrometry. Strontium-90 and alpha-emitting radionuclides were determined by sequential separation and counting. Determination of actinides involved co-precipitation, ion exchange separation, and alpha spectrometry.

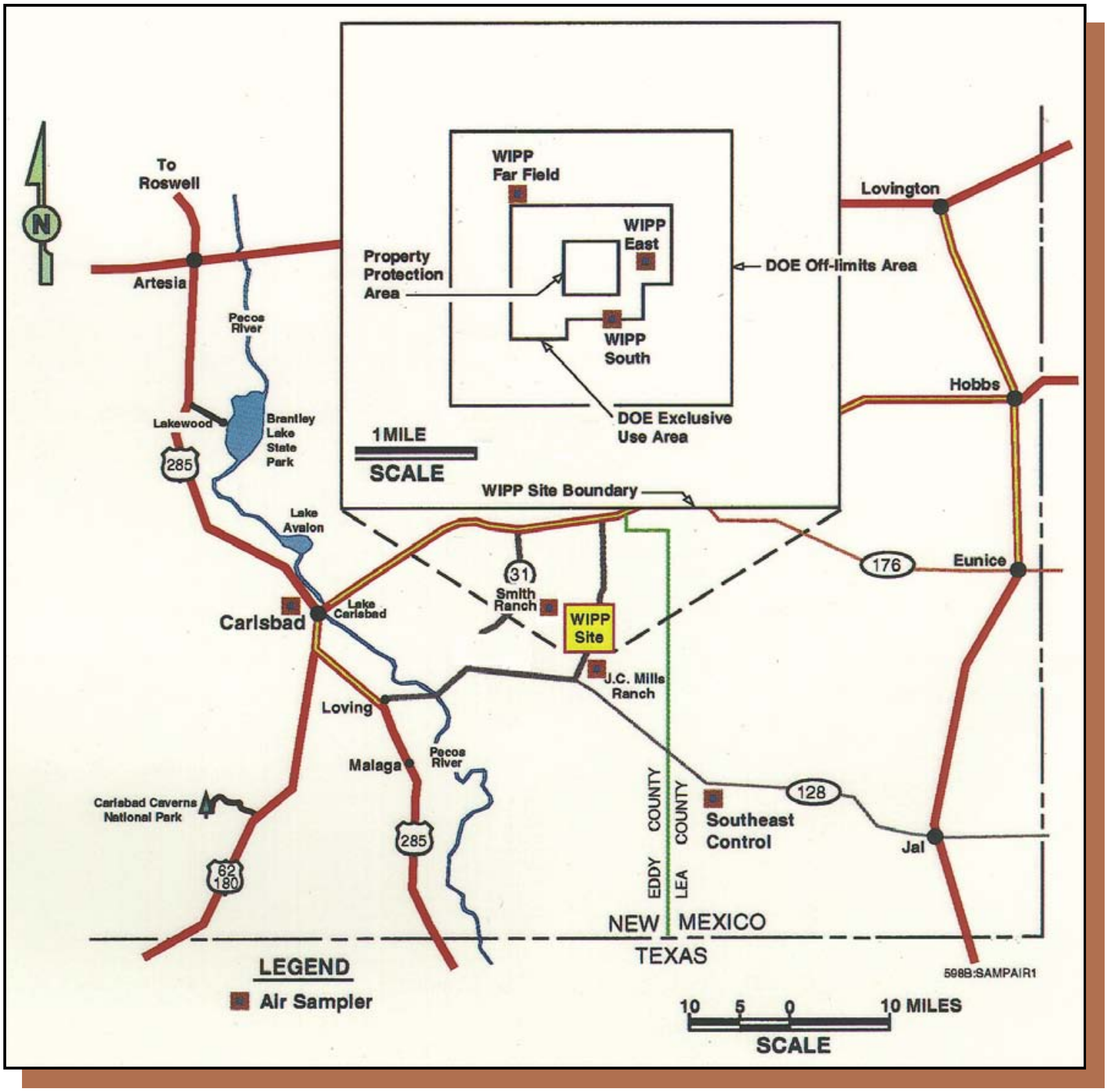

Figure 4.1 - Air Sampling Locations on and Near the WIPP Facility

4.2.4 Results and Discussion

The minimum, maximum, and average concentrations for all sampling locations combined are reported in Table 4.2. Detailed data for each station are reported in Appendix G (Table G.1).

Natural uranium isotopes were detected in every composite sample (Table G.1). Whenever the word "sample" is used in this section, it should be taken to mean "composite sample" and does not include blanks. Uranium-234 was detected in every sample. Uranium-235 was detected in 75 percent of the samples. Uranium-238 was detected in all but one sample. Concentrations of ^{235}U were 1 to 2 orders of magnitude less than the concentrations of ^{234}U and ^{238}U.

Table 4.2 - Minimum, Maximum, and Average Radionuclide Concentrations (Bq/m^3) in Air Filter Composites from Stations Surrounding the WIPP Site. See Appendix E for supporting data.

Radionuclide		[RN][a]	2 X TPU[b]	MDC[c]
^{241}Am	Minimum	-1.96×10^{-8}	N/A[e]	3.74×10^{-8}
	Maximum	8.80×10^{-8}	1.14×10^{-7}	2.16×10^{-7}
	Average[d]	4.43×10^{-8}	5.56×10^{-8}	1.07×10^{-7}
^{238}Pu	Minimum	-7.16×10^{-8}	N/A[e]	4.09×10^{-8}
	Maximum	1.90×10^{-7}	2.25×10^{-7}	4.46×10^{-7}
	Average	2.94×10^{-8}	1.15×10^{-7}	1.62×10^{-7}
$^{239+240}Pu$	Minimum	-4.43×10^{-8}	N/A[e]	4.26×10^{-8}
	Maximum	2.26×10^{-7}	1.71×10^{-7}	4.65×10^{-7}
	Average	4.72×10^{-8}	1.11×10^{-7}	1.51×10^{-7}
^{234}U	Minimum	1.93×10^{-6}	4.72×10^{-7}	1.48×10^{-8}
	Maximum	3.69×10^{-6}	7.81×10^{-7}	5.52×10^{-7}
	Average	2.58×10^{-6}	8.81×10^{-7}	8.51×10^{-8}
^{235}U	Minimum	1.88×10^{-8}	4.85×10^{-8}	4.20×10^{-8}
	Maximum	4.30×10^{-7}	1.97×10^{-7}	1.82×10^{-7}
	Average	1.65×10^{-7}	1.88×10^{-7}	8.37×10^{-8}
^{238}U	Minimum	1.89×10^{-6}	4.49×10^{-7}	3.24×10^{-8}
	Maximum	3.53×10^{-6}	5.62×10^{-6}	2.13×10^{-7}
	Average	2.51×10^{-6}	7.21×10^{-7}	6.67×10^{-8}
^{40}K	Minimum	1.00×10^{-4}	1.02×10^{-4}	1.45×10^{-4}
	Maximum	7.43×10^{-4}	3.90×10^{-4}	4.30×10^{-4}
	Average	3.24×10^{-4}	3.50×10^{-4}	2.66×10^{-4}
^{60}Co	Minimum	-1.15×10^{-5}	1.69×10^{-5}	1.94×10^{-5}
	Maximum	3.97×10^{-5}	4.24×10^{-5}	4.90×10^{-5}
	Average	9.38×10^{-6}	2.34×10^{-5}	3.02×10^{-5}
^{90}Sr	Minimum	-8.20×10^{-3}	2.60×10^{-6}	4.57×10^{-6}
	Maximum	4.71×10^{-3}	6.85×10^{-3}	1.39×10^{-2}
	Average	-7.49×10^{-4}	5.20×10^{-3}	3.53×10^{-3}
^{137}Cs	Minimum	-6.85×10^{-5}	1.23×10^{-5}	1.46×10^{-5}
	Maximum	1.43×10^{-5}	4.12×10^{-5}	3.81×10^{-5}
	Average	-1.23×10^{-5}	4.71×10^{-5}	2.53×10^{-5}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Arithmetic average for concentration and MDC; average TPU equals the standard deviation of the mean.
[e] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

The activity concentration of ^{235}U in the natural environment is very low compared to the concentrations of ^{234}U and ^{238}U (1 µg of natural uranium contains 12.5 mBq [millibecquerel] [0.338 pCi] of ^{238}U, 0.582 mBq [0.0152 pCi] of ^{235}U, and 12.8 mBq

[0.346 pCi] of ^{234}U) (Rosman and Taylor, 1998); therefore, the amount of ^{235}U in air particulate samples is expected to be lower.

Concentrations of uranium isotopes were compared, using analysis of variance, to determine if they were statistically different between 2002 and 2003. No such comparisons were possible for the other isotopes because of an insufficient number of detections to allow a valid statistical analysis. There was no significant difference between concentrations of ^{238}U measured in 2002 and 2003 (ANOVA, $p = 0.245$). Concentrations of both ^{234}U and ^{235}U showed statistically significant differences between 2002 and 2003, with ^{234}U concentrations being higher in 2002 and ^{235}U concentrations being higher in 2003 (^{234}U ANOVA, $p = 0.013$; ^{235}U ANOVA, $p = 0.010$). However, concentrations of all three uranium isotopes in 2003 fell within the 99 percent confidence interval ranges of radiological baseline data covering the period from 1985 to 1989 (DOE/WIPP 92-037), suggesting that WIPP operations have not resulted in the increase of these radioisotopes in the environment.

Plutonium-238 was not detected in any LVAS samples in 2003. Plutonium-239+240 was detected at sampling locations MLR, SEC, and WEE in the first quarter and ^{241}Am was detected at location SEC in the first and third quarters (Table E.1). However, all detected concentrations for both these isotopes were extremely small and for each the MDCs fell within the total error associated with the indicated results. This, combined with the fact that the detected concentrations of $^{239+240}Pu$ and ^{241}Am fell within the 99 percent confidence interval ranges of baseline values (DOE/WIPP 92-037), indicates that WIPP operations have not resulted in the increase of environmental levels of americium or plutonium.

Concentrations of ^{40}K (Table E.1) were detected in approximately 53 percent of the samples. Potassium-40 is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. The highest concentration of ^{40}K observed (7.43×10^{-4} Bq/m^3) was somewhat higher than the baseline values (upper 99th percentile: 3.2×10^{-4} Bq/m^3). These are both extremely small concentrations. Since airborne ^{40}K is mostly due to resuspension from soils, concentrations are highly variable, and it is not surprising that some sample results are outside the range of baseline values. This, coupled with the fact that there is no ^{40}K in WIPP waste streams, suggests that the measured concentrations were not due to WIPP operations.

Neither ^{137}Cs nor ^{90}Sr were detected in any samples in 2003. Cobalt-60 was detected once in the fourth quarter at sampling location CBD at a concentration of 3.67×10^{-5} Bq/m^3 (Table E.1). It was somewhat higher than the radiological baseline values (upper 99th percentile: 2.27×10^{-5} Bq/m^3); however, there is no corroborating evidence to suggest that this activity results from WIPP operations. This value is extremely small and the MDC falls within the total error of the result.

Duplicate air particulate samples were collected by rotating the portable sampler from one location to another every quarter: WSS in the first quarter, MLR in the second quarter, SMR in the third quarter, and CBD in the fourth quarter. The samples were collected by both samplers under identical conditions at all four locations. The duplicate samples were analyzed to check the reproducibility of the data. Relative error ratios (RERs) for all duplicate pairs for which both the sample and the duplicate contained a delectable concentration of a radionuclide were calculated. These RERs are shown in Table 4.3. An RER value less than or equal to 1.0 is considered to demonstrate reproducibility. RERs were less than one, indicating good reproducibility, for all duplicates except for ^{40}K at sampling location SMR. The lack of reproducibility at this location for ^{40}K is most likely due to variations in the particle concentrations seen by the two samplers.

Table 4.3 - Results of Duplicate Composite Air Filter Sampling. Units are Bq/m^3. See Appendix C for the sampling location codes.

Location	Quarter	[RN][a]	2×TPU[b]	MDC[c]	RER[d]
				^{40}K	
SMR	3	1.83×10^{-4}	1.14×10^{-4}	1.65×10^{-4}	2.07
SMR Dup.[e]	3	1.04×10^{-3}	3.97×10^{-4}	4.61×10^{-4}	
				^{234}U	
WSS	1	2.40×10^{-6}	5.72×10^{-7}	4.90×10^{-8}	0.27
WSS Dup.	1	2.20×10^{-6}	4.90×10^{-7}	1.01×10^{-7}	
MLR	2	2.90×10^{-6}	6.26×10^{-7}	1.15×10^{-7}	0.30
MLR Dup.	2	2.62×10^{-6}	6.82×10^{-7}	2.04×10^{-7}	
SMR	3	2.72×10^{-6}	5.85×10^{-7}	1.04×10^{-7}	0.27
SMR Dup.	3	2.50×10^{-6}	5.65×10^{-7}	4.71×10^{-8}	
CBD	4	2.88×10^{-6}	5.63×10^{-7}	3.26×10^{-8}	0.10
CBD Dup.	4	2.80×10^{-6}	5.40×10^{-7}	3.25×10^{-8}	
				^{238}U	
WSS	1	2.38×10^{-6}	5.67×10^{-7}	4.88×10^{-8}	0.35
WSS Dup.	1	2.12×10^{-6}	4.75×10^{-7}	3.68×10^{-8}	
MLR	2	2.58×10^{-6}	5.70×10^{-7}	4.20×10^{-8}	0.00
MLR Dup.	2	2.58×10^{-6}	6.69×10^{-7}	5.93×10^{-8}	
SMR	3	2.46×10^{-6}	5.39×10^{-7}	3.81×10^{-8}	0.13
SMR Dup.	3	2.56×10^{-6}	5.74×10^{-7}	4.69×10^{-8}	
CBD	4	2.64×10^{-6}	5.25×10^{-7}	3.24×10^{-8}	0.03
CBD Dup.	4	2.66×10^{-6}	5.20×10^{-7}	1.04×10^{-7}	

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

4.3 Groundwater

4.3.1 Sample Collection

Groundwater samples were collected twice in 2003 from seven different wells around the WIPP site as shown in Figure 6.1. Six of these wells are completed in the Culebra Member of the Rustler Formation (wells WQSP-1 through WQSP-6) and the seventh (well WQSP-6A) is completed in the Dewey Lake Redbeds Formation. Approximately three bore volumes (approximately 3,800 liters [1,004 gallons]) of water were pumped out of each well before collecting approximately 38 liters (10 gallons) of water samples. The water samples were collected from depths ranging from 180-270 m (591-886 ft) from six wells (WQSP-1 to WQSP-6), and from a depth of 69 m (226 ft) from WQSP-6A. Approximately 8 liters (2 gallons) of water were sent to the laboratory for the determination of radionuclides of interest. The rest of the samples were used to analyze for nonradiological parameters or were put into storage. The radiological samples were acidified to pH $\leq$ 2 by titrating with concentrated nitric acid.

4.3.2 Sample Preparation

Groundwater sample containers were shaken to distribute suspended material evenly, and the aliquot was measured into a glass beaker. Tracers (^{232}U, ^{243}Am, and ^{242}Pu) and carriers (strontium nitrate and barium nitrate) were added and the sample was then digested using concentrated nitric acid and hydrofluoric acid. The sample was then heated to dryness and wet ashed using concentrated nitric acid and hydrogen peroxide. Finally, the sample was heated to dryness again and the isotopic separation process was initiated.

4.3.3 Determination of Individual Radionuclides

The acidified water samples were used for the determination of the gamma-emitting radionuclides ^{40}K, ^{60}Co, and ^{137}Cs, by gamma spectrometry. An aliquot of approximately 0.5 liters (16.9 oz) was used for the determination of ^{90}Sr by proportional counting. Another aliquot was used for the sequential determinations of the uranium isotopes, the plutonium isotopes, and ^{241}Am by alpha spectrometry. Preparation of these samples for counting involved the co-precipitation of the actinides with an iron carrier, ion exchange chromatographic separation of individual radionuclides, and source preparation by micro-precipitation.

4.3.4 Results and Discussion

Isotopes of naturally occurring uranium were detected in every well in 2003 (Table 4.4). The concentrations of uranium isotopes were compared between 2002 and 2003 and also among sampling locations using ANOVA. Although significant variability was observed among sampling locations, there was no significant difference in the concentrations of uranium isotopes between 2002 and 2003 (ANOVA, ^{234}U $p = 0.798$, ^{235}U $p = 0.081$, ^{238}U $p = 0.856$). Variability among sampling locations is expected since natural uranium in the earth's crust varies widely and this variation is reflected in the amounts of uranium dissolved into groundwater. What is important is that there were no statistically significant increases in the levels of uranium isotopes between 2002 and 2003, indicating that WIPP operations in the current reporting year have not resulted in the release of any of these radioisotopes.

Concentrations of uranium isotopes were also compared with baseline levels observed between 1985 and 1989. Both ^{234}U and ^{238}U were within the 99 percent confidence interval ranges of baseline levels (DOE/WIPP 92-037). The four highest concentrations of ^{235}U observed (highest value: 0.082 Bq/L) were somewhat higher than baseline values (upper 99th percentile = 0.031 Bq/L). However, these are both extremely small concentrations and no increase was observed between the years 2002 and 2003. Therefore, it is concluded that WIPP operation has not resulted in changes in the radiological background in the vicinity of the WIPP site.

Plutonium-238, $^{239+240}$Pu, and ^{241}Am were also analyzed in these groundwater samples (Table 4.4). Plutonium-239+240 was not detected in any of the wells. Plutonium-238 was detected in one sample (Sampling Round 17 from well WQSP-3) at a concentration of 1.29×10^{-3} Bq/L and ^{241}Am was detected in one sample (Sampling Round 16 from well WQSP-1) at a concentration of 1.31×10^{-3} Bq/L. However, these levels are both small and the MDCs for both fall within the total error associated with the indicated results (Table 4.4). Since ^{238}Pu and ^{241}Am were only detected in one sample each, there were insufficient data for ANOVA comparisons between years or among locations.

The detected concentration of ^{238}Pu was compared to baseline levels. Results of this comparison showed that the ^{238}Pu concentration fell within the 99 percent confidence interval ranges of the baseline covering the period from 1985 to 1989 (DOE/WIPP 92-037). No such comparison was available for ^{241}Am since it was not analyzed for in baseline ground water samples.

As discussed in the 2000 annual SER (DOE/WIPP 01-2225, *Waste Isolation Pilot Plant 2000 Site Environmental Report*), groundwater results from wells WQSP-1, WQSP-3, and WQSP-4 showed a pattern of activity above the MDC for ^{238}Pu and ^{241}Am. To help explain why these concentrations are apparently above background, WIPP began analyzing groundwater for ^{226}Ra and ^{228}Ra during the fall sampling of 2000 and these analyses have continued through the present reporting year (2003). Radium-226 was detected in 100 percent of the samples except for well WQSP-6A in 2003 (Table 4.4). It should be noted that the highest concentrations were observed in wells WQSP-1, WQSP-3, and WQSP-4, as has been found previously. The samples in which ^{241}Am and ^{238}Pu were detected came from wells WQSP-1 and WQSP-3 respectively.

Relating the radium levels detected in these wells to the ^{241}Am and ^{238}Pu results may help explain why these two isotopes were apparently detected when there are no other indications that these radioisotopes have been released as a result of WIPP operations. One decay product of ^{226}Ra, ^{222}Rn, emits alpha particles with an energy of 5.489 MeV (million electron volts), very close to the most abundant alpha energy of ^{241}Am (5.486 MeV) and ^{238}Pu (5.499 MeV). Because these energies are close, the region of interest in the alpha spectrum from the groundwater samples likely contained counts originating from ^{222}Rn that could have been identified as ^{238}Pu or ^{241}Am. Additional ^{226}Ra progeny were also likely present. The solubility of the components can vary, causing the ^{222}Rn activity and associated ^{226}Ra progeny to appear in some analyses, but not all. This phenomenon may explain the apparent detection of ^{238}Pu and ^{241}Am in some groundwater samples over time.

Cesium-137 was the only one of the fission products detected in any of the samples. It was detected only once, in Sampling Round 16 in well WQSP-6 at a concentration of 3.08×10^{-1} Bq/L. However, this concentration is very close to the MDC and the MDC falls within the total error associated with the result (Table 4.4). Based on observations during the baseline program from the Project Gnome site, it is not surprising that fission products may occasionally be detected. There is no information or additional data to indicate that any release of ^{137}Cs has occurred as a result of WIPP operations. Neither ^{60}Co nor ^{90}Sr were detected in any of the samples. Comparison of the detected ^{137}Cs concentration with baseline data show that it fell within the 99 percent confidence interval ranges of the baseline concentrations (DOE/WIPP 92-037).

Potassium-40 was detected in all samples except for samples taken from well WQSP-6A (Table 4.4). Potassium is ubiquitous throughout the earth's crust. The levels are higher than average in these sampling wells due to the extremely briny nature of the Culebra water and its proximity to the Salado formation, resulting in a high level of dissolved potassium salts. Even so, the concentrations of ^{40}K observed during this reporting year fall within the 99 percent confidence interval range of the baseline concentrations. There was no significant difference in ^{40}K concentrations between 2002 and 2003 (ANOVA p=0.918).

Table 4.4 - Radionuclide Concentrations (Bq/L) in Groundwater from Wells at the WIPP Site. See Chapter 6 for the sampling locations.

Location	Sampling Round	[RN][a]	2 x TPU[b]	MDC[c]	[RN]	2 x TPU	MDC	[RN]	2 x TPU	MDC
			^{241}Am			^{238}Pu			$^{239+240}$Pu	
WQSP-1	16	1.31×10^{-3}	1.10×10^{-3}	5.92×10^{-4}	5.27×10^{-4}	6.15×10^{-4}	4.75×10^{-4}	1.75×10^{-4}	3.52×10^{-4}	4.75×10^{-4}
	17	2.87×10^{-4}	4.08×10^{-4}	3.88×10^{-4}	0.00×10^{0}	N/A[d]	4.86×10^{-4}	0.00×10^{0}	N/A[d]	1.32×10^{-3}
WQSP-2	16	1.89×10^{-4}	8.47×10^{-4}	1.76×10^{-3}	0.00×10^{0}	N/A[d]	1.52×10^{-3}	0.00×10^{0}	N/A[d]	1.52×10^{-3}
	17	0.00×10^{0}	N/A[d]	7.25×10^{-4}	4.05×10^{-4}	5.77×10^{-4}	5.47×10^{-4}	0.00×10^{0}	N/A[d]	5.47×10^{-4}
WQSP-3	16	1.86×10^{-4}	6.47×10^{-4}	1.37×10^{-3}	7.07×10^{-4}	8.28×10^{-4}	6.37×10^{-4}	0.00×10^{0}	N/A[d]	6.37×10^{-4}
	17	0.00×10^{0}	N/A[d]	2.14×10^{-3}	1.29×10^{-3}	1.18×10^{-3}	6.97×10^{-4}	5.15×10^{-4}	7.35×10^{-4}	6.97×10^{-4}
WQSP-4	16	2.61×10^{-4}	5.25×10^{-4}	9.63×10^{-4}	1.30×10^{-4}	2.60×10^{-4}	3.51×10^{-4}	0.00×10^{0}	N/A[d]	3.51×10^{-4}
	17	0.00×10^{0}	N/A[d]	1.08×10^{-3}	6.09×10^{-4}	7.38×10^{-4}	1.13×10^{-3}	2.43×10^{-4}	3.46×10^{-4}	3.30×10^{-4}
WQSP-5	16	4.57×10^{-4}	4.63×10^{-4}	3.09×10^{-4}	3.13×10^{-4}	3.65×10^{-4}	2.82×10^{-4}	1.04×10^{-4}	2.09×10^{-4}	2.82×10^{-4}
	17	6.26×10^{-4}	6.35×10^{-4}	4.24×10^{-4}	3.23×10^{-4}	4.60×10^{-4}	4.36×10^{-4}	1.61×10^{-4}	3.23×10^{-4}	4.36×10^{-4}
WQSP-6	16	2.56×10^{-4}	5.14×10^{-4}	9.44×10^{-4}	1.04×10^{-4}	3.61×10^{-4}	7.66×10^{-4}	1.04×10^{-4}	2.09×10^{-4}	2.82×10^{-4}
	17	4.17×10^{-4}	5.95×10^{-4}	5.65×10^{-4}	5.42×10^{-4}	6.70×10^{-4}	9.98×10^{-4}	0.00×10^{0}	N/A[d]	3.67×10^{-4}
WQSP-6A	16	6.32×10^{-4}	9.49×10^{-4}	1.55×10^{-3}	0.00×10^{0}	N/A[d]	3.63×10^{-4}	1.34×10^{-4}	2.69×10^{-4}	3.63×10^{-4}
	17	1.58×10^{-4}	5.48×10^{-4}	1.16×10^{-3}	-1.19×10^{-4}	4.12×10^{-4}	1.10×10^{-3}	1.19×10^{-4}	2.38×10^{-4}	3.22×10^{-4}
			^{234}U			^{235}U			^{238}U	
WQSP-1	16	1.30×10^{0}	3.69×10^{-1}	2.89×10^{-3}	8.21×10^{-2}	2.77×10^{-2}	1.93×10^{-3}	2.42×10^{-1}	7.19×10^{-2}	1.56×10^{-3}
	17	1.17×10^{0}	1.81×10^{-1}	8.64×10^{-4}	2.23×10^{-2}	4.95×10^{-3}	3.92×10^{-4}	2.02×10^{-1}	3.25×10^{-2}	8.60×10^{-4}
WQSP-2	16	9.43×10^{-1}	2.48×10^{-1}	2.40×10^{-3}	6.30×10^{-2}	2.04×10^{-2}	1.61×10^{-3}	1.55×10^{-1}	4.38×10^{-2}	1.30×10^{-3}
	17	1.07×10^{0}	1.84×10^{-1}	3.79×10^{-4}	7.74×10^{-2}	1.50×10^{-2}	4.68×10^{-4}	1.75×10^{-1}	3.13×10^{-2}	3.78×10^{-4}
WQSP-3	16	2.64×10^{-1}	5.39×10^{-2}	5.57×10^{-4}	1.47×10^{-2}	4.82×10^{-3}	6.87×10^{-4}	4.46×10^{-2}	1.07×10^{-2}	1.51×10^{-3}
	17	2.27×10^{-1}	4.78×10^{-2}	1.94×10^{-3}	2.32×10^{-3}	1.61×10^{-3}	6.98×10^{-4}	3.37×10^{-2}	8.61×10^{-3}	5.63×10^{-4}
WQSP-4	16	5.04×10^{-1}	8.88×10^{-2}	3.97×10^{-4}	9.03×10^{-3}	3.00×10^{-3}	4.90×10^{-4}	7.63×10^{-2}	1.48×10^{-2}	3.95×10^{-4}
	17	4.40×10^{-1}	1.07×10^{-1}	2.53×10^{-3}	9.32×10^{-3}	4.55×10^{-3}	1.15×10^{-3}	7.93×10^{-2}	2.15×10^{-2}	9.27×10^{-4}
WQSP-5	16	4.78×10^{-1}	8.09×10^{-2}	3.15×10^{-4}	3.16×10^{-2}	6.76×10^{-3}	3.89×10^{-4}	7.47×10^{-2}	1.38×10^{-2}	8.53×10^{-4}
	17	5.80×10^{-1}	9.47×10^{-2}	3.42×10^{-4}	1.32×10^{-2}	3.57×10^{-3}	4.22×10^{-4}	8.30×10^{-2}	1.48×10^{-2}	3.41×10^{-4}
WQSP-6	16	4.94×10^{-1}	8.79×10^{-2}	1.03×10^{-3}	3.94×10^{-2}	8.64×10^{-3}	4.67×10^{-4}	7.61×10^{-2}	1.48×10^{-2}	3.77×10^{-4}
	17	5.07×10^{-1}	8.27×10^{-2}	2.93×10^{-4}	5.73×10^{-3}	1.97×10^{-3}	3.61×10^{-4}	6.95×10^{-2}	1.24×10^{-2}	2.91×10^{-4}
WQSP-6A	16	2.22×10^{-1}	3.69×10^{-2}	9.20×10^{-4}	8.01×10^{-3}	2.56×10^{-3}	4.17×10^{-4}	1.18×10^{-1}	2.03×10^{-2}	3.37×10^{-4}
	17	2.07×10^{-1}	3.53×10^{-2}	8.78×10^{-4}	6.61×10^{-3}	2.25×10^{-3}	3.98×10^{-4}	1.17×10^{-1}	2.06×10^{-2}	8.74×10^{-4}

Table 4.4 - Radionuclide Concentrations (Bq/L) in Groundwater from Wells at the WIPP Site. See Chapter 6 for the sampling locations.

Location	Sampling Round	[RN][a]	2 x TPU[b]	MDC[c]	[RN]	2 x TPU	MDC	[RN]	2 x TPU	MDC
		^{137}Cs			^{60}Co			^{40}K		
WQSP-1	16	1.20×10^{-1}	3.47×10^{-1}	3.98×10^{-1}	7.21×10^{-2}	3.63×10^{-1}	4.28×10^{-1}	1.46×10^{1}	3.85×10^{0}	4.17×10^{0}
	17	4.79×10^{-2}	3.50×10^{-1}	3.83×10^{-1}	1.15×10^{-1}	4.00×10^{-1}	4.70×10^{-1}	1.79×10^{1}	4.57×10^{0}	4.35×10^{0}
WQSP-2	16	1.55×10^{-1}	2.38×10^{-1}	2.90×10^{-1}	1.39×10^{-1}	2.80×10^{-1}	3.34×10^{-1}	1.69×10^{1}	3.55×10^{0}	3.14×10^{0}
	17	-7.79×10^{-2}	5.23×10^{-1}	5.51×10^{-1}	-1.02×10^{-1}	5.48×10^{-1}	5.94×10^{-1}	1.79×10^{1}	5.21×10^{0}	6.31×10^{0}
WQSP-3	16	2.37×10^{-1}	2.39×10^{-1}	2.95×10^{-1}	1.12×10^{-1}	3.19×10^{-1}	3.72×10^{-1}	4.96×10^{1}	7.71×10^{0}	3.19×10^{0}
	17	2.85×10^{-1}	3.52×10^{-1}	3.98×10^{-1}	-1.30×10^{-3}	3.93×10^{-1}	4.49×10^{-1}	5.00×10^{1}	9.38×10^{0}	4.71×10^{0}
WQSP-4	16	3.50×10^{-1}	3.58×10^{-1}	4.20×10^{-1}	-1.41×10^{-2}	4.22×10^{-1}	4.82×10^{-1}	2.60×10^{1}	5.20×10^{0}	3.51×10^{0}
	17	-7.53×10^{-2}	3.65×10^{-1}	3.87×10^{-1}	3.37×10^{-1}	4.00×10^{-1}	4.84×10^{-1}	2.29×10^{1}	5.26×10^{0}	4.33×10^{0}
WQSP-5	16	1.68×10^{-1}	3.26×10^{-1}	3.77×10^{-1}	1.66×10^{-4}	3.91×10^{-1}	4.51×10^{-1}	1.11×10^{1}	3.10×10^{0}	3.31×10^{0}
	17	-5.33×10^{-1}	5.46×10^{-1}	5.38×10^{-1}	4.58×10^{-1}	5.08×10^{-1}	5.81×10^{-1}	9.74×10^{0}	4.14×10^{0}	5.81×10^{0}
WQSP-6	16	3.08×10^{-1}	2.17×10^{-1}	2.74×10^{-1}	-8.58×10^{-2}	2.99×10^{-1}	3.27×10^{-1}	4.79×10^{0}	2.37×10^{0}	3.40×10^{0}
	17	-1.04×10^{-1}	3.38×10^{-1}	3.54×10^{-1}	3.37×10^{-1}	3.45×10^{-1}	4.38×10^{-1}	7.01×10^{0}	2.49×10^{0}	2.82×10^{0}
WQSP-6A	16	5.93×10^{-2}	2.16×10^{-1}	2.59×10^{-1}	3.59×10^{-2}	2.71×10^{-1}	3.14×10^{-1}	1.25×10^{0}	2.75×10^{0}	3.28×10^{0}
	17	-5.17×10^{-1}	5.35×10^{-1}	5.27×10^{-1}	4.12×10^{-1}	4.95×10^{-1}	5.65×10^{-1}	5.45×10^{0}	5.22×10^{0}	5.81×10^{0}
		^{90}Sr			^{226}Ra			^{228}Ra		
WQSP-1	16	3.18×10^{-2}	2.42×10^{-2}	3.94×10^{-2}	6.03×10^{0}	4.10×10^{-1}	2.00×10^{-2}	1.31×10^{0}	1.10×10^{-1}	1.30×10^{-1}
	17	-1.14×10^{-2}	2.20×10^{-2}	3.81×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-2	16	-3.41×10^{-3}	2.62×10^{-2}	4.62×10^{-2}	3.58×10^{0}	2.40×10^{-1}	1.00×10^{-2}	5.31×10^{-1}	7.60×10^{-2}	1.11×10^{-1}
	17	-1.95×10^{-3}	2.22×10^{-2}	3.78×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-3	16	5.78×10^{-3}	2.51×10^{-2}	4.29×10^{-2}	8.51×10^{0}	5.70×10^{-1}	1.00×10^{-2}	1.39×10^{0}	1.10×10^{-1}	1.30×10^{-1}
	17	-1.38×10^{-2}	2.28×10^{-2}	3.98×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-4	16	-2.30×10^{-3}	1.70×10^{-2}	2.92×10^{-2}	8.51×10^{0}	5.70×10^{-1}	1.00×10^{-2}	1.39×10^{0}	1.10×10^{-1}	1.30×10^{-1}
	17	-4.56×10^{-3}	2.18×10^{-2}	3.67×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-5	16	2.04×10^{-3}	1.67×10^{-2}	2.87×10^{-2}	2.80×10^{0}	1.90×10^{-1}	1.00×10^{-2}	4.03×10^{-1}	8.30×10^{-2}	1.28×10^{-1}
	17	3.28×10^{-2}	2.44×10^{-2}	3.82×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-6	16	-1.01×10^{-3}	1.67×10^{-2}	2.84×10^{-2}	1.30×10^{0}	9.60×10^{-2}	1.50×10^{-2}	1.99×10^{-1}	7.50×10^{-2}	1.22×10^{-1}
	17	-2.92×10^{-3}	2.22×10^{-2}	3.71×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A
WQSP-6A	16	7.94×10^{-3}	1.99×10^{-2}	3.42×10^{-2}	3.00×10^{-3}	8.00×10^{-3}	1.30×10^{-2}	-1.80×10^{-2}	6.30×10^{-2}	1.08×10^{-1}
	17	-1.91×10^{-2}	2.34×10^{-2}	4.16×10^{-2}	N/A	N/A	N/A	N/A	N/A	N/A

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

Duplicate samples for all radionuclides analyzed were collected from each of the wells as a check on the reproducibility of the sampling and measurement techniques employed. RERs for all duplicate pairs for which both the sample and the duplicate contained a detectable concentration of a radionuclide were calculated. These RERs are shown in Table 4.5 for Sampling Round 16 and in Table 4.6 for Sampling Round 17. Most of the RER values were less than one, indicating no difference between duplicate samples and good reproducibility. However, six duplicates from Round 16 and five from Round 17 had RERs greater than 1, indicating poor reproducibility. All duplicates with RERs greater than 1 came from wells WQSP-2, WQSP-3, and WQSP-5, with all but one coming from WQSP-2 and WQSP-3. This is most likely due to inhomogeneities in the distributions of the associated radioisotopes within the wells.

Table 4.5 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 16. Units are Bq/L. See Chapter 6 for sampling locations.

Location	RN[a]	2 X TPU[b]	MDC[c]	RER[d]		RN[a]	TPU[b]	MDC[c]	RER[d]
		^{234}U					^{235}U		
WQSP-1	1.30×10^{0}	3.69×10^{-1}	2.89×10^{-3}	0.39	WQSP-1	8.21×10^{-2}	2.77×10^{-2}	1.93×10^{-3}	0.25
WQSP-1 D[e]	1.54×10^{0}	4.93×10^{-1}	3.62×10^{-3}		WQSP-1 D	9.30×10^{-2}	3.47×10^{-2}	2.42×10^{-3}	
WQSP-2	9.43×10^{-1}	2.48×10^{-1}	2.40×10^{-3}	0.60	WQSP-2	6.30×10^{-2}	2.04×10^{-2}	1.61×10^{-3}	1.14
WQSP-2 D	1.20×10^{0}	3.49×10^{-1}	1.74×10^{-3}		WQSP-2 D	1.20×10^{-1}	3.98×10^{-2}	2.15×10^{-3}	
WQSP-3	2.64×10^{-1}	5.39×10^{-2}	5.57×10^{-4}	4.55	WQSP-3	1.47×10^{-2}	4.82×10^{-3}	6.87×10^{-4}	4.81
WQSP-3 D	2.33×10^{-1}	4.32×10^{-2}	1.17×10^{-3}		WQSP-3 D	4.69×10^{-3}	2.16×10^{-3}	1.44×10^{-3}	
WQSP-4	5.04×10^{-1}	8.88×10^{-2}	3.97×10^{-4}	0.28	WQSP-4	9.03×10^{-3}	3.00×10^{-3}	4.90×10^{-4}	0.58
WQSP-4 D	4.71×10^{-1}	7.78×10^{-2}	3.47×10^{-4}		WQSP-4 D	6.79×10^{-3}	2.38×10^{-3}	1.16×10^{-3}	
WQSP-5	4.78×10^{-1}	8.09×10^{-2}	3.15×10^{-4}	0.80	WQSP-5	3.16×10^{-2}	6.76×10^{-3}	3.89×10^{-4}	0.74
WQSP-5 D	5.77×10^{-1}	9.44×10^{-2}	8.83×10^{-4}		WQSP-5 D	8.57×10^{-3}	2.64×10^{-3}	4.00×10^{-4}	
WQSP-6	4.94×10^{-1}	8.79×10^{-2}	1.03×10^{-3}	0.20	WQSP-6	3.94×10^{-2}	8.64×10^{-3}	4.67×10^{-4}	0.01
WQSP-6 D	5.19×10^{-1}	8.94×10^{-2}	3.66×10^{-4}		WQSP-6 D	3.77×10^{-2}	8.11×10^{-3}	4.52×10^{-4}	
WQSP-6A	2.22×10^{-1}	3.69×10^{-2}	9.20×10^{-4}	0.10	WQSP-6A	8.01×10^{-3}	2.56×10^{-3}	4.17×10^{-4}	0.51
WQSP-6A D	1.81×10^{-1}	3.05×10^{-2}	7.87×10^{-4}		WQSP-6A D	6.32×10^{-3}	2.09×10^{-3}	3.57×10^{-4}	
		^{238}U					^{40}K		
WQSP-1	2.42×10^{-1}	7.19×10^{-2}	1.56×10^{-3}	0.22	WQSP-1	1.46×10^{1}	3.85×10^{0}	4.17×10^{0}	0.83
WQSP-1 D	2.67×10^{-1}	8.93×10^{-2}	1.96×10^{-3}		WQSP-1 D	1.91×10^{1}	3.80×10^{0}	3.11×10^{0}	
WQSP-2	1.55×10^{-1}	4.38×10^{-2}	1.30×10^{-3}	0.77	WQSP-2	1.69×10^{1}	3.55×10^{0}	3.14×10^{0}	0.06
WQSP-2 D	2.16×10^{-1}	6.63×10^{-2}	1.73×10^{-3}		WQSP-2 D	1.66×10^{1}	3.38×10^{0}	2.72×10^{0}	
WQSP-3	4.46×10^{-2}	1.07×10^{-2}	1.51×10^{-3}	2.24	WQSP-3	4.96×10^{1}	7.71×10^{0}	3.19×10^{0}	0.20
WQSP-3 D	3.54×10^{-2}	7.88×10^{-3}	4.28×10^{-4}		WQSP-3 D	5.18×10^{1}	7.93×10^{0}	2.72×10^{0}	
WQSP-4	7.63×10^{-2}	1.48×10^{-2}	3.95×10^{-4}	0.27	WQSP-4	2.60×10^{1}	5.20×10^{0}	3.51×10^{0}	0.33
WQSP-4 D	8.19×10^{-2}	1.47×10^{-2}	3.45×10^{-4}		WQSP-4 D	2.37×10^{1}	4.75×10^{0}	4.26×10^{0}	
WQSP-5	7.47×10^{-2}	1.38×10^{-2}	8.53×10^{-4}	0.25	WQSP-5	1.11×10^{1}	3.10×10^{0}	3.31×10^{0}	0.76
WQSP-5 D	7.97×10^{-2}	1.43×10^{-2}	8.79×10^{-4}		WQSP-5 D	8.03×10^{0}	2.63×10^{0}	3.30×10^{0}	
WQSP-6	7.61×10^{-2}	1.48×10^{-2}	3.77×10^{-4}	0.10					
WQSP-6 D	7.71×10^{-2}	1.45×10^{-2}	3.65×10^{-4}				^{241}Am		
WQSP-6A	1.18×10^{-1}	2.03×10^{-2}	3.37×10^{-4}	0.89	WQSP-1	1.31×10^{-3}	1.10×10^{-3}	5.92×10^{-4}	0.27
WQSP-6A D	9.57×10^{-2}	1.67×10^{-2}	2.88×10^{-4}		WQSP-1 D	1.78×10^{-3}	1.39×10^{-3}	6.87×10^{-4}	

Table 4.5 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 16. Units are Bq/L. See Chapter 6 for sampling locations.

Location	RN[a]	2 X TPU[b]	MDC[c]	RER[d]		RN[a]	TPU[b]	MDC[c]	RER[d]
	^{226}Ra					^{228}Ra			
WQSP-1	6.03×10^{0}	4.10×10^{-1}	2.00×10^{-2}	0.41	WQSP-1	1.31×10^{0}	1.10×10^{-1}	1.30×10^{-1}	0.47
WQSP-1 D	5.80×10^{0}	3.90×10^{-1}	2.00×10^{-2}		WQSP-1 D	1.24×10^{0}	1.00×10^{-1}	1.20×10^{-1}	
WQSP-2	3.58×10^{0}	2.40×10^{-1}	1.00×10^{-2}	1.14	WQSP-2	5.31×10^{-1}	7.60×10^{-2}	1.11×10^{-1}	0.26
WQSP-2 D	3.99×10^{0}	2.70×10^{-1}	2.00×10^{-2}		WQSP-2 D	5.60×10^{-1}	8.40×10^{-2}	1.25×10^{-1}	
WQSP-3	8.51×10^{0}	5.70×10^{-1}	1.00×10^{-2}	1.87	WQSP-3	1.39×10^{0}	1.10×10^{-1}	1.30×10^{-1}	0.90
WQSP-3 D	7.12×10^{0}	4.80×10^{-1}	2.00×10^{-2}		WQSP-3 D	1.25×10^{0}	1.10×10^{-1}	1.30×10^{-1}	
WQSP-4	8.51×10^{0}	5.70×10^{-1}	1.00×10^{-2}	0.44	WQSP-4	1.39×10^{0}	1.10×10^{-1}	1.30×10^{-1}	0.13
WQSP-4 D	8.87×10^{0}	5.90×10^{-1}	1.00×10^{-2}		WQSP-4 D	1.37×10^{0}	1.10×10^{-1}	1.40×10^{-1}	
WQSP-5	2.80×10^{0}	1.90×10^{-1}	1.00×10^{-2}	0.84	WQSP-5	4.03×10^{-1}	8.30×10^{-2}	1.28×10^{-1}	0.55
WQSP-5 D	2.58×10^{0}	1.80×10^{-1}	1.00×10^{-2}		WQSP-5 D	3.42×10^{-1}	7.40×10^{-2}	1.15×10^{-1}	
WQSP-6	1.30×10^{0}	9.60×10^{-2}	1.50×10^{-2}	0.69	WQSP-6	1.99×10^{-1}	7.50×10^{-2}	1.22×10^{-1}	0.16
WQSP-6 D	1.21×10^{0}	8.90×10^{-2}	1.30×10^{-2}		WQSP-6 D	1.83×10^{-1}	6.80×10^{-2}	1.11×10^{-1}	

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

Table 4.6 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 17. Units are Bq/L. See Chapter 6 for sampling locations.

Location	RN[a]	TPU[b]	MDC[c]	RER[d]		RN[a]	TPU[b]	MDC[c]	RER[c]
	^{234}U					^{235}U			
WQSP-1	1.17×10^{0}	1.81×10^{-1}	8.64×10^{-4}	0.39	WQSP-1	2.23×10^{-2}	4.95×10^{-3}	3.92×10^{-4}	0.03
WQSP-1 D[e]	1.28×10^{0}	2.16×10^{-1}	3.55×10^{-4}		WQSP-1 D	2.25×10^{-2}	5.36×10^{-3}	4.38×10^{-4}	
WQSP-2	1.07×10^{0}	1.84×10^{-1}	3.79×10^{-4}	0.47	WQSP-2	7.74×10^{-2}	1.50×10^{-2}	4.68×10^{-4}	4.17
WQSP-2 D	9.56×10^{-1}	1.55×10^{-1}	2.99×10^{-4}		WQSP-2 D	1.32×10^{-2}	3.42×10^{-3}	3.69×10^{-4}	
WQSP-3	2.27×10^{-1}	4.78×10^{-2}	1.94×10^{-3}	4.88	WQSP-3	2.32×10^{-3}	1.61×10^{-3}	6.98×10^{-4}	4.71
WQSP-3 D	2.11×10^{-1}	4.00×10^{-2}	1.20×10^{-3}		WQSP-3 D	2.02×10^{-3}	1.33×10^{-3}	5.46×10^{-4}	
WQSP-4	4.40×10^{-1}	1.07×10^{-1}	2.53×10^{-3}	0.33	WQSP-4	9.32×10^{-3}	4.55×10^{-3}	1.15×10^{-3}	0.00
WQSP-4 D	4.84×10^{-1}	7.87×10^{-2}	3.15×10^{-4}		WQSP-4 D	9.33×10^{-3}	2.75×10^{-3}	3.89×10^{-4}	
WQSP-5	5.80×10^{-1}	9.47×10^{-2}	3.42×10^{-4}	0.41	WQSP-5	1.32×10^{-2}	3.57×10^{-3}	4.22×10^{-4}	1.15
WQSP-5 D	5.27×10^{-1}	8.58×10^{-2}	2.95×10^{-4}		WQSP-5 D	8.20×10^{-3}	2.48×10^{-3}	3.64×10^{-4}	
WQSP-6	5.07×10^{-1}	8.27×10^{-2}	2.93×10^{-4}	0.21	WQSP-6	5.73×10^{-3}	1.97×10^{-3}	3.61×10^{-4}	0.15
WQSP-6 D	4.82×10^{-1}	8.78×10^{-2}	1.46×10^{-3}		WQSP-6 D	6.21×10^{-3}	2.46×10^{-3}	5.26×10^{-4}	
WQSP-6A	2.07×10^{-1}	3.53×10^{-2}	8.78×10^{-4}	0.12	WQSP-6A	6.61×10^{-3}	2.25×10^{-3}	3.98×10^{-4}	0.28
WQSP-6A D	2.01×10^{-1}	3.29×10^{-2}	2.83×10^{-4}		WQSP-6A D	5.79×10^{-3}	1.95×10^{-3}	3.49×10^{-4}	

Table 4.6 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 17. Units are Bq/L. See Chapter 6 for sampling locations.

Location	RN[a]	TPU[b]	MDC[c]	RER[d]	RN[a]	TPU[b]	MDC[c]	RER[c]
	^{238}U							
WQSP-1	2.02×10^{-1}	3.25×10^{-2}	8.60×10^{-4}	0.04				
WQSP-1 D	2.04×10^{-1}	3.59×10^{-2}	3.54×10^{-4}					
WQSP-2	1.75×10^{-1}	3.13×10^{-2}	3.78×10^{-4}	0.50				
WQSP-2 D	1.55×10^{-1}	2.62×10^{-2}	2.98×10^{-4}					
WQSP-3	3.37×10^{-2}	8.61×10^{-3}	5.63×10^{-4}	4.01				
WQSP-3 D	3.40×10^{-2}	7.74×10^{-3}	4.41×10^{-4}					
WQSP-4	7.93×10^{-2}	2.15×10^{-2}	9.27×10^{-4}	0.02				
WQSP-4 D	7.99×10^{-2}	1.41×10^{-2}	3.14×10^{-4}					
WQSP-5	8.30×10^{-2}	1.48×10^{-2}	3.41×10^{-4}	0.24				
WQSP-5 D	7.81×10^{-2}	1.38×10^{-2}	2.94×10^{-4}					
WQSP-6	6.95×10^{-2}	1.24×10^{-2}	2.91×10^{-4}	0.04				
WQSP-6 D	7.03×10^{-2}	1.42×10^{-2}	4.24×10^{-4}					
WQSP-6A	1.17×10^{-1}	2.06×10^{-2}	8.74×10^{-4}	0.44				
WQSP-6A D	1.05×10^{-1}	1.78×10^{-2}	2.81×10^{-4}					

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

4.4 Surface Water

4.4.1 Sample Collection

Surface water samples were collected from various locations around the WIPP site, as shown in Figure 4.2 (see Appendix C for location codes). If a particular surface water collection location was dry, only the sediment was collected. Sediment results are described in Section 4.5.

Water from the sampling location was used to rinse 3.78-L (1-gallon) polyethylene containers at least three times. Approximately 3.78 L (1 gallon) of water was collected from each location. The samples were acidified immediately after collection with concentrated nitric acid to pH $\leq$ 2. Later, the samples were transferred to the WIPP Laboratories for analysis. Chain of custody was maintained throughout the process.

4.4.2 Sample Preparation

Surface water sample containers were shaken to distribute suspended material evenly, and the aliquot was measured into a glass beaker. Tracers (^{232}U, ^{243}Am, and ^{242}Pu) and carriers (strontium nitrate and barium nitrate) were added and the sample was then digested using concentrated nitric acid and hydrofluoric acid. The sample was then heated to dryness and wet ashed using concentrated nitric acid and hydrogen peroxide. Finally, the sample was heated to dryness again and the isotopic separation process was initiated.

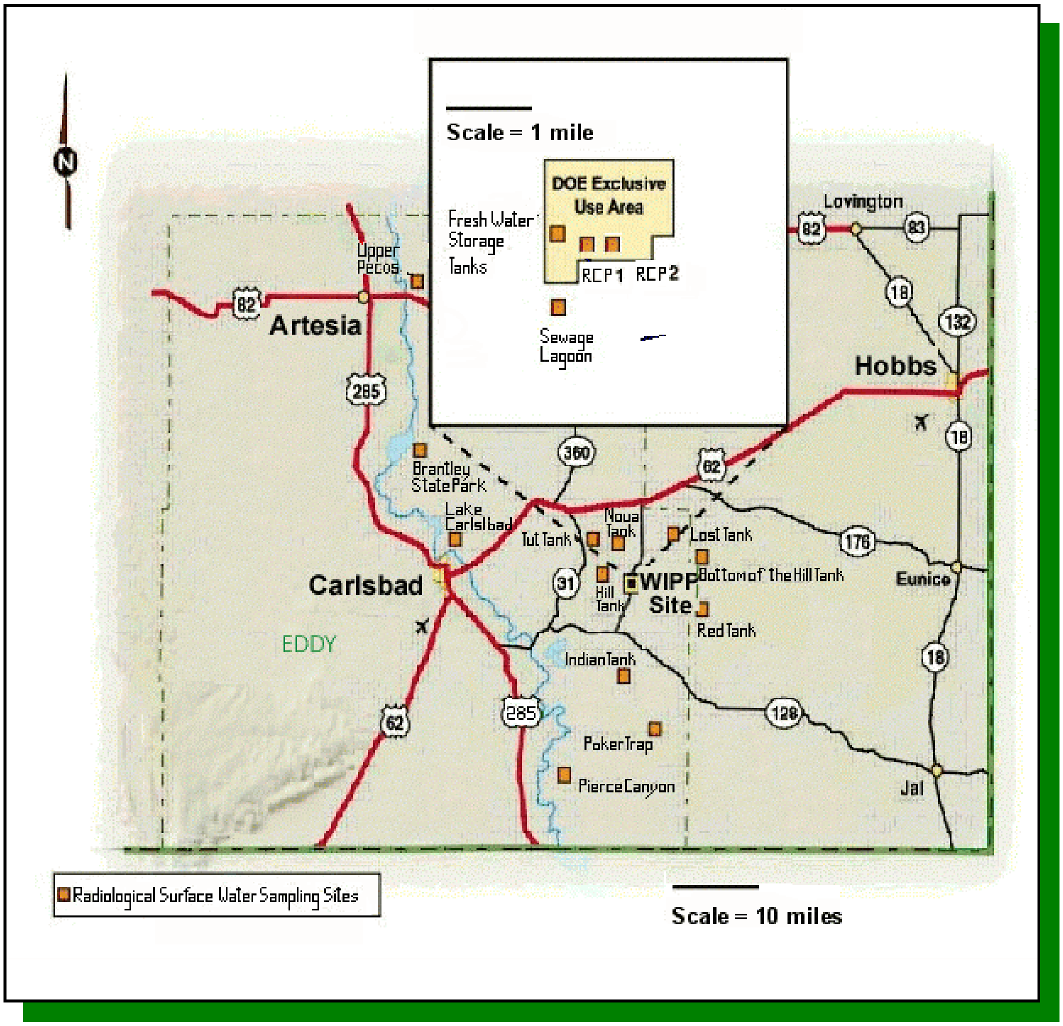

Figure 4.2 - Routine Surface Water Sampling Locations

4.4.3 Determination of Individual Radionuclides

Gamma-spectrometry was used for the determination of ^{40}K, ^{60}Co, and ^{137}Cs. Strontium-90, a beta-emitting radionuclide, was determined by chemical separation and counting using a gas proportional counter. Uranium, plutonium, and americium were determined by alpha spectrometry. These alpha-emitting radionuclides were separated from the bulk of water samples by co-precipitation with an iron carrier. Ion-exchange chromatography was used for the separation of individual radionuclides.

4.4.4 Results and Discussion

Isotopes of natural uranium (^{234}U and ^{238}U) were detected in all samples of surface water except COW (Table 4.7). Uranium-235 was detected in all samples except BHT, COW, RCP1, and SWL. The concentrations of uranium isotopes were compared between 2002 and 2003 and also among sampling locations using ANOVA for those sites sampled in both years. ANOVA results showed a statistically significant difference among sampling locations for ^{234}U (p=0.014), but no significant difference between 2002 and 2003 (p=0.577) at the 99 percent confidence level. Results for ^{235}U and ^{238}U showed no statistically significant difference among sampling locations (^{235}U p=0.364, ^{238}U p=0.351) or between 2002 and 2003 (^{235}U p=0.253, ^{238}U p=0.477). Variability among sampling locations is not surprising since the amount of natural uranium in the earth's crust can vary by location, and this variation is reflected in the amounts of uranium dissolved into groundwater. WIPP operations in the current reporting year have not resulted in the release of any of these radioisotopes.

Table 4.7 - Uranium Concentrations (Bq/L) in Surface Water Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{234}U			^{235}U			^{238}U		
BHT	1.15×10^{-2}	2.99×10^{-3}	3.24×10^{-4}	4.42×10^{-4}	5.16×10^{-4}	3.99×10^{-4}	6.07×10^{-3}	1.99×10^{-3}	8.77×10^{-4}
BRA	1.17×10^{-1}	2.22×10^{-2}	1.55×10^{-3}	3.08×10^{-3}	1.68×10^{-3}	5.56×10^{-4}	5.88×10^{-2}	1.20×10^{-2}	4.49×10^{-4}
CBD	1.18×10^{-1}	2.30×10^{-2}	4.61×10^{-4}	2.73×10^{-3}	1.59×10^{-3}	5.69×10^{-4}	6.40×10^{-2}	1.32×10^{-2}	4.59×10^{-4}
COW	3.37×10^{-4}	3.93×10^{-4}	3.04×10^{-4}	-1.39×10^{-4}	2.78×10^{-4}	1.02×10^{-3}	4.47×10^{-4}	4.53×10^{-4}	3.03×10^{-4}
FWT	4.36×10^{-2}	9.07×10^{-3}	1.08×10^{-3}	3.78×10^{-3}	1.77×10^{-3}	4.88×10^{-4}	1.45×10^{-2}	3.84×10^{-3}	3.94×10^{-4}
HIL	2.89×10^{-2}	5.98×10^{-3}	3.21×10^{-4}	1.32×10^{-3}	9.93×10^{-4}	1.08×10^{-3}	2.31×10^{-2}	5.00×10^{-3}	3.20×10^{-4}
IDN	2.50×10^{-1}	4.46×10^{-2}	4.10×10^{-4}	1.31×10^{-2}	3.84×10^{-3}	5.05×10^{-4}	2.66×10^{-1}	4.74×10^{-2}	4.08×10^{-4}
NOY	2.66×10^{-2}	5.53×10^{-3}	3.30×10^{-4}	1.05×10^{-3}	8.11×10^{-4}	4.07×10^{-4}	2.64×10^{-2}	5.50×10^{-3}	8.93×10^{-4}
PCN	2.15×10^{-1}	3.62×10^{-2}	8.83×10^{-4}	4.88×10^{-3}	1.87×10^{-3}	4.01×10^{-4}	9.90×10^{-2}	1.75×10^{-2}	3.23×10^{-4}
PKT	4.02×10^{-2}	7.71×10^{-3}	8.76×10^{-4}	1.91×10^{-3}	1.10×10^{-3}	3.97×10^{-4}	3.54×10^{-2}	6.93×10^{-3}	8.72×10^{-4}
RCP1	4.80×10^{-3}	2.12×10^{-3}	1.59×10^{-3}	6.34×10^{-4}	7.42×10^{-4}	5.73×10^{-4}	6.32×10^{-3}	2.37×10^{-3}	4.63×10^{-4}
RCP2	2.54×10^{-2}	5.18×10^{-3}	3.03×10^{-4}	9.67×10^{-4}	7.46×10^{-4}	3.74×10^{-4}	1.62×10^{-2}	3.67×10^{-3}	3.02×10^{-4}
RED	2.65×10^{-2}	5.23×10^{-3}	7.84×10^{-4}	1.05×10^{-3}	7.59×10^{-4}	3.56×10^{-4}	2.56×10^{-2}	5.08×10^{-3}	2.87×10^{-4}
SWL	8.32×10^{-2}	1.95×10^{-2}	6.79×10^{-4}	9.28×10^{-4}	1.09×10^{-3}	8.38×10^{-4}	3.24×10^{-2}	8.84×10^{-3}	1.84×10^{-3}
TUT	1.11×10^{-2}	3.15×10^{-3}	3.97×10^{-4}	2.35×10^{-3}	1.36×10^{-3}	4.89×10^{-4}	7.43×10^{-3}	2.42×10^{-3}	3.95×10^{-4}
UPR	1.59×10^{-1}	2.79×10^{-2}	3.55×10^{-4}	8.23×10^{-3}	2.72×10^{-3}	1.19×10^{-3}	7.49×10^{-2}	1.39×10^{-2}	3.53×10^{-4}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Concentrations of uranium isotopes were also compared with baseline levels observed between 1985 and 1989 (DOE/WIPP 92-037). The highest concentrations for tanks and tank-like structures for all three uranium isotopes exceeded the 99 percent confidence interval ranges of baseline levels. However, these were still extremely small concentrations, ranging from 0.01 to 0.27 Bq/L, and when taken together with the fact that no increases were observed between the years 2002 and 2003, indications are that WIPP operation has not resulted in changes in the radiological background in the vicinity of the WIPP site. The highest concentrations of all three uranium isotopes for samples taken from the Pecos River and associated bodies of water fell within the 99 percent confidence interval ranges of baseline levels.

These water samples were also analyzed for ^{238}Pu, $^{239+240}$Pu, and ^{241}Am (Table 4.8). Plutonium-238 was not detected at any of the sampling locations. Plutonium-239 was detected at two locations (IDN and NOY) at concentrations of 3.01×10^{-3} Bq/L and 7.74×10^{-4} Bq/L respectively. Americium-241 was detected at one location (FWT) at a concentration of 5.85×10^{-4} Bq/L. However, these are all extremely small concentrations and the MDCs for all three fall within the total error associated with the indicated results (Table 4.8). Due to the lack of a sufficient number of samples meeting the criteria for detection for these three isotopes, ANOVA comparisons between years and among locations were not performed.

The detected concentrations of $^{239+240}$Pu fell within the 99 percent confidence interval ranges of the baseline values (7.70×10^{-3} Bq/L). No such comparison was possible for ^{241}Am since it was not analyzed for in baseline surface water samples.

Table 4.8 - Americium and Plutonium Concentrations (Bq/L) in Surface Water Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}$Pu		
BHT	-1.19×10^{-4}	-5.34×10^{-4}	1.29×10^{-3}	0.00×10^{0}	N/A[d]	8.77×10^{-4}	0.00×10^{0}	N/A[d]	3.23×10^{-4}
BRA	5.47×10^{-4}	9.52×10^{-4}	1.64×10^{-3}	2.10×10^{-4}	4.22×10^{-4}	5.68×10^{-4}	-2.10×10^{-4}	4.21×10^{-4}	1.54×10^{-3}
CBD	0.00×10^{0}	N/A[d]	3.61×10^{-4}	4.42×10^{-4}	5.16×10^{-4}	3.99×10^{-4}	2.94×10^{-4}	4.19×10^{-4}	3.99×10^{-4}
COW	0.00×10^{0}	N/A[d]	1.37×10^{-3}	0.00×10^{0}	N/A[d]	9.18×10^{-4}	0.00×10^{0}	N/A[d]	9.18×10^{-4}
FWT	5.85×10^{-4}	5.31×10^{-4}	3.17×10^{-4}	1.28×10^{-4}	2.57×10^{-4}	3.46×10^{-4}	-1.28×10^{-4}	2.56×10^{-4}	9.41×10^{-4}
HIL	7.63×10^{-4}	1.03×10^{-3}	1.67×10^{-3}	1.76×10^{-4}	3.53×10^{-4}	4.75×10^{-4}	3.50×10^{-4}	4.99×10^{-4}	4.75×10^{-4}
IDN	1.31×10^{-3}	1.34×10^{-3}	8.86×10^{-4}	4.64×10^{-4}	6.62×10^{-4}	6.26×10^{-4}	3.01×10^{-3}	1.89×10^{-3}	1.70×10^{-3}
NOY	2.90×10^{-4}	4.13×10^{-4}	3.93×10^{-4}	3.88×10^{-4}	4.53×10^{-4}	3.50×10^{-4}	7.74×10^{-4}	6.44×10^{-4}	3.50×10^{-4}
PCN	1.58×10^{-4}	5.47×10^{-4}	1.16×10^{-3}	0.00×10^{0}	N/A[d]	8.99×10^{-4}	4.88×10^{-4}	4.94×10^{-4}	3.31×10^{-4}
PKT	3.79×10^{-4}	5.69×10^{-4}	9.31×10^{-4}	1.13×10^{-4}	3.93×10^{-4}	8.34×10^{-4}	4.52×10^{-4}	5.59×10^{-4}	8.34×10^{-4}
RCP1	0.00×10^{0}	N/A[d]	1.27×10^{-3}	1.64×10^{-4}	3.30×10^{-4}	4.43×10^{-4}	0.00×10^{0}	N/A[d]	4.43×10^{-4}
RCP2	3.63×10^{-4}	5.44×10^{-4}	8.90×10^{-4}	5.29×10^{-4}	6.18×10^{-4}	4.77×10^{-4}	-1.76×10^{-4}	3.53×10^{-4}	1.30×10^{-3}
RED	3.28×10^{-4}	3.82×10^{-4}	2.96×10^{-4}	2.76×10^{-4}	3.93×10^{-4}	3.74×10^{-4}	1.38×10^{-4}	2.77×10^{-4}	3.74×10^{-4}
SWL	0.00×10^{0}	N/A[d]	1.24×10^{-3}	0.00×10^{0}	N/A[d]	1.01×10^{-3}	1.37×10^{-4}	2.75×10^{-4}	3.72×10^{-4}
TUT	1.64×10^{-4}	3.29×10^{-4}	4.44×10^{-4}	2.27×10^{-4}	4.56×10^{-4}	8.35×10^{-4}	0.00×10^{0}	N/A[d]	3.07×10^{-4}
UPR	-2.58×10^{-4}	6.33×10^{-4}	1.55×10^{-3}	1.37×10^{-4}	4.75×10^{-4}	1.01×10^{-3}	2.73×10^{-4}	3.89×10^{-4}	3.70×10^{-4}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

Neither ^{137}Cs nor ^{90}Sr were detected in any of the samples. Cobalt-60 was detected only once at location UPR at a concentration of 6.13×10^{-1} Bq/L. This concentration is very close to the MDC and the MDC falls within the total error associated with the result (Table 4.9). Comparison of this value with baseline data shows that it fell within the 99 percent confidence interval ranges of the baseline concentrations (DOE/WIPP 92-037).

Potassium-40 was detected in approximately 50 percent of the surface water samples (Table 4.9). Potassium is ubiquitous throughout the earth's crust, so it is expected to be found in some surface water samples due to leaching from sediments. Potassium-40 concentrations detected in samples collected during this reporting year fell within the 99 percent confidence interval range of the baseline concentrations. There was no significant difference in ^{40}K concentrations at these locations between 2002 and 2003 (ANOVA $p = 0.444$).

Table 4.9 - Selected Radionuclide Concentrations (Bq/L) in Surface Water Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
		^{137}Cs			^{60}Co	
BHT	6.83×10^{-2}	2.04×10^{-1}	2.46×10^{-1}	1.10×10^{-1}	2.77×10^{-1}	3.31×10^{-1}
BRA	2.09×10^{-1}	3.00×10^{-1}	3.42×10^{-1}	5.72×10^{-3}	3.65×10^{-1}	4.20×10^{-1}
CBD	-1.53×10^{-1}	4.76×10^{-1}	5.18×10^{-1}	1.75×10^{-1}	4.77×10^{-1}	5.31×10^{-1}
COW	-2.02×10^{-1}	5.03×10^{-1}	5.21×10^{-1}	2.66×10^{-1}	5.08×10^{-1}	5.73×10^{-1}
FWT	4.39×10^{-2}	3.13×10^{-1}	3.44×10^{-1}	1.08×10^{-1}	3.80×10^{-1}	4.46×10^{-1}
HIL	-1.30×10^{-1}	5.13×10^{-1}	5.37×10^{-1}	3.30×10^{-1}	5.26×10^{-1}	5.94×10^{-1}
IDN	5.63×10^{-2}	2.21×10^{-1}	2.65×10^{-1}	-1.05×10^{-1}	3.12×10^{-1}	3.40×10^{-1}
NOY	3.55×10^{-2}	3.16×10^{-1}	3.46×10^{-1}	3.45×10^{-1}	3.47×10^{-1}	4.43×10^{-1}
PCN	-7.44×10^{-1}	5.24×10^{-1}	5.17×10^{-1}	1.68×10^{-1}	5.00×10^{-1}	5.55×10^{-1}
PKT	-5.74×10^{-2}	2.27×10^{-1}	2.61×10^{-1}	5.80×10^{-2}	3.05×10^{-1}	3.55×10^{-1}
RCP1	-8.61×10^{-2}	3.17×10^{-1}	3.34×10^{-1}	3.16×10^{-1}	3.07×10^{-1}	4.02×10^{-1}
RCP2	5.60×10^{-2}	2.22×10^{-1}	2.66×10^{-1}	4.21×10^{-2}	3.10×10^{-1}	3.58×10^{-1}
RED	-1.77×10^{-2}	2.21×10^{-1}	2.59×10^{-1}	2.98×10^{-1}	2.66×10^{-1}	3.38×10^{-1}
SWL	7.57×10^{-2}	3.42×10^{-1}	3.75×10^{-1}	-2.85×10^{-1}	4.44×10^{-1}	4.56×10^{-1}
TUT	6.40×10^{-2}	2.16×10^{-1}	2.60×10^{-1}	2.90×10^{-2}	3.00×10^{-1}	3.47×10^{-1}
UPR	-4.27×10^{-1}	5.35×10^{-1}	5.34×10^{-1}	6.13×10^{-1}	4.95×10^{-1}	5.71×10^{-1}
		^{90}Sr			^{40}K	
BHT	-9.64×10^{-3}	2.42×10^{-2}	4.27×10^{-2}	1.60×10^{0}	1.37×10^{0}	2.09×10^{0}
BRA	-4.16×10^{-4}	2.40×10^{-2}	4.09×10^{-2}	2.56×10^{0}	3.56×10^{0}	4.34×10^{0}
CBD	7.73×10^{-3}	2.41×10^{-2}	4.12×10^{-2}	6.30×10^{0}	5.06×10^{0}	5.77×10^{0}
COW	1.17×10^{-2}	2.58×10^{-2}	4.32×10^{-2}	3.23×10^{0}	5.31×10^{0}	5.82×10^{0}
FWT	5.61×10^{-4}	2.51×10^{-2}	4.28×10^{-2}	3.20×10^{0}	2.06×10^{0}	2.98×10^{0}
HIL	1.49×10^{-2}	2.83×10^{-2}	4.74×10^{-2}	7.99×10^{0}	5.53×10^{0}	6.17×10^{0}
IDN	2.81×10^{-2}	3.20×10^{-2}	5.30×10^{-2}	2.35×10^{0}	2.10×10^{0}	3.27×10^{0}
NOY	1.71×10^{-2}	2.59×10^{-2}	4.29×10^{-2}	4.65×10^{0}	3.42×10^{0}	4.43×10^{0}
PCN	6.77×10^{-3}	2.32×10^{-2}	3.95×10^{-2}	7.19×10^{0}	4.16×10^{0}	6.23×10^{0}
PKT	-2.73×10^{-4}	2.41×10^{-2}	4.17×10^{-2}	3.62×10^{0}	2.90×10^{0}	3.68×10^{0}
RCP1	-1.01×10^{-2}	2.30×10^{-2}	3.98×10^{-2}	1.81×10^{0}	1.42×10^{0}	2.10×10^{0}
RCP2	1.01×10^{-2}	2.38×10^{-2}	4.04×10^{-2}	1.92×10^{0}	3.15×10^{0}	3.78×10^{0}
RED	5.90×10^{-3}	2.42×10^{-2}	4.15×10^{-2}	1.84×10^{-1}	2.99×10^{0}	3.44×10^{0}
SWL	-7.83×10^{-3}	2.33×10^{-2}	4.02×10^{-2}	5.44×10^{1}	9.92×10^{0}	3.84×10^{0}
TUT	-6.08×10^{-3}	2.43×10^{-2}	4.25×10^{-2}	3.73×10^{0}	2.97×10^{0}	3.75×10^{0}
UPR	4.96×10^{-3}	2.44×10^{-2}	4.13×10^{-2}	1.09×10^{1}	5.21×10^{0}	5.90×10^{0}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Duplicate samples were collected from two locations (IDN and HIL) to check the reproducibility of the sampling and measurement techniques. Radioisotope concentrations for samples and their duplicates passing the criteria for detection were compared by calculation of the associated RER values (Table 4.10). All RER values were less than 1.0, indicating no difference between duplicate samples and confirming the required precision for the sampling and analytical techniques.

Table 4.10 - Results of Duplicate Surface Water Sample Analysis. Units are Bq/L. See Appendix C for sampling location codes.

Location	[RN][a]	2×TPU[b]	MDC[c]	RER[d]	[RN]	2×TPU	MDC	RER
		^{234}U				^{235}U		
IDN	2.50×10^{-1}	4.46×10^{-2}	4.10×10^{-4}	0.68	1.31×10^{-2}	3.84×10^{-3}	5.05×10^{-4}	0.73
IDN Dup.[e]	2.12×10^{-1}	3.35×10^{-2}	2.91×10^{-4}		9.68×10^{-3}	2.70×10^{-3}	3.60×10^{-4}	
HIL	2.89×10^{-2}	5.98×10^{-3}	3.21×10^{-4}	0.14	1.32×10^{-3}	9.93×10^{-4}	1.08×10^{-3}	0.01
HIL Dup.	2.77×10^{-2}	5.80×10^{-3}	3.25×10^{-4}		1.33×10^{-3}	1.01×10^{-3}	1.09×10^{-3}	
		^{238}U				^{239}Pu		
IDN	2.66×10^{-1}	4.74×10^{-2}	4.08×10^{-4}	0.89	3.01×10^{-3}	1.89×10^{-3}	1.70×10^{-3}	0.32
IDN Dup.	2.14×10^{-1}	3.39×10^{-2}	2.90×10^{-4}		2.21×10^{-3}	1.63×10^{-3}	7.50×10^{-4}	
HIL	2.31×10^{-2}	5.00×10^{-3}	3.20×10^{-4}	0.47				
HIL Dup.	2.66×10^{-2}	5.63×10^{-3}	8.80×10^{-4}					

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

4.5 Sediments

4.5.1 Sample Collection

Sediment samples were collected from 12 locations around the WIPP site, mostly from the same water bodies from which the surface water samples were collected (Figure 4.3, see Appendix C for location codes). The samples were collected in 1-L plastic containers from the top 15 cm (6 in.) of the sediments of the water bodies and transferred to the WIPP Laboratories for the determination of individual radionuclides.

4.5.2 Sample Preparation

Sediment samples were dried at 110°C (230°F) for several hours and homogenized by grinding to smaller particle sizes. A 2 g (0.08 oz) aliquot was dissolved by heating it with a mixture of nitric, hydrochloric, and hydrofluoric acids. The residue was heated with nitric and boric acids to remove hydrofluoric acid. Finally, the residue was dissolved in hydrochloric acid for the determination of individual radionuclides.

4.5.3 Determination of Individual Radionuclides

Approximately 100 g (4 oz) of dried and homogenized sediment samples were counted by gamma-spectrometry for the determinations of ^{40}K, ^{60}Co, and ^{137}Cs. Strontium-90 was determined from an aliquot of dissolved sediment samples by chemical separation and beta proportional counting. Uranium, plutonium, and americium were determined by alpha spectrometry after chemical separations, micro-precipitating, and filtering onto micro filter papers.

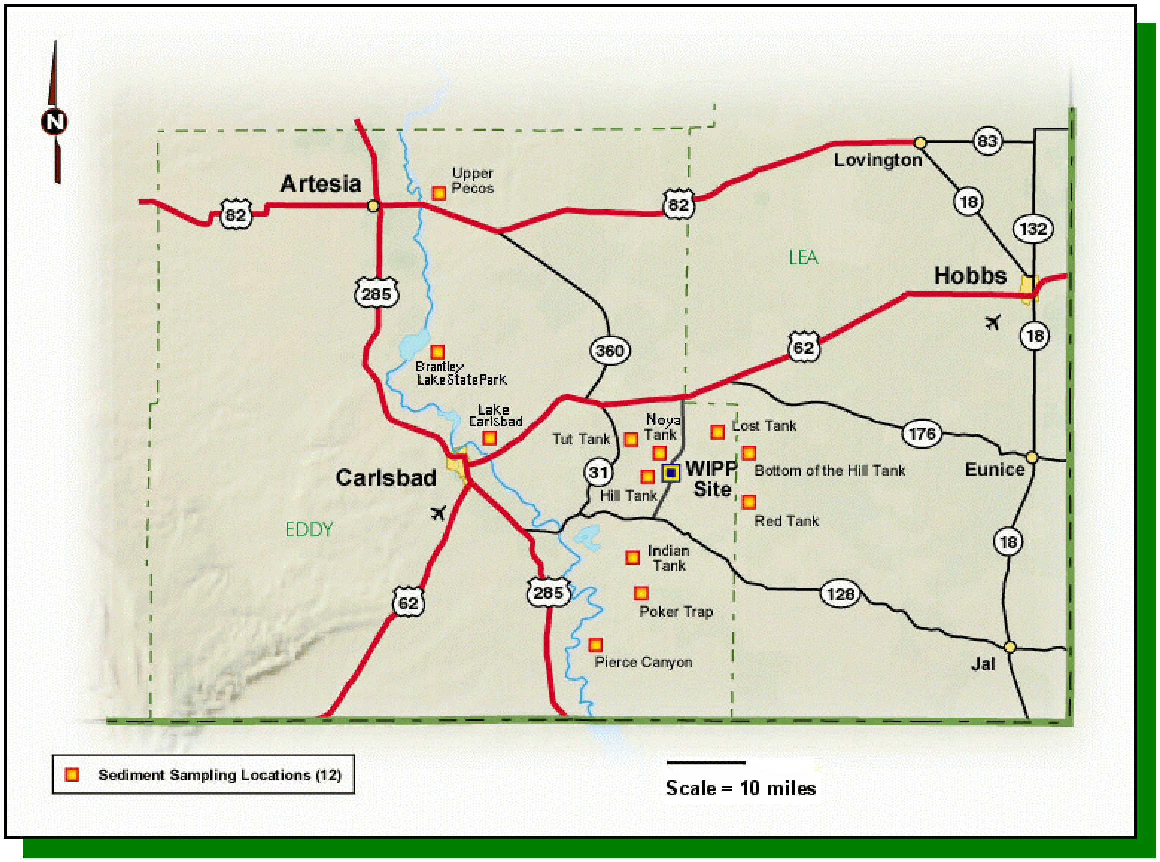

Figure 4.3 - Sediment Sampling Sites

4.5.4 Results and Discussion

Uranium-234, ^{235}U,and ^{238}U were detected in every sediment sample (Table 4.11). As expected, the ^{235}U concentrations were much lower (approximately two orders of magnitude) than the concentrations of ^{234}U and ^{238}U. There was not a significant difference between uranium concentrations for 2002 and 2003 (ANOVA ^{234}U p = 0.840, ^{235}U p = 0.996, ^{238}U p = 0.389). Concentrations of all three uranium isotopes fell within the 99 percent confidence interval ranges of the baseline data (^{234}U: 1.10×10^{-1} Bq/g; ^{235}U: 3.20×10^{-3} Bq/g; ^{238}U: 5.00×10^{-2} Bq/g).

Table 4.11 - Uranium Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{234}U			^{235}U			^{238}U		
BRA	2.70×10^{-2}	4.57×10^{-3}	6.88×10^{-5}	1.60×10^{-3}	5.13×10^{-4}	8.49×10^{-5}	2.59×10^{-2}	4.39×10^{-3}	6.85×10^{-5}
BHT	2.03×10^{-2}	3.43×10^{-3}	7.10×10^{-5}	1.62×10^{-3}	5.19×10^{-4}	8.75×10^{-5}	2.09×10^{-2}	3.52×10^{-3}	7.07×10^{-5}
CBD	4.58×10^{-2}	8.23×10^{-3}	1.06×10^{-4}	2.22×10^{-3}	7.56×10^{-4}	1.31×10^{-4}	3.18×10^{-2}	5.83×10^{-3}	1.06×10^{-4}
HIL	1.30×10^{-2}	2.56×10^{-3}	8.66×10^{-5}	9.46×10^{-4}	4.18×10^{-4}	1.07×10^{-4}	1.05×10^{-2}	2.12×10^{-3}	8.62×10^{-5}
IDN	2.14×10^{-2}	3.66×10^{-3}	1.81×10^{-4}	1.18×10^{-3}	4.30×10^{-4}	2.23×10^{-4}	2.19×10^{-2}	3.72×10^{-3}	6.63×10^{-5}
LST	1.20×10^{-2}	2.43×10^{-3}	2.51×10^{-4}	6.31×10^{-4}	3.43×10^{-4}	1.14×10^{-4}	1.12×10^{-2}	2.28×10^{-3}	2.50×10^{-4}
NOY	2.51×10^{-2}	3.92×10^{-3}	7.41×10^{-5}	1.79×10^{-3}	5.53×10^{-4}	9.15×10^{-5}	2.39×10^{-2}	3.75×10^{-3}	7.38×10^{-5}
PCN	3.23×10^{-2}	5.45×10^{-3}	7.94×10^{-5}	1.59×10^{-3}	5.41×10^{-4}	9.80×10^{-5}	2.98×10^{-2}	5.04×10^{-3}	7.91×10^{-5}

Table 4.11 - Uranium Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{234}U			^{235}U			^{238}U		
PKT	3.46×10^{-2}	7.03×10^{-3}	1.34×10^{-4}	1.95×10^{-3}	7.80×10^{-4}	1.65×10^{-4}	3.49×10^{-2}	7.10×10^{-3}	1.33×10^{-4}
RED	1.82×10^{-2}	3.16×10^{-3}	7.23×10^{-5}	1.25×10^{-3}	4.50×10^{-4}	1.65×10^{-4}	1.76×10^{-2}	3.06×10^{-3}	1.96×10^{-4}
TUT	2.15×10^{-2}	4.36×10^{-3}	1.16×10^{-4}	1.59×10^{-3}	6.64×10^{-4}	3.90×10^{-4}	2.31×10^{-2}	4.66×10^{-3}	3.97×10^{-4}
UPR	2.28×10^{-2}	4.29×10^{-3}	1.00×10^{-4}	1.19×10^{-3}	5.08×10^{-4}	1.24×10^{-4}	1.84×10^{-2}	3.54×10^{-3}	2.72×10^{-4}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Actinides were detected at several sampling locations. Americium-241 was detected at CBD at a concentration of 1.96×10^{-4} Bq/g, at PCN at 2.82×10^{-4} Bq/g, and at PKT at 2.45×10^{-4} Bq/g (Table 4.12). Plutonium-238 was detected once, at PKT, at a concentration of 2.11×10^{-4} Bq/g. Plutonium-239+240 was detected in three samples: at BHT at 7.75×10^{-4} Bq/g, at IDN at 3.22×10^{-4} Bq/g, and at PKT at 6.66×10^{-4} Bq/g. All of these concentrations are extremely small, all are fairly close to their respective MDCs, and for all except one ($^{239+240}Pu$ at PKT), the MDCs fall within the total error associated with the indicated results. In addition, detected concentrations for both plutonium isotopes fell within the 99 percent confidence interval ranges of baseline values (^{238}Pu: 2.90×10^{-3} Bq/g; $^{239+240}Pu$: 1.90×10^{-3} Bq/g). No such comparison could be made for ^{241}Am as this radioisotope was not reported for sediments in the baseline data. Taken together, these results do not indicate any release of actinides due to WIPP operation. None of the actinides were detected in a sufficient number of samples to allow statistical comparisons between years or among sampling locations.

Table 4.12 - Americium and Plutonium Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}Pu$		
BRA	0.00×10^{0}	N/A[d]	2.75×10^{-4}	4.19×10^{-5}	1.45×10^{-4}	3.08×10^{-4}	0.00×10^{0}	N/A[d]	1.13×10^{-4}
BHT	1.98×10^{-4}	2.11×10^{-4}	3.06×10^{-4}	1.30×10^{-4}	5.81×10^{-4}	1.20×10^{-3}	7.75×10^{-4}	6.67×10^{-4}	3.50×10^{-4}
CBD	1.96×10^{-4}	1.63×10^{-4}	8.84×10^{-5}	0.00×10^{0}	N/A[d]	4.29×10^{-4}	5.82×10^{-5}	1.17×10^{-4}	1.58×10^{-4}
HIL	3.55×10^{-5}	1.59×10^{-4}	3.30×10^{-4}	1.87×10^{-4}	2.19×10^{-4}	1.68×10^{-4}	6.20×10^{-5}	2.15×10^{-4}	4.57×10^{-4}
IDN	2.43×10^{-4}	2.13×10^{-4}	2.56×10^{-4}	0.00×10^{0}	N/A[d]	3.33×10^{-4}	3.22×10^{-4}	2.44×10^{-4}	2.64×10^{-4}
LST	3.14×10^{-5}	1.40×10^{-4}	2.91×10^{-4}	3.13×10^{-4}	4.73×10^{-4}	7.66×10^{-4}	2.08×10^{-4}	5.91×10^{-4}	1.12×10^{-3}
NOY	1.09×10^{-4}	1.27×10^{-4}	9.84×10^{-5}	3.74×10^{-4}	5.66×10^{-4}	9.15×10^{-4}	0.00×10^{0}	N/A[d]	3.37×10^{-4}
PCN	2.82×10^{-4}	2.28×10^{-4}	2.60×10^{-4}	0.00×10^{0}	N/A[d]	5.13×10^{-4}	6.96×10^{-5}	1.40×10^{-4}	1.89×10^{-4}
PKT	2.45×10^{-4}	1.78×10^{-4}	8.29×10^{-5}	2.11×10^{-4}	1.76×10^{-4}	9.50×10^{-5}	6.66×10^{-4}	3.26×10^{-4}	9.50×10^{-5}
RED	1.14×10^{-4}	1.33×10^{-4}	1.03×10^{-4}	4.16×10^{-4}	5.97×10^{-4}	9.63×10^{-4}	1.04×10^{-4}	3.60×10^{-4}	7.63×10^{-4}
TUT	1.34×10^{-4}	1.91×10^{-4}	3.12×10^{-4}	3.62×10^{-4}	3.71×10^{-4}	2.44×10^{-4}	0.00×10^{0}	N/A[d]	2.44×10^{-4}
UPR	1.15×10^{-4}	1.34×10^{-4}	1.04×10^{-4}	0.00×10^{0}	N/A[d]	2.45×10^{-4}	0.00×10^{0}	N/A[d]	2.45×10^{-4}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

Cesium-137 was detected in all the sediment samples except for the sample taken from sample location BRA (Table 4.13). Although ^{137}Cs concentrations differed among sampling locations, they did not differ statistically between sampling years 2002 and 2003 (ANOVA p = 0.498). In addition, all detected ^{137}Cs concentrations fell within the 99 percent confidence interval range of baseline concentrations.

Strontium-90 and ^{60}Co were not detected in any sediment samples. Therefore, no comparisons were available between locations or years.

Potassium-40 was detected in all sediment samples (Table 4.13). Concentrations of ^{40}K exhibited statistically significant variation among sampling locations (ANOVA p = 0.012), but did not vary significantly between 2002 and 2003 (ANOVA, p = 0.359). The highest concentration of ^{40}K observed in these samples was slightly higher than the 99 percent confidence interval range of baseline concentrations. However, overall, the concentrations measured in 2003 were similar to the average concentration of ^{40}K found in soils throughout the United States ($4.00×10^{-1}$ Bq/g [$1.08×10^{1}$ pCi/g]; NCRP, 1987a).

Table 4.13 - Selected Radionuclide Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
		^{137}Cs			^{60}Co	
BRA	$4.00×10^{-4}$	$5.01×10^{-4}$	$5.63×10^{-4}$	$2.70×10^{-5}$	$5.56×10^{-4}$	$6.06×10^{-4}$
BHT	$6.17×10^{-3}$	$8.34×10^{-4}$	$3.93×10^{-4}$	$3.44×10^{-4}$	$6.12×10^{-4}$	$6.75×10^{-4}$
CBD	$3.18×10^{-3}$	$4.67×10^{-4}$	$3.08×10^{-4}$	$2.72×10^{-4}$	$5.41×10^{-4}$	$6.24×10^{-4}$
HIL	$1.98×10^{-3}$	$4.01×10^{-4}$	$4.35×10^{-4}$	$2.05×10^{-4}$	$6.20×10^{-4}$	$7.01×10^{-4}$
IDN	$6.86×10^{-3}$	$9.57×10^{-4}$	$4.97×10^{-4}$	$2.67×10^{-5}$	$6.29×10^{-4}$	$7.05×10^{-4}$
LST	$5.19×10^{-3}$	$7.16×10^{-4}$	$4.19×10^{-4}$	$2.19×10^{-4}$	$6.26×10^{-4}$	$6.86×10^{-4}$
NOY	$7.72×10^{-4}$	$2.44×10^{-4}$	$3.26×10^{-4}$	$1.37×10^{-4}$	$4.64×10^{-4}$	$5.30×10^{-4}$
PCN	$6.39×10^{-4}$	$1.87×10^{-4}$	$3.54×10^{-4}$	$2.04×10^{-4}$	$6.11×10^{-4}$	$6.70×10^{-4}$
PKT	$5.51×10^{-3}$	$7.94×10^{-4}$	$4.68×10^{-4}$	$-2.73×10^{-4}$	$6.09×10^{-4}$	$6.39×10^{-4}$
RED	$9.12×10^{-4}$	$1.80×10^{-4}$	$2.25×10^{-4}$	$-1.30×10^{-4}$	$3.11×10^{-4}$	$4.68×10^{-4}$
TUT	$1.71×10^{-3}$	$3.65×10^{-4}$	$4.11×10^{-4}$	$-9.73×10^{-5}$	$6.41×10^{-4}$	$7.08×10^{-4}$
UPR	$3.36×10^{-4}$	$1.23×10^{-4}$	$2.72×10^{-4}$	$-1.47×10^{-4}$	$5.06×10^{-4}$	$5.54×10^{-4}$
		^{90}Sr			^{40}K	
BRA	$-1.01×10^{-4}$	$5.42×10^{-3}$	$9.34×10^{-3}$	$3.37×10^{-1}$	$4.41×10^{-2}$	$7.37×10^{-3}$
BHT	$1.06×10^{-3}$	$5.60×10^{-3}$	$9.55×10^{-3}$	$5.64×10^{-1}$	$7.29×10^{-2}$	$7.93×10^{-3}$
CBD	$2.14×10^{-3}$	$5.66×10^{-3}$	$9.58×10^{-3}$	$3.58×10^{-1}$	$4.70×10^{-2}$	$5.11×10^{-3}$
HIL	$-1.88×10^{-3}$	$5.24×10^{-3}$	$9.26×10^{-3}$	$8.30×10^{-1}$	$1.07×10^{-1}$	$4.77×10^{-3}$
IDN	$1.17×10^{-3}$	$6.19×10^{-3}$	$1.06×10^{-2}$	$6.45×10^{-1}$	$8.38×10^{-2}$	$5.41×10^{-3}$
LST	$1.19×10^{-3}$	$5.01×10^{-3}$	$8.60×10^{-3}$	$6.44×10^{-1}$	$8.32×10^{-2}$	$8.10×10^{-3}$
NOY	$7.80×10^{-4}$	$5.64×10^{-3}$	$9.75×10^{-3}$	$3.65×10^{-1}$	$4.78×10^{-2}$	$4.40×10^{-3}$
PCN	$2.10×10^{-3}$	$6.67×10^{-3}$	$1.14×10^{-2}$	$5.87×10^{-1}$	$7.60×10^{-2}$	$7.89×10^{-3}$
PKT	$1.85×10^{-3}$	$6.68×10^{-3}$	$1.14×10^{-2}$	$4.55×10^{-1}$	$5.90×10^{-2}$	$7.21×10^{-3}$
RED	$-2.07×10^{-3}$	$5.28×10^{-3}$	$9.24×10^{-3}$	$1.99×10^{-1}$	$2.66×10^{-2}$	$4.12×10^{-3}$
TUT	$-2.91×10^{-5}$	$5.93×10^{-3}$	$1.02×10^{-2}$	$7.74×10^{-1}$	$1.00×10^{-1}$	$5.19×10^{-3}$
UPR	$-9.50×10^{-5}$	$5.06×10^{-3}$	$8.79×10^{-3}$	$3.80×10^{-1}$	$4.97×10^{-2}$	$4.47×10^{-3}$

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Duplicate analyses were performed for all the radionuclides in sediment samples from sampling locations IDN and HIL (Table 4.14). RERs were calculated for all isotopes for which the concentrations in both original and duplicate samples were detected. The RERs were less than 1.0 for all isotopes and locations, indicating acceptable reproducibility, with the exception of ^{234}U, ^{235}U, and ^{238}U at HIL. The poor reproducibility of these samples was most likely due to inhomogeneity in the distribution of uranium isotopes at the collection location.

Table 4.14 - Results of Duplicate Sediment Sample Analysis. Units are Bq/g. See Appendix C for the sampling location codes.

Location	[RN][a]	2×TPU[b]	MDC[c]	RER[d]	[RN]	2×TPU[a]	MDC[b]	RER[c]
	$^{239+240}Pu$				^{137}Cs			
IDN	3.22×10^{-4}	2.44×10^{-4}	2.64×10^{-4}	0.29	6.86×10^{-3}	9.57×10^{-4}	4.97×10^{-4}	0.33
IDN Dup.[e]	4.93×10^{-4}	2.66×10^{-4}	8.90×10^{-5}		6.42×10^{-3}	9.34×10^{-4}	6.02×10^{-4}	
					1.98×10^{-3}	4.01×10^{-4}	4.35×10^{-4}	0.26
					1.85×10^{-3}	3.79×10^{-4}	4.09×10^{-4}	
	^{40}K				^{234}U			
IDN	6.45×10^{-1}	8.38×10^{-2}	5.41×10^{-3}	0.47	2.14×10^{-2}	3.66×10^{-3}	1.81×10^{-4}	0.52
IDN Dup.	5.92×10^{-1}	7.66×10^{-2}	7.09×10^{-3}		2.43×10^{-2}	4.20×10^{-3}	2.09×10^{-4}	
HIL	8.30×10^{-1}	1.07×10^{-1}	4.77×10^{-3}	0.60	1.30×10^{-2}	2.56×10^{-3}	8.66×10^{-5}	1.97
HIL Dup.	7.44×10^{-1}	9.60×10^{-2}	7.75×10^{-3}		2.54×10^{-2}	5.87×10^{-3}	4.54×10^{-4}	
	^{235}U				^{238}U			
IDN	1.18×10^{-3}	4.30×10^{-4}	2.23×10^{-4}	0.23	2.19×10^{-2}	3.72×10^{-3}	6.63×10^{-5}	0.61
IDN Dup.	1.33×10^{-3}	2.44×10^{-4}	9.48×10^{-5}		2.54×10^{-2}	4.38×10^{-3}	7.65×10^{-5}	
HIL	9.46×10^{-4}	4.18×10^{-4}	1.07×10^{-4}	1.37	1.05×10^{-2}	2.12×10^{-3}	8.62×10^{-5}	2.49
HIL Dup.	2.43×10^{-3}	9.99×10^{-4}	2.06×10^{-4}		2.67×10^{-2}	6.15×10^{-3}	1.66×10^{-4}	

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

4.6 Soil Samples

4.6.1 Sample Collection

Soil samples were collected from near the low-volume air samplers at six different locations around the WIPP site: MLR, SEC, SMR, WEE, WFF, and WSS (Figure 4.4). Samples were collected from each location in three incremental profiles: surface soil (SS, 0-2 cm [0-0.8 in.]), intermediate soil (SI, 2-5 cm [0.8-2 in.]), and deep soil (SD, 5-10 cm [2-4 in.]). Measurements of radionuclides in depth profiles provide information about their vertical movements in the soil systems.

4.6.2 Sample Preparation

Soil samples were dried at 110°C (230°F) for several hours and homogenized by grinding to small particle sizes. Two grams (0.08 oz) of soil was dissolved by heating it with a mixture of nitric, hydrochloric, and hydrofluoric acids. Finally, it was heated with nitric and boric acids, and the residue was dissolved in hydrochloric acid for the determination of individual radionuclides.

4.6.3 Determination of Individual Radionuclides

Gamma-emitting radionuclides (^{40}K, ^{60}Co, and ^{137}Cs) were determined by counting an aliquot of well-homogenized ground soil samples by gamma-spectrometry. Strontium-90 was analyzed from an aliquot of the sample solution by separating it from other stable and radioactive elements using radiochemical techniques and beta counting using a proportional counter. Another aliquot of the sample solution was used for the sequential determinations of the alpha-emitting radionuclides ^{234}U, ^{235}U, and ^{238}U; ^{238}Pu and $^{239+240}Pu$; and ^{241}Am. These radionuclides were separated from the bulk of the inorganic materials present in the soil samples and from one another by radiochemical separations including co-precipitation and ion-exchange chromatography. Finally, the samples were micro-precipitated, filtered onto micro-filters, and counted on the alpha spectrometer.

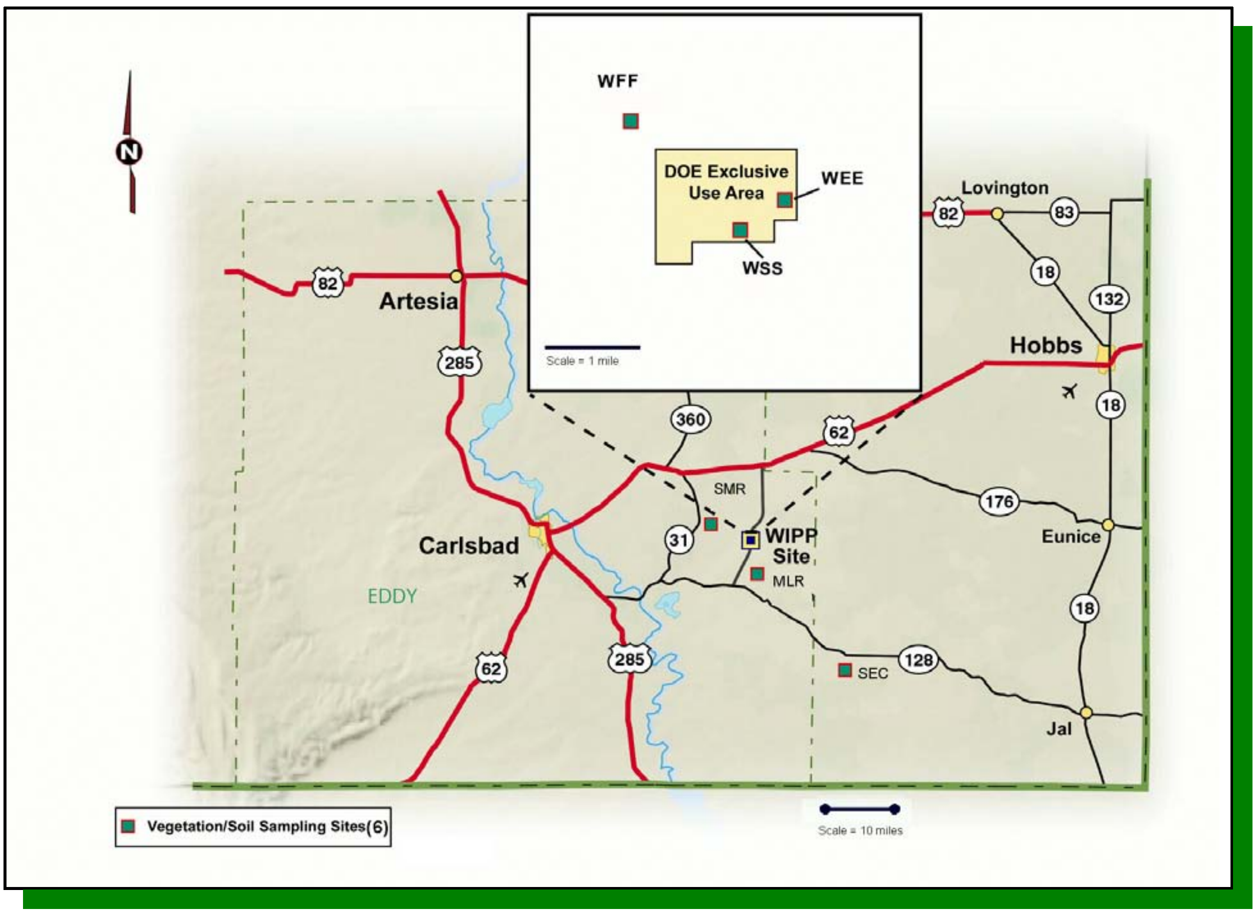

Figure 4.4 - Routine Soil and Vegetation Sampling Areas

4.6.4 Results and Discussion

Uranium-234, ^{238}U, and ^{235}U were detected in every soil sample in 2003, with the exception of ^{235}U at the 2-5 cm depth at location WEE (Table 4.15). Although there was significant variation among sampling locations, uranium isotope concentrations showed no significant differences between 2002 and 2003 (ANOVA, ^{234}U p = 0.323, ^{238}U p = 0.370, ^{235}U p = 0.721). Uranium concentrations in the vicinity of WIPP were somewhat higher than baseline concentrations (DOE/WIPP 92-037). However, these detected concentrations fell within the range of natural concentrations of uranium found in soils throughout the world (NCRP Report No. 50, 1977). All these results taken together suggest a pattern of natural variability consistent with the existence of natural uranium, without enhancement from the WIPP facility.

Table 4.15 - Uranium Concentrations (Bq/g) in Soil Near the WIPP Site. See Appendix C for the sampling location codes.

Location	Depth(cm)	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
			^{234}U			^{235}U			^{238}U	
MLR	0-2	2.41×10^{-2}	4.27×10^{-3}	2.19×10^{-4}	2.05×10^{-3}	6.50×10^{-4}	2.70×10^{-4}	2.62×10^{-2}	4.61×10^{-3}	2.18×10^{-4}
MLR	2-5	1.12×10^{-2}	2.22×10^{-3}	8.72×10^{-5}	3.57×10^{-4}	2.45×10^{-4}	1.08×10^{-4}	1.22×10^{-2}	2.38×10^{-3}	8.68×10^{-5}
MLR	5-10	1.16×10^{-2}	2.20×10^{-3}	7.95×10^{-5}	6.88×10^{-4}	3.34×10^{-4}	9.81×10^{-5}	1.24×10^{-2}	2.32×10^{-3}	7.92×10^{-5}
SEC	0-2	2.53×10^{-2}	5.41×10^{-3}	1.46×10^{-4}	1.06×10^{-3}	6.26×10^{-4}	6.16×10^{-4}	2.81×10^{-2}	5.95×10^{-3}	1.45×10^{-4}
SEC	2-5	1.16×10^{-2}	2.60×10^{-3}	3.37×10^{-4}	8.47×10^{-4}	4.65×10^{-4}	1.53×10^{-4}	1.30×10^{-2}	2.86×10^{-3}	3.36×10^{-4}
SEC	5-10	2.40×10^{-2}	4.74×10^{-3}	3.29×10^{-4}	1.27×10^{-3}	5.95×10^{-4}	4.06×10^{-4}	2.33×10^{-2}	4.61×10^{-3}	3.28×10^{-4}
SMR	0-2	2.57×10^{-2}	4.50×10^{-3}	8.89×10^{-5}	1.66×10^{-3}	5.82×10^{-4}	1.10×10^{-4}	2.61×10^{-2}	4.56×10^{-3}	8.85×10^{-5}
SMR	2-5	2.52×10^{-2}	4.45×10^{-3}	8.66×10^{-5}	1.85×10^{-3}	6.37×10^{-4}	3.66×10^{-4}	2.65×10^{-2}	4.66×10^{-3}	8.62×10^{-5}
SMR	5-10	1.61×10^{-2}	2.98×10^{-3}	8.93×10^{-5}	9.76×10^{-4}	4.44×10^{-4}	3.00×10^{-4}	1.58×10^{-2}	2.93×10^{-3}	8.89×10^{-5}
WEE	0-2	8.12×10^{-3}	1.74×10^{-3}	9.49×10^{-5}	5.61×10^{-4}	3.25×10^{-4}	1.17×10^{-4}	7.74×10^{-3}	1.67×10^{-3}	9.44×10^{-5}
WEE	2-5	8.09×10^{-3}	1.92×10^{-3}	1.21×10^{-4}	1.65×10^{-4}	2.47×10^{-4}	4.04×10^{-4}	7.30×10^{-3}	1.77×10^{-3}	3.26×10^{-4}
WEE	5-10	6.35×10^{-3}	1.35×10^{-3}	8.07×10^{-5}	2.94×10^{-4}	2.13×10^{-4}	9.96×10^{-5}	7.50×10^{-3}	1.54×10^{-3}	8.04×10^{-5}
WFF	0-2	9.29×10^{-3}	2.40×10^{-3}	1.61×10^{-4}	6.61×10^{-4}	4.61×10^{-4}	1.99×10^{-4}	1.06×10^{-2}	2.66×10^{-3}	1.61×10^{-4}
WFF	2-5	1.23×10^{-2}	2.86×10^{-3}	1.48×10^{-4}	5.37×10^{-4}	3.94×10^{-4}	1.82×10^{-4}	9.70×10^{-3}	2.36×10^{-3}	1.47×10^{-4}
WFF	5-10	1.11×10^{-2}	2.63×10^{-3}	1.47×10^{-4}	8.72×10^{-4}	5.12×10^{-4}	1.82×10^{-4}	1.10×10^{-2}	2.62×10^{-3}	1.47×10^{-4}
WSS	0-2	1.28×10^{-2}	2.46×10^{-3}	8.33×10^{-5}	6.06×10^{-4}	3.54×10^{-4}	3.53×10^{-4}	1.14×10^{-2}	2.23×10^{-3}	8.29×10^{-5}
WSS	2-5	1.28×10^{-2}	2.30×10^{-3}	7.11×10^{-5}	1.17×10^{-3}	4.38×10^{-4}	2.39×10^{-4}	1.31×10^{-2}	2.34×10^{-3}	7.08×10^{-5}
WSS	5-10	1.49×10^{-2}	2.70×10^{-3}	7.35×10^{-5}	1.47×10^{-3}	5.02×10^{-4}	9.07×10^{-5}	1.28×10^{-2}	2.37×10^{-3}	7.32×10^{-5}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Plutonium-238, $^{239+240}Pu$, and ^{241}Am were also analyzed in these soil samples (Table 4.16). Plutonium-238 was not detected in any of the samples. Plutonium-239+240 was detected in 44 percent of the samples and ^{241}Am was detected in 39 percent of the samples (Table 4.16). All detected concentrations of both isotopes were extremely small and were relatively close to the respective MDCs. There were insufficient detections of these two isotopes to permit analysis of variance among sampling locations or between years. However, the detected concentrations of all three actinides fell within the 99 percent confidence interval ranges of their respective baseline values (DOE/WIPP 92-037), indicating that their presence is not due to WIPP operations. Historically, soil samples collected in the same locations have shown positive results on numerous occasions (DOE/WIPP 03-2225). Since 1997, soil samples collected at WEE, SEC, MLR, and SMR have shown levels of ^{241}Am and $^{239+240}$Pu slightly above the baseline. Three different analytical laboratories were used to analyze these data, and all had similar results. The source of actinide activity in WIPP samples could be due to natural transport of contaminated soil from the Gnome Site via wind. The Gnome Site lies approximately 9 km southwest of the WIPP boundary and was contaminated with actinides and fission products in 1961 when an underground test of a 3-kiloton ^{239}Pu device vented to the surface.

Table 4.16 - Americium and Plutonium Concentrations (Bq/g) in Soil Near the WIPP Site. See Appendix C for the sampling location codes.

Location	Depth(cm)	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
		^{241}Am			^{238}Pu			$^{239+240}$Pu		
MLR	0-2	5.16×10^{-4}	2.90×10^{-4}	2.82×10^{-4}	3.29×10^{-5}	6.60×10^{-5}	8.88×10^{-5}	6.55×10^{-4}	3.10×10^{-4}	8.88×10^{-5}
MLR	2-5	9.97×10^{-5}	1.77×10^{-4}	3.09×10^{-4}	-4.60×10^{-5}	9.24×10^{-5}	3.38×10^{-4}	9.18×10^{-5}	1.31×10^{-4}	1.24×10^{-4}
MLR	5-10	6.79×10^{-5}	1.36×10^{-4}	2.50×10^{-4}	0.00×10^{0}	N/A[d]	1.04×10^{-4}	-3.84×10^{-5}	1.33×10^{-4}	3.58×10^{-4}
SEC	0-2	2.20×10^{-4}	2.11×10^{-4}	2.92×10^{-4}	8.00×10^{-5}	1.14×10^{-4}	1.08×10^{-4}	2.39×10^{-4}	2.00×10^{-4}	1.08×10^{-4}
SEC	2-5	1.79×10^{-4}	1.49×10^{-4}	8.08×10^{-5}	5.61×10^{-5}	7.98×10^{-5}	7.57×10^{-5}	4.47×10^{-4}	2.47×10^{-4}	2.06×10^{-4}
SEC	5-10	5.03×10^{-4}	2.88×10^{-4}	2.47×10^{-4}	1.00×10^{-4}	2.01×10^{-4}	3.67×10^{-4}	3.49×10^{-4}	2.71×10^{-4}	1.35×10^{-4}
SMR	0-2	2.07×10^{-4}	1.98×10^{-4}	2.74×10^{-4}	3.68×10^{-5}	7.38×10^{-5}	9.94×10^{-5}	2.93×10^{-4}	2.13×10^{-4}	9.94×10^{-5}
SMR	2-5	8.98×10^{-5}	1.59×10^{-4}	2.78×10^{-4}	7.58×10^{-5}	1.53×10^{-4}	2.05×10^{-4}	3.03×10^{-4}	4.33×10^{-4}	7.03×10^{-4}
SMR	5-10	2.35×10^{-4}	1.90×10^{-4}	2.17×10^{-4}	5.02×10^{-5}	1.74×10^{-4}	3.69×10^{-4}	1.50×10^{-4}	1.76×10^{-4}	1.36×10^{-4}
WEE	0-2	0.00×10^{0}	N/A[d]	4.57×10^{-4}	8.88×10^{-5}	1.33×10^{-4}	2.18×10^{-4}	5.90×10^{-5}	8.40×10^{-5}	8.00×10^{-5}
WEE	2-5	8.71×10^{-5}	1.31×10^{-4}	2.14×10^{-4}	3.11×10^{-5}	6.23×10^{-5}	8.39×10^{-5}	1.24×10^{-4}	1.53×10^{-4}	2.28×10^{-4}
WEE	5-10	1.40×10^{-4}	1.27×10^{-4}	7.58×10^{-5}	2.91×10^{-5}	5.84×10^{-5}	7.86×10^{-5}	1.16×10^{-4}	1.18×10^{-4}	7.86×10^{-5}
WFF	0-2	3.31×10^{-4}	2.54×10^{-4}	3.08×10^{-4}	1.62×10^{-4}	1.90×10^{-4}	1.46×10^{-4}	3.24×10^{-4}	2.72×10^{-4}	1.46×10^{-4}
WFF	2-5	2.42×10^{-4}	2.33×10^{-4}	3.22×10^{-4}	8.46×10^{-5}	1.70×10^{-4}	2.29×10^{-4}	4.22×10^{-4}	4.57×10^{-4}	6.22×10^{-4}
WFF	5-10	1.97×10^{-4}	1.89×10^{-4}	2.42×10^{-4}	2.98×10^{-5}	5.98×10^{-5}	8.06×10^{-5}	2.38×10^{-4}	1.72×10^{-4}	8.06×10^{-5}
WSS	0-2	7.49×10^{-5}	1.84×10^{-4}	3.48×10^{-4}	2.01×10^{-4}	3.02×10^{-4}	4.93×10^{-4}	2.01×10^{-4}	2.36×10^{-4}	1.81×10^{-4}
WSS	2-5	2.90×10^{-4}	2.11×10^{-4}	9.82×10^{-5}	-1.13×10^{-4}	1.61×10^{-4}	5.23×10^{-4}	3.94×10^{-4}	3.81×10^{-4}	5.23×10^{-4}
WSS	5-10	3.33×10^{-5}	1.16×10^{-4}	2.46×10^{-4}	1.41×10^{-4}	2.50×10^{-4}	4.36×10^{-4}	4.69×10^{-4}	3.08×10^{-4}	1.27×10^{-4}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

Potassium-40 was detected in every sample (Table 4.17). This naturally occurring gamma-emitting radionuclide is ubiquitous in soils. The concentration of ^{40}K was not significantly different between 2002 and 2003 (ANOVA, $p = 0.867$). Potassium-40 concentrations at some locations were higher than baseline levels (DOE/WIPP 92-037). However, the range of concentrations observed is consistent with the average natural ^{40}K concentration in soils around the world (4.00×10^{-1} Bq/g [1.08×10^{1} pCi/g]; NCRP, 1987a).

Cesium-137 was detected in all soil samples (Table 4.17). Although concentrations varied among sampling locations, there was no statistically significant difference in concentrations between the years 2002 and 2003 (ANOVA, $p = 0.673$). In addition, all ^{137}Cs concentrations fell within the 99 percent confidence interval range of baseline values, indicating that WIPP operations were not the source of this contamination.

Although ^{137}Cs is a fission product, it is ubiquitous in soils because of global fallout from atmospheric nuclear weapons testing (Beck and Bennett, 2002; and UNSCEAR, 2000).

Strontium-90 and ^{60}Co were not detected at any sampling locations (Table 4.17).

Table 4.17 - Selected Radionuclide Concentrations (Bq/g) in Soil Near the WIPP Site. See Appendix C for the sampling location codes.

Location	Depth (cm)	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
		^{137}Cs			^{60}Co		
MLR	0-2	1.01×10^{-2}	1.30×10^{-3}	2.86×10^{-4}	8.72×10^{-5}	4.99×10^{-4}	5.66×10^{-4}
MLR	2-5	3.63×10^{-3}	5.21×10^{-4}	3.48×10^{-4}	3.95×10^{-4}	5.68×10^{-4}	6.30×10^{-4}
MLR	5-10	4.88×10^{-4}	1.35×10^{-4}	2.34×10^{-4}	1.50×10^{-5}	4.85×10^{-4}	5.46×10^{-4}
SEC	0-2	2.99×10^{-3}	4.38×10^{-4}	3.14×10^{-4}	-2.38×10^{-4}	4.85×10^{-4}	5.14×10^{-4}
SEC	2-5	1.62×10^{-3}	3.36×10^{-4}	3.60×10^{-4}	-3.50×10^{-4}	5.32×10^{-4}	5.47×10^{-4}
SEC	5-10	3.83×10^{-3}	5.89×10^{-4}	4.21×10^{-4}	2.73×10^{-4}	5.13×10^{-4}	5.72×10^{-4}
SMR	0-2	3.69×10^{-3}	5.24×10^{-4}	3.30×10^{-4}	5.35×10^{-4}	5.64×10^{-4}	6.53×10^{-4}
SMR	2-5	4.54×10^{-3}	7.67×10^{-4}	3.48×10^{-4}	-2.37×10^{-4}	6.51×10^{-4}	7.07×10^{-4}
SMR	5-10	5.90×10^{-3}	8.72×10^{-4}	5.94×10^{-4}	-5.40×10^{-5}	6.12×10^{-4}	6.60×10^{-4}
WEE	0-2	3.27×10^{-3}	5.39×10^{-4}	4.50×10^{-4}	-1.67×10^{-4}	5.43×10^{-4}	5.77×10^{-4}
WEE	2-5	3.25×10^{-3}	5.35×10^{-4}	4.44×10^{-4}	3.48×10^{-4}	5.13×10^{-4}	5.72×10^{-4}
WEE	5-10	3.47×10^{-3}	6.48×10^{-4}	6.81×10^{-4}	5.02×10^{-5}	4.31×10^{-4}	4.90×10^{-4}
WFF	0-2	1.41×10^{-3}	2.79×10^{-4}	2.74×10^{-4}	4.06×10^{-6}	3.59×10^{-4}	4.35×10^{-4}
WFF	2-5	1.81×10^{-3}	3.91×10^{-4}	4.47×10^{-4}	3.95×10^{-4}	4.85×10^{-4}	5.47×10^{-4}
WFF	5-10	1.66×10^{-3}	3.02×10^{-4}	2.70×10^{-4}	-9.60×10^{-5}	3.85×10^{-4}	4.23×10^{-4}
WSS	0-2	2.26×10^{-3}	3.42×10^{-4}	2.35×10^{-4}	-4.27×10^{-5}	4.20×10^{-4}	4.69×10^{-4}
WSS	2-5	2.87×10^{-3}	4.44×10^{-4}	2.92×10^{-4}	2.52×10^{-5}	4.13×10^{-4}	4.68×10^{-4}
WSS	5-10	3.82×10^{-3}	6.31×10^{-4}	5.47×10^{-4}	1.59×10^{-4}	5.03×10^{-4}	5.56×10^{-4}
		^{90}Sr			^{40}K		
MLR	0-2	3.87×10^{-3}	5.43×10^{-3}	9.25×10^{-3}	3.89×10^{-1}	5.09×10^{-2}	4.35×10^{-3}
MLR	2-5	1.01×10^{-3}	5.13×10^{-3}	8.95×10^{-3}	3.89×10^{-1}	5.06×10^{-2}	5.61×10^{-3}
MLR	5-10	6.44×10^{-3}	5.50×10^{-3}	9.18×10^{-3}	3.70×10^{-1}	4.85×10^{-2}	4.48×10^{-3}
SEC	0-2	6.17×10^{-3}	9.14×10^{-3}	1.55×10^{-2}	2.11×10^{-1}	3.06×10^{-2}	6.92×10^{-3}
SEC	2-5	2.70×10^{-3}	8.38×10^{-3}	1.44×10^{-2}	2.06×10^{-1}	2.72×10^{-2}	4.53×10^{-3}
SEC	5-10	-6.01×10^{-4}	9.91×10^{-3}	1.74×10^{-2}	2.44×10^{-1}	3.53×10^{-2}	7.10×10^{-3}
SMR	0-2	4.04×10^{-3}	5.40×10^{-3}	9.20×10^{-3}	6.79×10^{-1}	8.80×10^{-2}	4.80×10^{-3}
SMR	2-5	4.14×10^{-3}	8.17×10^{-3}	1.41×10^{-2}	6.38×10^{-1}	1.03×10^{-1}	5.03×10^{-3}
SMR	5-10	4.51×10^{-3}	5.39×10^{-3}	9.15×10^{-3}	5.60×10^{-1}	7.24×10^{-2}	5.54×10^{-3}
WEE	0-2	5.86×10^{-3}	5.26×10^{-3}	8.81×10^{-3}	2.56×10^{-1}	3.37×10^{-2}	5.87×10^{-3}
WEE	2-5	1.24×10^{-3}	5.18×10^{-3}	9.01×10^{-3}	2.51×10^{-1}	3.30×10^{-2}	6.83×10^{-3}
WEE	5-10	4.31×10^{-3}	5.19×10^{-3}	8.80×10^{-3}	2.50×10^{-1}	3.30×10^{-2}	4.09×10^{-3}
WFF	0-2	4.95×10^{-3}	8.68×10^{-3}	1.48×10^{-2}	1.97×10^{-1}	2.62×10^{-2}	4.02×10^{-3}
WFF	2-5	5.47×10^{-3}	9.29×10^{-3}	1.58×10^{-2}	2.00×10^{-1}	2.92×10^{-2}	7.14×10^{-3}
WFF	5-10	1.06×10^{-2}	9.00×10^{-3}	1.49×10^{-2}	1.97×10^{-1}	2.61×10^{-2}	2.98×10^{-3}
WSS	0-2	1.75×10^{-3}	8.38×10^{-3}	1.41×10^{-2}	2.09×10^{-1}	2.79×10^{-2}	4.47×10^{-3}
WSS	2-5	-7.54×10^{-5}	7.99×10^{-3}	1.36×10^{-2}	2.21×10^{-1}	2.94×10^{-2}	4.28×10^{-3}
WSS	5-10	-3.01×10^{-3}	8.04×10^{-3}	1.39×10^{-2}	2.37×10^{-1}	3.13×10^{-2}	6.67×10^{-3}

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration

Soil samples collected from one location (WFF) were divided into two parts and analyzed separately (Table 4.18). Concentrations of ^{234}U, ^{235}U, ^{238}U, ^{40}K, and ^{137}Cs were compared between the duplicates. Other radionuclides of interest had insufficient detections to allow a reasonable comparison. The RERs were less than 1.0, indicating good reproducibility for all duplicate samples except for ^{234}U at the 0-2 cm depth. This is probably due to nonhomogeneous distribution of radionuclides in the soils. Because of small-scale differences in topography, soil type and structure, soil moisture, and other microenvironmental conditions, radionuclides are rarely homogeneously distributed in soils, and good agreement between duplicate samples is sometimes difficult to achieve.

Table 4.18 - Results of Duplicate Soil Sample Analysis. Units are Bq/g. See Appendix C for the sampling location codes.

Location	Depth (cm)	[RN][a]	2×TPU[b]	MDC[c]	RER[d]	[RN]	2×TPU[a]	MDC[b]	RER[c]
		^{234}U				^{238}U			
WFF	0-2	9.29×10^{-3}	2.40×10^{-3}	1.61×10^{-4}	1.10	1.06×10^{-2}	2.66×10^{-3}	1.61×10^{-4}	0.69
WFF D[e]	0-2	1.36×10^{-2}	3.10×10^{-3}	4.04×10^{-4}		1.34×10^{-2}	3.08×10^{-3}	1.48×10^{-4}	
WFF	2-5	1.23×10^{-2}	2.86×10^{-3}	1.48×10^{-4}	0.08	9.70×10^{-3}	2.36×10^{-3}	1.47×10^{-4}	0.65
WFF D	2-5	1.20×10^{-2}	2.80×10^{-3}	1.49×10^{-4}		1.21×10^{-2}	2.82×10^{-3}	1.48×10^{-4}	
WFF	5-10	1.11×10^{-2}	2.63×10^{-3}	1.47×10^{-4}	0.43	1.10×10^{-2}	2.62×10^{-3}	1.47×10^{-4}	0.08
WFF D	5-10	1.28×10^{-2}	2.93×10^{-3}	1.38×10^{-4}		1.13×10^{-2}	2.62×10^{-3}	1.37×10^{-4}	
		^{235}U				^{137}Cs			
WFF	0-2	6.61×10^{-4}	4.61×10^{-4}	1.99×10^{-4}	0.03	1.41×10^{-3}	2.79×10^{-4}	2.74×10^{-4}	0.12
WFF D	0-2	6.77×10^{-4}	4.47×10^{-4}	1.83×10^{-4}		1.46×10^{-3}	3.23×10^{-4}	3.69×10^{-4}	
WFF	2-5	5.37×10^{-4}	3.94×10^{-4}	1.82×10^{-4}	0.44	1.81×10^{-3}	3.91×10^{-4}	4.47×10^{-4}	0.24
WFF D	2-5	8.12×10^{-4}	4.94×10^{-4}	1.84×10^{-4}		1.69×10^{-3}	3.06×10^{-4}	2.70×10^{-4}	
WFF	5-10	8.72×10^{-4}	5.12×10^{-4}	1.82×10^{-4}	0.10	1.66×10^{-3}	3.02×10^{-4}	2.70×10^{-4}	0.48
WFF D	5-10	9.42×10^{-4}	5.19×10^{-4}	1.70×10^{-4}		1.45×10^{-3}	3.21×10^{-4}	3.62×10^{-4}	
		^{40}K							
WFF	0-2	1.97×10^{-1}	2.62×10^{-2}	4.02×10^{-3}	0.21				
WFF D	0-2	1.89×10^{-1}	2.76×10^{-2}	6.90×10^{-3}					
WFF	2-5	2.00×10^{-1}	2.92×10^{-2}	7.14×10^{-3}	0.13				
WFF D	2-5	2.05×10^{-1}	2.73×10^{-2}	3.44×10^{-3}					
WFF	5-10	1.97×10^{-1}	2.61×10^{-2}	2.98×10^{-3}	0.29				
WFF D	5-10	2.08×10^{-1}	2.75×10^{-2}	5.58×10^{-3}					

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

4.7 Biota

4.7.1 Sample Collection

The concentration of radionuclides in plants is an important factor in estimating the intake of individual radionuclides by humans through ingestion. Therefore, rangeland vegetation samples were collected from the same six locations from which the soil samples were collected (Figure 4.4). Locations were selected based on the direction of prevailing winds. Also collected were muscle tissues from one deer and one quail, both species commonly consumed by humans. Fish is also consumed in large amounts; therefore, a sample of fish from the Pecos River was also collected. All biota samples, when available, were analyzed for concentrations of the radionuclides of interest.

Due to abnormally low water levels in the Pecos River, fishing was restricted to the collection of one sample from one location (lower Pecos). Neither Pierce Canyon (PCN) nor Brantley Lake (BRA) had sufficient water levels to warrant collection of fish samples. In fact, the historic launch site at Pierce Canyon was dry, with adjacent accessible areas failing to have enough water to draft a boat. During 2003, Brantley Lake sustained the lowest recorded water levels since the construction of the reservoir (T. Davis, director, Carlsbad Irrigation District).

4.7.2 Sample Preparation

Vegetation

The vegetation samples were chopped into 2.5-5-cm (1-2-in.) pieces, mixed together well, and air dried at room temperature. Weighed aliquots were taken from the bulk of the chopped vegetation samples from each location. The aliquots were transferred into separate containers and dried at 100°C (212°F). Gamma spectrometric determinations of ^{40}K, ^{60}Co, and ^{137}Cs were performed directly from these aliquots. The samples were then dry-ashed, followed by wet-ashing and dissolution in 8 M nitric acid. Aliquots from the dissolved samples were taken for the determinations of ^{90}Sr, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239+240}$Pu, and ^{241}Am.

Animals

The samples of tissue were placed in a digestion beaker, concentrated nitric acid was added to cover the sample and the sample was heated until nearly dry. The sample was then wet ashed using nitric acid and hydrogen peroxide until the residue is light colored. The residue was dissolved in nitric acid and transferred to a Teflon beaker. Concentrated hydrofluoric acid was added and the sample was heated to dryness. Concentrated nitric acid and boric acid was added and the sample was heated again to dryness. The sample was then dissolved in nitric acid and transferred back into its original glass beaker. It was then heated in a muffle oven at 350-375°C for 8-12 hours. If gamma analysis was required, 5M nitric acid was added to the sample to 500 ml and it was heated to dryness after counting was completed. The sample then underwent another wet ashing and it was ready for the isotopic separation process.

4.7.3 Results and Discussion

Vegetation

Uranium-234 and ^{238}U were detected in all vegetation samples. Uranium-235 was detected in 83 percent of the samples (Table 4.19). Statistical comparison of concentrations of ^{234}U and ^{238}U between years 2002 and 2003 indicated higher concentrations in 2003 for both isotopes (ANOVA, ^{234}U $p = 0.019$, ^{238}U $p = 0.010$). In addition, comparison of detected uranium concentrations with baseline values suggest higher concentrations in 2003 for all three uranium isotopes than during the years in which the baseline data were collected (1985-1989, DOE/WIPP 92-037). The word "suggest" must be used, as the small sample sizes analyzed in the baseline study did not permit the fitting of probability distributions to the baseline results. This resulted in comparisons of 2003 data having to be made to the mean ± the standard error of a few baseline samples as opposed to the upper 99th percentile as was done for other environmental media. This was true for all radioisotopes in vegetation samples. The primary source for uranium in plant tissues is the soil. Therefore, the apparent increase in uranium concentrations from 2002 to 2003, while soil concentrations of these same isotopes remained statistically the same, may seem counterintuitive. However, uptake of radionuclides and contamination by resuspension are highly species dependent. Because of small-scale differences in soil type, shading, water availability, and other microenvironmental conditions, plants of the same species collected adjacent to one another and/or at the same time, will often have very different radionuclide concentrations. Based upon uranium concentrations found in other environmental media, there is nothing to suggest that the slightly higher levels found in vegetation in 2003 were the result of WIPP operations. This is also borne out by comparisons of uranium concentrations in animal tissue samples to baseline values, as discussed below.

Plutonium-238 and ^{241}Am were not detected in any of the vegetation samples (Table 4.19). Plutonium-239+240 was detected in one sample at location SEC. However, this concentration was extremely low and the associated MDC fell within the total error associated with the result. In addition, this concentration fell within the mean ± 1 standard error of baseline values (DOE/WIPP 92-037). This information taken as a whole indicates no increase in actinide concentrations in plants as a result of WIPP operations.

Potassium-40 was detected in every vegetation sample (Table 4.19). The concentration of ^{40}K in vegetation showed a statistically significant difference between 2002 and 2003, with 2002 having the higher concentrations (ANOVA, $p = 0.0002$). However, ^{40}K concentrations fell within the range of baseline levels. Like uranium, the primary source for potassium in plant tissues is the soil, and variation between years in its concentration in plants but not in its soil concentrations is probably due to the same factors discussed above.

Cesium-137 and ^{60}Co were not detected in vegetation samples. Strontium-90 was detected once at sampling location WSS (Table 4.19). As with the single $^{239+240}$Pu detection, this concentration was very small and the MDC fell within the total error associated with the result. There were insufficient detections of these fission products to allow statistical comparisons between years. No comparison with baseline data was available for the single detected ^{90}Sr concentration, as it was not reported for vegetation samples analyzed for the baseline report (DOE/WIPP 92-037). Even so, there is no indication from results of ^{90}Sr concentrations measured in other environmental media that WIPP operations have resulted in any increase of ^{90}Sr in vegetation over baseline levels.

Table 4.19 - Radionuclide Concentrations (Bq/g Wet Mass) in Vegetation Near the WIPP Site. See Appendix C for the sampling location codes.

Location	[RN][a]	2×TPU[b]	MDC[c]	[RN]	2×TPU	MDC	[RN]	2×TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}$Pu		
MLR	3.50×10^{-5}	4.08×10^{-5}	3.16×10^{-5}	4.65×10^{-5}	9.34×10^{-5}	1.67×10^{-4}	1.55×10^{-5}	5.37×10^{-5}	1.14×10^{-4}
SEC	4.78×10^{-5}	4.85×10^{-5}	3.24×10^{-5}	-1.45×10^{-5}	6.48×10^{-5}	1.56×10^{-4}	1.01×10^{-4}	7.28×10^{-5}	3.92×10^{-5}
SMR	2.75×10^{-5}	5.51×10^{-5}	1.01×10^{-4}	-1.27×10^{-5}	4.41×10^{-5}	1.18×10^{-4}	2.54×10^{-5}	5.09×10^{-5}	9.35×10^{-5}
WEE	3.50×10^{-5}	5.24×10^{-5}	8.58×10^{-5}	1.33×10^{-5}	5.94×10^{-5}	1.23×10^{-4}	1.32×10^{-5}	2.66×10^{-5}	3.59×10^{-5}
WFF	4.59×10^{-5}	6.89×10^{-5}	1.13×10^{-4}	-3.21×10^{-5}	7.88×10^{-5}	1.93×10^{-4}	3.20×10^{-5}	6.43×10^{-5}	1.18×10^{-4}
WSS	0.00×10^{0}	N/A[d]	1.22×10^{-4}	0.00×10^{0}	N/A[d]	5.12×10^{-5}	1.89×10^{-5}	6.55×10^{-5}	1.39×10^{-4}
	^{234}U			^{235}U			^{238}U		
MLR	6.33×10^{-3}	1.20×10^{-3}	3.53×10^{-5}	3.21×10^{-4}	1.53×10^{-4}	4.35×10^{-5}	5.85×10^{-3}	1.11×10^{-3}	3.51×10^{-5}
SEC	2.09×10^{-3}	5.33×10^{-4}	4.50×10^{-5}	1.23×10^{-4}	1.03×10^{-4}	5.56×10^{-5}	2.45×10^{-3}	6.01×10^{-4}	4.48×10^{-5}
SMR	5.45×10^{-3}	1.25×10^{-3}	1.80×10^{-4}	3.59×10^{-4}	1.98×10^{-4}	6.49×10^{-5}	6.01×10^{-3}	1.36×10^{-3}	5.24×10^{-5}
WEE	1.10×10^{-3}	2.90×10^{-4}	8.70×10^{-5}	8.74×10^{-5}	7.27×10^{-5}	3.95×10^{-5}	1.13×10^{-3}	2.91×10^{-4}	3.19×10^{-5}
WFF	1.74×10^{-3}	4.25×10^{-4}	9.44×10^{-5}	7.90×10^{-5}	7.20×10^{-5}	4.28×10^{-5}	1.66×10^{-3}	4.09×10^{-4}	9.40×10^{-5}
WSS	1.55×10^{-3}	4.27×10^{-4}	1.36×10^{-4}	9.12×10^{-5}	9.24×10^{-5}	6.18×10^{-5}	1.77×10^{-3}	4.62×10^{-4}	4.99×10^{-5}
	^{137}Cs			^{60}Co					
MLR	2.58×10^{-4}	2.69×10^{-4}	3.30×10^{-4}	2.16×10^{-4}	3.83×10^{-4}	4.55×10^{-4}			
SEC	-9.45×10^{-5}	2.95×10^{-4}	3.37×10^{-4}	-6.43×10^{-5}	3.82×10^{-4}	4.26×10^{-4}			
SMR	-3.64×10^{-4}	5.86×10^{-4}	6.25×10^{-4}	2.75×10^{-4}	6.06×10^{-4}	6.73×10^{-4}			
WEE	-1.05×10^{-3}	6.23×10^{-4}	5.99×10^{-4}	2.14×10^{-4}	5.93×10^{-4}	6.58×10^{-4}			
WFF	1.11×10^{-4}	2.64×10^{-4}	3.17×10^{-4}	4.09×10^{-5}	3.85×10^{-4}	4.42×10^{-4}			
WSS	7.95×10^{-5}	2.69×10^{-4}	3.22×10^{-4}	7.88×10^{-5}	3.78×10^{-4}	4.38×10^{-4}			
	^{90}Sr			^{40}K					
MLR	5.82×10^{-4}	2.87×10^{-3}	4.87×10^{-3}	8.96×10^{-1}	1.50×10^{-2}	3.52×10^{-3}			
SEC	4.78×10^{-3}	3.14×10^{-3}	5.00×10^{-3}	1.24×10^{-1}	2.08×10^{-2}	4.13×10^{-3}			
SMR	2.17×10^{-3}	3.52×10^{-3}	5.87×10^{-3}	1.35×10^{-1}	2.29×10^{-2}	8.67×10^{-3}			
WEE	4.24×10^{-3}	2.94×10^{-3}	4.71×10^{-3}	8.63×10^{-2}	1.54×10^{-2}	8.04×10^{-3}			
WFF	4.00×10^{-3}	3.25×10^{-3}	5.26×10^{-3}	1.04×10^{-1}	1.76×10^{-2}	4.37×10^{-3}			
WSS	5.60×10^{-3}	3.01×10^{-3}	4.73×10^{-3}	6.87×10^{-2}	1.21×10^{-2}	4.24×10^{-3}			

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

A duplicate analysis of the vegetation sample from sampling location SEC was performed for all the radionuclides of interest. RERs were calculated for those duplicate pairs for which each sample was detected (Table 4.20). RER values were less than one for all radioisotopes, indicating good reproducibility.

Table 4.20 - Results of Duplicate Vegetation Sample Analysis. Units are Bq/g. See Appendix C for the sampling location codes.

Location	[RN][a]	2×TPU[b]	MDC[c]	RER[d]	[RN]	2×TPU	MDC	RER
	^{234}U				^{40}K			
SEC	2.09×10^{-3}	5.33×10^{-4}	4.50×10^{-5}	0.76	1.24×10^{-1}	2.08×10^{-2}	4.13×10^{-3}	0.80
SEC Dup.[e]	3.00×10^{-3}	1.08×10^{-3}	1.20×10^{-4}		1.50×10^{-1}	2.52×10^{-2}	7.86×10^{-3}	
	^{238}U							
SEC	2.45×10^{-3}	6.01×10^{-4}	4.48×10^{-5}	0.68				
SEC Dup.	1.80×10^{-3}	7.37×10^{-4}	1.19×10^{-4}					

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Relative error ratio
[e] Duplicate

Animals

Of the radionuclides of interest, ^{234}U, ^{235}U,^{238}U, ^{40}K, $^{239+240}$Pu, ^{60}Co, and ^{90}Sr were detected in animal tissues (Table 4.21). All uranium isotopes, ^{40}K, and $^{239+240}$Pu were detected in all animals. Cobalt-60 was detected in deer and ^{90}Sr in quail. Americium-241 and ^{238}Pu were not detected in any of the animal samples. Although there were too few samples to allow statistical comparison between years, detected radionuclide concentrations in all samples fell within the range of concentrations for the same animals determined during baseline data analyses (DOE/WIPP 92-037). These results can be used only as a gross indication of uptakes, as the sample sizes are too small to provide a robust analysis; however, the data do not suggest any contribution to animal uptake of the radionuclides of interest due to WIPP operations. Due to the limited sample sizes of only one sample per animal type, duplicate analyses were not performed.

Table 4.21 - Radionuclide Concentrations (Bq/g Wet Mass) in Deer, Quail, and Fish Near the WIPP Site

Sample Type	[RN][a]	2×TPU[b]	MDC[c]	[RN]	2×TPU	MDC	[RN]	2×TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}$Pu		
Deer[d]	1.99×10^{-6}	2.84×10^{-6}	2.70×10^{-6}	0.00×10^{0}	N/A[e]	1.01×10^{-5}	3.15×10^{-5}	1.56×10^{-5}	1.28×10^{-5}
Quail[d]	5.65×10^{-7}	5.73×10^{-7}	3.83×10^{-7}	1.21×10^{-7}	2.42×10^{-7}	3.26×10^{-7}	9.63×10^{-7}	6.97×10^{-7}	3.26×10^{-7}
Fish[d]	0.00×10^{0}	N/A[e]	3.41×10^{-6}	1.18×10^{-6}	2.36×10^{-6}	3.17×10^{-6}	7.02×10^{-6}	5.88×10^{-6}	3.17×10^{-6}
	^{234}U			^{235}U			^{238}U		
Deer	2.51×10^{-5}	6.27×10^{-6}	7.55×10^{-7}	4.13×10^{-6}	2.45×10^{-6}	9.32×10^{-7}	2.41×10^{-5}	6.11×10^{-6}	7.52×10^{-7}
Quail	1.61×10^{-4}	2.87×10^{-5}	3.73×10^{-7}	8.83×10^{-6}	2.87×10^{-6}	4.60×10^{-7}	1.40×10^{-4}	2.52×10^{-5}	3.71×10^{-7}
Fish	3.69×10^{-4}	6.11×10^{-5}	1.59×10^{-6}	1.31×10^{-5}	6.44×10^{-6}	1.96×10^{-6}	1.83×10^{-4}	3.36×10^{-5}	1.59×10^{-6}
	^{137}Cs			^{60}Co					
Deer	1.09×10^{-4}	1.38×10^{-4}	1.68×10^{-4}	2.49×10^{-4}	1.94×10^{-4}	2.40×10^{-4}			
Quail	-7.71×10^{-5}	3.93×10^{-4}	4.33×10^{-4}	-1.18×10^{-4}	4.37×10^{-4}	4.81×10^{-4}			
Fish	-1.69×10^{-3}	1.06×10^{-3}	1.03×10^{-3}	4.85×10^{-4}	1.01×10^{-3}	1.13×10^{-3}			

Table 4.21 - Radionuclide Concentrations (Bq/g Wet Mass) in Deer, Quail, and Fish Near the WIPP Site

Sample Type	[RN][a]	2×TPU[b]	MDC[c]	[RN]	2×TPU	MDC	[RN]	2×TPU	MDC
	^{90}Sr			^{40}K					
Deer	5.99×10^{-4}	4.07×10^{-4}	6.37×10^{-4}	1.07×10^{-1}	1.75×10^{-2}	1.90×10^{-3}			
Quail	5.32×10^{-4}	7.78×10^{-5}	5.93×10^{-5}	1.05×10^{-1}	1.57×10^{-2}	4.96×10^{-3}			
Fish	5.08×10^{-5}	2.80×10^{-4}	4.85×10^{-4}	8.75×10^{-2}	1.74×10^{-2}	1.33×10^{-2}			

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Single sample
[e] Not applicable. An anomaly in the Canberra software for the alpha spectrometer prevents it from calculating uncertainty when the activity is 0.

4.8 Potential Dose from WIPP Operations

4.8.1 Dose Limits

Title 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," states "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem/year."

Compliance with the above regulatory requirement is determined by measuring effluent flow rate; monitoring, extracting, collecting, and measuring radionuclides; and calculating the EDE. The EDE is the weighted sum of the doses to the individual organs of the body. The dose to each organ is weighted according to the risk that dose represents. These organ doses are then added together, and that total is the EDE. In this manner, the risk from different sources of radiation can be controlled by a single standard.

Calculating the EDE to members of the public requires the use of CAP88-PC or other EPA approved computer models and procedures. The WIPP Effluent Monitoring Program generally uses CAP88-PC. CAP88-PC is a set of computer programs, datasets and associated utility programs for estimating dose and risk from radionuclide air emissions. CAP88-PC uses a Gaussian Plume dispersion model, which predicts air concentrations, deposition rates, concentrations in food, and intake rates for people. CAP88-PC estimates dose and risk to individuals and populations from multiple pathways. Dose and risk is calculated for ingestion, inhalation, ground level air immersion, and ground surface irradiation exposure pathways.

Environmental radiation protection standards for the management and disposal of TRU wastes set limits on the total annual radiation dose equivalent to members of the public at 0.25 mSv (25 mrem) to the whole body and 0.75 mSv (75 mrem) to any critical organ (40 CFR §191.03). National standards for emissions of radionuclides from DOE facilities state that the maximum annual dose equivalent to any member of the public from air emissions must be no greater than 0.1 mSv (10 mrem) (40 CFR §61.92). The SDWA (40 CFR §141.66) states that average annual concentrations of beta- and gamma-emitting human-made radionuclides in drinking water shall not result in an annual dose equivalent greater than 0.04 mSv (4 mrem). It is important to note that all of these dose equivalent limits are set for radionuclides released to the environment from DOE operations. They do not include, but are limits in addition to, doses from natural background radiation or from medical procedures.

4.8.2 Background Radiation

Radiation is a naturally occurring phenomenon that has been in the environment since the beginning of time. There are several sources of natural radiation: cosmic and cosmogenic radiation (from outer space and the earth's atmosphere), terrestrial radiation (from the earth's crust), and internal radiation (naturally occurring radiation in our bodies, such as ^{40}K). The most common sources of terrestrial radiation are uranium, thorium, and their decay products. Potassium-40 is another source of terrestrial radiation. While not a major radiation source, ^{40}K may be enhanced in the southeastern New Mexico environment due to the deposition of tailings from local potash mining. Radon gas, a decay product of uranium, is the most widely known naturally occurring terrestrial radionuclide. In addition to natural radioactivity, small amounts of radioactivity from above-ground nuclear weapons tests that occurred from 1945 through 1980 and the 1986 Chernobyl nuclear accident are also present in the environment. Together, these sources of radiation are called "background" radiation. Every human is constantly exposed to background radiation. Exposure to radioactivity from weapons testing fallout is quite small compared to natural radioactivity and continually gets smaller as radionuclides decay.

Naturally occurring radiation in our environment can deliver both internal and external doses. Internal dose is received as a result of the intake of radionuclides. The major routes of intake of radionuclides for members of the public are ingestion and inhalation. Ingestion includes the intake of the radionuclides from eating and drinking contaminated food or drink. Inhalation includes the intake of radionuclides through breathing dust particles containing radioactive materials or radon gas. External dose can occur from submersion in contaminated air or deposition of contaminants on surfaces. The average annual dose received by a member of the public from naturally occurring radionuclides is approximately 3 mSv (300 mrem) (Table 4.22).

Table 4.22 - Annual Estimated Average Radiation Dose Received by a Member of the Population of the United States from Naturally Occurring Radiation Sources (adapted from NCRP, 1987)

Source	Average Annual EDE (mSv)	(mrem)
Inhaled (Radon and Decay Products)	2	200
Internal Radionuclides	0.39	39
Terrestrial Radiation	0.28	28
Cosmic Radiation	0.27	27
Cosmogenic Radioactivity	0.01	1
Rounded Total from Natural Sources	3	300

4.8.3 Dose from Air Emissions

The NESHAP issued by the EPA set limits for radionuclide emissions to air (40 CFR Part 61, Subpart H). Compliance procedures for DOE facilities (40 CFR §61.93[a]) require the use of CAP88-PC or AIRDOS-PC computer models, or an equivalent, to calculate dose to members of the public. Source term input for CAP88-PC was determined by radiochemical analyses of filter air samples taken from the effluent Stations A, B, and C. Air filter samples were analyzed for ^{241}Am, $^{239+240}$Pu, ^{238}Pu, and ^{90}Sr because they constitute over 98 percent of the dose potential from CH waste. Measured activity values greater than the MDC were used as a part of the source term for the air emission pathway and, for measured results less than the MDC, the MDC value was used as part of the source term (see Table 4.1). CAP88-PC dose calculations are based on the assumption that exposed persons remain at home during the entire year and all vegetables, milk, and meat consumed are home produced. Thus, this dose calculation is a maximum potential dose which encompasses dose from inhalation, submersion, deposition, and ingestion of air emitted radionuclides.

For 2003, the CAP88-PC model predicted the effective equivalent dose to a receptor residing at the Smith Ranch, approximately 7.5 km (4.66 miles) west-northwest of WIPP. Results showed the whole body dose potentially received by the receptor residing at this location to be approximately 5.43×10^{-8} mSv (5.43×10^{-6} mrem) per year.

4.8.4 Total Potential Dose from WIPP Operations

The radiation dose equivalent received by members of the public as a result of the management and storage of TRU radioactive wastes at any disposal facility operated by the DOE is regulated under 40 CFR Part 191, Subpart A. Specific standards state that the combined annual dose equivalent to any member of the public in the general environment resulting from the discharges of radioactive material and direct radiation from management and storage shall not exceed 0.25 mSv (25 mrem) to the whole body and 0.75 mSv (75 mrem) to any other critical organ. Section 4.8.3 discussed the potential dose equivalent received from radionuclides released to the air from WIPP. The following sections discuss the potential dose equivalent through other pathways and the total potential dose equivalent a member of the public may have received from WIPP operations during 2003.

4.8.4.1 Potential Dose from Water Ingestion Pathway

The potential dose to individuals from the ingestion of WIPP-related radionuclides transported in water is determined to be near zero for several reasons. Drinking water for communities near WIPP comes from groundwater sources which are not expected to be affected by potential WIPP contaminants based on current radionuclide transport scenarios summarized in *Waste Isolation Pilot Plant Contact-Handled (CH) Documented Safety Analysis*, DOE/WIPP 95-2065. The only credible pathway for contaminants from WIPP to accessible groundwater is through the Culebra Member of the Rustler Formation as stated in DOE/CAO 96-2184, *40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant*. Water from the Culebra is naturally not potable due to high levels of TDS. Water from the Dewey Lake Redbeds Formation is suitable for livestock consumption having TDS values below 10,000 mg/L. Groundwater and surface water samples collected around WIPP during 2003 did not contain radionuclide concentrations discernable from those in samples collected prior to WIPP receiving waste.

4.8.4.2 Potential Dose from Wild Game Ingestion

Game animals sampled during 2003 were mule deer, quail, and fish. The only radionuclides detected were not different from baseline levels measured prior to commencement of waste shipments to WIPP. Therefore, no dose from WIPP-related radionuclides could have been received by any individual from this pathway during 2003.

4.8.4.3 Total Potential Dose from All Pathways

Air emissions was the only credible pathway to humans and, therefore, was the only pathway for which a dose was calculated. Air emissions from WIPP were not above background ambient air levels. The EDE potentially received by the maximally exposed individual assumed to be residing 7.5 km (4.66 miles) west-northwest of WIPP was calculated to be 5.43×10^{-8} mSv (5.43×10^{-6} mrem) per year whole body. This value is in compliance with the requirements of 0.1 mSv (10 mrem) per year as specified in 40 CFR §61.92. The total radiological dose and atmospheric release at WIPP in 2003 is summarized in Table 4.23.

Table 4.23 - WIPP Radiological Dose and Release Summary

WIPP Radiological Atmospheric Releases [a] During 2003			
^{238}Pu	$^{239+240}Pu$	^{241}Am	^{90}Sr
4.9×10^{-8} Ci[b]	4.3×10^{-8} Ci	1.0×10^{-7} Ci	3.6×10^{-6} Ci
1.81×10^{3} Bq[c]	1.59×10^{3} Bq	3.70×10^{3} Bq	1.33×10^{5} Bq

WIPP Radiological Dose Reporting Table in 2003 per 40 CFR §61.92							
Pathway	EDE to the Maximally Exposed Individual at 7500 Meters WNW		% of EPA 10-mrem/ year limit to member of the public	Estimated Population Dose within 50 miles		Estimated Population within 50 miles	Estimated Natural Radiation Population Dose[d]
	(mrem/year)	(*mSv/year*)		*(person-rem/year)*	(*person-Sv/year*)		(*person-rem*)
Air	5.43×10^{-6}	5.43×10^{-8}	5.43×10^{-5}	3.87×10^{-5}	3.87×10^{-7}	100944	30288
Water	N/A[e]	N/A	N/A	N/A	N/A	N/A	N/A
Other Pathways	N/A	N/A	N/A	N/A	N/A	N/A	N/A

WIPP Radiological Dose Reporting Table in 2003 per 40 CFR §191.03(b)						
Pathway	Dose equivalent to the receptor's whole body resides year-round at WIPP fence line 350 meters NW		% of EPA 25-mrem/year whole body limit	Dose equivalent to the receptor's critical organ resides year-round at WIPP fence line 350 meters NW		% of EPA 75-mrem/year critical organ limit
	(*mrem/year*)	*(mSv/year)*		*(mrem/year)*	*(mSv/year)*	
Air	1.15×10^{-4}	1.15×10^{-6}	4.6×10^{-4}	1.85×10^{-3}	1.85×10^{-5}	2.47×10^{-3}
Water	N/A[e]	N/A	N/A	N/A	N/A	N/A
Other Pathways	N/A	N/A	N/A	N/A	N/A	N/A

[a] Total releases from the combination of the WIPP Effluent Monitoring Stations A, B, and C. Values are calculated from detected activities or MDA values (where activities were less than MDA) and multiplied by the ratio of flow to stack flow volumes.
[b] Curies
[c] Becquerels
[d] Estimated natural radiation populations dose = (Estimated population within 50 miles) x (300 mrem/year)
[e] Not applicable at WIPP

In compliance with 40 CFR Part 191, Subpart A, the receptor selected is assumed to reside year-round at the WIPP fence line located 350 meters in the NW sector. The dose to this receptor is estimated to be 1.15×10^{-6} mSv (1.15×10^{-4} mrem) per year whole body and 1.85×10^{-5} mSv (1.85×10^{-3} mrem) per year to the critical organ. These values are in compliance with the requirements specified in 40 CFR §191.03(b).

4.8.5 Dose to Nonhuman Biota

Dose limits below which deleterious effects on populations of aquatic and terrestrial organisms are acceptably low have been discussed in NCRP Report No. 109, *Effects of*

Ionizing Radiation on Aquatic Organisms (NCRP, 1991), and the International Atomic Energy Agency (IAEA Technical Report Series No. 332). Those dose limits are:

- Aquatic animals - 10 mGy/d (1 rad/d)
- Terrestrial plants - 10 mGy/d (1 rad/d)
- Terrestrial animals - 1 mGy/d (0.1 rad/d)

The DOE has considered establishing these dose standards for aquatic and terrestrial biota in proposed rule 10 CFR Part 834, "Radiation Protection of the Public and the Environment" but has delayed finalizing this rule until guidance for demonstrating compliance was developed. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002) was developed to meet this need. The DOE requires reporting of radiation doses to nonhuman biota in the annual SER using DOE-STD-1153-2002.

The DOE-STD-1153-2002 requires an initial general screening using conservative assumptions. In the initial screen, biota concentration guides (BCGs) are derived using conservative assumptions for a variety of generic organisms. Maximum concentrations of radionuclides detected in soil, sediment, and water during environmental monitoring are divided by the BCGs and the results are summed for each organism. If the sum of these fractions is less than 1, the site is deemed to have passed the screen and no further action is required. This screening evaluation is intended to provide a very conservative evaluation of whether the site is in compliance with the recommended limits.

This guidance was used to screen radionuclide concentrations observed around WIPP during 2003 using the maximum radionuclide concentrations listed in Table 4.24. The sum of fractions was less than one for all media, demonstrating compliance with the proposed rule.

Table 4.24 - General Screening Results for Potential Radiation Dose to Nonhuman Biota from Radionuclide Concentrations in Surface Water (Bq/L), Sediment (Bq/g), and Soil (Bq/g) Near the WIPP Site in 2003.

Medium	Radionuclide	Maximum Observed Concentration	BCG	Concentration/BCG
		Aquatic System Evaluation		
Sediment (Bq/g)	^{60}Co	3.44×10^{-4}	5.00×10^{1}	6.88×10^{-6}
	^{137}Cs	6.86×10^{-3}	1.00×10^{2}	6.86×10^{-5}
	^{234}U	4.58×10^{-2}	2.00×10^{2}	2.29×10^{-4}
	^{235}U	2.22×10^{-3}	1.00×10^{2}	2.22×10^{-5}
	^{238}U	3.49×10^{-2}	9.00×10^{1}	3.88×10^{-4}
	^{239}Pu	7.75×10^{-4}	2.00×10^{2}	3.88×10^{-6}
	^{241}Am	2.82×10^{-4}	2.00×10^{2}	1.41×10^{-6}
Water[b] (Bq/L)	^{60}Co	6.13×10^{-1}	1.00×10^{2}	6.13×10^{-3}
	^{137}Cs	2.09×10^{-1}	2.00×10^{0}	1.05×10^{-1}
	^{234}U	2.50×10^{-1}	7.00×10^{0}	3.57×10^{-2}
	^{235}U	1.31×10^{-2}	8.00×10^{0}	1.64×10^{-3}
	^{238}U	2.66×10^{-1}	8.00×10^{0}	3.33×10^{-2}
	^{239}Pu	3.01×10^{-3}	7.00×10^{0}	4.30×10^{-4}
	^{241}Am	1.31×10^{-3}	2.00×10^{1}	6.55×10^{-5}
			Sum of Fractions	1.83×10^{-1}
		Terrestrial System Evaluation		
Soil (Bq/g)	^{60}Co	5.35×10^{-4}	3.00×10^{1}	1.78×10^{-5}
	^{137}Cs	1.01×10^{-2}	8.00×10^{-1}	1.26×10^{-2}
	^{234}U	2.57×10^{-2}	2.00×10^{2}	1.29×10^{-4}
	^{235}U	2.05×10^{-3}	1.00×10^{2}	2.05×10^{-5}
	^{238}U	2.81×10^{-2}	6.00×10^{1}	4.68×10^{-4}
	^{239}Pu	6.55×10^{-4}	2.00×10^{2}	3.28×10^{-6}
	^{241}Am	5.16×10^{-4}	1.00×10^{2}	5.16×10^{-6}
Water (Bq/L)	^{60}Co	6.13×10^{-1}	4.00×10^{4}	1.53×10^{-5}
	^{137}Cs	2.09×10^{-1}	2.00×10^{4}	1.05×10^{-5}
	^{234}U	2.50×10^{-1}	1.00×10^{4}	2.50×10^{-5}
	^{235}U	1.31×10^{-2}	2.00×10^{4}	6.55×10^{-7}
	^{238}U	2.66×10^{-1}	2.00×10^{4}	1.33×10^{-5}
	^{239}Pu	3.01×10^{-3}	7.00×10^{3}	4.30×10^{-7}
	^{241}Am	1.31×10^{-3}	7.00×10^{3}	1.87×10^{-7}
			Sum of Fractions	1.33×10^{-2}

[a] The radionuclide concentration in the medium that would produce a radiation dose in the organism equal to the dose limit under the conservative assumptions in the model.
[b] Sediment and water samples were assumed to be co-located.
Note: Maximum detected concentrations were compared with BCG[a] values to assess potential dose to biota. As long as the sum of the ratios between observed maximum concentrations and the associated BCG is below 1.0, no adverse effects on plant or animal populations are expected (DOE-STD-1153-2002).

4.8.6 Release of Property Containing Residual Radioactive Material

There was no release of radiologically contaminated materials or property in 2003. The release of contaminated materials or property at WIPP is prevented based on contractor institutional controls.

4.9 Radiological Program Conclusions

Effluent Monitoring

For calendar year 2003, the EDE to the maximally exposed individual from normal operations conducted at the WIPP is less than 5.43×10^{-6} mrem per year. For the WIPP Effluent Monitoring Program, Figure 4.5 and Table 4.25 show the EDE to the maximally exposed individual for calendar years 1999 to 2003. Note that these EDE values are more than six orders of magnitude below the EPA standard of 10 mrem per year as specified in 40 CFR §61.92.

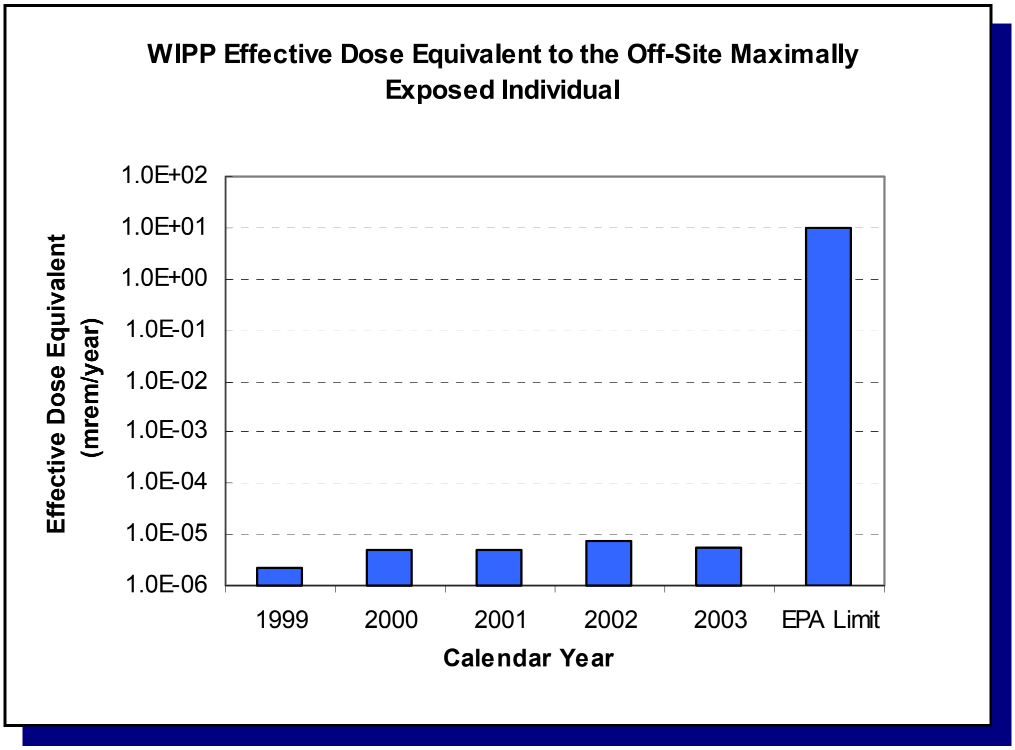

Figure 4.5 - WIPP Effective Dose Equivalent to the Off-Site Maximally Exposed Individual

Table 4.25 - Comparison of Effective Dose Equivalents to EPA Limit

Year	Annual Dose (mrem/yr)	Percent of EPA Limit
1999	2.23E-06	22.3 millionth
2000	5.18E-06	51.8 millionth
2001	4.96E-06	49.6 millionth
2002	7.61E-06	76.1 millionth
2003	5.43E-06	54.3 millionth

Environmental Monitoring

Radionuclide concentrations observed in environmental monitoring were extremely small and mostly comparable to radiological baseline levels. In cases where the radionuclide concentrations slightly exceeded baseline levels (uranium isotopes, ^{60}Co, and ^{40}K in some samples), these differences are most likely due to natural spatial variability. However, even if they were assumed to have originated from WIPP operations, there is no impact to human health or the environment since the resulting doses are so far below the regulatory limit. Therefore, it is concluded that no changes to WIPP operations are needed.

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CHAPTER 5 - ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

Nonradiological programs at WIPP include wildlife population monitoring, meteorological monitoring, and seismic monitoring, VOC monitoring to comply with the provisions of WIPP's hazardous waste permit, and surface water monitoring in accordance with WIPP's Discharge Permit (DP-831). Groundwater monitoring is discussed in Chapter 6.

5.1 Principal Functions of Nonradiological Sampling

The principal functions of the nonradiological environmental surveillance program are to:

- Assess the impacts of WIPP operations on the surrounding ecosystem;
- Monitor ecological conditions in the Los Medaños region;
- Investigate unusual or unexpected elements in the ecological databases;
- Provide environmental data which are important to the mission of the WIPP project, but which have not or will not be acquired by other programs; and
- Comply with applicable commitments identified with existing agreements (e.g., BLM/DOE MOU and Interagency Agreements).

5.2 WIPP Raptor Research Program

During 2003, the DOE reexamined the need for its raptor research program. It recognized that these studies have resulted in a better understanding of how to conduct WIPP activities in a manner that protects WIPP raptor populations from the impacts of human activities. It recognized that raptor management is now a well-established environmental protection policy at WIPP and will continue as a part of WIPP's land management and biological monitoring programs. However, the DOE determined there is little new information to be gained from continuing the raptor research program and decided to discontinue this program.

5.3 Meteorology

The primary WIPP meteorological station is located 600 m (1,970 ft) northeast of the Waste Handling Building. The main function of the station is to provide data for atmospheric dispersion modeling. The station measures and records wind speed, wind direction, and temperature at elevations of 2,10, and 50 m (6.5, 33, and 165 ft). Measurements taken at 10 m (33 ft) are provided in this report. The station also records ground-level measurements of barometric pressure, relative humidity, precipitation, and solar radiation.

5.3.1 Climatic Data

The precipitation at the WIPP site for 2003 was 206 mm (8.01 in.), which was 80 mm (3.15 in.) less than the previous year's rainfall. Figure 5.1 displays the monthly precipitation at WIPP.

The mean temperature at the WIPP site in 2003 was 18.1°C (64.6°F). The mean monthly temperatures for the WIPP area ranged from 8.1°C (46.6°F) during January to 27.5°C (81.5°F) in July. Generally, maximum temperatures occurred from May through September, while minimum temperatures occurred in January, November, and December. The lowest recorded temperature was -9.1°C (15.6°F) in December. The maximum recorded temperature was 39.2°C (102.7°F) in August. Monthly temperatures are illustrated in Figures 5.2, 5.3, and 5.4.

5.3.2 Wind Direction and Wind Speed

Winds in the WIPP area are predominantly from the southeast. Seasonal weather systems move through this area, briefly altering the predominant southeasterly winds and sometimes resulting in violent convectional storms.

In 2003, wind speed measured at the 10-m (33-ft) level were calm (less than 0.5 meters per second [m/s]) (1.1 miles per hour [mph]) less than one percent of the time. Winds of 3.71 through 6.30 m/s (1.12 to 3.15 mph) were the most prevalent over 2003, occurring 36.55 percent of the time. Figure 5.5 displays the annual wind data at WIPP for 2003.

Precipitation Report
January 1, 2003 to December 31, 2003

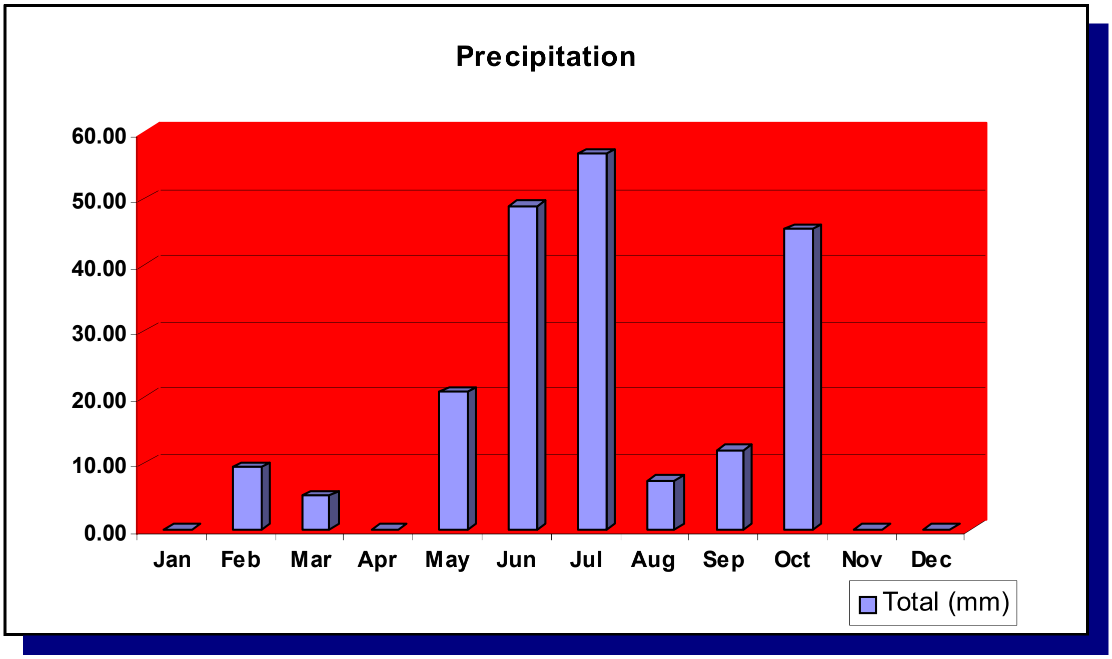

Figure 5.1 - 2003 Precipitation at WIPP

Month	Total (mm)
January	0.00
February	9.32
March	5.04
April	0.00
May	20.80
June	49.00
July	56.85
August	7.35
September	11.89
October	45.47
November	0.00
December	0.00

Temperature Report - Highs
January 1, 2003, to December 31, 2003, Elevation 10.0 meters

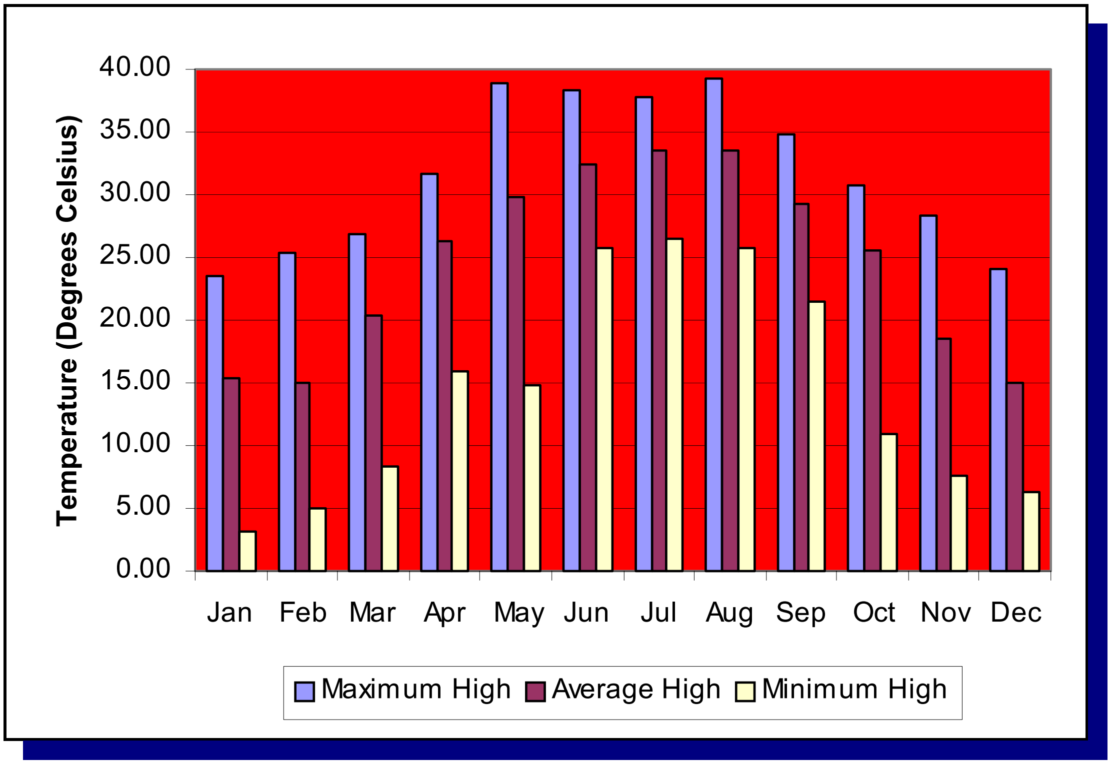

Figure 5.2 - 2003 High Temperatures at WIPP

Month	Maximum High	Average High	Minimum High
January	23.51	15.44	3.09
February	25.32	15.04	5.00
March	26.82	20.29	8.39
April	31.61	26.34	16.01
May	38.88	29.89	14.90
June	38.26	32.33	25.76
July	37.82	33.60	26.48
August	39.22	33.45	25.78
September	34.82	29.19	21.52
October	30.69	25.50	11.00
November	28.38	18.43	7.59
December	24.00	14.98	6.34

Temperature Report - Averages
January 1, 2003, to December 31, 2003, Elevation 10.0 meters

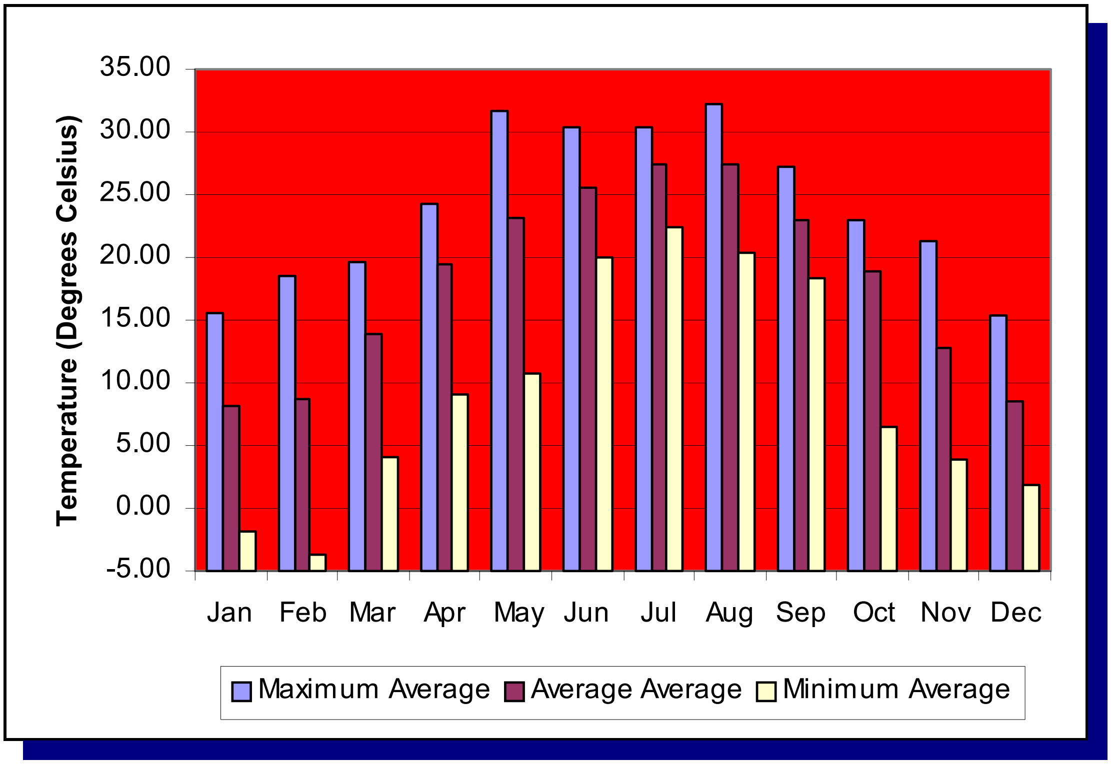

Figure 5.3 - 2003 Average Temperatures at WIPP

Month	Maximum Average	Average Average	Minimum Average
January	15.50	8.14	-1.94
February	18.59	8.76	-3.63
March	19.63	13.81	4.13
April	24.19	19.49	9.00
May	31.64	23.19	10.79
June	30.30	25.61	20.01
July	30.29	27.45	22.48
August	32.28	27.43	20.28
September	27.27	22.99	18.31
October	22.95	18.93	6.56
November	21.34	12.80	3.87
December	15.40	8.46	1.86

Temperature Report - Averages
January 1, 2003, to December 31, 2003, Elevation 10.0 meters

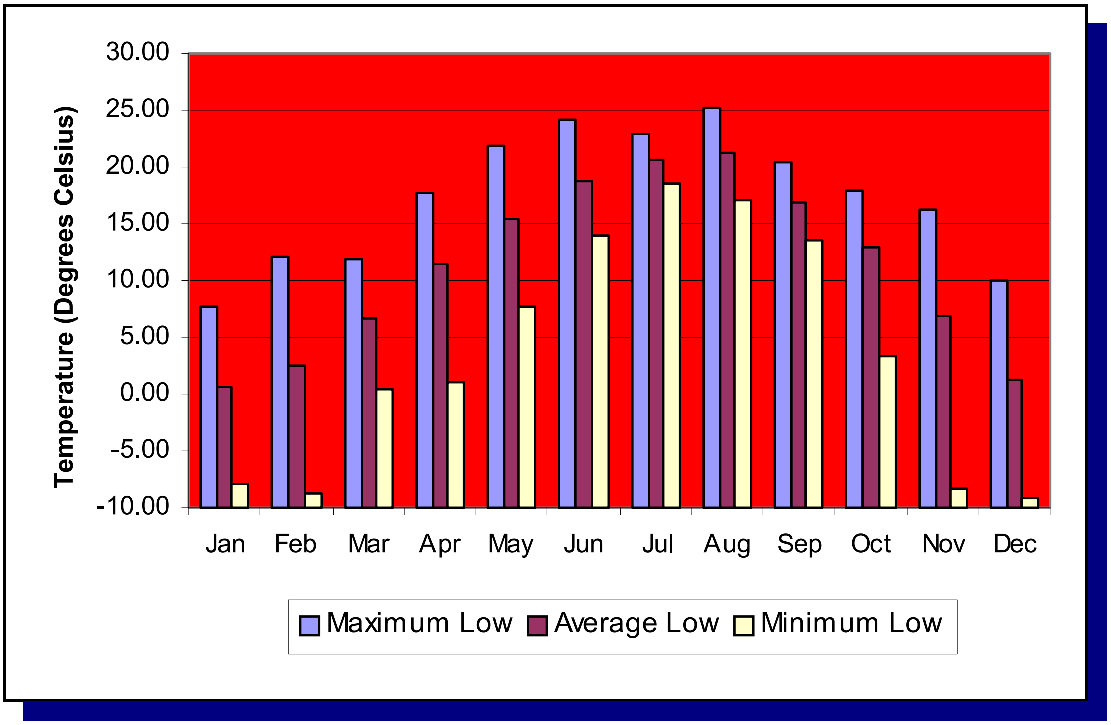

Figure 5.4 - 2003 Low Temperatures at WIPP

Month	Maximum Low	Average Low	Minimum Low
January	7.70	0.54	-7.90
February	12.12	2.56	-8.84
March	11.80	6.59	0.39
April	17.66	11.53	1.00
May	21.81	15.48	7.71
June	24.09	18.77	14.00
July	23.01	20.70	18.54
August	25.29	21.27	16.99
September	20.34	16.87	13.51
October	17.95	13.01	3.43
November	16.35	6.78	-8.40
December	9.92	1.29	-9.10

Wind Speed Report (Meters/Second)
January 1, 2003, to December 31, 2003, Elevation 10.0 meters

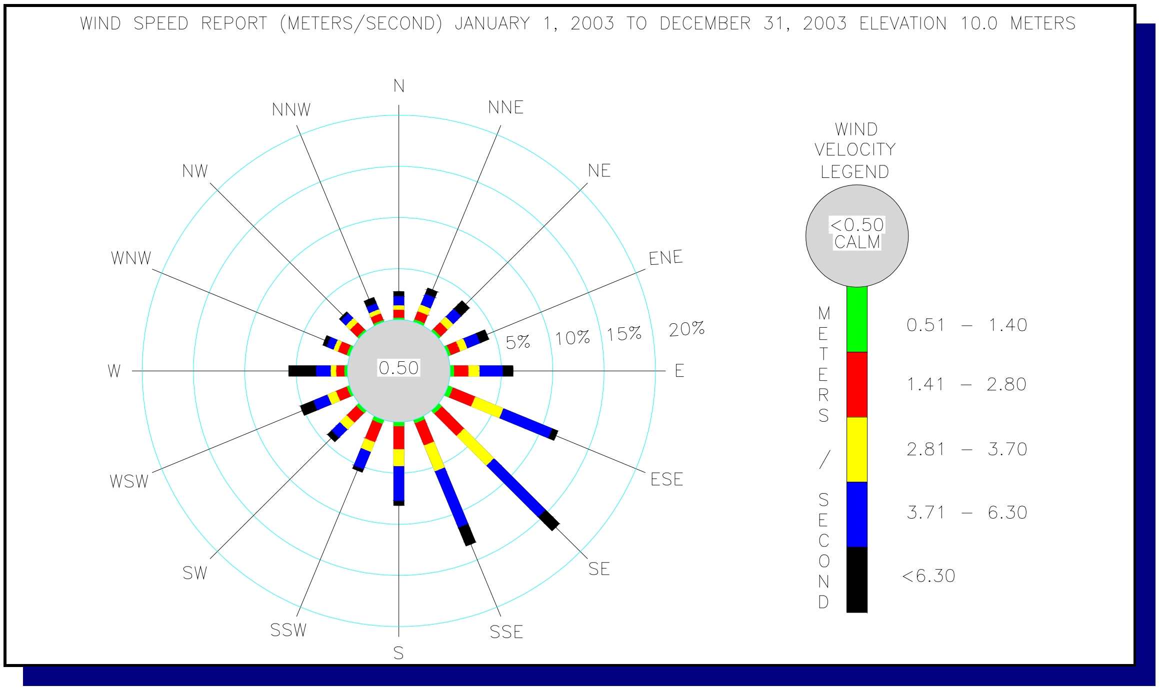

Figure 5.5 - 2003 Wind Speed Direction (meters/second)

Wind Direction	0.0-0.50	0.51-1.40	1.41-2.80	2.81-3.70	3.71-6.30	>6.30	Total Percent Occurrence by Direction
E	0.05	0.42	1.39	1.10	2.51	0.70	6.16
ENE	0.05	0.32	0.98	0.75	1.34	0.89	4.32
NE	0.03	0.30	0.95	0.76	1.09	1.11	4.25
NNE	0.03	0.24	0.90	0.71	1.13	0.61	3.62
N	0.01	0.18	0.76	0.43	0.9	0.50	2.78
NNW	0.04	0.23	0.68	0.44	0.65	0.59	2.63
NW	0.01	0.25	0.98	0.59	0.68	0.19	2.70
WNW	0.03	0.28	0.91	0.46	0.72	0.44	2.85
W	0.03	0.28	0.79	0.54	1.42	2.70	5.75
WSW	0.03	0.26	1.13	0.90	1.49	1.40	5.21
SW	0.02	0.31	1.32	0.95	1.15	0.59	4.35
SSW	0.03	0.40	1.92	1.03	1.84	0.35	5.56
S	0.02	0.39	2.23	1.66	3.4	0.49	8.20
SSE	0.03	0.39	2.33	2.74	5.96	1.92	13.36
SE	0.04	0.40	3.05	4.12	7.11	1.94	16.66
ESE	0.03	0.48	2.34	2.97	5.15	0.63	11.60
	0.48%	0.05	22.64%	20.15%	36.55%	15.06%	100.00%

5.4 Volatile Organic Compound Monitoring

VOC monitoring was implemented on April 21, 1997, in accordance with WP12-VC.01, *Confirmatory Volatile Organic Compound Monitoring Program*. This program is a requirement of the HWFP Condition IV.D and Attachment N. VOC monitoring is performed to verify that regulated VOCs emitted by the waste are within the concentration limits specified by the HWFP.

Nine target compounds, which contribute approximately 99 percent of the calculated human health risks from RCRA constituents, were chosen for monitoring. These target compounds are 1,1-dichloroethylene, methylene chloride, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, 1,2-dichloroethane, toluene, chlorobenzene, and 1,1,2,2-tetrachloroethane.

Sampling for target compounds is performed at two air monitoring stations. The stations are identified as VOC-A, located downstream from hazardous waste disposal unit Panel 1 in Drift E300, and VOC-B, located upstream from Panel 2. In 2003, VOC-B was moved to Drift S2520 as Panel 2 was opened. As waste is placed in new panels, VOC-B will be relocated to ensure that it samples underground air before it passes the waste panels. The location of VOC-A is not anticipated to change.

Target compounds found in VOC-B represent background concentrations found in the underground. The VOC concentrations measured at this location are the sum of background concentrations entering the mine through the air intake shaft plus additional concentrations contributed by facility operations upstream of the waste panels. Differences measured between the two stations represent any VOC contributions from the waste panels. Any positive concentration differences between the two stations must be less than the concentrations of concern listed in Attachment N of the HWFP (Table 5.1).

Table 5.1 - Concentrations of Concern for Volatile Organic Compounds, from Attachment N of the HWFP (No. NM4890139088)

Compound	Concentration of Concern ppbv[a]
1,1,1-Trichloroethane	590
1,1,2,2-Tetrachloroethane	50
1,1-Dichloroethylene	100
1,2-Dichloroethane	45
Carbon tetrachloride	165
Chlorobenzene	220
Chloroform	180
Methylene chloride	1930
Toluene	190

[a] Parts per billion by volume

VOC sampling reported in this section was performed using guidance included in Compendium Method TO-14A, *Compendium Methods for the Determination of Toxic Organic Compounds in Ambient Air* (EPA, 1999). The samples were analyzed using gas chromatography/mass spectrometry under an established QA/QC program. Laboratory analytical procedures were developed based on the concepts contained in both TO-14A and the draft *EPA Contract Laboratory Program Volatile Organics Analysis of Ambient Air in Canisters* (EPA, 1994).

The routine method reporting limit (MRL) was 5.0 ppbv for 1,1,1-trichloroethane, 1,1-dichloroethylene, methylene chloride, and toluene and 2.0 ppbv for 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, carbon tetrachloride, chlorobenzene, and chloroform. For dilution factors greater than one, the 5.0 ppbv and 2.0 ppbv values are multiplied by the dilution factor to calculate the MRLs for the diluted sample. The MRLs are shown in Table 5.2. It should be noted that the MRLs are approximately 22 times and 386 times lower than the respective concentrations of concern for the nine target compounds.

The results of 2003 VOC monitoring indicated an increase in the concentration of carbon tetrachloride and toluene in air downstream of Panel 1, while the concentration of 1,1,1-trichloroethane and methylene chloride detections were less than in 2002. During 2003, all VOC sample results were all below the MRL and well below the concentrations of concern listed in Table 5.1.

Table 5.2 - Volatile Organic Compound MRLs in 2003

Compound	MRL (ppbv)[a]
1,1,1-Trichloroethane	5
1,1,2,2-Tetrachloroethane	2
1,1-Dichloroethylene	5
1,2-Dichloroethane	2
Carbon Tetrachloride	2
Chlorobenzene	2
Chloroform	2
Methylene Chloride	5
Toluene	5

[a] Parts per billion by volume

5.5 Seismic Activity

WIPP is located about 100 km (60 mi.) east of the western margin of the Permian Basin. The geologic structure and tectonic pattern of the Permian Basin are chiefly the result of large-scale subsidence and uplift during the Paleozoic Era. The broad basin is divided into a series of subbasins that passed through their last stage of significant subsidence during the Late Permian Age. The Delaware subbasin occupies the southwestern portion of the Permian Basin and hosts the WIPP site. It is bordered by the Roosevelt Uplift to the north, the Marathon Thrust Belt to the south, the Central (Permian) Basin Platform to the east, and the Sierra Diablo Platform and Guadalupe and Sacramento Mountains to the west. The Delaware Basin contains a thick sequence of evaporite layers.

All major tectonic elements of the Delaware Basin were essentially formed before deposition of the Permian evaporites, and the region has been relatively stable since then. Deep-seated faults are rare, except along the western and eastern basin margins, and there is no evidence of young, deep-seated faults inside the basin. Researchers suspect that some low-magnitude earthquakes may result from secondary oil recovery (water flooding). Their foci are about as deep as the bottom of relatively shallow hydrocarbon wells.

Significant recent seismic events near WIPP on January 2, 1992, and April 14, 1995, had magnitudes of 5.0 and 5.3 respectively. The January 2, 1992, Rattlesnake Canyon earthquake had an epicenter 60 km (36 mi) east-southeast of the WIPP site, while an April 14, 1995, event's epicenter was located about 240 km (144 mi) southwest of WIPP, near Alpine, Texas. Neither earthquake had any effect on WIPP structures, as documented by post-event inspections by WIPP staff and the NMED. The magnitudes of both events were within the parameters used to develop the seismic risk assessment of the WIPP structures.

Seismic information for the WIPP region before 1962 was derived from chronicles of the effects of those tremors on people, structures, and surface features. Seismicity in New Mexico reported prior to 1962 was mostly limited to the corridor between Albuquerque and Socorro, part of a structure known as the Rio Grande Rift. Since 1962, most seismic information has been based on instrumental data recorded at various seismograph stations.

Currently, seismicity within 300 km (186 mi) of the WIPP site is being monitored by the New Mexico Institute of Mining and Technology (NMIMT) using data from an eight-station network approximately centered on the site (Figure 5.6). A new monitoring station was installed in Dagger Draw and brought on line during this reporting period, to closely monitor events possibly induced by hydrocarbon extraction activities. Station signals are transmitted to the NMIMT Seismological Observatory in Socorro. When appropriate, readings from the WIPP network stations are combined with readings from an additional NMIMT network in the central Rio Grande Rift. Occasionally, data are also exchanged with the University of Texas at El Paso and Texas Tech University in Lubbock, both of which operate stations in West Texas.

The mean operational efficiency of the WIPP seismic monitoring stations during 2003 was approximately 98 percent. From January 1 through December 31, 2003, locations for 174 seismic events were recorded within 300 km (186 mi) of WIPP. These data included origin times, epicenter coordinates, and magnitudes. The strongest recorded event (magnitude 3.3) occurred on June 21, 2003 and was located approximately 91 km (56 mi) west-northwest of the site. The closest event to the site had a magnitude of 2.1 and was located approximately 55 km (34 mi) east. These events had no effect on WIPP structures.

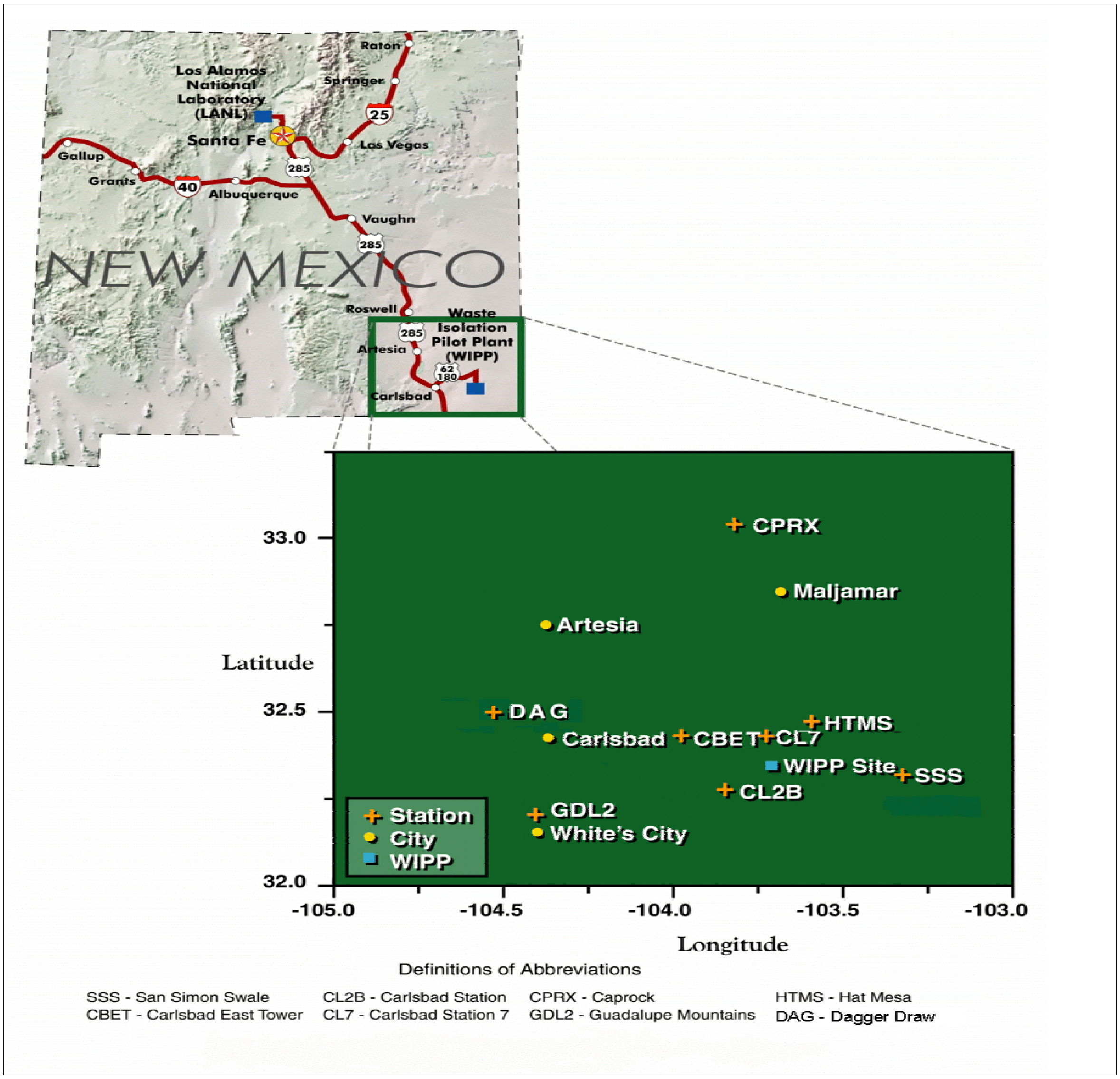

Figure 5.6 - WIPP Seismograph Station Locations

5.6 Liquid Effluent Monitoring

The WIPP sewage lagoon system is a zero-discharge facility consisting of two primary settling lagoons, two polishing lagoons, and three evaporation basins. The entire facility is lined with 30-mil synthetic liners and is designed to dispose of domestic sewage as well as site-generated brine waters from observation well pumping and underground dewatering activities at the site.

The WIPP sewage facility is operated under DP-831, issued by the state of New Mexico; New Mexico Water Quality Control Regulations (20.6.2 NMAC, "Ground and Surface Water Protection"); and applicable WIPP procedures. These requirements provide the framework for disposal of domestic sewage, site-generated brine waters, and nonhazardous waste waters.

DP-831 allows for the disposal of up to 23,000 gpd of sewage effluent and 7,570 liters (2,000 gallons) of nonhazardous brine water to the north evaporation pond and to the sewage lagoon system. An additional 30,283 liters (8,000 gallons) per day of nonhazardous brine waters are permitted for disposal in the H-19 Evaporation Pond. Discharge monitoring reports are submitted to the NMED to demonstrate compliance with the inspection monitoring and reporting requirements identified in the plan. The requirement for these reports was changed from quarterly to semiannually in 2003. Data from the discharge monitoring reports are summarized in the tables below.

Table 5.3 - Discharge Volumes

Location	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
Facultative Lagoon System	771,448 gallons	2,629,821 gallons	957,897 gallons
Miscellaneous Water Discharged to the Lagoon System	None	467 gallons	1,050 gallons
Evaporation Pond B	None	None	None
H-19 Evaporation Pond	4,110 gallons	12,900 gallons	17,607 gallons
Neutralized Spent Acid Waste pH ˜ 10.0	18.8 gallons	36 gallons	0 gallons

Table 5.4 - Water Quality Analysis of Inflow to Facultative Lagoon System[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
Nitrate (as N)	< 0.10 mg/L	< 0.10 mg/L	1600 mg/L
Total Kjeldahl Nitrogen (as N)	44.5 mg/L	44.6 mg/L	24.4 mg/L
Total Dissolved Solids (TDS)	539 mg/L	685 mg/L	585 mg/L
^{238}Pu	0.0089 ± 0.0126 pCi/L	0.008 ± 0.011 pCi/L	0.00297 ± 0.00597 pCi/L
$^{239+240}$Pu	0.007 ± 0.0131 pCi/L	0.009 ± 0.014 pCi/L	0.00297± 0.0103 pCi/L
^{241}Am	0.0021 ± 0.0207 pCi/L	0.013 ± 0.024 pCi/L	0.0 ± 0.0 pCi/L
^{234}U	0.5127 ± 0.1047 pCi/L	0.619 ± 0.114 pCi/L	0.4 ± 0.104 pCi/L

Table 5.4 - Water Quality Analysis of Inflow to Facultative Lagoon System[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
^{235}U	0.0122 ± 0.0367 pCi/L	0.024 ± 0.032 pCi/L	0.0186 ± 0.0189 pCi/L
^{238}U	0.225 ± 0.0707 pCi/L	0.29 ± 0.073 pCi/L	0.12 ± 0.0484 pCi/L
^{90}Sr	-0.34 ± 0.49 pCi/L	-0.02 ± 0.56 pCi/L	-0.478 ± 1.04 pCi/L
Gross Alpha	0.61 ± 3.67 pCi/L	NR[b]	NR
^{226}Ra	-0.07 ± 0.28 pCi/L	NR	NR
^{228}Ra	1.48 ± 1.83 pCi/L	NR	NR

[a] Activities listed are the activity ± TPU
[b] Not Reported

Table 5.5 - Analysis of Evaporation Pond B[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
TDS	29,850 mg/L	27,400 mg/L	13,000 mg/L
^{238}Pu	-0.0013 ± 0.0075 pCi/L	0.002 ± 0.012 pCi/L	0.0 ± 0.0 pCi/L
$^{239+240}Pu$	0.0148 ± 0.016 pCi/L	0.013 ± 0.016 pCi/L	0.00581 ± 0.00824 pCi/L
$^{24}1Am$	0.0031 ± 0.0193 pCi/L	-0.002 ± 0.022 pCi/L	0.00289 ± 0.013 pCi/L
^{234}U	2.1963 ± 0.295 pCi/L	1.52 ± 0.205 pCi/L	0.126 ± 0.268 pCi/L
^{235}U	0.0503 ± 0.0397 pCi/L	0.021 ± 0.025 pCi/L	0.0632 ± 0.0384 pCi/L
^{238}U	0.8871 ± 0.1616 pCi/L	0.604 ± 0.115 pCi/L	0.497 ± 0.128 pCi/L
^{90}Sr	0.2 ± 0.6 pCi/L	0.18 ± 0.68 pCi/L	-0.286 ± 1.25 pCi/L
Gross Alpha	123.07 ± 222.04 pCi/L	NR[b]	NR
^{226}Ra	8.97 ± 0.9 pCi/L	NR	NR
^{228}Ra	1.38 ± 1.75 pCi/L	NR	NR

[a] Activities listed are the activity ± TPU
[b] Not Reported

Table 5.6 - Analysis of Evaporation Pond C[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
TDS	4,960 mg/L	32,400 mg/L	6,010 mg/L
^{238}Pu	0.003 ± 0.0078 pCi/L	0.003 ± 0.008 pCi/L	0.0 ± 0.0 pCi/L
$^{239+240}Pu$	0.0012 ± 0.0086 pCi/L	0.005 ± 0.007 pCi/L	0.00286 ± 0.00578 pCi/L
^{241}Am	0.0065 ± 0.0209 pCi/L	0.019 ± 0.025 pCi/L	0.00938 ± 0.0166 pCi/L
^{234}U	1.5127 ± 0.1944 pCi/L	1.4 ± 0.196 pCi/L	1.08 ± 0.236 pCi/L
^{235}U	0.0658 ± 0.0477 pCi/L	0.028 ± 0.03 pCi/L	0.0589 ± 0.0037 pCi/L
^{238}U	0.7755 ± 0.1252 pCi/L	0.573 ± 0.111 pCi/L	0.441 ± 0.116 pCi/L
^{90}Sr	0.48 ± 0.56 pCi/L	-0.06 ± 0.56 pCi/L	0.786 ± 0.102 pCi/L

Table 5.6 - Analysis of Evaporation Pond C[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
Gross Alpha	22.59 ± 163.97 pCi/L	NR[b]	NR
^{226}Ra	6.52 ± 0.74 pCi/L	NR	NR
^{228}Ra	1.93 ± 1.74 pCi/L	NR	NR

[a] Activities listed are the activity ± TPU
[b] Not Reported

Table 5.7 - Analysis of the H-19 Evaporation Pond[a]

Parameter	1/1/03 – 3/31/03	1/1/03 – 6/30/03	7/1/03 – 12/31/03
TDS	45,100 mg/L	197,000 mg/L	371,500 mg/L
^{238}Pu	0.0031 ± 0.0079 pCi/L	0.014 ± 0.014 pCi/L	0.00919 ± 0.0131 pCi/L
$^{239+240}Pu$	0.0098 ± 0.0098 pCi/L	0.014 ± 0.014 pCi/L	0.00916 ± 0.0131 pCi/L
^{241}Am	-0.0045 ± 0.0193 pCi/L	0.02 ± 0.026 pCi/L	0.0 ± 0.0 pCi/L
^{234}U	2.2048 ± 0.3068 pCi/L	4.01 ± 0.418 pCi/L	7.05 ± 1.47 pCi/L
^{235}U	0.0535 ± 0.0583 pCi/L	0.085 ± 0.042 pCi/L	0.424 ± 1.42 pCi/L
^{238}U	0.8468 ± 0.1622 pCi/L	1.49 ± 0.201 pCi/L	2.22 ± 0.503 pCi/L
^{90}Sr	0.09 ± 0.66 pCi/L	0.22 ± 0.73 pCi/L	1.35 ± 1.29 pCi/L
Gross Alpha	-127.5 ± 160.56 pCi/L	NR[b]	NR
^{226}Ra	7.3 ± 0.8 pCi/L	NR	NR
^{228}Ra	2.62 ± 1.79 pCi/L	NR	NR

[a] Activities listed are the activity ± TPU
[b] Not Reported

CHAPTER 6 - SITE HYDROLOGY, GROUNDWATER MONITORING, AND PUBLIC DRINKING WATER PROTECTION

Current groundwater monitoring activities at WIPP are outlined in the WIPP Groundwater Monitoring Program Plan (WP 02-1). In addition, WIPP has detailed procedures for performing specific activities, such as pumping system installations, field parameter analyses and documentation, and QA records management. Groundwater monitoring activities are also defined in the EMP.

6.1 Site Hydrology

The hydrology at and surrounding the WIPP site has been thoroughly characterized over the last 25 years. A summary of the hydrology in this area is contained in the following sections. Figure 1.1 presents the WIPP stratigraphy.

6.1.1 Surface Hydrology

Surface water is absent at the WIPP site. The nearest significant surface water body, Laguna Grande de la Sal is about 13 kilometers (8 miles) west-southwest of the center of the WIPP site in Nash Draw where shallow brine ponds occur. Small, manmade livestock water holes ("tanks") occur several kilometers from the WIPP site, but are not hydrologically connected to the formations overlying the WIPP repository.

6.1.2 Subsurface Hydrology

Several water-bearing zones have been identified and extensively studied near WIPP. Limited amounts of potable water are found in the middle Dewey Lake Redbeds and the overlying Triassic Dockum group in the vicinity of WIPP. Two water-bearing units, the Culebra and Magenta Dolomites, occur in the Rustler Formation and produce brackish to saline water in the vicinity of the site. Another very low transmissivity, saline water-bearing zone identified is the Rustler-Salado contact.

6.1.2.1 Hydrology of the Castile Formation

The Castile Formation is composed of a sequence of three thick anhydrite beds separated by two thick halite beds. This formation acts as an aquitard, separating the Salado Formation from the underlying water-bearing sandstones of the Bell Canyon Formation. In the halite zones, the occurrence of circulating groundwater is restricted because halite at these depths does not readily maintain secondary porosity, open fractures, or solution channels.

No regional groundwater flow system is present in the Castile Formation. The only significant water present in the formation occurs in isolated brine reservoirs in fractured anhydrite. These brine reservoirs are not increasing in volume or pressure, are unconnected with surrounding aquifers or the surface, and have little potential to dissolve the host rocks or move through them.

6.1.2.2 Hydrology of the Salado Formation

The massive halite beds within the Salado Formation host the WIPP facility horizon. The Salado Formation represents a regional aquiclude due to the hydraulic properties of the bedded halite that forms most of the formation. In the halites, the presence of circulating groundwater is restricted because halites do not readily maintain primary porosity, solution channels, or open fractures.

The results of permeability testing, both within the facility and from the surface, are generally consistent with a permeability of the undisturbed salt mass of approximately 0.001 to 0.01 microdarcy, with no distinguishable strata variability. The only significant variation to these extremely low permeabilities occurs in the immediate vicinity of the underground workings (Stormont et al., 1987). This increase is believed to be a result of near-field fracturing and possible matrix flow lines due to stress relief.

6.1.2.3 Hydrology of the Rustler-Salado Contact

In Nash Draw and areas immediately west of the site, the contact exists as a dissolution residue capable of transmitting water. Eastward from Nash Draw toward the WIPP site, the amount of dissolution decreases and the transmissivity of this interval decreases. All tests within the boundary of the WIPP site showed very low transmissivities, ranging from 2.8×10^{-6} to 7.43×10^{-1} m^2/day (3×10^{-5} to 8 ft^2/day) (Mercer, 1983).

6.1.2.4 Hydrology of the Culebra Member

The Culebra Member of the Rustler Formation is the most transmissive hydrologic unit in the WIPP site area and is considered the only plausible hydrologic pathway to the accessible environment for any potential contamination.

Tests show that the Culebra Dolomite is a fractured, heterogeneous system with varying local anisotropic characteristics (Mercer and Orr, 1977; Mercer, 1983; Beauheim, 1986, 1987; Beauhiem and Ruskauff, 1998) . Calculated transmissivities for the Culebra within the WIPP site boundary have a wide range with values between 2.7×10^{-3} to approximately 21 meters²/day (9×10^{-2} to approximately 69 ft^2/day); the majority of the values are less than 0.3 meters²/day (1 ft^2/day) (Beauheim, 1987). Transmissivities generally decrease from west to east across the site area. The regional flow direction of groundwater in the Culebra Member is generally to the south.

6.1.2.5 Hydrology of the Magenta Member

The hydrology of the Magenta Member of the Rustler Formation was tested in 15 cased and open holes at the WIPP site. Transmissivities within the WIPP site study area calculated from the results of these tests range from 3.72×10^{-4} to 2.79×10^{-2} m^2/day (4.0×10^{-3} to 3.0×10^{1} ft^2/day) (Mercer, 1983).

6.1.2.6 Hydrology of the Dewey Lake Redbeds

The Dewey Lake Redbeds Formation at the WIPP site is approximately 500-ft thick and consists of alternating thin beds of siltstone and fine-grained sandstone. The Dewey Lake Redbeds is at the base of the WIPP shallow subsurface water and has saturated conditions found in an overlying perched zone. The upper Dewey Lake Redbeds consists of a thick, generally unsaturated section. The middle Dewey Lake Redbeds is the interval immediately above the sulfate cementation change, where saturated conditions and a natural water table have been identified in limited areas. The average saturated thickness is 16.6 ft. The lower Dewey Lake Redbeds is below the sulfate cementation change, with predominately unsaturated conditions and low permeabilities. See Section 6.5 and 6.6, as appropriate, for additional information.

WIPP monitoring well WQSP-6A intersects water in the Dewey Lake Redbeds. At this location, the saturated horizon is within the middle portion of the formation. Water recently encountered in the upper Dewey Lake Redbeds at monitor well C-2811 (Figure 6.12) may be interconnected with the SSW in the Santa Rosa, although the interconnection is uncertain. The saturated zone at C-2811 is both vertically and laterally distinct from the water at WQSP-6A, located about one mile to the southwest. The Dewey Lake Redbeds Formation generally does not yield a water supply to wells; however, about one mile south of the WIPP site, domestic and stock supply wells produce water from the middle Dewey Lake Redbeds (Daniel B. Stephens & Associates, Inc., 2003). See Section 6.6 for more details.

6.1.2.7 Hydrology of the Gatuña and Santa Rosa Formations

The Gatuña Formation unconformably overlies the Santa Rosa Formation at the WIPP site. This formation ranges from 19 to 31 ft at the WIPP site and consists of silt, sand, and clay, with deposits in localized depressions.

The Gatuña Formation is water-bearing in some areas, with saturation occurring in discontinuous perched zones. However, because of its erratic distribution, the Gatuña Formation has no known continuous saturation zone. Drilling at the WIPP site, including 30 exploration borings drilled between 1978 and 1979, did not identify any saturated zones in the Gatuña Formation (Daniel B. Stephens & Associates, Inc., 2003).

Water in the Santa Rosa Formation has been found in the center part of the WIPP site and since no water was found in this zone during the mapping of the shafts in 1980s, this water is deemed to be anthropogenic (Daniel B. Stephens & Associates, Inc., 2003). To assess the quantity and quality of this water, piezometers PZ-1 to PZ-12 were installed in the area between the WIPP shafts. Also, three wells, C-2505, C-2506 and C-2507 were drilled and tested in 1996 and 1997 (DOE/WIPP 97-2219). More details on this investigation are provided in Section 6.5 of this report.

6.2 Groundwater Monitoring

6.2.1 Program Objectives

The objectives of the Groundwater Monitoring Program are to:

- Determine the physical and chemical characteristics of groundwater;
- Maintain surveillance of groundwater levels and water chemistry surrounding the WIPP facility throughout the operational lifetime of the facility;
- Document and identify effects, if any, of WIPP operations on groundwater parameters.

Data obtained by the WIPP Groundwater Monitoring Program support two major programs at WIPP: (1) the RCRA Detection Monitoring Program supporting the HWFP in compliance with 20.4.1.500 NMAC, and (2) performance assessment supporting the Compliance Certification Application (DOE/CAO 96-2184). Each of these programs requires a unique set of data and analyses. The monitoring program focuses on two groundwater-bearing formations, the Culebra Dolomite and the Dewey Lake Redbeds.

Baseline water chemistry data were collected from 1995 through 1997 and reported in the *Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report* (DOE/WIPP 98-2285). The baseline data were expanded in 2000 to include ten rounds of sampling instead of five. The data were published in Addendum 1, Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Update Report (IT Corporation, 2000). These baseline data will be compared to water quality data collected throughout the operational life of the facility.

6.2.2 Summary of 2003 Activities

Groundwater monitoring support activities during 2003 included drilling of four new wells, well development, testing, groundwater quality sampling and groundwater level surveillance. Table 6.1 categorizes WIPP groundwater monitoring activities according to DOE SER guidance. The guidance calls for the wells to be broken out by purpose (i.e., remediation, waste management, and environmental surveillance). All of WIPP's groundwater monitoring wells are used for environmental surveillance. Radiological data from 2003 from the groundwater monitoring program are summarized in Section 4.3. The remainder of the results from the groundwater monitoring program are contained in this chapter.

Table 6.1 - Summary of 2003 DOE Sitewide Groundwater Monitoring Program

	Purposes for Which Monitoring was Performed			
	Remediation	Waste Management	Environmental Surveillance	Other Drivers
Number of Active Wells Monitored	N/A	N/A	84	N/A
Number of Samples Taken	N/A	N/A	14	N/A
Number of Water Level Measurements	N/A	N/A	809	N/A
Number of Analyses Performed	N/A	N/A	1708	N/A
% of Analyses that are Non-Detects	N/A	N/A	75%*	N/A

* All VOCs, SVOCs, and the majority of trace metals were nondetect. Most detections are the routine major water chemistry parameters.

Groundwater quality samples were gathered twice from seven wells: six wells completed in the Culebra Member of the Rustler Formation (WQSP-1 through WQSP-6) and one well completed in the Dewey Lake Redbeds Formation (WQSP-6A; Figure 6.1).

Four new wells were constructed in 2003: SNL-2 (Culebra), SNL-3 (Culebra), SNL-9 (Culebra), and SNL-12 (Culebra). These wells were drilled to provide new hydraulic testing locations to address the issue of rising water levels in the Culebra. The total number of gallons removed from the Culebra Member of the Rustler Formation as a result of well development was 15,255. Total gallons removed for each of these activities were estimated based on flow rates, well bore volumes and meter readings.

Hydrologic testing activities took place in eight wells in 2003 in the Magenta and Culebra Members of the Rustler Formation. The wells tested were H-18 (Magenta), DOE-2 (Magenta), H-9c (Magenta/Culebra), H-15 (Magenta/Culebra), H-11b2 (Magenta), C-2737 (Magenta/Culebra), SNL-9 (Culebra), and SNL-2 (Culebra). There were a total of 73,680 gallons of water removed from the Culebra member of the Rustler Formation and a total of 10,085 gallons removed from the Magenta member of the Rustler Formation during testing activities.

Groundwater surface elevation data were gathered from 84 well bores located across the WIPP region, four of which were equipped with production-injection-packers (PIPs) to allow groundwater level surveillance of more than one producing zone through the same well (Figure 6.2).

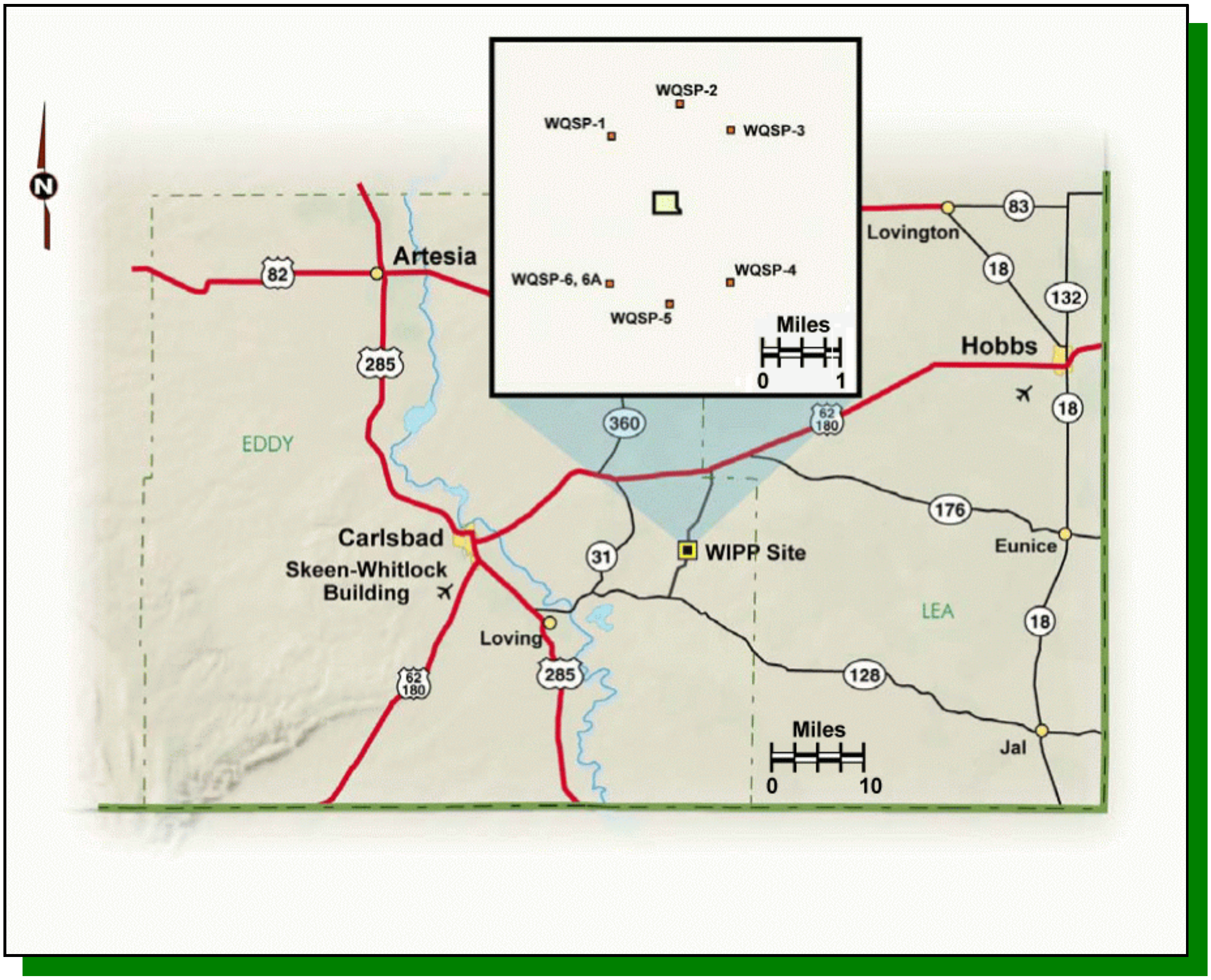

Figure 6.1 - Water Quality Sampling Program Wells (Inset represents the locations of the DMP wells in the 16-square-mile area of the WIPP site [Land Withdrawal Area].)

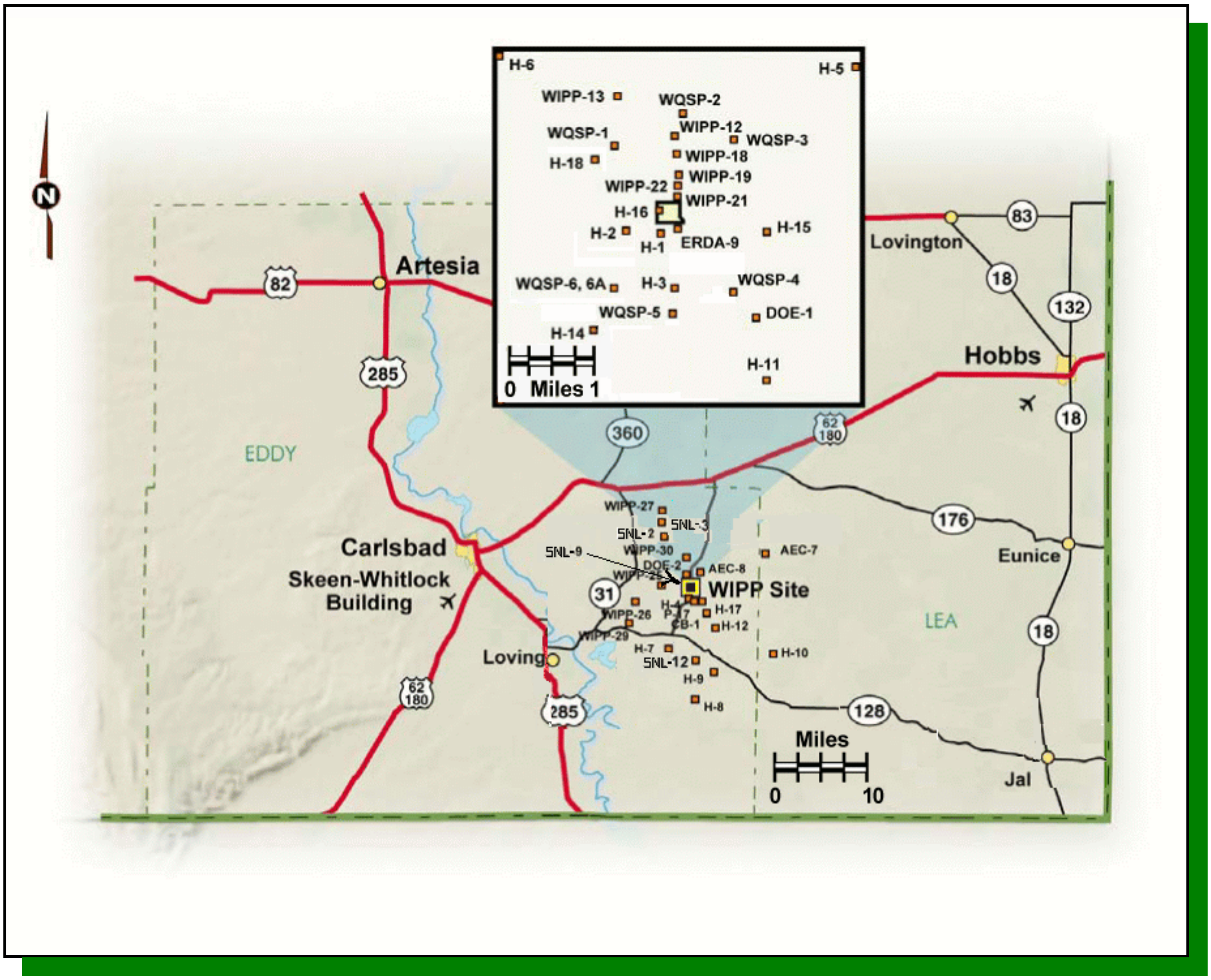

Figure 6.2 - Groundwater Level Surveillance Wells (Inset represents the groundwater surveillance wells in the 16-square-mile area of the WIPP site [Land Withdrawal Area].)

6.2.3 Groundwater Quality Sampling

The HWFP Module V requires groundwater quality sampling twice a year, from March through May (Round 16 for 2003) and, again, from September through November (Round 17 for 2003). Sampling for groundwater quality was performed at seven well sites during 2003 (Figure 6.1). Field analysis for Eh (Intensity factor: an indicator of oxidation or reduction of chemical species), specific gravity, specific conductance, acidity or alkalinity, chloride, divalent cations, and total iron were performed periodically during the sampling.

The HWFP 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 HWFP groundwater monitoring network was not installed immediately downgradient of this plane. However, due to the relatively unique containment and transport aspects of the site, monitoring at the sited locations will allow for detection of releases before contaminants could be released beyond the WLWA boundary.

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. WQSP-4, WQSP-5, and WQSP-6 were located downgradient of the WIPP shaft based on the greatest velocity magnitude of groundwater flow leaving the shaft area. WQSP-4 was also specifically located to monitor the zone of higher transmissivity around wells DOE-1 and H-11. WQSP-6a was installed in the Dewey Lake Formation at the WQSP-6 location to assess groundwater conditions at this location.

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. Transport modeling of contaminant migration throughout the Culebra to the boundary suggests that travel times could be on the order of thousands of years if, under worst case conditions, hazardous constituents 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 WLWA boundary such that the contaminants would be detected long before reaching the boundary.

The difference between the depth of the WIPP repository and the depth of the DMP wells varies from 1,271 feet to 1,925 feet. DOE does not anticipate finding WIPP related contamination in groundwater because no pathways for migration of hazardous constituents exists via groundwater to the accessible environment. For migration to occur there must be a driving force or hydraulic gradient. During the disposal phase, the underground disposal areas are at or near atmospheric pressure, while the hydrostatic fluid pressures in the Salado, Castile, Culebra, and Magenta are well above atmospheric pressure inducing flow towards the repository openings.

Table 6.2 lists the analytical parameters included in the year 2003 groundwater sampling program.

Table 6.2 - Analytical Parameters for Which Groundwater Was Analyzed

CAS No.[a]	Parameter	EPA Method Number	CAS No.	Parameter	EPA Method Number
71-55-6	1,1,1-Trichloroethane	8260B	7782-50-5	Chloride	300
79-34-5	1,1,2,2-Tetrachloroethane	8260B		Density[b]	
79-00-5	1,1,2-Trichloroethane	8260B	7727-37-9	Nitrate (as N)	300
75-34-3	1,1-Dichloroethane	8260B		pH	150.1
75-35-4	1,1-Dichloroethylene	8260B		Specific conductance	120.1
107-06-2	1,2-Dichloroethane	8260B		Sulfate	300
56-23-5	Carbon tetrachloride	8260B		Total dissolved solids (TDS)	160.1
108-90-7	Chlorobenzene	8260B		Total organic carbon (TOC)	415.1
67-66-3	Chloroform	8260B		Total organic halogen (TOH)	9020B

Table 6.2 - Analytical Parameters for Which Groundwater Was Analyzed

CAS No.[a]	Parameter	EPA Method Number	CAS No.	Parameter	EPA Method Number
540-59-0	*cis*-1,2-Dichloroethylene	8260B		Total suspended solids (TSS)	160.2
540-59-0	*trans*-1, 2-Dichloroethylene	8260B			
78-93-3	Methyl ethyl ketone	8260B			
75-09-2	Methylene chloride	8260B			
127-18-4	Tetrachloroethylene	8260B	7440-36-0	Alkalinity	310.1
108-88-3	Toluene	8260B	7440-38-2	Antimony	6010B
79-01-6	Trichloroethylene	8260B	7440-39-3	Arsenic	6010B
75-69-4	Trichlorofluoromethane	8260B	7440-41-7	Barium	6010B
75-01-4	Vinyl chloride	8260B	7440-43-9	Beryllium	6010B
1330-20-7	Xylene	8260B	7440-70-2	Cadmium	6010B
95-50-1	1,2-Dichlorobenzene	8270C	7440-47-3	Calcium	6010B
106-46-7	1,4-Dichlorobenzene	8270C	7439-89-6	Chromium	6010B
51-28-5	2,4-Dinitrophenol	8270C	7439-92-1	Iron	6010B
121-14-2	2,4-Dinitrotoluene	8270C	7439-95-4	Lead	6010B
95-48-7	2-Methylphenol	8270C	7439-97-6	Magnesium	6010B
108-39-4/ 106-44-5	3-Methylphenol/ 4-Methylphenol	8270C	2023473	Mercury	7470A
			2023692	Nickel	6010B
118-74-1	Hexachlorobenzene	8270C	7782-49-2	Potassium	6010B
67-72-1	Hexachloroethane	8270C	7440-22-4	Selenium	6010B
98-95-3	Nitrobenzene	8270C	7440-23-5	Silver	6010B
87-86-5	Pentachlorophenol	8270C	7440-28-0	Sodium	6010B
110-86-1	Pyridine	8270C	7440-62-2	Thallium	6010B
78-83-1	Isobutanol	8015B	7440-66-6	Vanadium	6010B

[a] Chemical Abstract Service Registry Number
[b] Analysis method was ASTM [American Society for Testing and Materials] D854-92

6.2.4 Evaluation of Groundwater Quality

The quality of the Culebra water sampled near WIPP is naturally poor and not suitable for human consumption or for agricultural purposes, because the TDS concentrations are generally above 10,000 milligrams per liter (mg/L). In 2003, TDS concentrations in the Culebra varied from a low of 14,600 mg/L to a high of 232,000 mg/L. The groundwater of the Culebra is considered to be Class III water by EPA guidelines.

Water quality measurements performed in the Dewey Lake Redbeds Formation indicate the waters are considerably better quality than the Culebra water. In 2003, the TDS values in this formation (WQSP-6A) were less than 5,000 mg/L. This water is suitable for livestock consumption, and is classified as Class II water by EPA guidelines. Saturation of the Dewey Lake Redbeds Formation in the area of WIPP is discontinuous. Anthropogenic shallow subsurface water (SSW) has been encountered in the upper Dewey Lake Redbeds Formation at the Santa Rosa Formation contact (see Section 6.5).

Because of the highly variable transmissivity and TDS values within the Culebra, baseline groundwater quality was defined for each individual well. The analytical results for detectable constituents are plotted as Time Trend Plots compared to the baseline established prior to 2000 (Appendix E, Figures E.1 through E.98). The results of analyses for each parameter or constituent for the two sampling sessions in 2003 (Rounds 16 and 17) are summarized in Appendix F, Tables F.1 through F.7.

In these tables, either the 95^{th} upper tolerance limit value (UTLV) or the 95^{th} percentile value is presented depending on the type of distribution exhibited by the parameter or constituent. Both values represent the value beneath which 95 percent of the values in a population are expected to occur. The UTLVs were calculated for data that exhibited a normal or a lognormal distribution. The 95^{th} percentile was determined for data that were considered nonparametric; having neither a normal nor a lognormal distribution. Due to the large number of nondetectable concentrations of organic compounds, the limits for organic compounds were considered nonparametric and based on the method detection limit reported by the laboratory. These values have been recomputed after baseline sampling was completed in 2000, and were used for sampling Rounds 16 and 17 to evaluate potential contamination of the groundwater wells.

In a few isolated cases, reported concentrations of some parameters, such as potassium and total organic halogens (TOX) slightly exceeded the calculated 95^{th} percentile or the 95^{th} UTLV. Such exceedences do not indicate the presence of contamination. The 95^{th} UTLV or percentile is a value representing where 5 percent of the concentration in the population will be greater than the UTLV or percentile. WIPP groundwater in the Culebra Dolomite Member of the Rustler Formation has very high concentrations of dissolved solids. The contract analytical laboratory has had some difficulty performing the analyses for TOX and some of the cations found in the highly concentrated brines.

6.2.5 Groundwater Level Surveillance

Groundwater surface elevations in the vicinity of WIPP have been and may still be caused by localized disturbances, such as pumping tests for site characterization, water quality sampling, or well development. Other causes of groundwater surface elevation changes may be natural groundwater level fluctuations and industrial water use for agriculture, mining, and resource exploration. Water levels in the Culebra have generally been rising over the past 25 years, but have leveled off in 2003, and declined in some wells.

Well bores were used to perform surveillance of six water-bearing zones in the WIPP area:

- Shallow Subsurface water (Santa Rosa/Dewey Lake Interface)
- Dewey Lake Redbeds
- Magenta
- Culebra

- Rustler/Salado Contact
- Bell Canyon

The two zones of primary interest were the Culebra and Magenta Members of the Rustler Formation (see Figure 1.1). Throughout the year, 51 measurements were taken in the Culebra and 13 in the Magenta. Two measurements were taken in the Dewey Lake Redbeds Formation. Two measurements were taken in the Bell Canyon Formation. One measurement was taken in the Rustler/Salado contact. Fifteen measurements were taken in the shallow zone of the Santa Rosa/Dewey Lake interface. In 2003, groundwater level measurements were taken monthly in at least one accessible well bore at each well site for each available formation (Figure 6.2). Redundant well bores (well bores located on well pads with multiple wells completed in the same formation) at each well site were measured on a quarterly basis (Appendix F, Table F.8).

Four well bores (WIPP-30-Culebra/Magenta, Cabin Baby-Culebra/Bell Canyon, C-2737-Culebra/Magenta, and WIPP-25-Culebra/Magenta) were completed at multiple depths. By using packers, these well bores can monitor more than one formation.

Groundwater elevation measurements in the Culebra Member indicate that the flow of groundwater is north to south at the center of the WIPP site (Figure 6.3). Regionally, the flow is from the north to the southwest. Water elevation trend analysis was performed in 34 of 51 wells completed in the Culebra. Rising water level trends were noted in 11 wells while 23 of the wells had falling trends.

The HWFP requires that the NMED be notified if a cumulative groundwater surface elevation change of more than two feet is observed in any detection monitoring program (DMP) well which is not attributable to site tests or natural stabilization of the site hydrologic system. None of the DMP wells had such a change in 2003.

A rise in groundwater level occurred this year in three other wells completed in the Culebra. Cabin Baby (CB-1) had an 85-foot increase due to a leaky packer. SNL-2 and SNL-9 each had increases totaling more than two feet as a direct result of well development activities.

A total decrease in groundwater level occurred in wells WIPP-25 and WIPP-27. Each of these wells is located on the edge of Nash draw and is believed to be part of a generalized trend of falling water levels, beginning during this reporting period, projecting from the northwest to the southeast across the site. The wells not trended were redundant wells, and wells with fewer than five readings throughout the year.

Groundwater level data were transmitted on a monthly basis to the NMED, the EEG, SNL, the CBFO Technical Assistance Contractor. A copy of the data was placed in the operating record for inspection by authorized agencies.

Culebra flow rates across the Land Withdrawal Area were determined using numerical modeling techniques calibrated to current groundwater head elevations. Flow rates ranged from 1.06×10^{-2} cm per day (cm/d) (3.5×10^{-5} ft per day [ft/d]) in the eastern part of the Land Withdrawal Area to 1.83 cm/d (6×10^{-4} ft/d) in the southwestern and west sections of the Land Withdrawal Area. Flow rates in the central portion of the Land Withdrawal Area ranged from 1.03 cm/d (3.4×10^{-4} ft/d) to 1.31 cm/d (4.3×10^{-4} ft/d). Centrally, the flow rate ranged from 0.31 cm/d (1.1×10^{-4} ft/d) to 2.5 cm/d (8.2×10^{-4} ft/d).

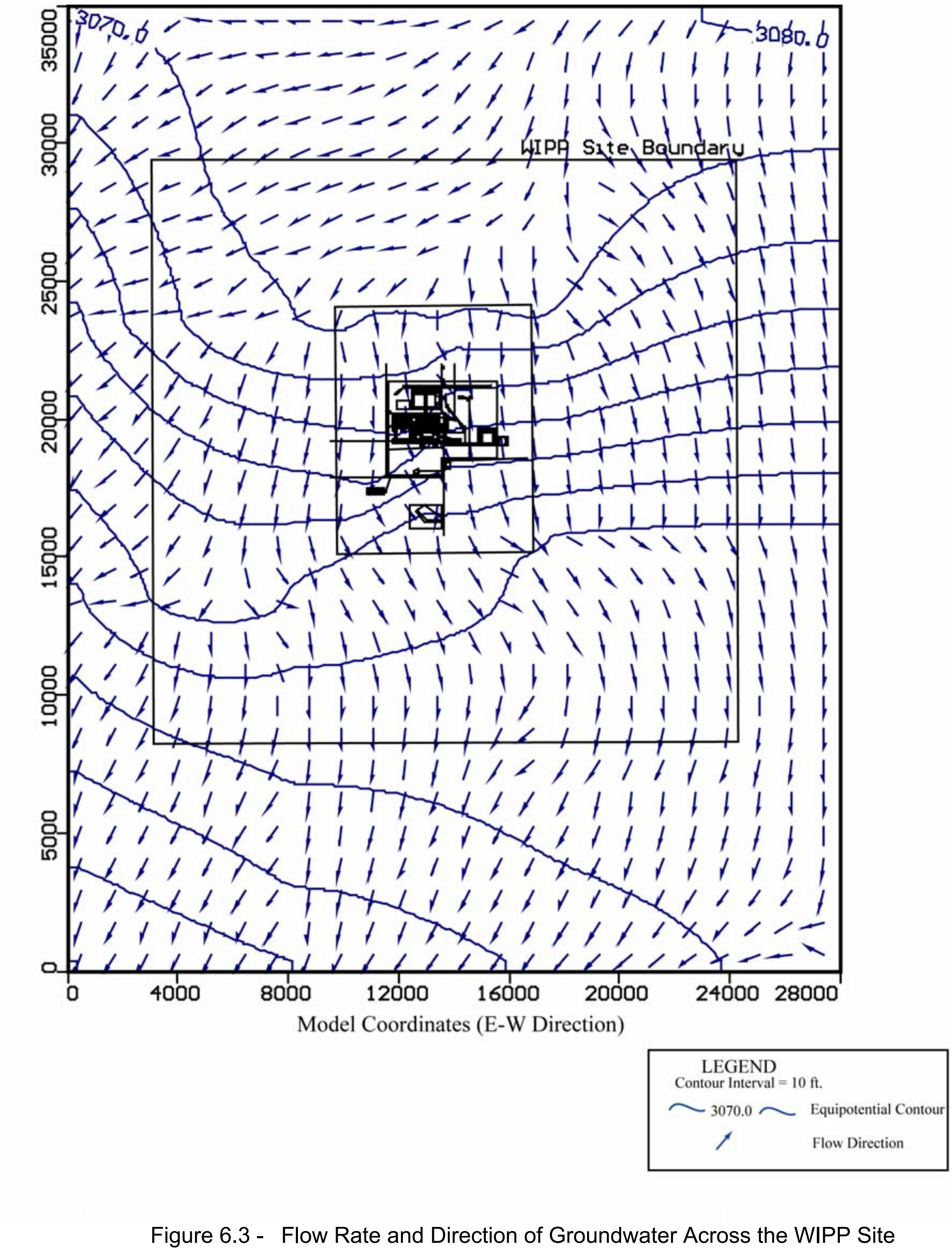

Figure 6.3 - Flow Rate and Direction of Groundwater Across the WIPP Site in the Culebra Formation

Groundwater data collected in 2003 are similar to previous years. Figures 6.4 through 6.10 provide hydrographs of the DMP wells for 2003.

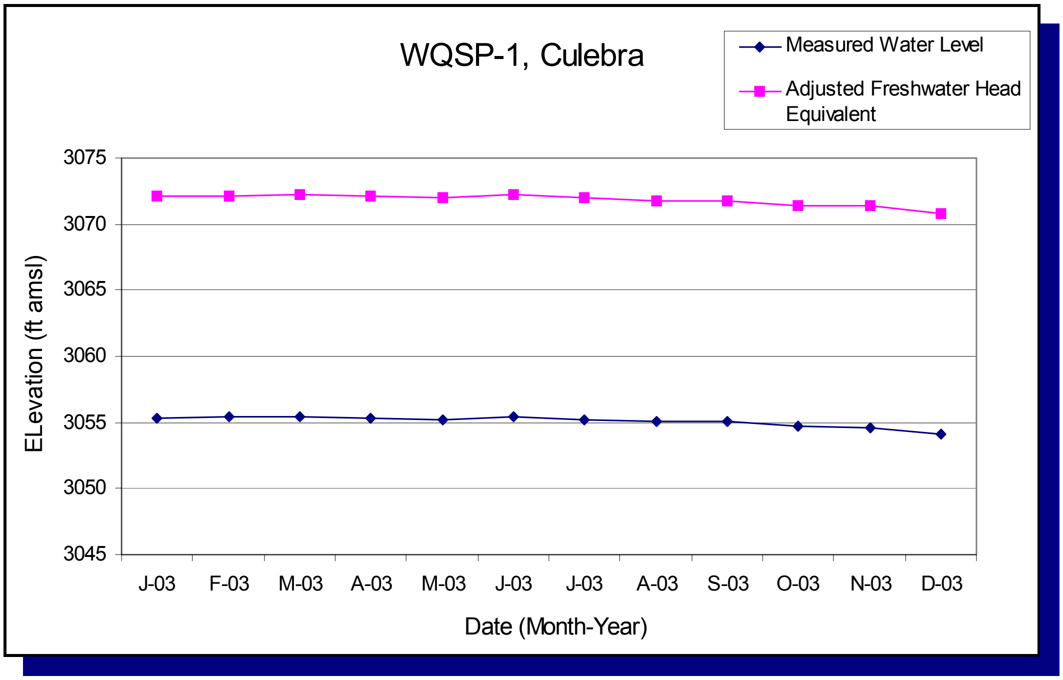

Figure 6.4 - Hydrograph of WQSP-1

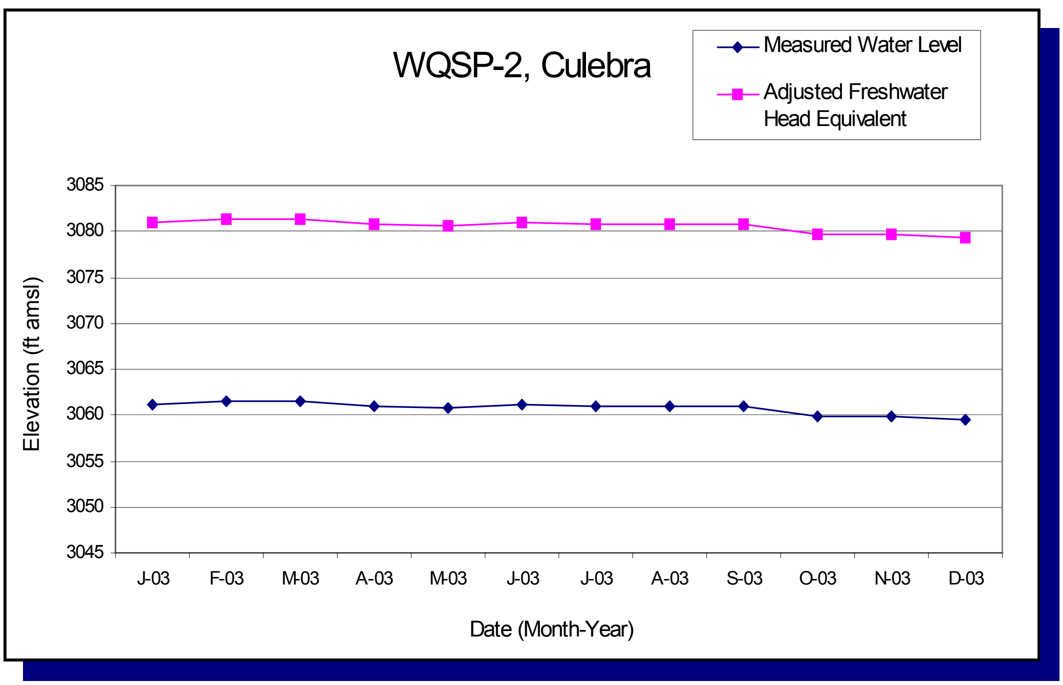

Figure 6.5 - Hydrograph of WQSP-2

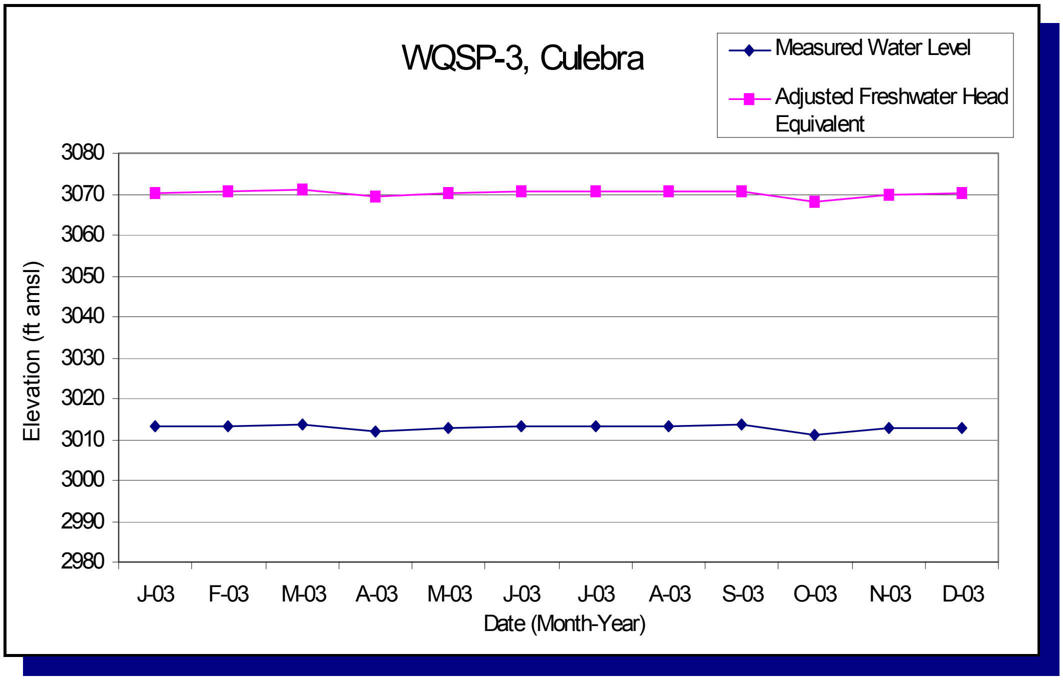

Figure 6.6 - Hydrograph of WQSP-3

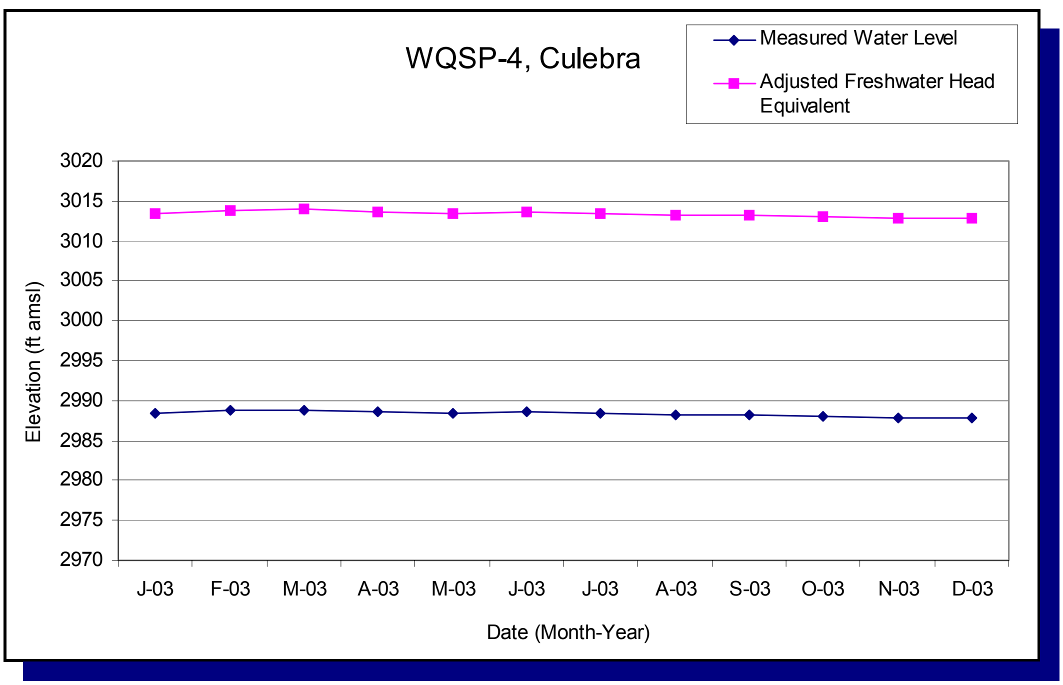

Figure 6.7 - Hydrograph of WQSP-4

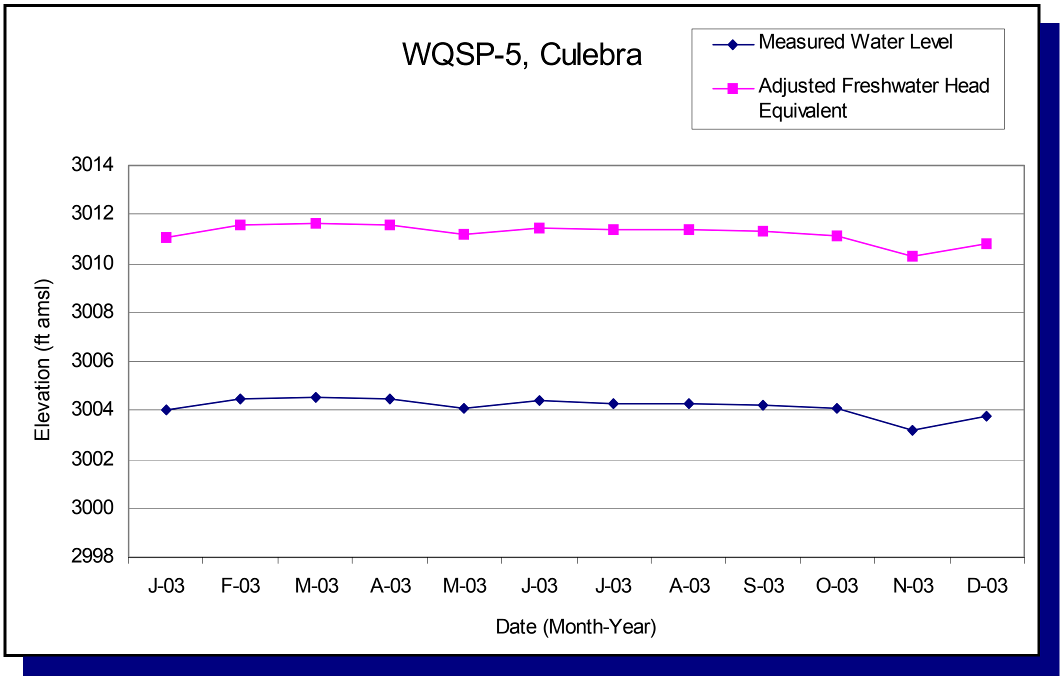

Figure 6.8 - Hydrograph of WQSP-5

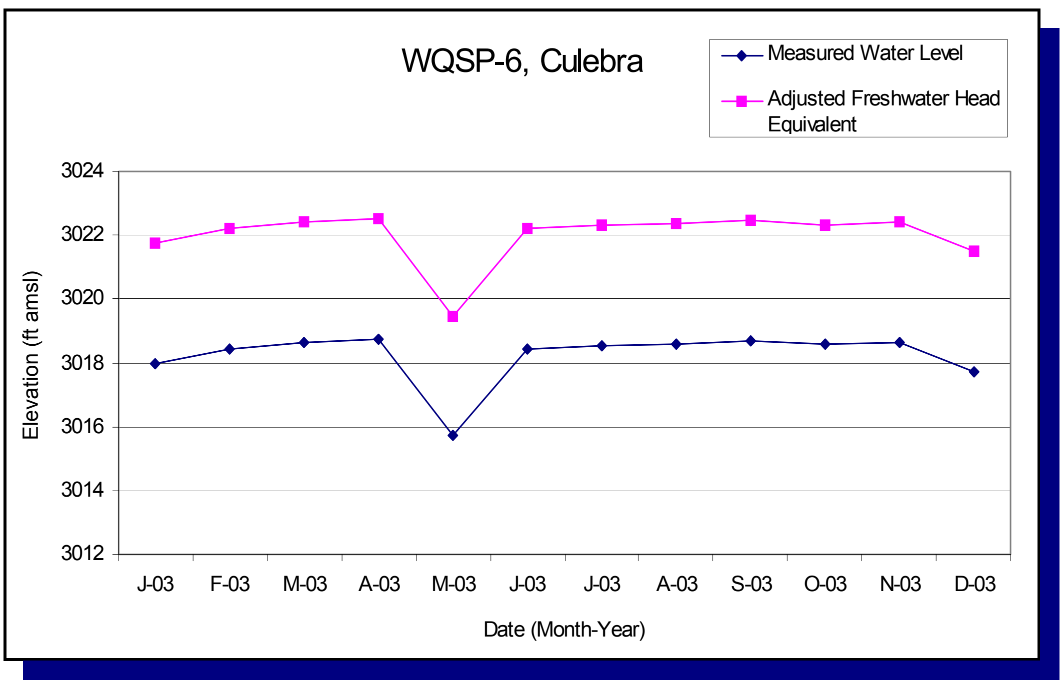

Figure 6.9 - Hydrograph at WQSP-6

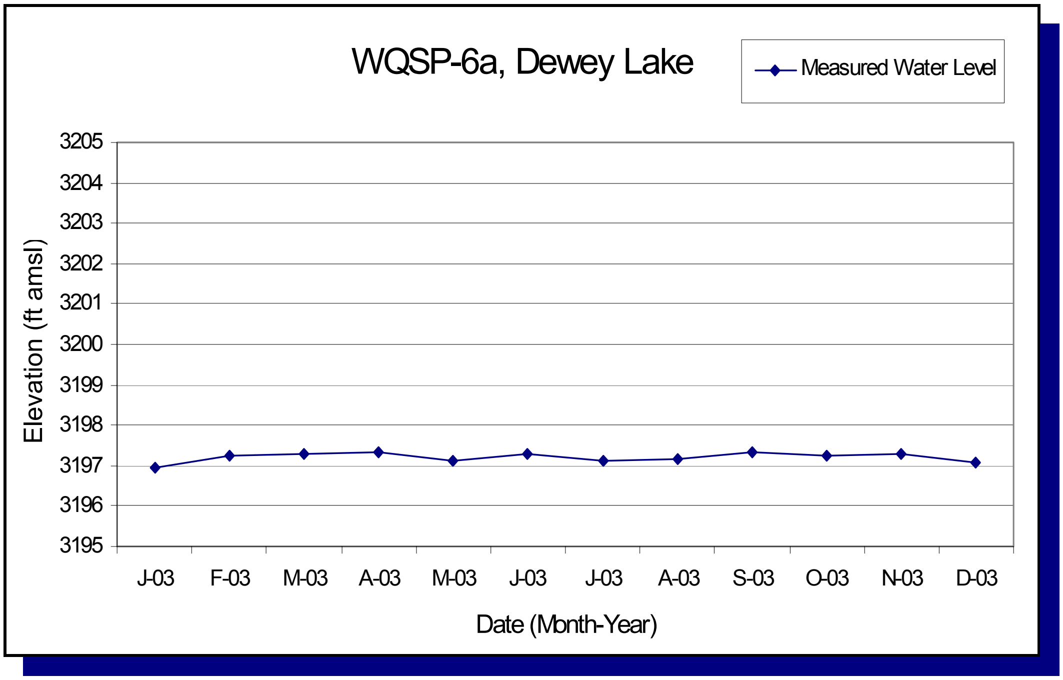

Figure 6.10 - Hydrograph of WQSP-6A

6.2.6 Pressure Density Surveys

At WIPP, variable TDS concentrations are reflected in a commensurate variability in groundwater density. Each year the WIPP measures the density of well-bore fluids in water level monitoring wells to accurately determine relative water levels between wells. Measured water levels are then adjusted to equivalent fresh-water head values.

In 2003, pressure-density measurements were taken in ten wells, as shown in Table 6.3.

Table 6.3 - Pressure Density Survey for 2003

Well Name	Date	Formation	Density
DOE-1	10/28/03	Culebra	1.0886 g/cc
H-03b2	12/2/03	Culebra	1.0360 g/cc
H-04b	11/18/03	Culebra	1.0030 g/cc
H-05b	11/17/03	Culebra	1.0892 g/cc
H-06b	11/17/03	Culebra	1.0343 g/cc
H-11b4	12/2/03	Culebra	1.0640 g/cc
H-17	11/18/03	Culebra	1.1291 g/cc
H-19b2	10/22/03	Culebra	1.0627 g/cc
WIPP-26	12/2/03	Culebra	1.0190 g/cc
WIPP-29	12/2/03	Culebra	1.2210 g/cc

6.3 Drilling Activities

The overall objective of drilling activities was to provide data needed for comprehensive modeling of WIPP hydrology. Four new wells were drilled and completed in the Culebra Formation during 2003: SNL-2, SNL-3, SNL-9, and SNL-12. These wells were drilled to provide new monitoring and testing locations to support continued area-wide modeling of groundwater flow in the Culebra Dolomite. The new hydrologic testing and modeling is intended to address the issue of region-wide rises in Culebra water levels observed over the past several years. The wells were also drilled to provide additional geologic and hydrologic information such as degree of dissolution in the upper Salado Formation, fracturing and transmissivity of the Culebra, and hydrologic information such as groundwater flow directions and potential connection to the flow system in Nash Draw. The testing program is underway and the results are bring analyzed now. These results will be reported in the future.

SNL-2 was drilled in Section 12 of T22S, R30E, 574 ft from the north line (FNL) and 859 ft from the west line (FWL). Drilling started at SNL-2 on April 28, 2003, and the well was cased and cemented on May 15, 2003. The well was drilled to a total depth of 614 ft below ground level (bgl) and geophysical logs were obtained. The fluid density derived from final well development was 1.015 g/cc. Specific details of drilling, geophysical descriptions, and well completion can be found in the *Basic Data Report for SNL-2 (C-2948)* (DOE/WIPP 03-3290).

SNL-3 was drilled in Section 34 of T21S, R31E, 2,369 ft from the south line (FSL) and 2,701 ft FWL. Drilling started at SNL-3 on August 14, 2003 and the well was cased and cemented on September 11, 2003. The well was drilled to a total depth of 790 ft bgl and geophysical logs were obtained. The fluid density derived from final well development was 1.028 g/cc. Specific details of drilling, geophysical descriptions, and well completion can be found in the *Basic Data Report for SNL-3 (C-2949)* (DOE/WIPP 03-3294).

SNL-9 was drilled in Section 23 of T22S, R30E, 1,197 ft FSL and 627 ft from the east line (FEL). Drilling started at SNL-9 on May 17, 2003 and the well was cased and cemented on June 20, 2003. The well was drilled to a total depth of 845 ft bgl and geophysical logs were obtained. The fluid density derived from final well development was 1.017 g/cc. Specific details of drilling, geophysical descriptions, and well completion can be found in the *Basic Data Report for SNL-9 (C-2950)* (DOE/WIPP 03-3291).

SNL-12 was drilled in Section 20 of T21S, R31E, 1,171 ft FSL and 2,137 ft FEL. Drilling started at SNL-12 on June 25, 2003, and the well was cased and cemented on July 29, 2003. The well was drilled to a total depth of 905 ft bgl and geophysical logs were obtained. The fluid density derived from final well development was 1.004 g/cc. Specific details of drilling, geophysical descriptions, and well completion can be found in the *Basic Data Report for SNL-12 (C-2954)* (DOE/WIPP 03-3295).

6.4 Well Maintenance Activities

Traditional well maintenance activities (i.e., rehabilitation or plugging and abandonment) were not performed in 2003. Also, no well reconstruction, hydraulic testing, or pumping activities occurred in DMP wells. The only activities performed were reconfiguration of some wells to support hydraulic testing in non-DMP wells by SNL. The following well maintenance and associated activities were performed by SNL for hydraulic testing:

- On February 28, 2003, a PIP was installed in well H-9c allowing dual completion and monitoring in both the Magenta Member and Culebra Member of the Rustler Formation.
- On May 12, 2003, the PIP was removed at well C-2737 and a mechanical bridge plug was installed to monitor and test the Magenta Member of the Rustler Formation.
- On May 19, 2003, the well casing at H-11b2 was scraped, bailed, and a pump installed in preparation for testing of the Magenta Member.
- On July 14, 2003, the well casing at DOE-2 was scraped and the well bailed of debris. SNL subsequently removed their monitoring equipment from the hole and stopped continuous monitoring at this location.
- On November 18, 2003, H-15 was converted to dual completion for both Magenta and Culebra monitoring.
- On November 19, 2003, the mechanical bridge plug was removed from C-2737 and an inflatable packer installed to test the Culebra Member of the Rustler Formation.

6.5 Shallow Subsurface Water Monitoring Program

Shallow subsurface water occurs beneath the WIPP site at a depth of less than 100 ft bgl at the contact between the Santa Rosa Formation and the upper Dewey Lake Redbeds Formation (Figure 1.1). The formations containing shallow water yield generally less than one gallon per minute in monitoring wells and piezometers and contain high concentrations of total dissolved solids and chlorides. The origin of this water is believed to be primarily from anthropogenic causes, with some contribution from natural sources. The shallow subsurface water occurs not only under the WIPP site surface facilities but also to the south as indicated by shallow water in drill hole C-2811, about one half mile south of the Waste Handling Shaft (Figure 6.11). Natural shallow groundwater occurs in the middle part of the Dewey Lake Redbeds Formation at the southern portion of the WIPP site and to the south of the WIPP site. To date, there is no indication that the shallow subsurface water has affected the naturally occurring groundwater in the Dewey Lake Redbeds Formation.

Since discovery of the shallow subsurface water in the late 1990's, 12 piezometers and four wells (C-2505, C-2506, C-2507, and C-2811) have been part of a monitoring program to measure spatial and temporal changes in shallow subsurface water levels and water quality. Shallow subsurface water monitoring activities during 2003 included shallow subsurface water level surveillance at these 16 locations (Figure 6.11).

An application was submitted to the NMED, Ground Water Quality Bureau to modify the existing Discharge Permit, DP-831, to address discharges associated with salt storage operations. In this application it was proposed to build a new salt storage area and a new salt storage evaporation basin, and to reshape the existing salt pile and close it by installing a geotextile/synthetic liner cover. Additionally, the application proposed installing synthetic liners in all existing evaporation ponds at the facility. The liners are designed to limit infiltration of surface water to the shallow subsurface. The DP-831 permit modification application also proposed a monitoring and sampling plan for the shallow subsurface water well/piezometer network.

The application was approved by the NMED, Ground Water Quality Bureau and a Discharge Permit Modification for DP-831 was issued on December 22, 2003. The permit included all modifications to the salt storage and evaporation pond operations described above. Additionally, the permit contained specific language that addressed the monitoring program for the shallow subsurface water monitoring network. The permit requires quarterly monitoring of water levels and semiannual sampling from 12 wells/piezometers. Required parameters for laboratory analysis are nitrate, sulfate, chloride, total dissolved solids, selenium, and chromium. Field parameters (pH, conductivity, and temperature) are also to be measured during serial sampling.

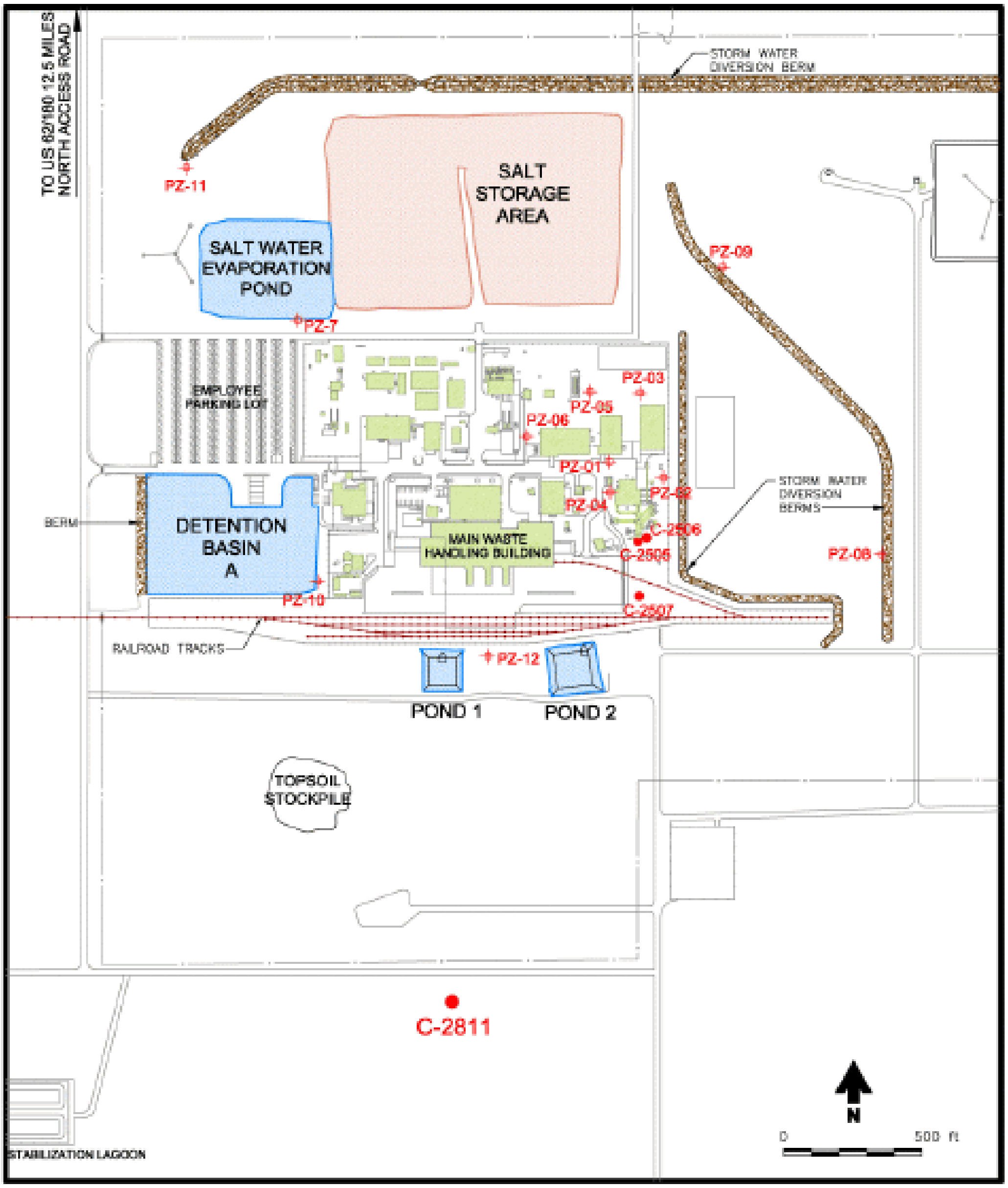

Figure 6.11 - Locations of SSW Wells (Piezometers PZ-1 through 12; Wells C2811, C2505, C2506 and C2507)

6.5.1 Shallow Subsurface Water Quality Sampling

Sampling of the shallow subsurface water wells and piezometers was suspended in 2003 pending the outcome of the DP-831 permit modification. Sampling is scheduled to resume in 2004.

6.5.2 Shallow Subsurface Water Level Surveillance

Sixteen wells were used to perform surveillance of the shallow subsurface water-bearing horizon in the Santa Rosa Formation and the upper portion of the Dewey Lake Redbeds Formation. Water levels were collected monthly for seven months, and then changed to quarterly for all locations presented in Figure 6.11. Fluctuations in water level have varied less than one foot during the year. Average shallow water levels indicated an increasing trend during the year (Appendix F, Table F.8). Piezometer PZ-8 has historically been dry.

Groundwater elevation measurements in the shallow subsurface water indicate that flow moves radially away from a potentiometric high located near PZ-7 adjacent to the Salt Pile Evaporation Pond (Figure 6.12). A potentiometric low is located near PZ-12. A second low is located east of PZ-8.

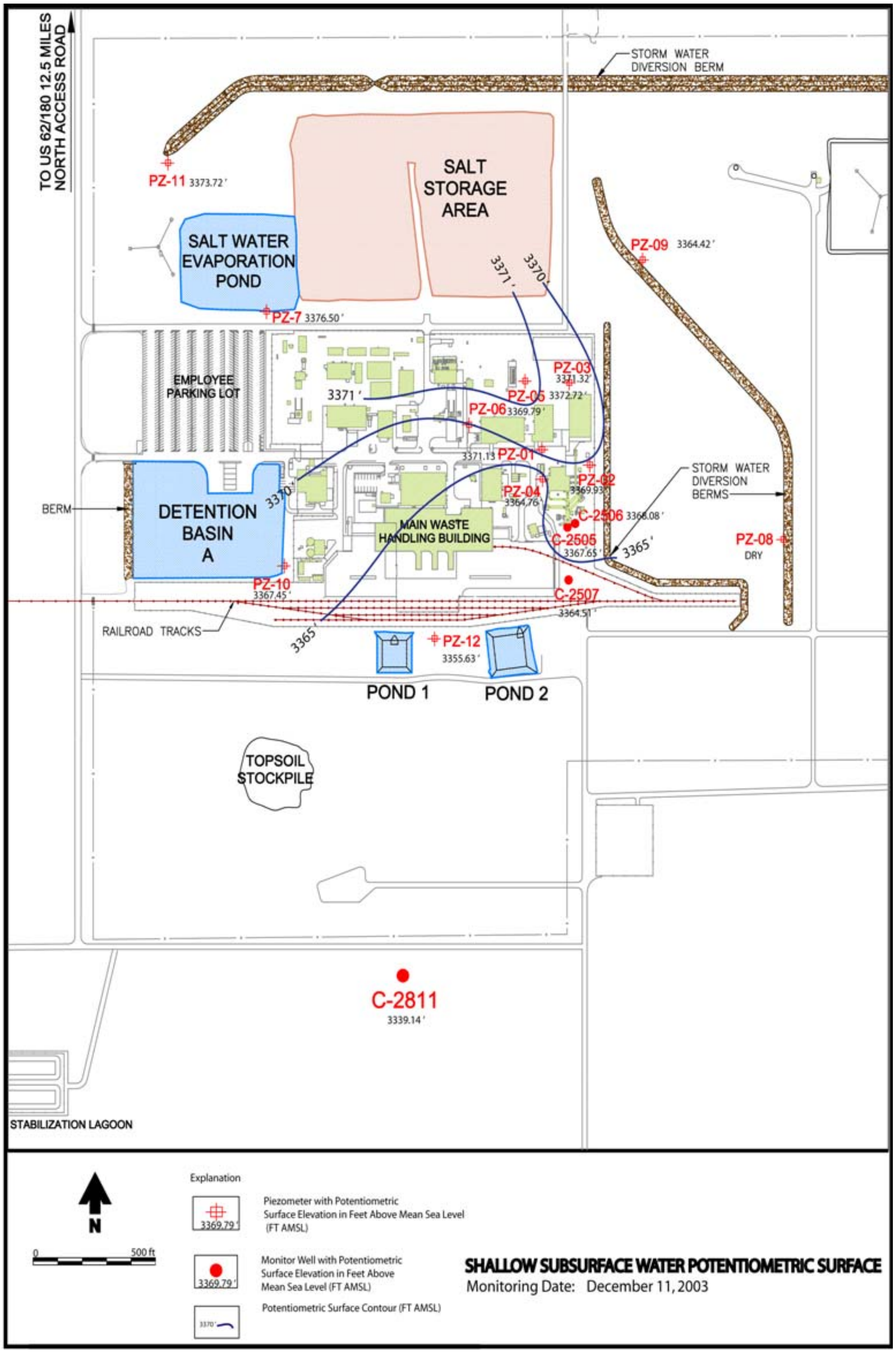

Figure 6.12 - Contour Plot of the SSW Potentionmetric Surface in the Santa Rosa Formation

6.6 Public Drinking Water Protection

The natural Dewey Lake Redbeds groundwater is monitored and sampled in WQSP-6A (Figure 6.1). The piezometric head in WQSP-6A is approximately 3,198 ft above mean sea level (amsl) compared to about 3,337 ft amsl at C-2811 - a difference of 139 vertical feet. The TDS concentration in the water at WQSP-6A has remained stable at around 4,000 mg/L since the well was installed. This represents the nearest source of potential drinking water at the site.

The water wells nearest the WIPP site that are using the natural shallow groundwater from the middle Dewey Lake Formation are the Barn Well and Ranch Well located on the J. C. Mills Ranch. These wells are located approximately three miles south-southwest of the WIPP surface facilities, and about 1.75 miles south of WQSP-6A (Figure 6.1). TDS concentrations in the Barn Well have ranged from 630 to 720 mg/L, and TDS concentrations in the Ranch Well have ranged from 2,800 to 3,300 mg/L (DOE, 1996).

Because of the nearest potable water supply at the Mills Ranch and the discovery of shallow subsurface water at the site, a water budget analysis of the shallow subsurface water was performed by Daniel B. Stephens & Associates in parallel with the discharge application. The analysis was performed to evaluate important hydrologic processes controlling the shallow subsurface water and provide:

- An estimate of the volume of water contained within the perched zone
- Quantification of seepage inputs to the SSW from past and current practices
- A model of SSW accumulation, flow conditions, and potential long-term migration
- Determination of the effects of engineered seepage reduction measures that could be implemented at existing seepage sources.

The water budget analysis included compilation of recorded discharges, site drainage summary, surface infiltration modeling, saturated flow modeling, and long-term migration modeling. Water budget results indicated that seepage from five primary sources (salt pile and four surface water detention basins) provided sufficient recharge to account for the observed shallow subsurface water saturated lens and that the lens is expected to spread.

The potential extent for long-term shallow subsurface water migration was examined by expanding the saturated flow model domain to include the 16-square mile WIPP land withdrawal area. The long-term migration model simulations indicated that the engineered seepage controls would substantially reduce the extent of migration (Daniel B. Stephens & Associates, Inc., 2003).

CHAPTER 7 - QUALITY ASSURANCE

The fundamental objective of a QA program, as applied to environmental work, is to ensure high-quality measurements are produced and reported from the analyses of samples collected using proven methods and practices. The defensibility of data generated by laboratories must be based on sound scientific principles, method evaluations, and data verification and validation.

In 2003, WIPP Laboratories performed the radiological analyses of WIPP environmental samples, while contract laboratories, Air Toxics, Ltd., in Folsom, California; and Trace Analysis, in Lubbock, Texas, performed the nonradiological analyses. All laboratories were required contractually to have documented QA programs, including standard procedures to perform the work, and to participate in intercomparison programs with the National Institute of Standards and Technology Radiochemistry Intercomparison Program (NRIP), the Environmental Monitoring Laboratory of the DOE Environmental Measurements Laboratory (EML) Quality Assessment Program (QAP), the Environmental Resource Associates® (ERA) interlaboratory assessment, and/or any other reputable intercomparison program.

The laboratories used one or more of these accepted protocols in their QA program:

- American Society of Mechanical Engineers NQA [Nuclear Quality Assurance] -1-1989, *Quality Assurance Program Requirements for Nuclear Facilities*

- Title 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

- EPA/600 14-83-004, QAMS-005/80, *Interim Guidelines and Specification for Preparing Quality Assurance Project Plans*

- NRC Regulatory Guide 4.15, Rev. 1, Quality Assurance for Radiological Monitoring Program-Effluent Streams and the Environment

- HPS N13.30 ANSI [American National Standards Institute], *Performance Criteria for Radiobioassay*

- Proposed ANSI/ASQC [American Society for Quality Control]-E4, *Quality Assurance Program Requirements for Environmental Programs*

The WIPP Environmental Monitoring Section performed assessments and audits to ensure the quality of the systems, processes, and deliverables were maintained or improved. Along with these regulatory requirements, the Environmental Monitoring Section also implements DOE Order 414.1B, *Quality Assurance*. The parameters for performance evaluations are completeness, precision, accuracy, comparability, and representativeness.

Representativeness is the extent to which measurements actually represent the true environmental condition or population at the time a sample was collected.
The primary objective of environmental monitoring is to protect the health and safety of the population surrounding the WIPP facility. The quality objective of representativeness was based on potential radiation exposure of the population through inhalation and ingestion. Samples of ambient air, surface water, sediment, soil, groundwater, and biota were collected from areas representative of potential pathways for intake.

The samples were collected using generally accepted methodologies for environmental sampling and approved procedures, ensuring they were representative of the media sampled. These samples were analyzed for natural radioactivity, fallout radioactivity from nuclear weapons tests, and other anthropogenic radionuclides. The reported concentrations at various locations were representative of the baseline information for radionuclides of interest at the WIPP facility.

The following sections assess the laboratories that provided services to WIPP in terms of how they met the performance evaluation parameters.

7.1 WIPP Laboratories

7.1.1 Completeness

The Statement of Work (SOW) for analyses performed by WIPP Laboratories states that "analytical completeness, as measured by the amount of valid data collected versus the amount of data expected or needed, shall be greater than 90 percent for WTS sampling programs." For radiological sampling and analysis programs, this contract requirement translates into the following quantitative definition:

> *Completeness is expressed as the number of samples analyzed with valid results as a percent of the total number of samples submitted for analysis*, or

$$\%C = \frac{V}{n} \times 100$$

Where:
%C = Percent Completeness
V = Number of Samples with Valid Results
n = Number of Samples Submitted for Analysis

Samples and measurements for air particulates were 99 percent complete for 2003. This value is based on the inability to perform valid analyses on 6 air filters due to sample collection problems. All other environmental media (groundwater, surface water, soil, sediment, and animal and plant tissues) were 100 percent complete for 2003.

7.1.2 Precision

The SOW states that analytical precision (as evaluated through replicate measurements) will meet or surpass control criteria or guidelines established in the industry-standard methods used for sample analysis. To ensure overall quality of analysis of environmental samples, precision was evaluated for both sample collection and sample analysis. Precision or reproducibility in sample collection was evaluated through comparison of analytical results for duplicate collected samples. A portable low-volume air sampler was rotated in each quarter from location to location, and was operated along with routine stationary air particulate samplers. The results of these duplicate comparisons are shown in Table 4.3 for the four quarters of 2003. The duplicate samples for other environmental media were collected at the same time, same place, and under similar conditions as routine samples. Tables 4.6, 4.10, 4.14, 4.18, and 4.20 show duplicate results for groundwater, surface water, soil, sediment, and vegetation samples, respectively.

The measure of precision used is the Relative Error Ratio (RER). The RER is expressed as follows:

$$RER = \frac{\left|(MeanActivity)_{ori} - (MeanActivity)_{dup}\right|}{\sqrt{(2 \times SD)^2_{ori} + (2 \times SD)^2_{dup}}}$$

Where:
(Mean Activity)$_{ori}$ = Mean Activity of Original Sample
(Mean Activity)$_{dup}$ = Mean Activity of Duplicate Sample
SD = Standard Deviation of Original and Duplicate Samples

RER results equal to or less than one are acceptable and considered to demonstrate reproducibility. RERs for most collection duplicates were less than one, indicating good reproducibility of sampling techniques and methods. However, one or more duplicate pairs for air particulates, groundwater, soil, and sediments showed RERs greater than one (Tables 4.3, 4.6, 4.14, and 4.18). This was likely caused by inhomogeneities in the sampled media. More detailed explanations for each of these duplicates can be found in Sections 4.2, 4.3, 4.5, and 4.6.

Laboratory precision was verified through analysis by the laboratory of replicate samples. Replicate analyses are performed on 10 percent of samples when sample volume allows. A second aliquot is taken of the chosen sample and prepared and analyzed with the associated batch. If the sample replicates do not meet the RER acceptance criterion, the entire batch is re-aliquoted and analyzed again. If the RER acceptance criterion is not met the second time, it indicates that the original sample is inhomogeneous. All laboratory replicates for 2003 passed the RER acceptance criterion, indicating acceptable laboratory precision.

7.1.3 Accuracy

The SOW requires accuracy (as evaluated through analytical spikes) to meet or surpass control criteria or guidelines established in the industry-standard methods used for sample analysis. Instrument accuracy was assured/controlled by using National Institute of Standards and Technology (NIST) traceability for instrument calibration. Overall analytical accuracy is maintained through the use of NIST-traceable, spiked, laboratory control samples (LCSs). Analysis of LCSs containing the isotopes of interest is performed on a 10 percent basis (one per every ten samples or part thereof). Results must be within plus or minus 20 percent of the known values. If this criterion is not met, the entire batch of samples is reanalyzed. LCS results for each isotope are tracked on a running basis on control charts. All LCS results for 2003 fell within the acceptable ranges, indicating good accuracy.

Accuracy is also ensured through participation by the laboratory in the DOE EML QAP and NRIP interlaboratory comparison programs, as discussed in more detail in Section 7.1.4 below. Under these programs, the WIPP Laboratories sample analysis results of furnished samples are compared with the results obtained by EML and NRIP. Performance is established by percent bias, calculated as shown below:

$$\% Bias = \frac{\left(A_m - A_k\right)}{A_k} \times 100$$

Where:

% Bias	=	Percent Bias
A_m	=	Measured Sample Activity
A_k	=	Known Sample Activity

7.1.4 Comparability

The SOW requires analytical comparability to be assured through the consistent use of standard sampling and analytical methods, and analytical methods that are equivalent in method performance criteria and reporting units for specific lists of target parameters. Sampling comparability is maintained through the use of standardized sample collection methods and procedures that govern the disposition of the samples and their transfer to the laboratory. The WIPP Laboratories ensure consistency through the use of standard analytical methods coupled with specific procedures that govern the handling of samples and the reporting of analysis results.

Comparability is reinforced through participation by the WIPP Laboratories in interlaboratory comparison programs. In 2003, the WIPP Laboratories participated in both the DOE EML QAP and the NRIP programs. The EML and NRIP prepare QC samples containing various alpha-, beta-, and gamma-emitting nuclides in water, soil, air filter, vegetation, synthetic urine, and tissue media and distribute them to participating laboratories. The programs are interlaboratory comparisons in that results from the participants are compared with the experimentally determined results of EML and NRIP. Also, the administering programs assess the results as acceptable or not based on the accuracy of the analyses.

Tables 7.1 through 7.4 contain the results of the EML comparisons for air filters, soil, vegetation, and water, respectively for 2003. Results are presented for two rounds of comparison: June 2003 (QAP 58) and December 2003 (QAP 59). The WIPP Laboratories' percent bias was acceptable for all radionuclides and all media with three exceptions: ^{228}Ac, ^{214}Bi, and ^{137}Cs in soil for the December 2003 comparison round. Of these three radioisotopes, the ^{137}Cs results are of the most concern since it is one of the isotopes analyzed for in all environmental media for 2003. Upon reviewing the data for these three gamma emitters, the laboratory discovered that the results had been incorrectly reported due to a failure to correct for the density of the sample. Recalculation using the appropriate sample density corrections yielded results that would have met the EML acceptance criteria.

Results of the NRIP comparisons for 2003 are presented in Table 7.5. WIPP results were rated as "P" (for pass) for all applicable radionuclides in synthetic urine and synthetic feces. Results were not given a rating for the categories of glass fiber filters and acidified water. However, the accuracy for the applicable radionuclides in those media ranged from -0.9 to -9.7, which demonstrates acceptable results.

7.1.5 Representativeness

According to the SOW, analytical representativeness is assured through the application of technically sound and accepted approaches for environmental investigations, industry-standard procedures for sample collection, and monitoring for potential sample cross-contamination through the analysis of field-generated and laboratory blank samples. These conditions were satisfied through the sample collection and analysis practices of the WIPP Environmental Monitoring Program. The environmental media samples (air, groundwater, surface water, soil, sediment, and biota) were collected from areas representative of potential pathways for intake. The samples were collected using generally accepted methodologies for environmental sampling and approved procedures, ensuring that they would be representative of the media sampled. Both sample collection blanks and analytical method blanks were used to check for cross-contamination and ensure sample purity.

Table 7.1 - Environmental Measurements Laboratory Assessments for WIPP Laboratories, 2003
MATRIX: Air Filter (Bq/Filter)

	QAP[a] 58 June 2003						QAP 59 December 2003					
	Reported		EML[b]			%	Reported		EML			%
[RN][c]	Value	Error	Value	Error	E.[d]	Bias	Value	Error	Value	Error	E.	Bias
^{241}Am	0.259	0.035	0.34	0.04	W	-33.8	0.314	0.0492	0.435	0.043	W	-27.8
^{60}Co	33.5	4.41	33.5	0.87	A	0	57.3	8.37	55.1	1.1	A	3.99
^{137}Cs	97.1	13	99.7	2.3	A	-2.61	54	8.49	54.8	1.1	A	-1.46
^{54}Mn	43.6	6.14	43.8	1.13	A	-0.46	58.4	8.52	58	1.3	A	0.69
^{238}Pu	0.492	0.063	0.52	0.01	A	-5.38	0.2204	0.0512	0.229	0.01	A	-3.76
^{239}Pu	0.322	0.042	0.33	0.01	A	-2.42	0.4067	0.092	0.401	0.01	A	1.42
^{90}Sr	2.348	0.123	2.8	0.14	A	-16.1	1.771	0.109	2.058	0.073	A	-14

[a] Quality Assurance Program
[b] Environmental Measurements Laboratory
[c] Radionuclide
[d] Evaluation Rating (A = acceptable, W = Acceptable with warning, N = Not acceptable)

Table 7.2 - Environmental Measurements Laboratory Assessments for WIPP Laboratories, 2003
MATRIX: Soil (Bq/kg)

	QAP[a] 58 June 2003						QAP 59 December 2003					
	Reported		EML[b]			%	Reported		EML			%
[RN][c]	Value	Error	Value	Error	E.[d]	Bias	Value	Error	Value	Error	E.	Bias
^{228}Ac	52.9	8.43	57.6	2.5	A	-8.16	39.5	6.49	50.8	1.8	N	-22.2
^{241}Am	12.54	1.783	15.6	1	W	-19.62	17.63	2.662	18.4	1.8	A	-4.18
^{212}Bi	63.7	17.7	60.6	4	A	5.12	41.9	10.2	53.9	4.3	A	-22.3
^{214}Bi	57.2	8.31	67	2.3	W	-14.63	25.5	4.31	34.4	1.4	N	-25.8
^{137}Cs	1310	166	1450	73	A	-9.66	1560	197	1973	99	N	-20.9
^{40}K	686	92.3	636	33	A	7.86	441	60.6	488	26	A	-9.63
^{212}Pb	65.6	9.4	57.9	2.9	A	13.3	43.9	6.71	50.7	2.7	W	-13.4
^{214}Pb	67.2	9.52	71.1	2.3	A	-5.48	28.8	4.81	35.2	1.5	W	-18.2
^{239}Pu	20.78	3.387	23.4	1.1	A	-11.2	33.63	4.794	30.4	3	A	10.63
^{90}Sr	54.17	5.306	64.4	3.1	A	-15.88	70.02	10.58	80.3	2.9	A	-12.8
BqU	237.2	24.96	249	0.3	A	-4.74	204.8	23.17	259.3	4.1	W	-21

[a] Quality Assurance Program
[b] Environmental Measurements Laboratory
[c] Radionuclide
[d] Evaluation Rating (A = acceptable, W = Acceptable with warning, N = Not acceptable)

Table 7.3 - Environmental Measurements Laboratory Assessments for WIPP Laboratories, 2003 MATRIX: Vegetation (Bq/kg)

	QAP[a] 58 June 2003						QAP 59 December 2003					
	Reported		EML[b]			%	Reported		EML			
[RN][c]	Value	Error	Value	Error	E.[d]	Bias	Value	Error	Value	Error	E.	% Bias
^{241}Am	3.842	0.68	3.51	0.13	A	9.46	QAP 59 did not evaluate vegetation					
^{244}Cm	1.806	0.398	2.01	0.1	A	-10.2						
^{60}Co	12.3	1.86	12.1	0.7	A	1.65						
^{137}Cs	403	51	444	22	A	-9.23	QAP 59 did not evaluate vegetation					
^{40}K	1210	161	1120	60	A	8.04						
^{239}Pu	5.12	0.951	5.17	0.52	A	-0.97						
^{90}Sr	545.2	49.57	650	27	A	-16.1						

[a] Quality Assurance Program
[b] Environmental Measurements Laboratory
[c] Radionuclide
[d] Evaluation Rating (A = acceptable, W = Acceptable with warning, N = Not acceptable)

Table 7.4 - Environmental Measurements Laboratory Assessments for WIPP Laboratories, 2003 MATRIX: Water (Bq/L)

	QAP[a] 58 June 2003						QAP 59 December 2003					
	Reported		EML[b]			%	Reported		EML			
[RN][c]	Value	Error	Value	Error	E.[d]	Bias	Value	Error	Value	Error	E.	% Bias
^{241}Am	2.12	0.344	2.13	0.15	A	-0.47	8.776	1.135	8.76	0.88	A	0.18
^{60}Co	254	33.2	234	8.4	A	8.55	534	77.6	513	18	A	4.09
^{134}Cs	29.9	4.41	30.5	1.09	A	-1.97	59.5	9.62	63	2	A	-5.56
^{137}Cs	65.5	8.88	63.8	3.4	A	2.66	79	12.5	80.3	4.1	A	-1.62
^{238}Pu	3.4	0.44	3.33	0.3	A	2.1	1.9	0.2711	2.07	0.045	A	-8.21
^{239}Pu	3.794	0.494	3.92	0.3	A	-3.21	4.246	0.5738	4.99	0.19	W	-14.91
^{90}Sr	4.086	0.329	4.34	0.2	A	-5.85	6.106	0.433	7.04	0.33	A	-13.27
BqU	4.58	0.48	4.29	0.39	A	6.76	5.315	0.4672	5.69	0.24	A	-6.59

[a] Quality Assurance Program
[b] Environmental Measurements Laboratory
[c] Radionuclide
[d] Evaluation Rating (A = acceptable, W = Acceptable with warning, N = Not acceptable)

Table 7.5 - NRIP for WIPP Laboratories, 2003

	Synthetic Urine (Bq/g^{-})						Glass Fiber Filters (Bq/g^{-})				
	Reported		NIST[a]				Reported		NIST		
[RN][b]	Value	% 2 σ Error	Value	% 2 σ Error	E.[c]	% Bias	Value	% 2 σ Error	Value	% 2 σ Error	% Bias
^{241}Am	0.673	17.1	0.804	0.41	P	-16.3	0.278	17.236	0.2840	0.67	-2.1
^{238}Pu	0.670	17.2	0.711	0.44	P	-5.7	0.231	15.818	0.2511	1.12	-8.0
^{90}Sr	2.417	11.0	3.113	0.48	P	-22.4	0.993	11.081	1.1002	0.77	-9.7
^{230}Th	NR[d]	NR	1.205	0.37	N/A[a]	N/A	NR	NR	0.426	0.61	N/A
^{234}U	NR	NR	3.031	0.64	N/A	N/A	NR	NR	NR	NR	N/A
^{238}U	3.058	17.1	3.147	0.39	P	-2.8	1.06	25.349	1.112	0.63	-4.7

Table 7.5 - NRIP for WIPP Laboratories, 2003

	Synthetic Feces (Bq/g)						Acidified Water (Bq/g)				
	Reported		NIST[a]				Reported		NIST		
[RN][b]	Value	% 2σ Error	Value	% 2 σ Error	E.[c]	% Bias	Value	% 2 σ Error	Value	% 2 σ Error	% Bias
^{241}Am	0.784	15.2	0.803	0.41	P	-2.4	2.33	16.47	2.505	0.65	-7
^{238}Pu	0.661	16.6	0.71	0.44	P	-7	2.083	19.91	2.229	0.69	-7
^{230}Th	NR	NR	1.205	0.37	N/A	N/A	NR	NR	3.753	0.59	N/A
^{90}Sr	2.898	16.7	3.112	0.48	P	-6.9	9.731	11.78	9.925	0.75	-2
^{238}U	2.908	37.7	3.146	0.39	P	-7.5	9.703	15.24	9.796	0.61	-1

[a] National Institute of Standards and Technology
[b] Radionuclide
[c] Evaluation Rating (P = pass, F = fail)
[d] Not Reported
[e] Not Applicable

7.2 Air Toxics

The company Air Toxics, Ltd., was subcontracted to perform the analyses of VOC samples collected in the WIPP underground during 2003.

7.2.1 Completeness

Completeness is defined in WP 12-VC.01, Confirmatory Volatile Organic Compound Monitoring Plan, as being "the percentage of the ratio of the number of valid sample results received versus the total number of samples collected." The VOC monitoring program must maintain a completeness of 90 percent. During 2003 Air Toxics performed analysis of the submitted VOC samples without losing sample or data integrity. For 2003, 220 samples were collected of which 220 produced valid data. This results in a completion percentage of 100 percent.

7.2.2 Precision

Precision is evaluated by two means in the VOC monitoring program. These are by comparing laboratory duplicate samples and also field duplicate samples. The laboratory duplicate samples consist of an LCS and Laboratory Control Sample Duplicate (LCSD). The field duplicate is a duplicate sample that is collected parallel with the original sample. Both of these duplicate samples are evaluated using the "Relative Percent Difference (RPD)" as defined in WP 12-VC.01 (Confirmatory Volatile Organic Compound Monitoring Plan). The RPD is calculated using the following equation:

$$RPD = \frac{(A - B)}{(|A + B|)/2} \times 100$$

Where: A = Original Sample Result
B = Duplicate Sample Result

During 2003, a LCS and LCSD were generated and evaluated for every sample batch that was analyzed. The result from the evaluation of the comparison resulted in 100 percent of the data within the acceptable range.

During 2003, field duplicate samples did not yield high enough concentrations to make a precision determination. All of the detections that were reported were estimated concentrations that were very minute. Any detection that is determined below the reporting limit is qualified as estimated.

7.2.3 Accuracy

The VOC monitoring program evaluates both quantitative and qualitative accuracy. The quantitative evaluation includes performance verification for instrument calibrations, LCS recoveries, sample surrogate recoveries, and sample internal standard areas. Qualitative evaluation consists of the evaluation of standard ion abundance criteria for the instrument tune.

7.2.3.1 Quantitative Accuracy

Instrument calibrations

Instrument calibrations are required to have a Relative Standard Deviation (RSD) percentage of less than 30 percent for each analyte of the calibration. This is calculated by first calculating the Relative Response Factor (RRF) as indicated below:

$$RRF = \frac{(\text{Analyte Response})(\text{Internal Standard Concentration})}{(\text{Internal Standard Response})(\text{Analyte Concentration})}$$

$$RSD = \frac{\text{Standard Deviation of RRF}}{\text{Average RRF of Analyte} \times 100}$$

During 2003, 100 percent of instrument calibrations met the ± <30 percent criteria.

LCS recoveries

LCS recoveries are required to have a percent recovery of ± <25 percent. LCS recoveries are calculated as follows:

$$\text{Percent Recovery} = \frac{\text{Concentration Result}}{\text{Introduced Concentration} \times 100}$$

During 2003, 100 percent of the LCS recoveries met the ± <25 percent criterion.

Sample Surrogate Recoveries

Surrogates are introduced to determine the accuracy of the process of extracting the sample from the sample container. The surrogate recoveries are evaluated to determine if they have met the ± 40 percent criterion.

During 2003, 100 percent of the surrogates introduced met the recovery criteria.

Internal Standard Area

Internal standard areas are compared to a calibrated standard to evaluate accuracy. The acceptance criteria is ± 40 percent.

During 2003, 100 percent of all standards met this criterion.

7.2.3.2 Qualitative Accuracy

The standard ion abundance criteria for bromofluorobenzene is used to evaluate the accuracy of the analytical system in the identification of target analytes as well as unknown contaminants (qualitative accuracy). This ensures that the instrumentation is correctly identifying individual compounds during the analysis of air samples.

During 2003, all ion abundance criteria were within tolerance.

7.2.4 Comparability

Air Toxics, Ltd., participates in a biennial independent assessment. In 2002, Air Toxics participated in the ERA, for 49 VOCs in nonpotable water. Results were 100 percent satisfactory. An assessment was not completed in 2003.

7.2.5 Representativeness

The VOC monitoring program is designed to provide the best representation of the underground air in the disposal circuit. Sampling locations are designated based on where the air enters and exits the disposal units. Sample representativeness is achieved by collecting VOC samples continuously over a six hour period. By collecting samples in this manner, rather than an instantaneous sample, fluctuations in VOC concentration during the six hour period will be captured.

7.3 TRACE Analysis

TRACE Analysis of Lubbock, Texas, was subcontracted for 2003 to perform the analyses of groundwater samples collected at the WIPP site.

7.3.1 Completeness

The WIPP Detection Monitoring Program samples seven monitoring wells twice each year. For 2003, all seven wells were sampled for all required parameters on schedule. TRACE Analysis completed all required analyses without losing sample or data integrity and provided all analytical results as prescribed by the HWFP. For 2003, 14 sets of water samples were collected of which all produced complete and valid data. For 2003, the completeness percentage was 100 percent.

7.3.2 Precision

Precision for water quality analyses was based on the RPD between reported concentrations for the original sample analyses and the duplicate analyses as well as the results for LCSs and LCSDs. For 2003, precision was very good for both sampling Rounds 16 and 17. The precision for the general chemistry analyses averaged 4.0 percent RPD. Precision for metals averaged 6.0 percent RPD. Precision for VOCs and SVOCs were both less than 1 percent RPD.

7.3.3 Accuracy

Accuracy of the groundwater-sample analyses is based on the percentage of recovery of individual chemical parameters from the LCSs and LCSDs. The recoveries from the LCSs and LCSDs are evaluated to determine if they exceeded the ± 25 percent criterion for the general chemistry parameters, metals, and VOCs. SVOC recoveries are evaluated based on the individual prescribed recovery ranges specific to each chemical compound. For 2003, all recoveries from LCSs and LCSDs were within the acceptable range for general chemistry, metals and VOCs except for one single metals result, which was recovered above the prescribed limit. The majority of SVOC recovery results were also within the acceptable range except for a few isolated results that were recovered above the prescribed recovery percentage range.

7.3.4 Comparability

TRACE Analysis, Inc., participated in an AbsoluteGrade PT Program interlaboratory assessment. For the assessment program, runs from October to November 2003 analyzing blind performance standards (Tables 7.6, 7.7, and 7.8), 217 of 224 (97 percent) parameters were acceptable.

7.3.5 Representativeness

The Groundwater Detection Monitoring Program is designed to collect representative groundwater samples from specific monitoring well locations. During the sampling process, serial samples are collected to help determine when final samples should be collected. Field water quality analyses are conducted to determine that the water being pumped from the monitoring wells is stable and representative of the natural groundwater at each well. A final sample is only collected when it is determined from serial sampling that the produced water is representative of natural groundwater at each location.

Table 7.6 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc.
October - November, 2003

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
pH	SU[c]	6.37	6.3	5.67-6.93	ACCEPT
Cyanide	mg/L	0.358	0.406	0.305-0.508	ACCEPT
Phenolics, total	mg/L	1.82	1.71	1.20-2.21	ACCEPT
Grease & Oil (Gravimeteric)	mg/L	12.8	13.1	8.25-15.7	ACCEPT
Total Residual Chlorine	mg/L	0.3	0.341	0.257-0.425	ACCEPT
Mercury	µg/L	3.23	3.2	2.24-4.16	ACCEPT
Hexavalent Chromium	µg/L	483	380	330-415	NOT ACCEPT
Minerals					
Total solids at 105°C	mg/L	312	408	310-506	ACCEPT
Total Dissolved Solids	mg/L	284	321	276-366	ACCEPT
Conductivity at 25°C	µmhos	526	530	502-558	ACCEPT
Alkalinity as CaCO3	mg/L	30	27.2	24.5-30.8	ACCEPT
Chloride	mg/L	116	109	102-116	ACCEPT
Fluoride	mg/L	1.82	1.69	1.53-1.82	ACCEPT
Potassium	mg/L	29.1	31.1	28.3-34.0	ACCEPT
Sodium	mg/L	13.7	14.6	13.5-16.1	ACCEPT
Sulfate	mg/L	36.9	38.1	33.1-42.1	ACCEPT
Hardness					
Total suspended solids	mg/L	312	408	310-506	ACCEPT
Calcium	mg/L	43.3	41.6	38.8-45.6	ACCEPT
Magnesium	mg/L	12.3	12.2	11.2-13.2	ACCEPT
Calcium hardness as $CaCO_3$	mg/L	210	217	204-231	ACCEPT
Total hardness as $CaCO_3$	mg/L	N/A	N/A	N/A	NOT REPORTED
Demand					
BOD	mg/L	134	149	99.9-198	ACCEPT
CBOD	mg/L	117	128	80.9-175	ACCEPT
COD	mg/L	239	243	204-260	ACCEPT
TOC	mg/L	98	96.2	85.4-105	ACCEPT
Nutrients					
Ammonia as N	mg/L	3.25	3.39	2.84-3.93	ACCEPT
Nitrate as N	mg/L	6.1	6.46	5.53-7.27	ACCEPT
Ortho-phosphate as P	mg/L	2.16	2.07	1.86-2.29	ACCEPT
Total phosphorus as P	mg/L	1.24	1.31	1.09-1.47	ACCEPT
Total kjeldahl nitrogen as N	mg/L	5.32	9.11	7.31-10.7	NOT ACCEPT
Trace Metals					
Aluminum	µg/L	1730	1800	1628-1960	ACCEPT
Antimony	µg/L	484	481	376-539	ACCEPT
Arsenic	µg/L	452	450	389-511	ACCEPT
Barium	µg/L	1440	1420	1207-1633	ACCEPT
Beryllium	µg/L	307	310	278-336	ACCEPT
Boron	µg/L	993	1000	930-1105	ACCEPT
Cadmium	µg/L	269	260	234-284	ACCEPT

**Table 7.6 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc.
October - November, 2003**

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Chromium	µg/L	669	660	604-718	ACCEPT
Cobalt	µg/L	409	400	367-432	ACCEPT
Copper	µg/L	488	498	468-531	ACCEPT
Iron	µg/L	1340	1320	1222-1436	ACCEPT
Lead	µg/L	493	480	438-520	ACCEPT
Manganese	µg/L	1420	1370	1280-1474	ACCEPT
Molybdenum	µg/L	195	190	171-209	ACCEPT
Nickel	µg/L	1230	1220	1149-1319	ACCEPT
Selenium	µg/L	393	400	340-439	ACCEPT
Silver	µg/L	215	200	181-220	ACCEPT
Strontium	µg/L	179	170	153-187	ACCEPT
Thallium	µg/L	555	550	476-606	ACCEPT
Vanadium	µg/L	972	940	878-1001	ACCEPT
Zinc	µg/L	841	820	759-890	ACCEPT
PCBs in H_2O (Standard #1)					
Aroclor 1242	µg/L	1.47	0	0	NOT ACCEPT
Aroclor 1221	µg/L	N/A	N/A	N/A	NOT REPORTED
Aroclor 1232	µg/L	<0.50	2.6	1.16-3.61	NOT ACCEPT
Aroclor 1248	µg/L	<0.50	0	0	ACCEPT
Aroclor 1254	µg/L	<0.50	0	0	ACCEPT
Aroclor 1260	µg/L	<0.50	0	0	ACCEPT
PCBs in H_2O (Standard #2)					
Aroclor 1242	µg/L	<0.50	0	0	ACCEPT
Aroclor 1221	µg/L	N/A	N/A	N/A	NOT REPORTED
Aroclor 1232	µg/L	<0.50	0	0	ACCEPT
Aroclor 1248	µg/L	<0.50	0	0	ACCEPT
Aroclor 1254	µg/L	<0.50	0	0	ACCEPT
Aroclor 1260	µg/L	2.17	2.4	1.46-2.85	ACCEPT
PCBs in Oil (Standard #1)					
Aroclor 1016/1242	mg/kg	<1.0	0	0	ACCEPT
Aroclor 1254	mg/kg	<1.0	0	0	ACCEPT
Aroclor 1260	mg/kg	27.1	43.1	16.6-51.8	ACCEPT
PCBs in Oil (Standard #2)					
Aroclor 1016/1242	mg/kg	17.3	26	9.35-31.5	ACCEPT
Aroclor 1254	mg/kg	<1.0	0	0	ACCEPT
Aroclor 1260	mg/kg	<1.0	0	0	ACCEPT
Volatiles					
Acetone	µg/L	N/A	N/A	N/A	NOT REPORTED
Acetonitrile	µg/L	N/A	N/A	N/A	NOT REPORTED
Acrylonitrile	µg/L	N/A	N/A	N/A	NOT REPORTED
Acrolein	µg/L	N/A	N/A	N/A	NOT REPORTED
Benzene	µg/L	35.7	32	26.0-38.3	ACCEPT
Bromodichloromethane	µg/L	55.6	48	38.8-57.7	ACCEPT
Bromoform	µg/L	45	40	30.6-50	ACCEPT
Bromomethane	µg/L	<5.0	0	0	ACCEPT

**Table 7.6 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc.
October - November, 2003**

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
2-Butanone (MEK)	µg/L	N/A	N/A	N/A	NOT REPORTED
Carbon disulfide	µg/L	N/A	N/A	N/A	NOT REPORTED
Carbon tetrachloride	µg/L	44.4	40	30.1-51.2	ACCEPT
Chlorobenzene	µg/L	31.8	28	22.7-33.0	ACCEPT
Chlorodibromomethane	µg/L	55.1	48	37.1-58.4	ACCEPT
Chloroethane	µg/L	<1.0	0	0	ACCEPT
2-Chloroethylvinylether	µg/L	N/A	N/A	N/A	NOT REPORTED
Chloroform	µg/L	46.4	40	31.8-47.5	ACCEPT
Chloromethane	µg/L	<1.0	0	0	ACCEPT
DBCP	µg/L	N/A	N/A	N/A	NOT REPORTED
1,2-Dibromoethane (EDB)	µg/L	53.2	44	26.4-61.6	ACCEPT
Dibromomethane	µg/L	47.5	40	24.0-56.0	ACCEPT
1,2-Dichlorobenzene	µg/L	32.6	28	22.3-33.1	ACCEPT
1,3-Dichlorobenzene	µg/L	32.2	28	22.2-32.6	ACCEPT
1,4-Dichlorobenzene	µg/L	31.6	28	22.0-33.5	ACCEPT
Dichlorodifluoromethane	µg/L	<1.0	0	0	ACCEPT
1,1-Dichloroethane	µg/L	47.2	40	24.0-56.0	ACCEPT
1,2-Dichloroethane	µg/L	54.4	44	35.1-54.0	CK FOR ERROR
1,1-Dichloroethylene	µg/L	53.3	48	33.8-66.1	ACCEPT
cis-1,2-Dichloroethylene	µg/L	55.3	48	28.8-67.2	ACCEPT
trans-1,2-Dichloroethylene	µg/L	54.8	48	35.5-60.5	ACCEPT
1,2-Dichloropropane	µg/L	53.7	44	34.6-51.5	CK FOR ERROR
cis-1,3-Dichloropropylene	µg/L	53.4	52.2	32.6-71.7	ACCEPT
trans-1,3-Dichloropropylene	µg/L	54.8	44	23.9-57.0	ACCEPT
Ethylbenzene	µg/L	37	32	24.9-38.3	ACCEPT
2-Hexanone	µg/L	N/A	N/A	N/A	NOT REPORTED
Methylene chloride	µg/L	53.2	48	36.3-60.2	ACCEPT
4-Methyl-2-pentanone (MIBK)	µg/L	N/A	N/A	N/A	NOT REPORTED
Styrene	µg/L	37.9	32	19.2-44.8	ACCEPT
1,1,1,2-Tetrachloroethane	µg/L	52.9	44	26.4-61.6	ACCEPT
1,1,2,2-Tetrachloroethane	µg/L	54.1	44	31.5-55.6	ACCEPT
Tetrachloroethylene	µg/L	32.3	40	30.6-47.2	ACCEPT
Toluene	µg/L	34.9	32	25.7-37.3	ACCEPT
1,1,1-Trichloroethane	µg/L	45.5	40	30.4-48.3	ACCEPT
1,1,2-Trichloroethane	µg/L	54	44	34.8-52.6	CK FOR ERROR
Trichloroethylene	µg/L	50.5	44	33.3-52.2	ACCEPT
Trichlorofluoromethane	µg/L	<1.0	0	0	ACCEPT
1,2,3-Trichloropropane	µg/L	40.4	44	26.4-61.6	ACCEPT
Vinyl acetate	µg/L	N/A	N/A	N/A	NOT REPORTED
Vinyl chloride	µg/L	43	40.1	24.4-61.4	ACCEPT
Xylenes, total	µg/L	103	88	61.6-108	ACCEPT
Acids					
Benzoic acid	µg/L	N/A	N/A	N/A	NOT REPORTED
4-Chloro-3-methylphenol	µg/L	69.6	148	80.1-168	CK FOR ERROR
2-Chlorophenol.	µg/L	59.5	167	74.1-182	CK FOR ERROR

Table 7.6 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc.
October - November, 2003

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
2,4-Dichlorophenol	µg/L	39.7	122	61.2-130	NOT ACCEPT
2,6-Dichlorophenol	µg/L	N/A	N/A	N/A	NOT REPORTED
2,4-Dimethylphenol	µg/L	59.3	114	45.1-128	ACCEPT
4,6-Dinitro-2-methylphenol	µg/L	N/A	N/A	N/A	NOT REPORTED
2,4-Dinitrophenol	µg/L	<5.0	38.2	11.0-54.7	NOT ACCEPT
2-Methlyphenol	µg/L	N/A	N/A	N/A	NOT REPORTED
3-Methylphenol	µg/L	N/A	N/A	N/A	NOT REPORTED
4-Methylphenol	µg/L	N/A	N/A	N/A	NOT REPORTED
2-Nitrophenol	µg/L	69.6	195	90.9-225	CK FOR ERROR
3-Nitrophenol	µg/L	N/A	N/A	N/A	NOT REPORTED
4-Nitrophenol	µg/L	<5.0	30.8	0.0-39.1	ACCEPT
Pentachlorophenol	µg/L	47.9	163	75.0-195	CK FOR ERROR
Phenol	µg/L	6.2	32.2	0.179-36.8	ACCEPT
2,4,5-Trichlorophenol	µg/L	27.1	75.6	67.7-83.5	NOT ACCEPT
2,4,6-Trichlorophenol	µg/L	<5.0	0	0	ACCEPT
Base Neturals					
Acenaphthene	µg/L	118	161	83.4-181	ACCEPT
Acenaphthylene	µg/L	128	170	91-182	ACCEPT
Aniline	µg/L	N/A	N/A	N/A	NOT REPORTED
Anthracene	µg/L	150	195	94.7-220	ACCEPT
Benzidine	µg/L	N/A	N/A	N/A	NOT REPORTED
Benzo(a)anthracene	µg/L	85.9	110	69.2	ACCEPT
Benzo(b)fluoranthene	µg/L	53.9	80	35.5-98.2	ACCEPT
Benzo(k)fluoranthene	µg/L	30.7	39.8	17.6-51.8	ACCEPT
Benzo(g,h,i)perylene	µg/L	43.2	57.4	24.6-73.6	ACCEPT
Benzo(a)pyrene	µg/L	22.3	25	19.5-30.5	ACCEPT
Benzyl alcohol	µg/L	N/A	N/A	N/A	NOT REPORTED
4-Bromophenyl-phenylether	µg/L	90.4	124	70.2-141	ACCEPT
Butylbenzylphthalate	µg/L	67.1	90.1	15.5-118	ACCEPT
Carbazole	µg/L	N/A	N/A	N/A	NOT REPORTED
4-Chloroaniline	µg/L	N/A	N/A	N/A	NOT REPORTED
bis(2-Chloroethoxy)methane	µg/L	40.2	57.1	30.1-61.1	ACCEPT
bis(2-Chloroethyl)ether	µg/L	43.7	63.9	28.6-69.9	ACCEPT
bis(2-Chloroisopropyl)ether	µg/L	121	183	84.6-243	ACCEPT
1-Chloronaphthalene	µg/L	N/A	N/A	N/A	NOT REPORTED
2-Chloronaphthalene	µg/L	64.1	102	53.5-104	ACCEPT
4-Chlorophenyl-phenylether	µg/L	128	172	86.0-193	ACCEPT
Chrysene	µg/L	146	115	61-134	CK FOR ERROR
Dibenz(a,h)anthracene	µg/L	133	115	92-138	ACCEPT
Dibenzofuran	µg/L	57.9	65	48.6-81.3	ACCEPT
Di-n-butylphthalate	µg/L	121	166	52.5-196	ACCEPT
1,2-Dichlorobenzene	µg/L	44	54	38.5-69.5	ACCEPT
1,3-Dichlorobenzene	µg/L	61.1	70.7	53.3-88.1	ACCEPT
1,4-Dichlorobenzene	µg/L	64.6	76.1	58.5-93.6	ACCEPT
3,3'-Dichlorobenzidine	µg/L	N/A	N/A	N/A	NOT REPORTED

**Table 7.6 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc.
October - November, 2003**

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Diethylphthalate	µg/L	55.8	75.9	21.6-96.8	ACCEPT
Dimethlyphthalate	µg/L	75	106	9.63-131	ACCEPT
2,4-Dinitrotoluene	µg/L	48.5	65	34.8-75.8	ACCEPT
2,6-Dinitrotoulene	µg/L	62.4	79.2	42.4-90.9	ACCEPT
Di-n-octylphthalate	µg/L	107	150	52.6-184	ACCEPT
bis(2-ethylhexyl)phthalate	µg/L	175	181	62.8-225	ACCEPT
Fluoranthene	µg/L	74.7	102	58.9-118	ACCEPT
Fluorene	µg/L	45.7	60.6	34.3-69.5	ACCEPT
Hexachlorobenzene	µg/L	94	122	70.6-140	ACCEPT
Hexachlorobutadiene	µg/L	34.6	50.7	16.5-53.3	ACCEPT
Hexachlorocyclopentadiene	µg/L	134	168	20.8-174	ACCEPT
Hexachloroethane	µg/L	41.7	62.2	18.9-65.9	ACCEPT
Indeno(1,2,3-cd)pyrene	µg/L	49.1	47.8	32.5-63.1	ACCEPT
Isophorone	µg/L	28.2	34.8	19.7-40	ACCEPT
1-Methylnaphthalene	µg/L	N/A	N/A	N/A	NOT REPORTED
2-Methylnaphthalene	µg/L	<5.0	0	0	ACCEPT
Naphthalene	µg/L	137	194	79.6-217	ACCEPT
2-Nitroaniline	µg/L	56.8	60.6	48.6-72.7	ACCEPT
3-Nitroaniline	µg/L	54.4	60	51.5-68.6	ACCEPT
4-Nitroaniline	µg/L	36.3	36.6	24.2-49	ACCEPT
Nitrobenzene	µg/L	29.5	40.1	20.7-45.7	ACCEPT
N-Nitrosodiethylamine	µg/L	N/A	N/A	N/A	NOT REPORTED
N-Nitrosodimethylamine	µg/L	28.4	55.9	5.05-56	ACCEPT
N-Nitrosodiphenylamine	µg/L	N/A	N/A	N/A	NOT REPORTED
N-Nitroso-di-n-propylamine	µg/L	100	126	60.1-143	ACCEPT
Phenanthrene	µg/L	46.4	64.1	37.2-73.1	ACCEPT
Pyrene	µg/L	81.2	105	52.9-125	ACCEPT
Pyridine	µg/L	N/A	N/A	N/A	NOT REPORTED
1,2,4-Trichlorobenzene	µg/L	102	150	66.2-155	ACCEPT

[a] Not reported
[b] Check for Error indicates result is above the warning limit, but within the acceptance limit.
[c] Standard Unit

**Table 7.7 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc., Petroleum
October - November, 2003**

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Gasoline in Water					
Unleaded Gasoline	µg/L	2560	2197	1538-2857	ACCEPT
Benzene	µg/L	35.7	32	26.0-38.3	ACCEPT
Ethylbenzene	µg/L	37	32	24.9-38.3	ACCEPT
Toluene	µg/L	34.9	32	25.7-37.3	ACCEPT
Xylenes, M/P	µg/L	103	88	61.6-108	ACCEPT
Diesel in Water					
No. 2 Diesel	µg/L	N/A	N/A	N/A	NOT REPORTED

Table 7.7 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc., Petroleum October - November, 2003

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
TPH in Water					
TPH (gravimetric)	mg/bttl	N/A	N/A	N/A	NOT REPORTED
TPH (IR)	mg/bttl	N/A	N/A	N/A	NOT REPORTED

[a] Not applicable

Table 7.8 - AbsoluteGrade PT Program Assessment of Trace Analysis, Inc., Pesticides October - November, 2003

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Aldrin	µg/L	2.4	2.71	1.19-3.16	ACCEPT
alpha-BHC	µg/L	11.2	14	7.31-17.1	ACCEPT
beta-BHC	µg/L	4.62	5.71	3.09-7.28	ACCEPT
delta-BHC	µg/L	30.1	40	16.9-50	ACCEPT
gamma-BHC (Lindane)	µg/L	16.4	20	10.1-25.3	ACCEPT
alpha-Chlordane	µg/L	16	20	12-28	ACCEPT
gamma-Chlordane	µg/L	15.5	20	12-28	ACCEPT
Chlordane, technical	µg/L	N/A[a]	N/A[a]	N/A[a]	NOT REPORTED
4,4'-DDD	µg/L	4.2	3.91	2.51-4.86	ACCEPT
4,4'-DDE	µg/L	2.9	3.51	2.18-4.26	ACCEPT
4,4'-DDT	µg/L	4.6	5.91	3.59-7.11	ACCEPT
Dieldrin	µg/L	3.5	4.5	2.97-5.57	ACCEPT
Endrin	µg/L	47.3	60.1	32.2-80.3	ACCEPT
Endrin aldehyde	µg/L	5.7	5.01	2.60-6.41	ACCEPT
Endrin ketone	µg/L	8.12	8.4	5.04-11.8	ACCEPT
Endosulfan I	µg/L	14	18	10.6-23.2	ACCEPT
Endosulfan II	µg/L	25.6	33.1	14.1-45.5	ACCEPT
Endosulfan sulfate	µg/L	8.92	10	4.56-13.7	ACCEPT
Heptachlor	µg/L	2.2	2.7	1.22-3.26	ACCEPT
Heptachlor epoxide	µg/L	1.83	2.5	1.60-2.89	ACCEPT
Methoxychlor	µg/L	5.52	5.81	3.28-7.75	ACCEPT
Toxaphene	µg/L	424	317	176-457	ACCEPT

[a] Not applicable

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Appendix A
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Appendix B
Active Environmental Permits

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2003 (Does Not Include Hazardous Waste Facility Permit)

	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
1	Department of the Interior, Bureau of Land Management	Right-of-Way for Water Pipeline	NM53809	8/17/83	None
2	Department of the Interior, Bureau of Land Management	Right-of-Way for the North Access Road	NM55676	8/24/83	None
3	Department of the Interior, Bureau of Land Management	Right-of-Way for Railroad	NM55699	9/27/83	None
4	Department of the Interior, Bureau of Land Management	Right-of-Way for Dosimetry and Aerosol Sampling Sites	NM63136	7/31/86	7/31/11
5	Department of the Interior, Bureau of Land Management	Right-of-Way for Seven Subsidence Monuments	NM65801	11/7/86	None
6	Department of the Interior, Bureau of Land Management	Right-of-Way for Aerosol Sampling Site	NM77921	8/18/89	8/18/19
7	Department of the Interior, Bureau of Land Management	Right-of-Way for 2 Survey Monuments	NM82245	12/13/89	12/13/19
8	Department of the Interior, Bureau of Land Management	Right-of-Way for telephone cable	NM46029	7/3/90	9/4/11
9	Department of the Interior, Bureau of Land Management	Right-of-Way for SPS Powerline	NM43203	2/20/96	10/19/11
10	Department of the Interior, Bureau of Land Management	Right-of-Way for South Access Road Fence	NM94304	9/26/94	8/17/31
11	Department of the Interior, Bureau of Land Management	Right-of-Way for Duval telephone line	NM60174	11/6/96	3/8/15
12	Department of the Interior, Bureau of Land Management	Right-of-Way for Wells AEC-7 & AEC-8	NM108365	8/30/02	8/30/32
13	Department of the Interior, Bureau of Land Management	Right-of-Way for ERDA-6	NM108365	8/30/02	8/30/32
14	Department of the Interior, Bureau of Land Management	Right-of-Way for Monitoring Well C-2756 (P-18)	NM108365	8/30/02	8/30/32
15	Department of the Interior, Bureau of Land Management	Right-of-way for Monitoring Well C-2664 (Cabin Baby)	NM107944	4/23/02	4/23/32
16	Department of the Interior, Bureau of Land Management	Right-of-Way for Seismic Monitoring Station	NM85426	9/23/91	None
17	Department of the Interior, Bureau of Land Management	Right-of-Way for Wells C-2725 (H-4A), C-2775 (H-4B), & C-2776 (H-4C)	NM108365	8/30/02	8/30/32

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2003 (Does Not Include Hazardous Waste Facility Permit)

	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
18	Department of the Interior, Bureau of Land Management	Right-of-Way for Monitoring Wells C-2723 (WIPP-25), C-2724 (WIPP-26), C-2722 (WIPP-27), C-2636 (WIPP-28), C-2743 (WIPP-29), & C-2727 (WIPP-30)	NM108365	8/30/02	8/30/32
19	Department of the Interior, Bureau of Land Management	Right-of-Way Easement for Accessing State Trust Lands in Eddy & Lea Counties	NM25430	2/29/00	9/28/04
20	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-2	109174	4/15/03	4/15/33
21	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-9	109175	4/15/03	4/15/33
22	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-12	109176	4/15/03	4/15/33
23	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-1 (access road)	109177	6/17/03	6/17/33
24	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-11	110735	10/17/03	10/17/33
25	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-5	110735	10/17/03	10/17/33
26	U.S. Department of the Interior, Fish and Wildlife Service	Concurrence that WIPP construction activities will have no significant impact on federally-listed threatened or endangered species	None	5/29/80	None
27	New Mexico Commissioner of Public Lands	Right-of-Way for High Volume Air Sampler	RW-22789	10/3/85	10/3/20
28	New Mexico Commissioner of Public Lands	Monitoring Well WTS-3	RW-28537	7/31/03	7/31/38
29	New Mexico Commissioner of Public Lands	Monitoring Well WTS-1	RW-28535	8/27/03	8/27/38
30	New Mexico Environment Department Groundwater Bureau	Discharge Permit	DP-831	04/29/03 12/22/03 (modified)	4/29/08
31	New Mexico Environment Department Air Quality Bureau	Operating Permit for two backup diesel generators	310-M-2	12/7/93	None
32	New Mexico Department of Game and Fish	Concurrence that WIPP construction activities will have no significant impact on state-listed threatened or endangered species	None	5/26/89	None
33	New Mexico Environment Department-UST Bureau	Underground Storage Tanks	Facility No. 31539	7/1/03	6/30/04
34	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2801	2/23/01	None
35	New Mexico State Engineer Office	Monitoring Well	C-2811	3/2/02	None
36	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2802	2/23/01	None
37	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2803	2/23/01	None

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2003 (Does Not Include Hazardous Waste Facility Permit)

	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
38	New Mexico State Engineer Office	Appropriation: WQSP-1 Well	C-2413	10/21/96	None
39	New Mexico State Engineer Office	Appropriation: WQSP-2 Well	C-2414	10/21/96	None
40	New Mexico State Engineer Office	Appropriation: WQSP-3 Well	C-2415	10/21/96	None
41	New Mexico State Engineer Office	Appropriation: WQSP-4 Well	C-2416	10/21/96	None
42	New Mexico State Engineer Office	Appropriation: WQSP-5 Well	C-2417	10/21/96	None
43	New Mexico State Engineer Office	Appropriation: WQSP-6 Well	C-2418	10/21/96	None
44	New Mexico State Engineer Office	Appropriation: WQSP-6a Well	C-2419	10/21/96	None
45	New Mexico State Engineer Office	Monitoring Well AEC-7	C-2742	11/6/00	None
46	New Mexico State Engineer Office	Monitoring Well AEC-8	C-2744	11/6/00	None
47	New Mexico State Engineer Office	Monitoring Well Cabin Baby	C-2664	7/30/99	None
48	New Mexico State Engineer Office	Monitoring Well D-268	C-2638	1/12/99	None
49	New Mexico State Engineer Office	Monitoring Well DOE-1	C-2757	11/6/00	None
50	New Mexico State Engineer Office	Monitoring Well DOE-2	C-2682	4/17/00	None
51	New Mexico State Engineer Office	Monitoring Well ERDA-9	C-2752	11/6/00	None
52	New Mexico State Engineer Office	Monitoring Well H-1	C-2765	11/6/00	None
53	New Mexico State Engineer Office	Monitoring Well H-2A	C-2762	11/6/00	None
54	New Mexico State Engineer Office	Monitoring Well H-2B1	C-2758	11/6/00	None
55	New Mexico State Engineer Office	Monitoring Well H-2B2	C-2763	11/6/00	None
56	New Mexico State Engineer Office	Monitoring Well H-2C	C-2759	11/6/00	None
57	New Mexico State Engineer Office	Monitoring Well H-3B1	C-2764	11/6/00	None
58	New Mexico State Engineer Office	Monitoring Well H-3B2	C-2760	11/6/00	None
59	New Mexico State Engineer Office	Monitoring Well H-3B3	C-2761	11/6/00	None
60	New Mexico State Engineer Office	Monitoring Well H-3D	pending	11/6/00	None
61	New Mexico State Engineer Office	Monitoring Well H-4A	C-2725	11/6/00	None
62	New Mexico State Engineer Office	Monitoring Well H-4B	C-2775	11/6/00	None
63	New Mexico State Engineer Office	Monitoring Well H-4C	C-2776	11/6/00	None
64	New Mexico State Engineer Office	Monitoring Well H-5A	C-2746	11/6/00	None
65	New Mexico State Engineer Office	Monitoring Well H-5B	C-2745	11/6/00	None

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2003 (Does Not Include Hazardous Waste Facility Permit)

	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
66	New Mexico State Engineer Office	Monitoring Well H-5C	C-2747	11/6/00	None
67	New Mexico State Engineer Office	Monitoring Well H-6A	C-2751	11/6/00	None
68	New Mexico State Engineer Office	Monitoring Well H-6B	C-2749	11/6/00	None
69	New Mexico State Engineer Office	Monitoring Well H-6C	C-2750	11/6/00	None
70	New Mexico State Engineer Office	Monitoring Well H-7A	C-2694	4/17/00	None
71	New Mexico State Engineer Office	Monitoring Well H-7B1	C-2770	11/6/00	None
72	New Mexico State Engineer Office	Monitoring Well H-7B2	C-2771	11/6/00	None
73	New Mexico State Engineer Office	Monitoring Well H-7C	C-2772	11/6/00	None
74	New Mexico State Engineer Office	Monitoring Well H-8A	C-2780	11/6/00	None
75	New Mexico State Engineer Office	Monitoring Well H-8B	C-2781	11/6/00	None
76	New Mexico State Engineer Office	Monitoring Well H-8C	C-2782	11/6/00	None
77	New Mexico State Engineer Office	Monitoring Well H-9A	C-2785	11/6/00	None
78	New Mexico State Engineer Office	Monitoring Well H-9B	C-2783	11/6/00	None
79	New Mexico State Engineer Office	Monitoring Well H-9C	C-2784	11/6/00	None
80	New Mexico State Engineer Office	Monitoring Well H-10A	C-2779	11/6/00	None
81	New Mexico State Engineer Office	Monitoring Well H-10B	C-2778	11/6/00	None
82	New Mexico State Engineer Office	Monitoring Well H-10C	C-2695	4/17/00	None
83	New Mexico State Engineer Office	Monitoring Well H-11B1	C-2767	11/6/00	None
84	New Mexico State Engineer Office	Monitoring Well H-11B2	C-2687	4/17/00	None
85	New Mexico State Engineer Office	Monitoring Well H-11B3	C-2768	11/6/00	None
86	New Mexico State Engineer Office	Monitoring Well H-11B4	C-2769	11/6/00	None
87	New Mexico State Engineer Office	Monitoring Well H-12	C-2777	11/6/00	None
88	New Mexico State Engineer Office	Monitoring Well H-14	C-2766	11/6/00	None
89	New Mexico State Engineer Office	Monitoring Well H-15	C-2685	4/17/00	None
90	New Mexico State Engineer Office	Monitoring Well H-16	C-2753	11/6/00	None
91	New Mexico State Engineer Office	Monitoring Well H-17	C-2773	11/6/00	None
92	New Mexico State Engineer Office	Monitoring Well H-18	C-2683	4/17/00	None
93	New Mexico State Engineer Office	Monitoring Well P-17	C-2774	11/6/00	None

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2003 (Does Not Include Hazardous Waste Facility Permit)

	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
94	New Mexico State Engineer Office	Monitoring Well WIPP-12	C-2639	1/12/99	None
95	New Mexico State Engineer Office	Monitoring Well WIPP-13	C-2748	11/6/00	None
96	New Mexico State Engineer Office	Monitoring Well WIPP-18	C-2684	4/17/00	None
97	New Mexico State Engineer Office	Monitoring Well WIPP-19	C-2755	11/6/00	None
98	New Mexico State Engineer Office	Monitoring Well WIPP-21	C-2754	11/6/00	None
99	New Mexico State Engineer Office	Monitoring Well WIPP-25	C-2723	7/26/00	None
100	New Mexico State Engineer Office	Monitoring Well WIPP-26	C-2724	11/6/00	None
101	New Mexico State Engineer Office	Monitoring Well WIPP-27	C-2722	11/6/00	None
102	New Mexico State Engineer Office	Monitoring Well WIPP28	C-2636	1/12/99	None
103	New Mexico State Engineer Office	Monitoring Well WIPP-29	C-2743	11/6/00	None
104	New Mexico State Engineer Office	Monitoring Well WIPP-30	C-2727	8/4/00	None
105	New Mexico State Engineer Office	Monitoring Well SNL-2	C-2948	2/14/03	None
106	New Mexico State Engineer Office	Monitoring Well SNL-9	C-2950	2/14/03	None
107	New Mexico State Engineer Office	Monitoring Well SNL-12	C-2954	2/25/03	None
108	New Mexico State Engineer Office	Monitoring Well SNL-1	C-2953	2/25/03	None
109	New Mexico State Engineer Office	Monitoring Well SNL-3	C-2949	2/14/03	None
110	New Mexico State Engineer Office	Monitoring Well WTS-4	C-2960	3/18/03	None
111	New Mexico State Engineer Office	Monitoring Well SNL-5	C-3002	10/1/03	None
112	New Mexico State Engineer Office	Monitoring Well IMC-461	C-3015	11/25/03	None
113	New Mexico State Engineer Office	Monitoring Well SNL-11	C-3003	10/1/03	None

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Appendix C
Location Codes

Table C.1 - Codes Used to Identify the Sites from Which Samples Were Collected

Code	Location	Code	Location
BHT	Bottom of the Hill Tank	RCP1	Rainwater Catchment Pond (1)
BRA	Brantley Lake	RCP2	Rainwater Catchment Pond (2)
CBD	Carlsbad	RED	Red Tank
COW	Coyote Well (deionized water blank)	SEC	South East Control
FWT	Fresh Water Tank	SMR	Smith Ranch
HIL	Hill Tank	SWL	Sewage Lagoons
IDN	Indian Tank	TUT	Tut Tank
LST	Lost Tank	UPR	Upper Pecos River
MLR	Mills Ranch	WAB	WIPP Air Blank
NOY	Noya Tank	WEE	WIPP East
PCN	Pierce Canyon	WFF	WIPP Far Field
PEC	Pecos River	WQSP	Water Quality Sample Program
PKT	Poker Trap	WSS	WIPP South

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Appendix D
Equations

Minimum Detectable Concentration (MDC)

The MDC is the smallest amount (activity or mass) of an analyte in a sample that will be detected with a 5 percent probability of non-detection while accepting a 5 percent probability of erroneously deciding that a positive quantity of analyte is present in an appropriate blank sample. This method assures that any claimed MDC has at least a 95 percent chance of being detected. It is possible to achieve a very low level of detection by analyzing a large sample size and counting for a very long time.

The WIPP Laboratories used the following equation for calculating the MDCs for each radionuclide in various sample matrices:

$$MDC = \frac{4.65 \quad S_b}{K \; T} + \frac{3}{K \; T}$$

Where:

S_b	=	Standard deviation of the background count
K	=	A correction factor that includes items such as unit conversions, sample volume/weight, decay correction, detector efficiency, chemical recovery and abundance correction, etc.
T	=	Counting time

For further evaluation of the MDC, refer to HPS N13.30 - 1996, *Performance Criteria for Radiobioassay*.

Total Propagated Uncertainty (TPU)

The TPU is an estimate of the uncertainty in the measurement due to all sources, including counting error, measurement error, chemical recovery error, detector efficiency, randomness of radioactive decay, and any other sources of uncertainty.

The total propagated uncertainty for each data point must be reported at 2σ level. The TPU was calculated by using the following equation:

$$TPU_{1\sigma} = \sigma_{ACT} = \frac{\sqrt{\sigma_{NCR}{}^2 + (NCR)^2 * (RE_{EFF}^2 + RE_{ALI}^2 + RE_R^2 + \Sigma\, RE_{CF}^2)}}{2.22 * EFF * ALI * R * ABN_S * e^{-\lambda t} * CF}$$

Where:

EFF	=	Detector Efficiency
ALI	=	Sample Aliquot Volume or Mass

R	=	Sample Tracer/Carrier Recovery
ABN_s	=	Abundance Fraction of the Emissions Used for Identification/Quantification
σ^2_{NCR}	=	Variance of the Net Sample Count Rate
NCR	=	Net Sample Count Rate
RE^2_{EFF}	=	Square of the Relative Error of the Efficiency Term
RE^2_{ALI}	=	Square of the Relative Error of the Aliquot
RE^2_{R}	=	Square of the Relative Error of the Sample Recovery
RE^2_{CF}	=	Square of the Relative Error of Other Correction Factors
λ	=	Analyte Decay Constant = ln 2/(half-life) [Same units as the half-life used to compute λ]
t	=	Time from Sample Collection to Radionuclide Separation or Mid-Point of Count Time (Same units as half-life)
CF	=	Other Correction Factors as Appropriate (i.e., ingrowth factor, self-absorption factor, etc.).

For further discussion of TPU, refer to HPS N13.30-1996, *Performance Criteria for Radiobioassay*, and/or *Waste Acceptance Criteria for Off-Site Generators*, Fernald Environmental Management Project (DOE, 1994).

Relative Error Ratio (RER)

The Relative Error Ratio is a method, similar to a t-test, with which to compare duplicate results (see Chapters 4 and 8; WP 02-EM3004).

$$RER = \frac{| x_A - x_B |}{\sqrt{(2\sigma_A)^2 + (2\sigma_B)^2}}$$

Where:

X_A	=	Mean Activity of Population A
X_B	=	Mean Activity of Population B
σ_A	=	Standard Deviation of Population A
σ_B	=	Standard Deviation of Population B

Percent Bias (% Bias)

A measure of the accuracy of radiochemical separation methods and counting instruments; that is, a measure of how reliable the results of analyses are when compared to the actual values.

$$\%\ BIAS = [\frac{A_m - A_k}{A_k}] * 100\%$$

Where:

% BIAS	=	Percent Bias
A_m	=	Measured Sample Activity
A_k	=	Known Sample Activity

Appendix E
Time Trend Plots for Detectable Constituents in Groundwater

The figures in this appendix show the concentrations of various groundwater constituents relative to a baseline concentration, and are in a form required by the NMED and the HWFP. Baseline concentrations were measured from 1995 through 2000. These plots indicate the sample and duplicate concentration values with respect to sample round. Sampling round 16 occurred in March through May 2003 and sampling round 17 occurred from September through November 2003. See Appendix F for specific concentration information on the groundwater wells.

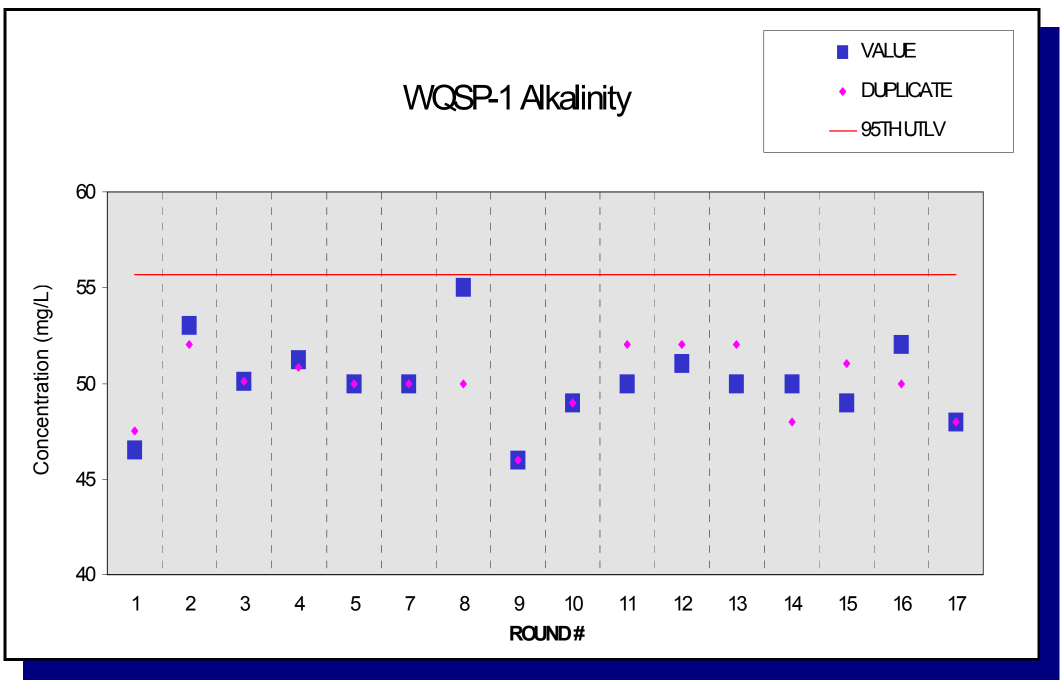

Figure E.1 - Time Trend Plot for Alkalinity at WQSP-1

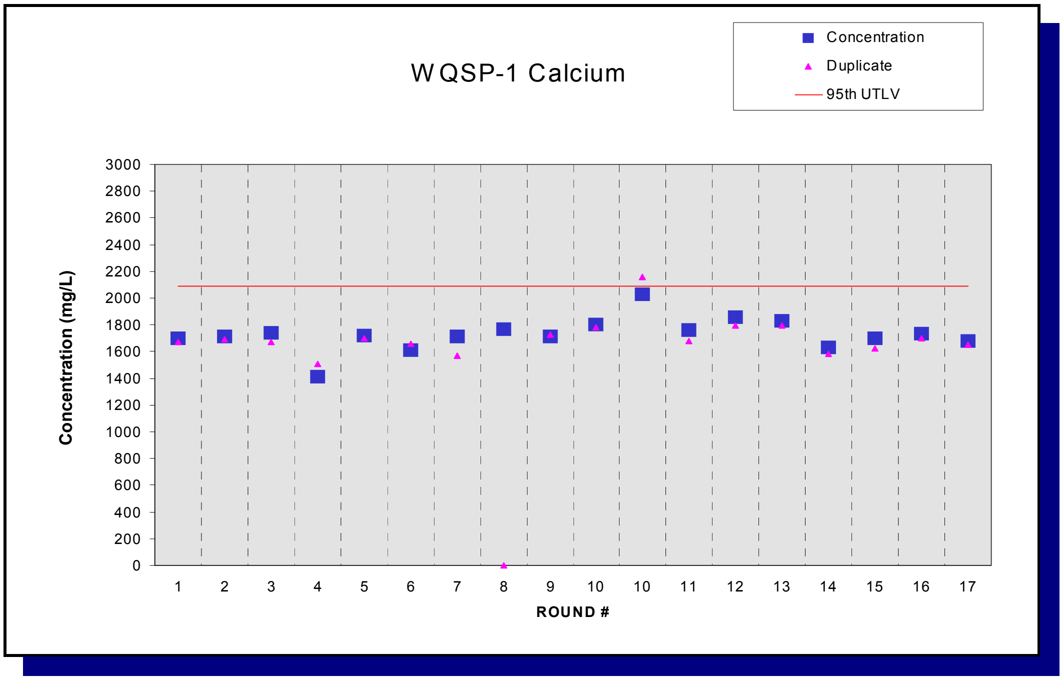

Figure E.2 - Time Trend Plot for Calcium at WQSP-1

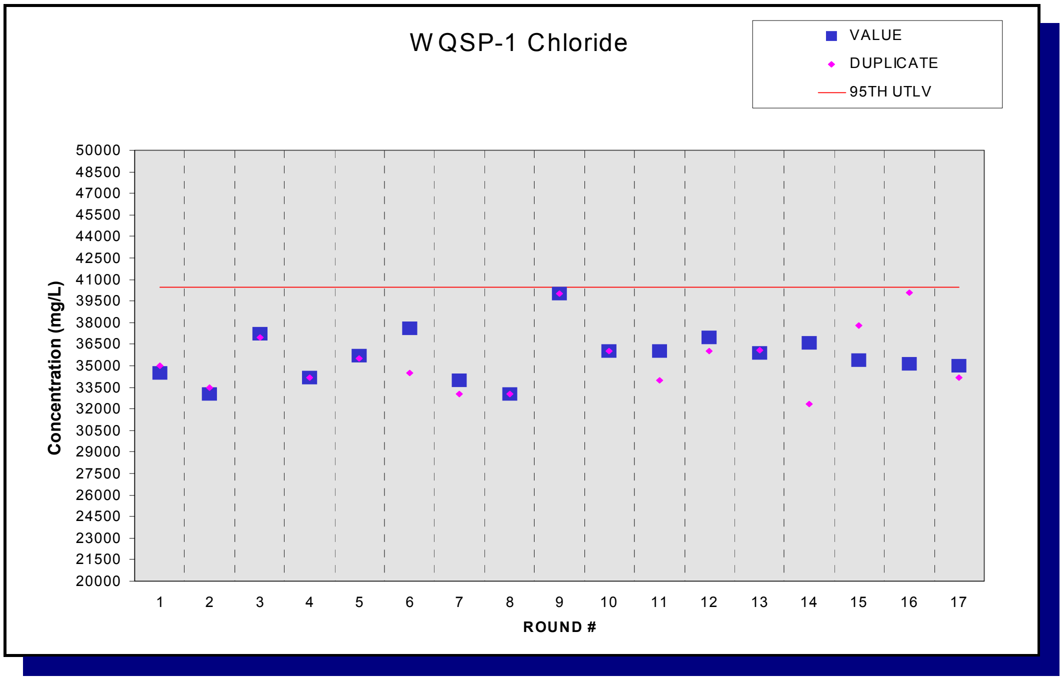

Figure E.3 - Time Trend Plot for Chloride at WQSP-1

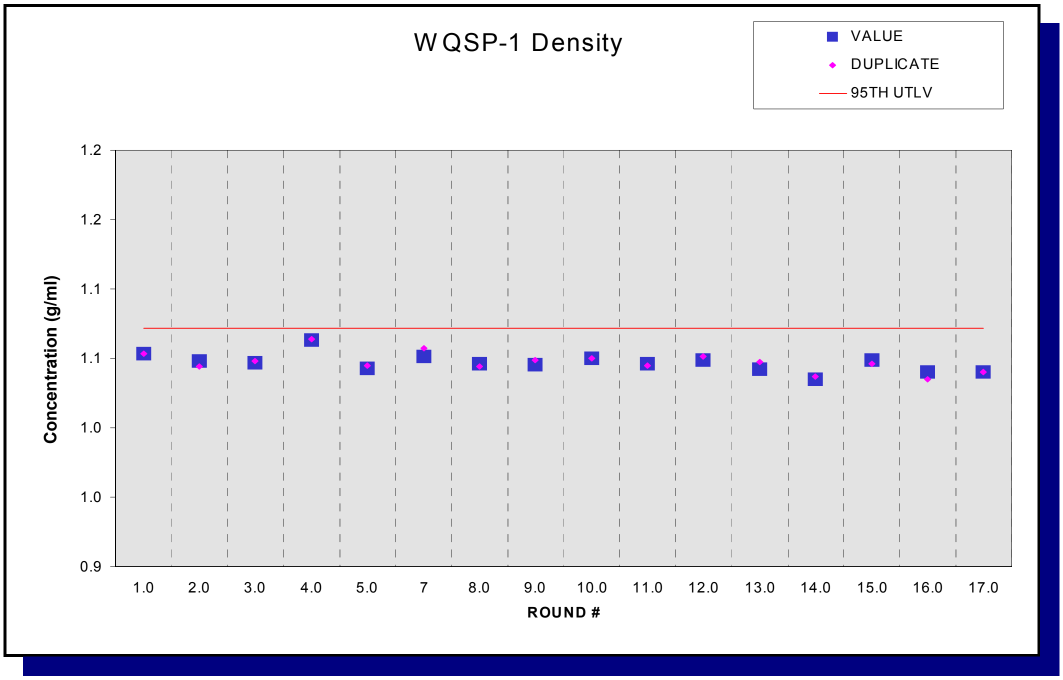

Figure E.4 - Time Trend Plot for Density at WQSP-1

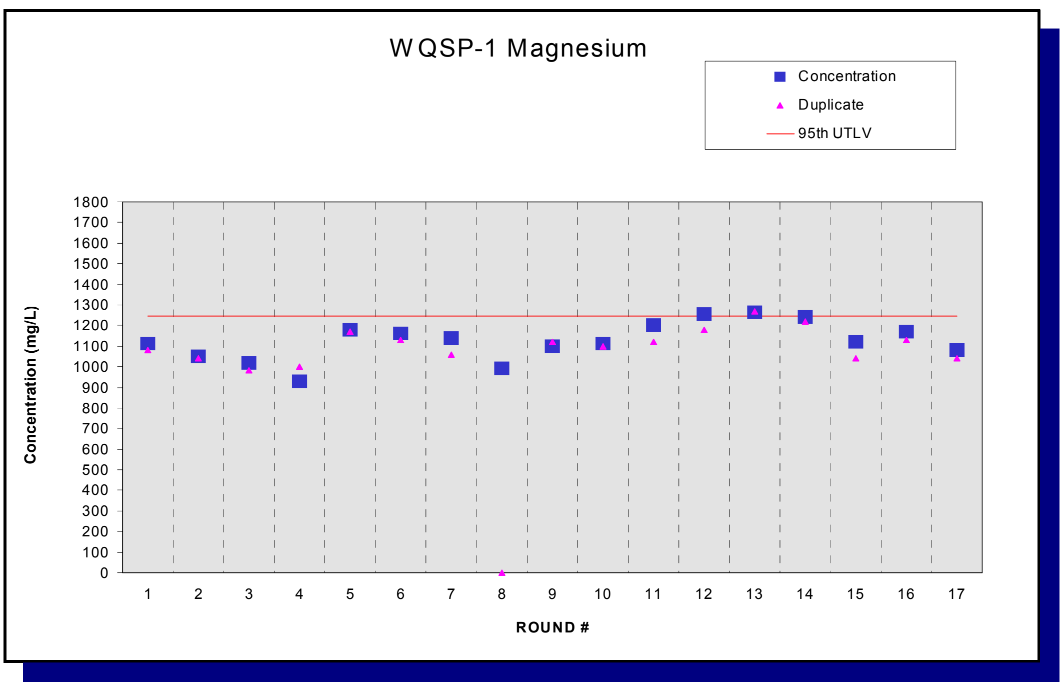

Figure E.5 - Time Trend Plot for Magnesium at WQSP-1

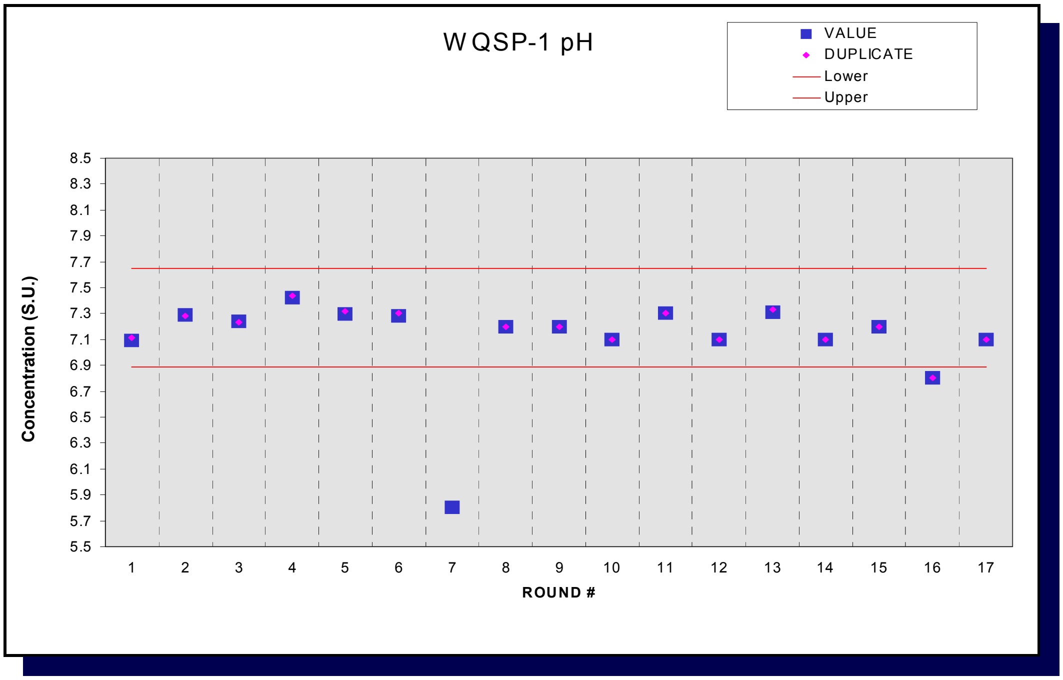

Figure E.6 - Time Trend Plot for pH at WQSP-1

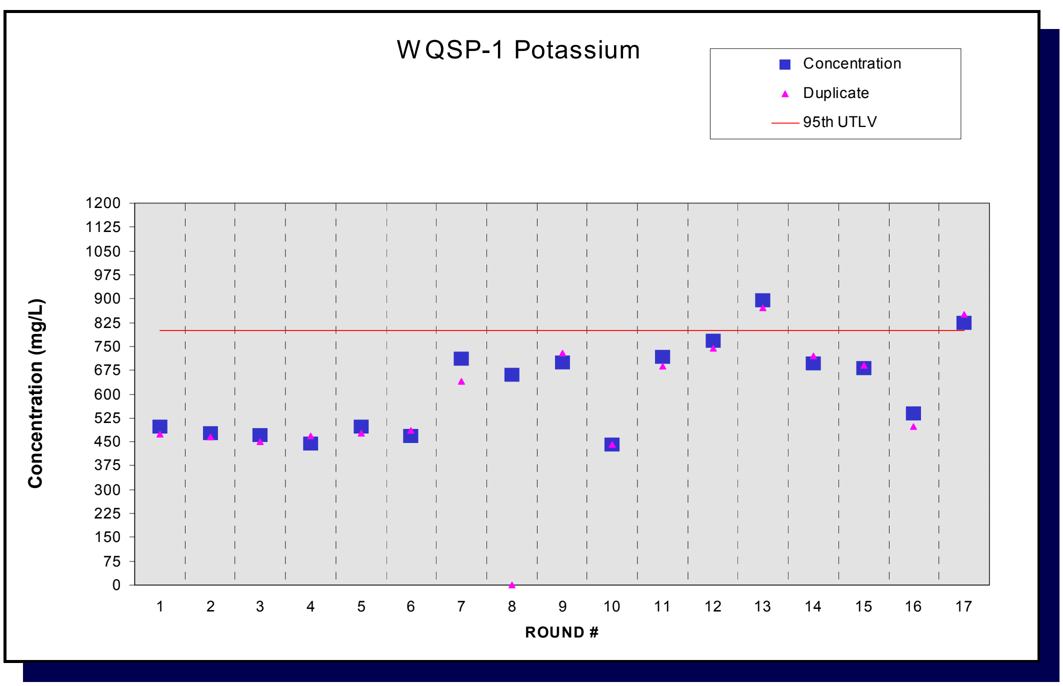

Figure E.7 - Time Trend Plot for Potassium at WQSP-1

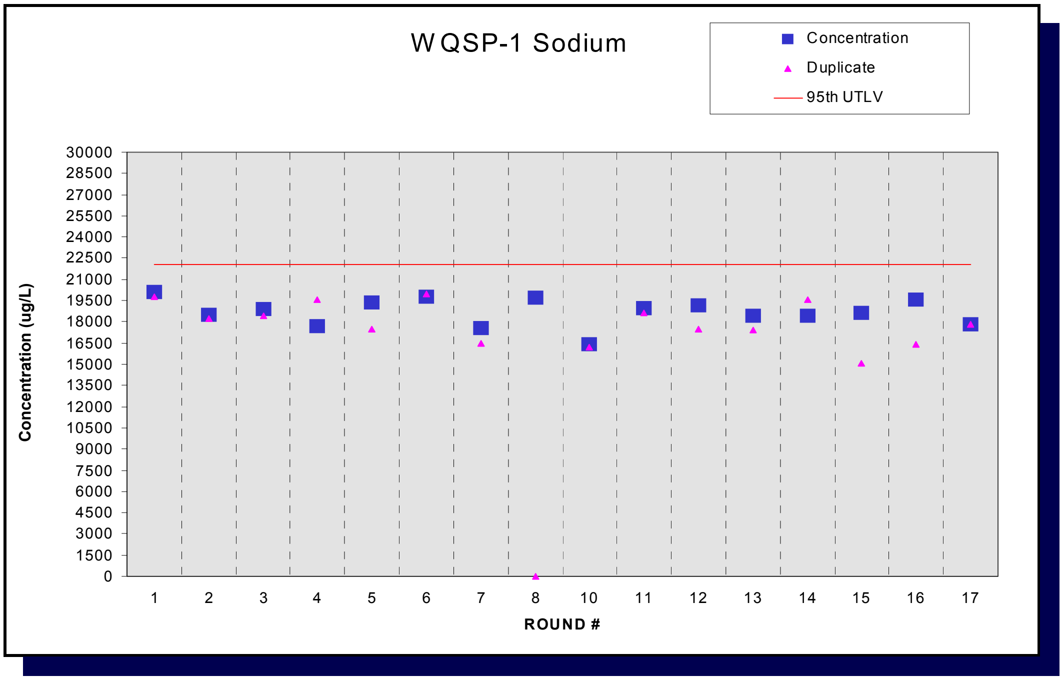

Figure E.8 - Time Trend Plot for Sodium at WQSP-1

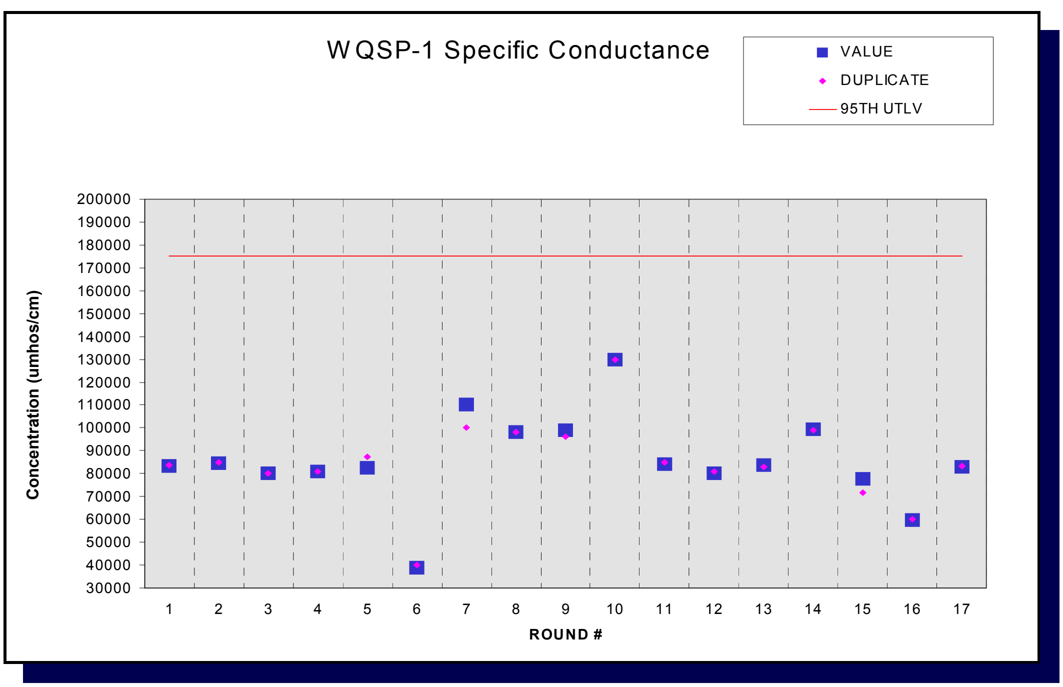

Figure E.9 - Time Trend Plot for Specific Conductance at WQSP-1

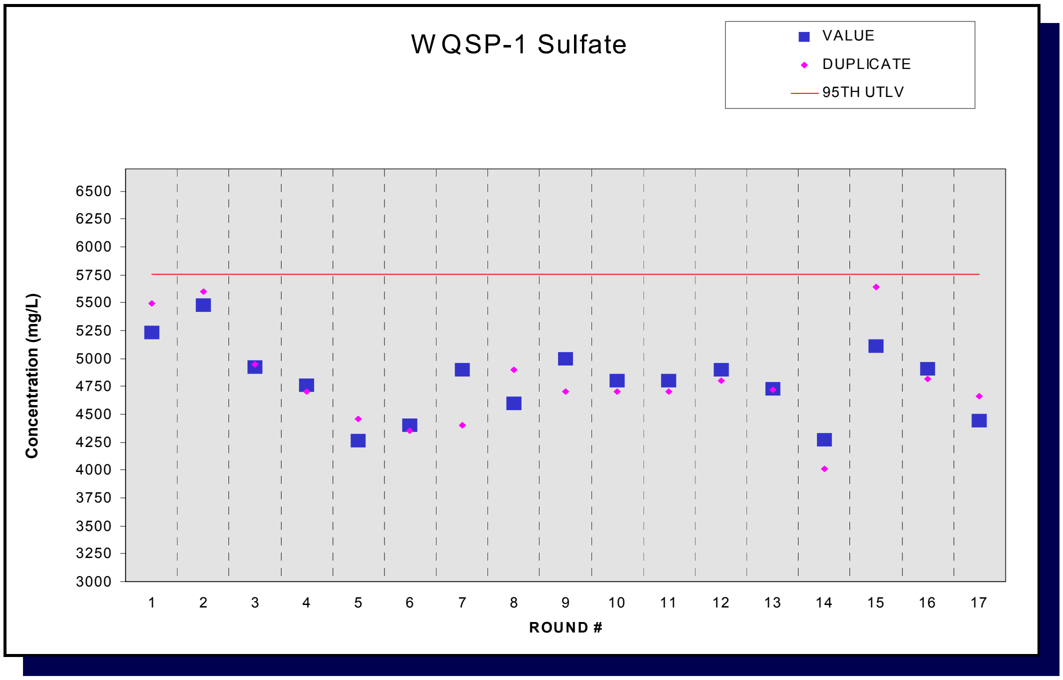

Figure E.10 - Time Trend Plot for Sulfate at WQSP-1

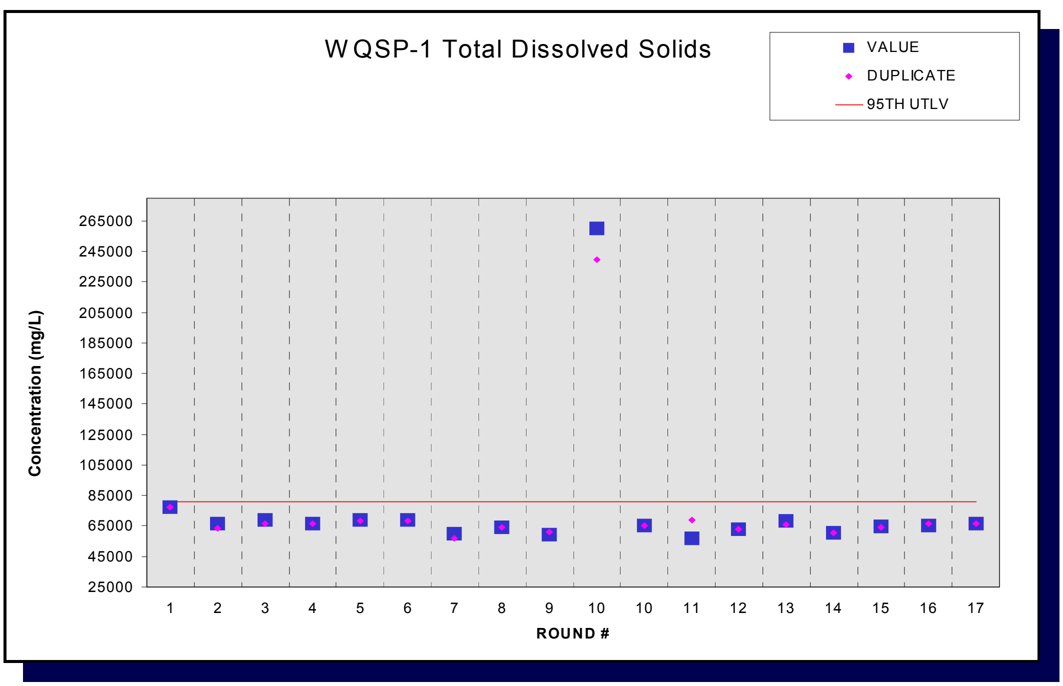

Figure E.11 - Time Trend Plot for Total Dissolved Solids at WQSP-1

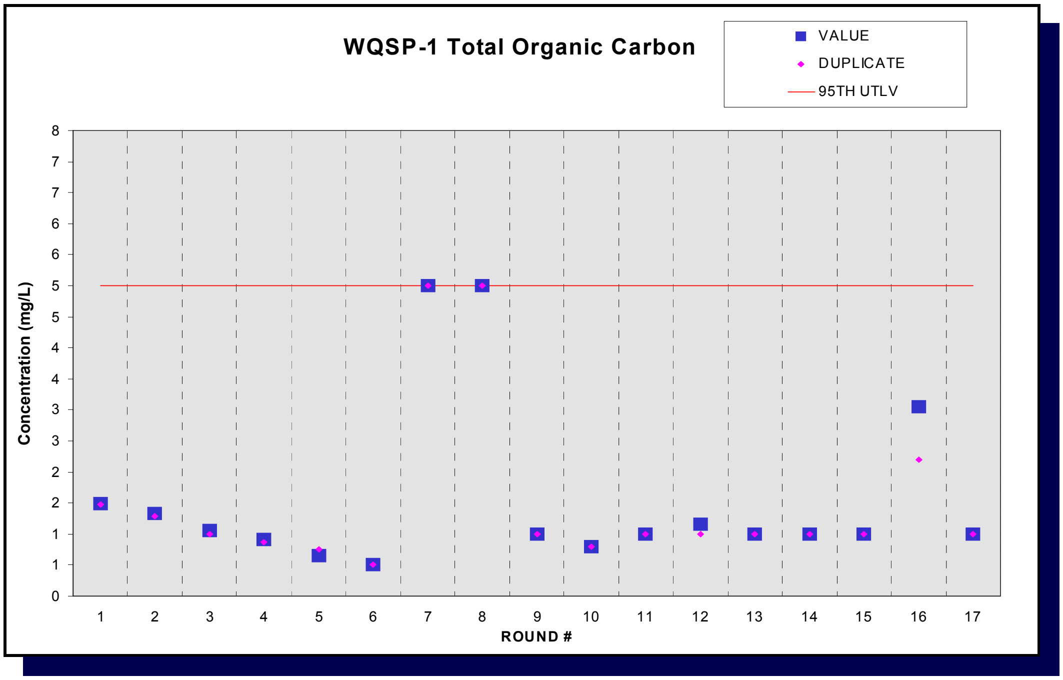

Figure E.12 - Time Trend Plot for Total Organic Carbon at WQSP-1

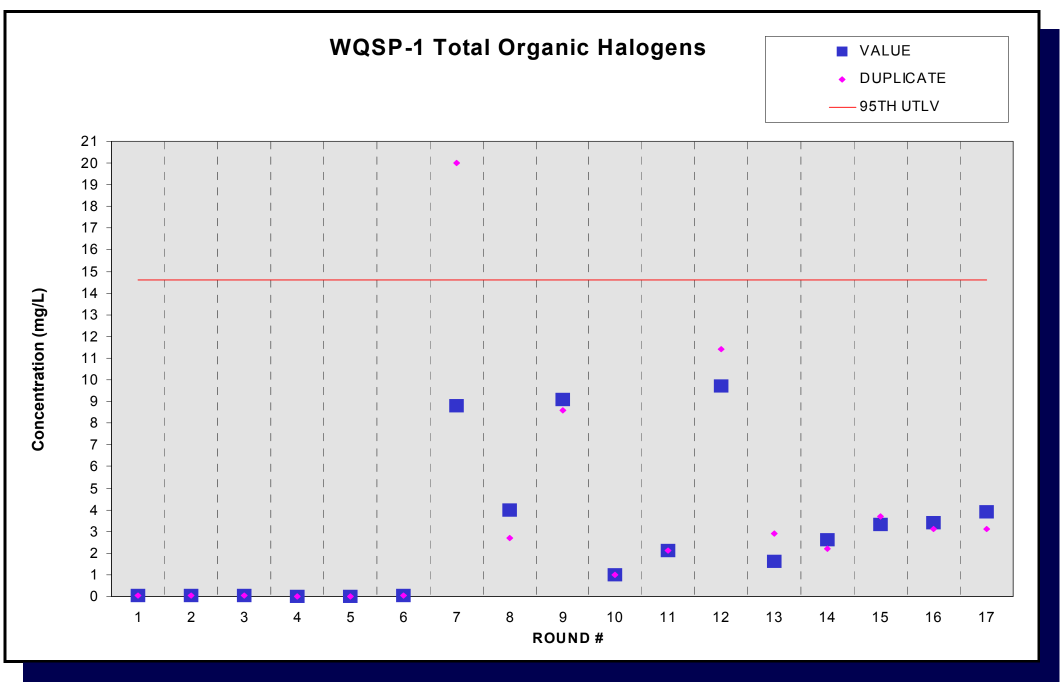

Figure E.13 - Time Trend Plot for Total Organic Halogens at WQSP-1

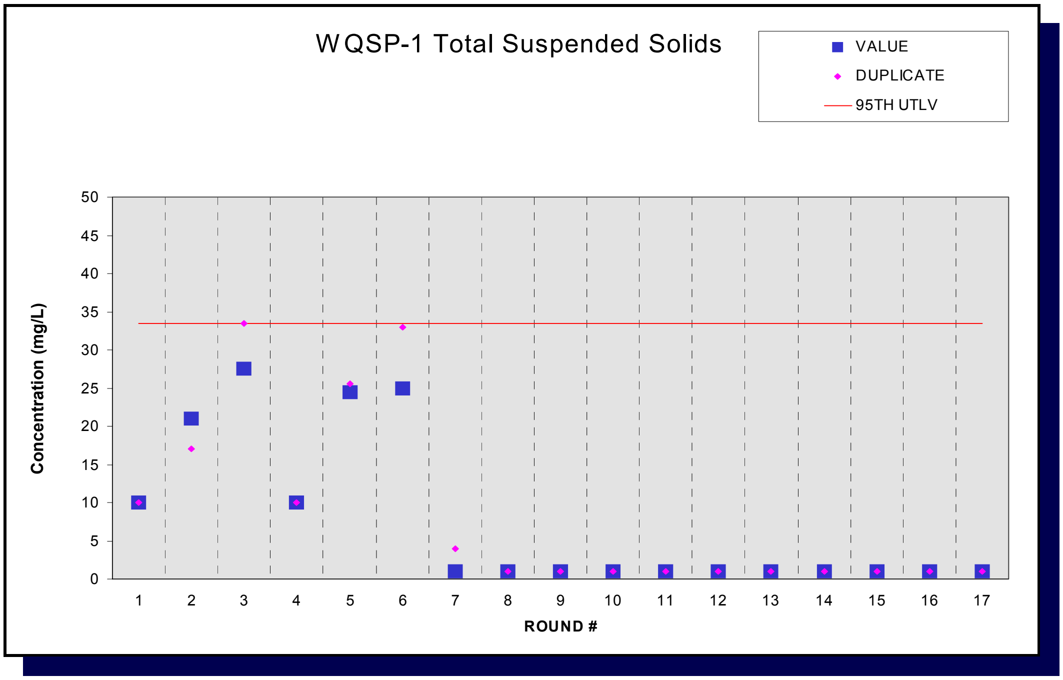

Figure E.14 - Time Trend Plot for Total Suspended Solids at WQSP-1

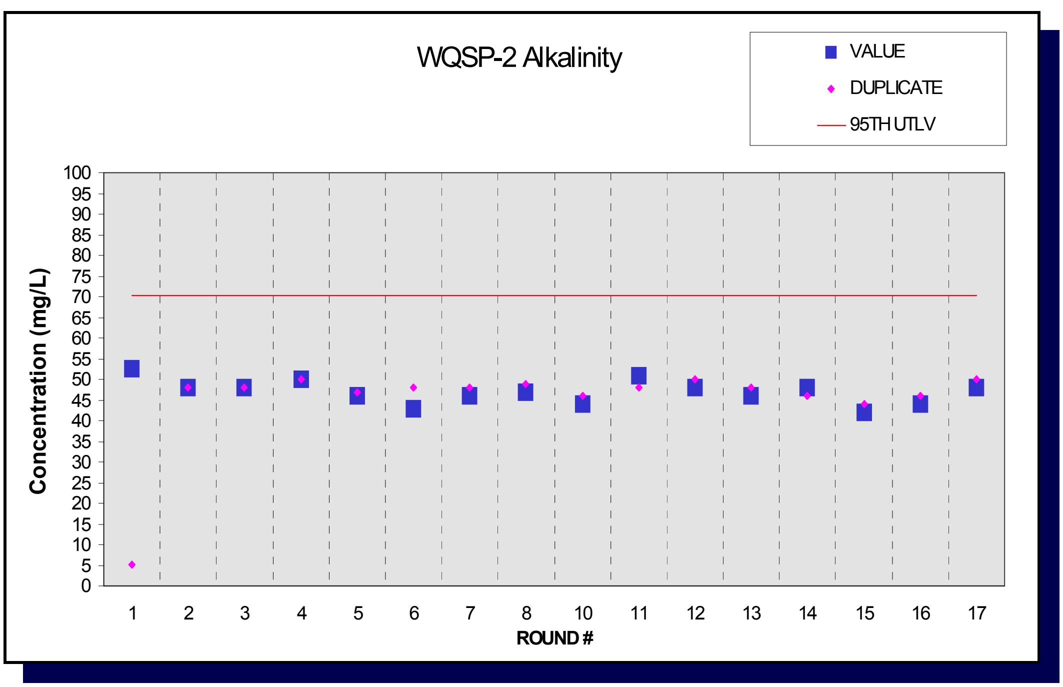

Figure E.15 - Time Trend Plot for Alkalinity at WQSP-2

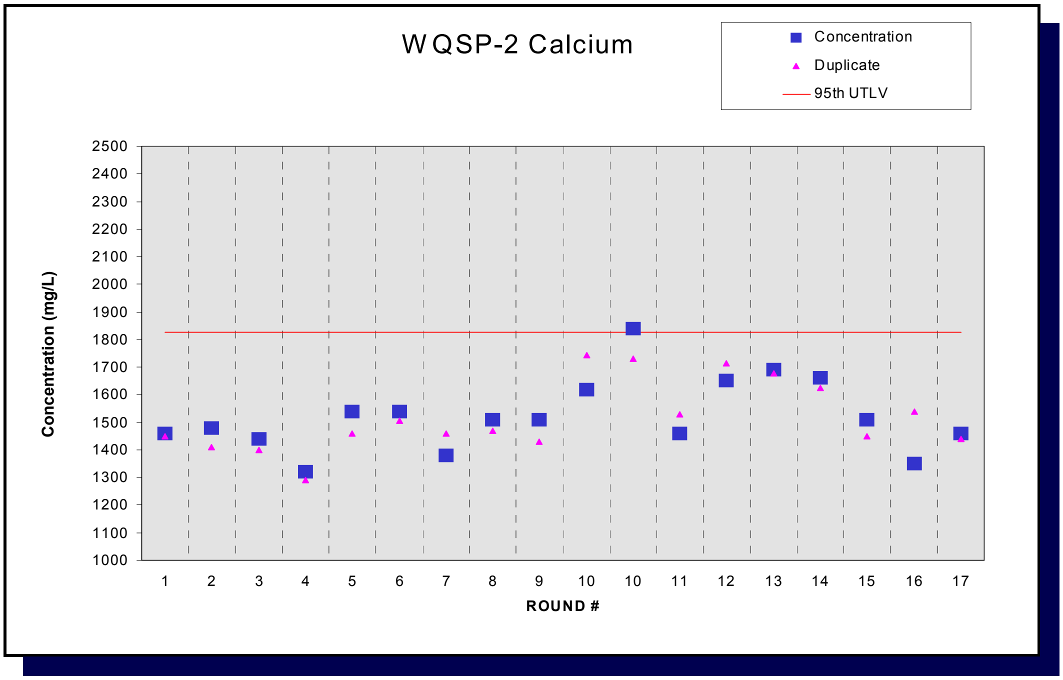

Figure E.16 - Time Trend Plot for Calcium at WQSP-2

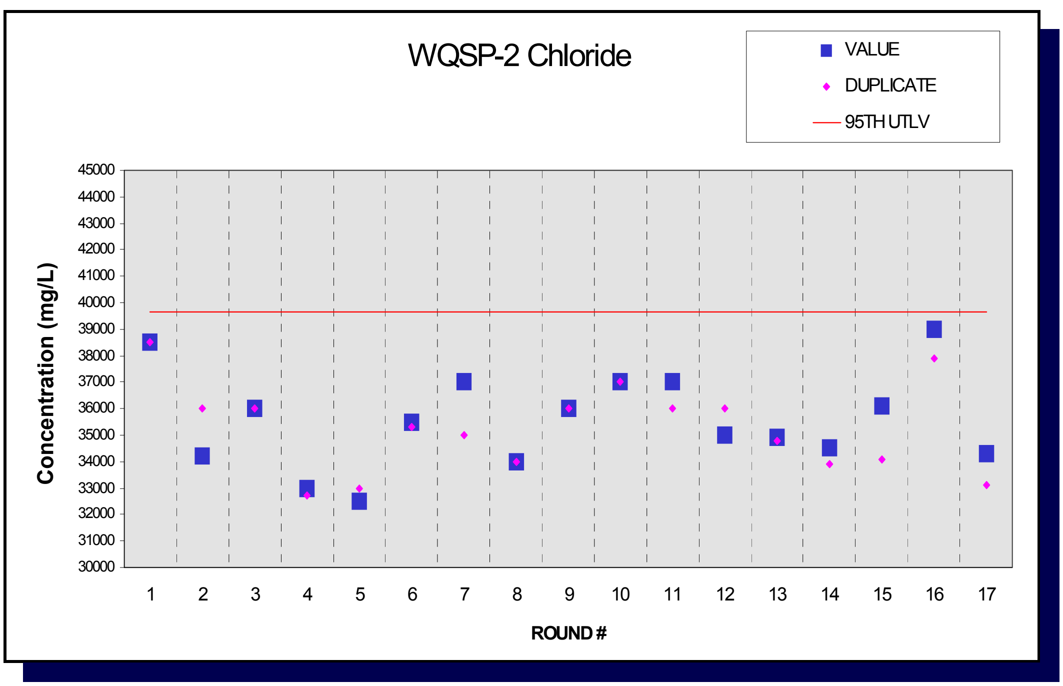

Figure E.17 - Time Trend Plot for Chloride at WQSP-2

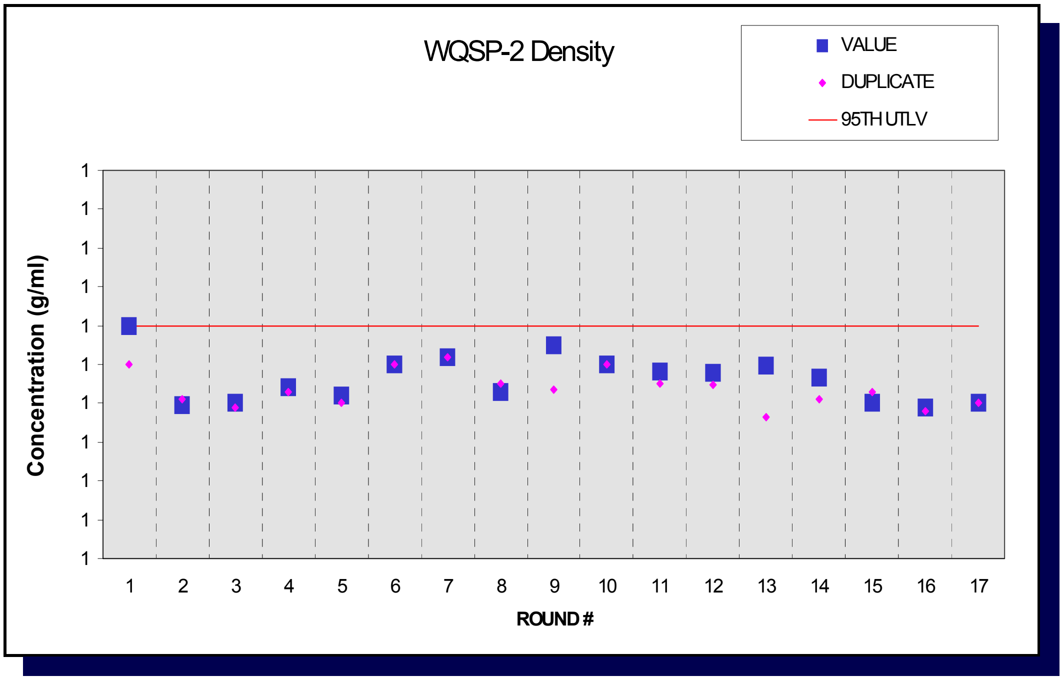

Figure E.18 - Time Trend Plot for Density at WQSP-2

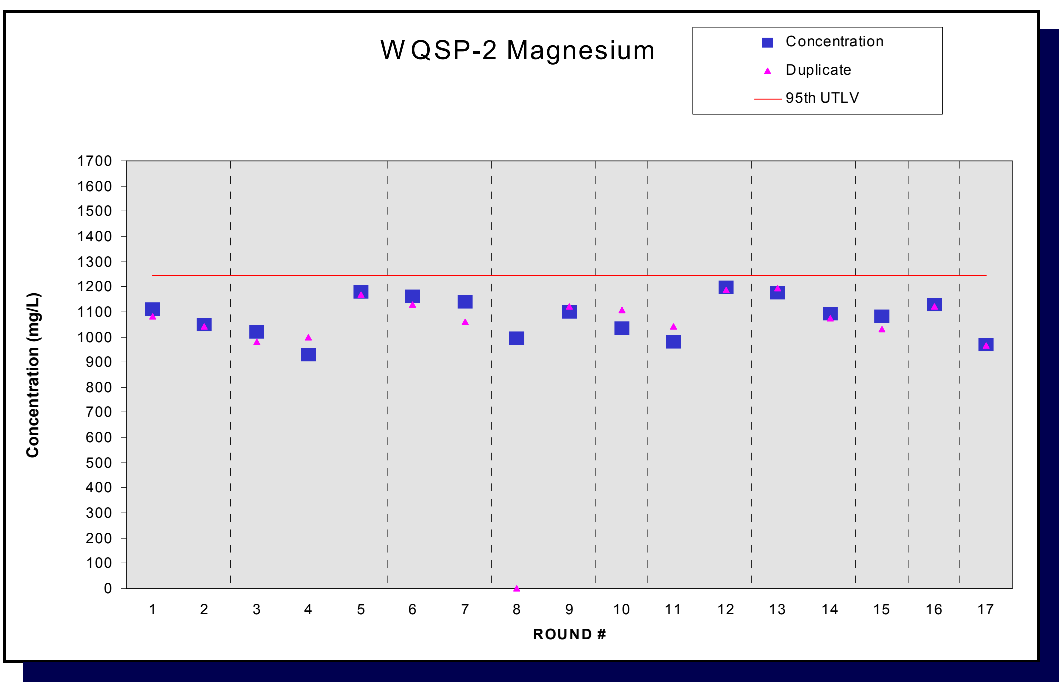

Figure E.19 - Time Trend Plot for Magnesium at WQSP-2

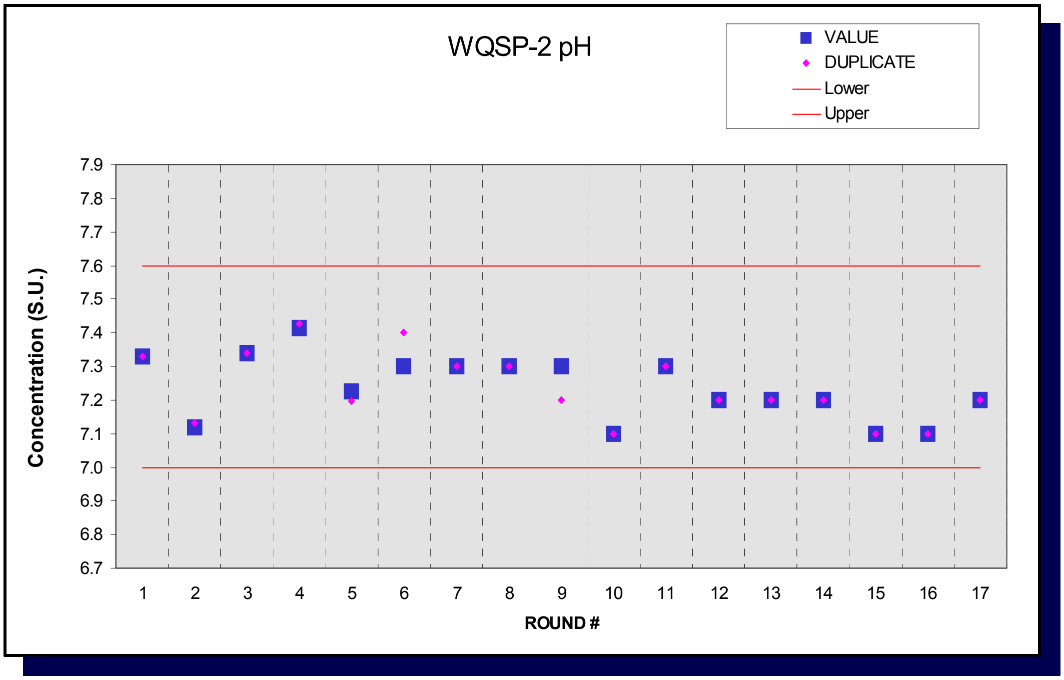

Figure E.20 - Time Trend Plot for pH at WQSP-2

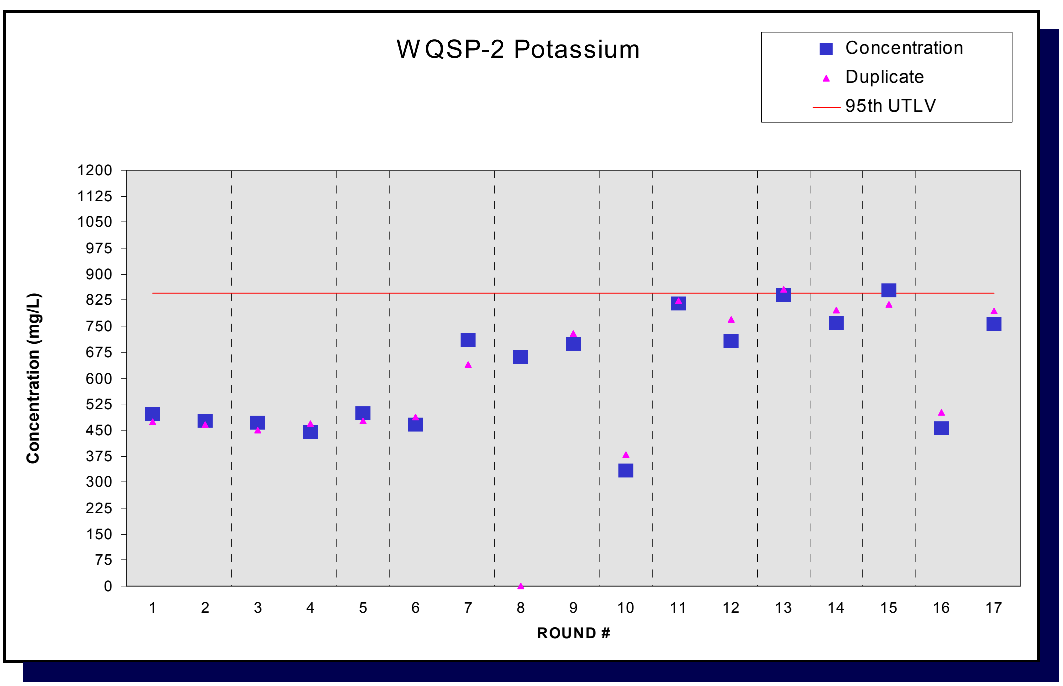

Figure E.21 - Time Trend Plot for Potassium at WQSP-2

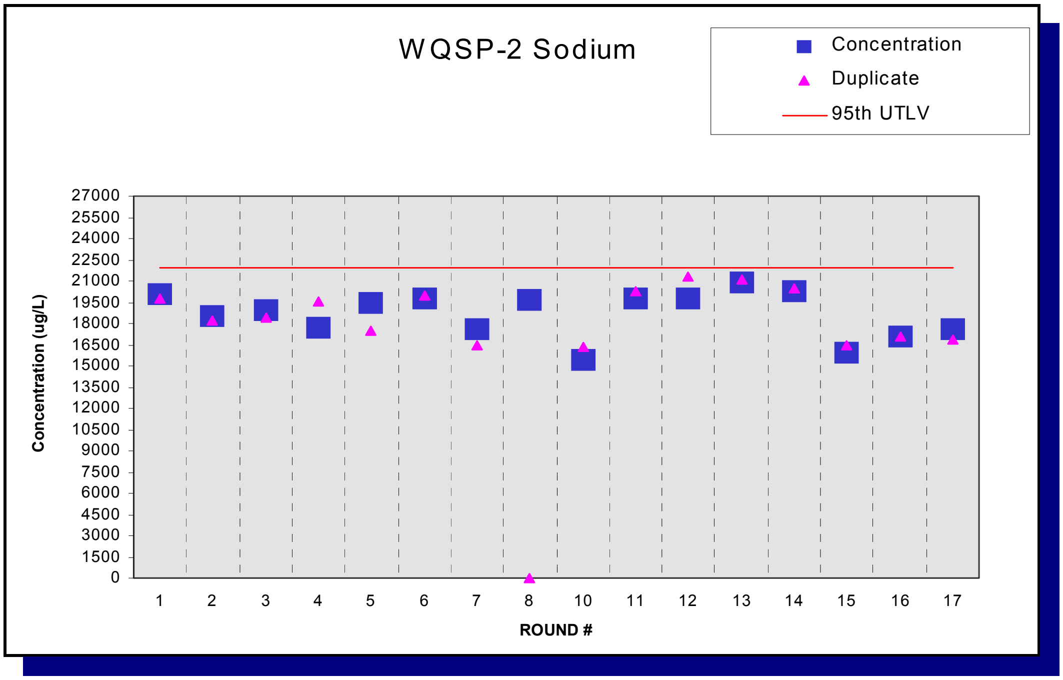

Figure E.22 - Time Trend Plot for Sodium at WQSP-2

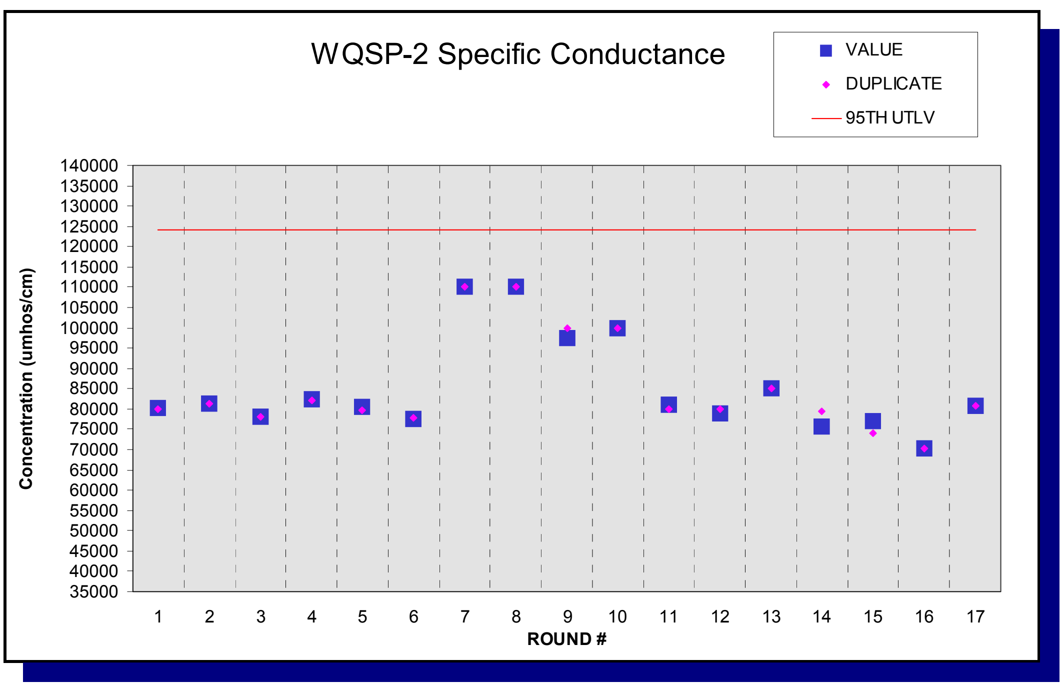

Figure E.23 - Time Trend Plot for Specific Conductance at WQSP-2

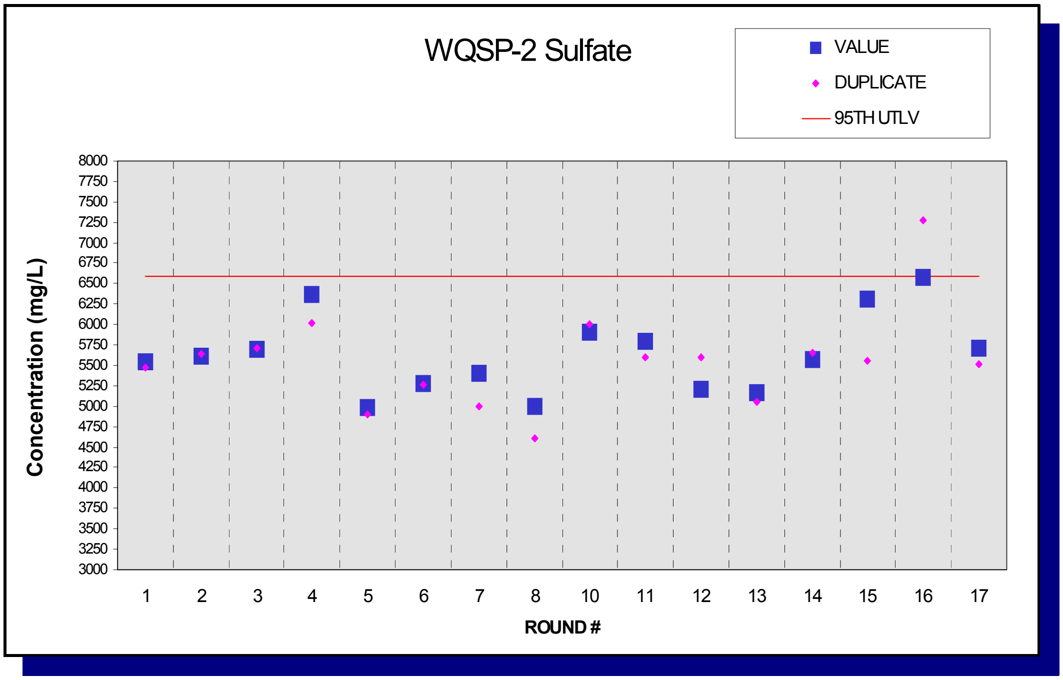

Figure E.24 - Time Trend Plot for Sulfate at WQSP-2

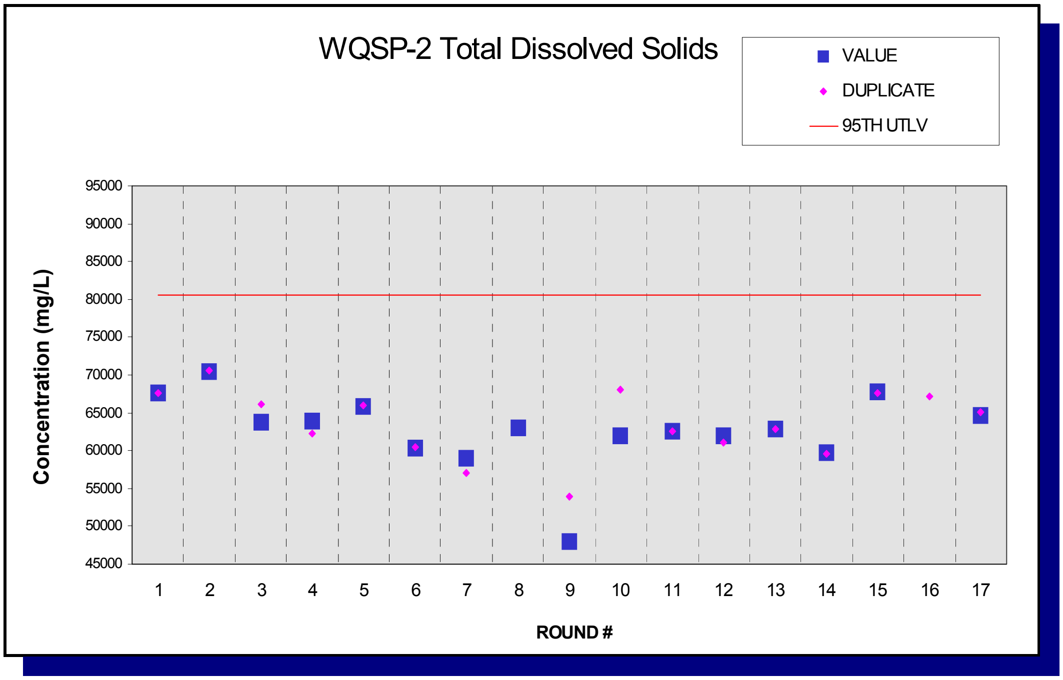

Figure E.25 - Time Trend Plot for Total Dissolved Solids at WQSP-2

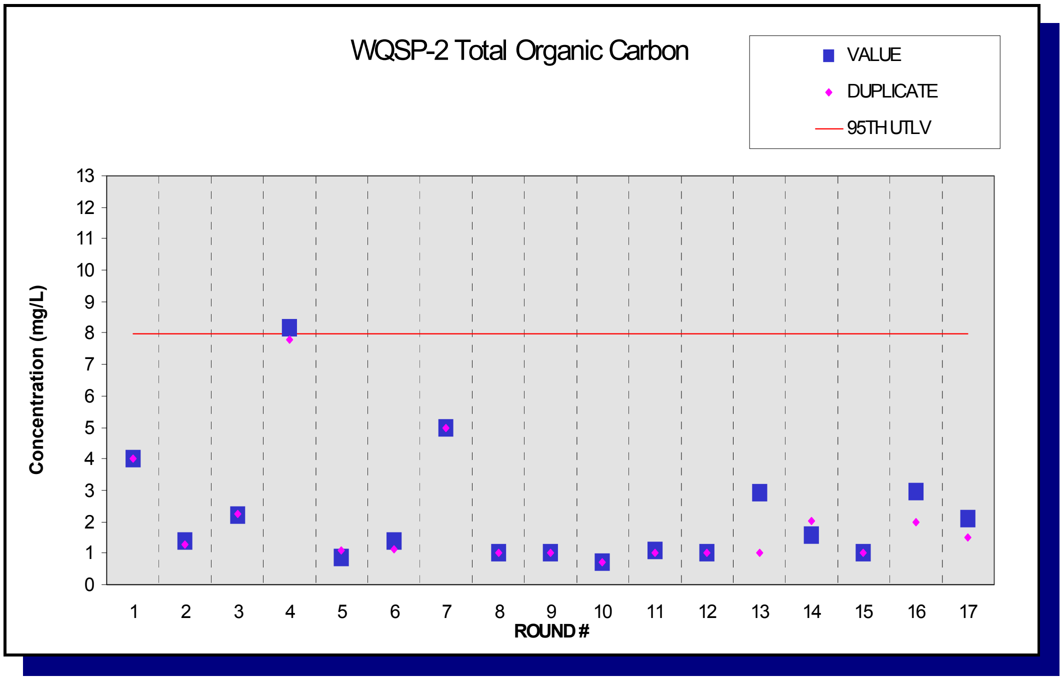

Figure E.26 - Time Trend Plot for Total Organic Carbon at WQSP-2

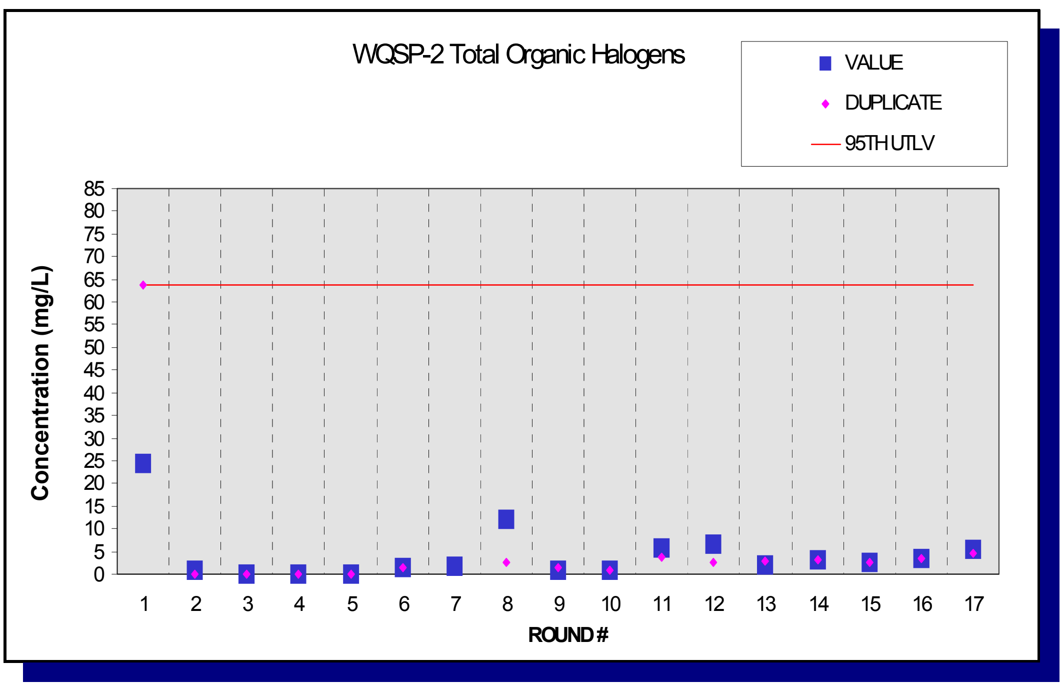

Figure E.27 - Time Trend Plot for Total Organic Halogens at WQSP-2

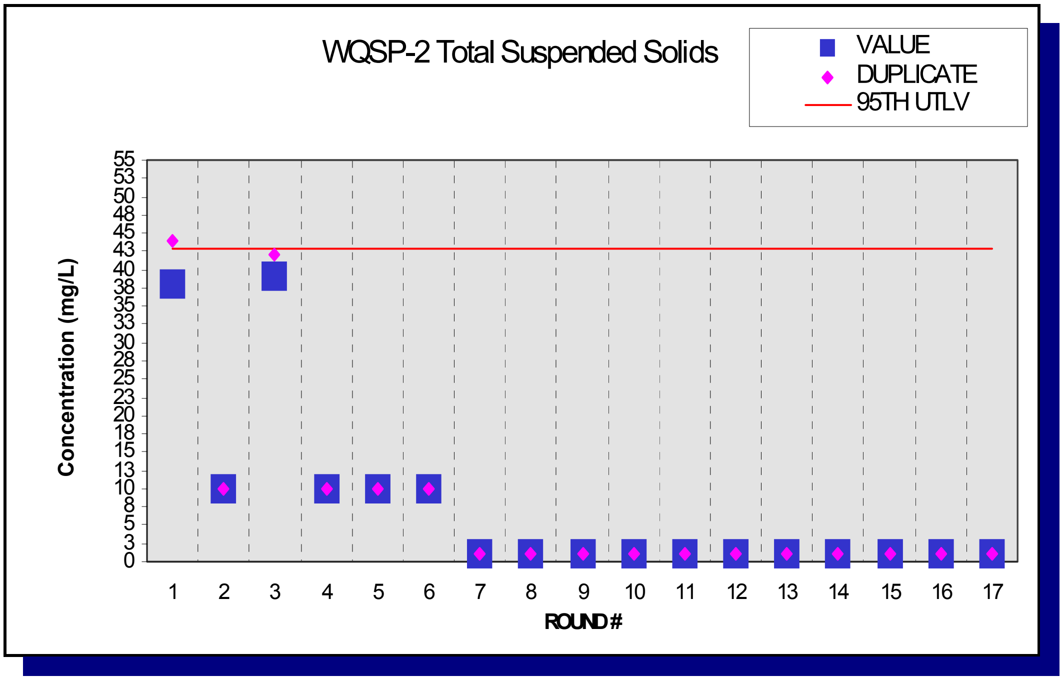

Figure E.28 - Time Trend Plot for Total Suspended Solids at WQSP-2

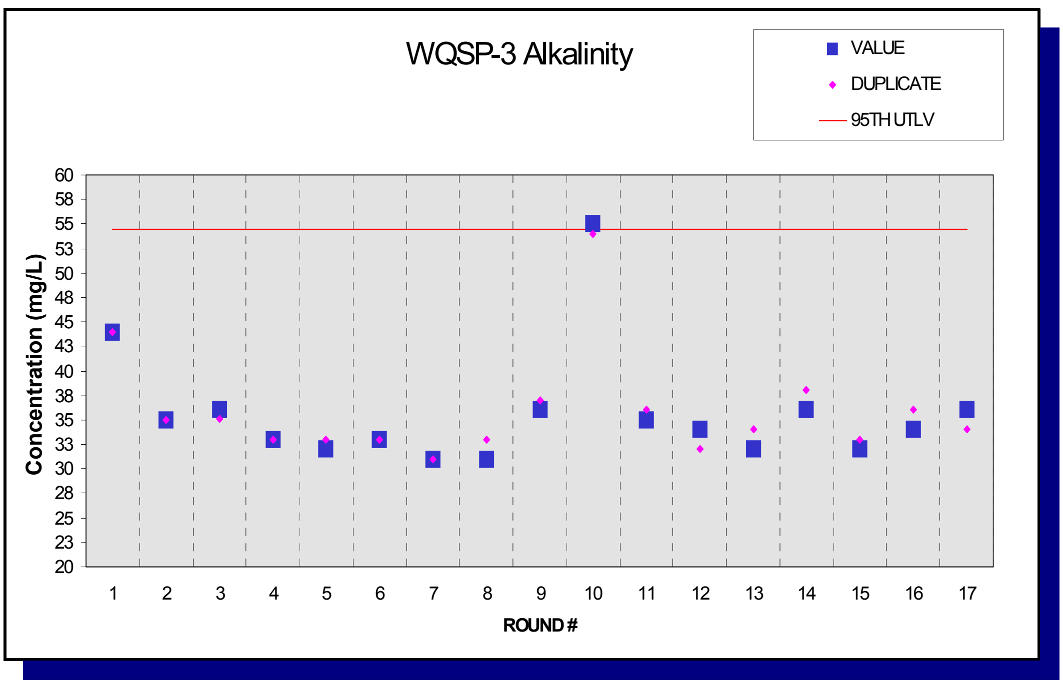

Figure E.29 - Time Trend Plot for Alkalinity at WQSP-3

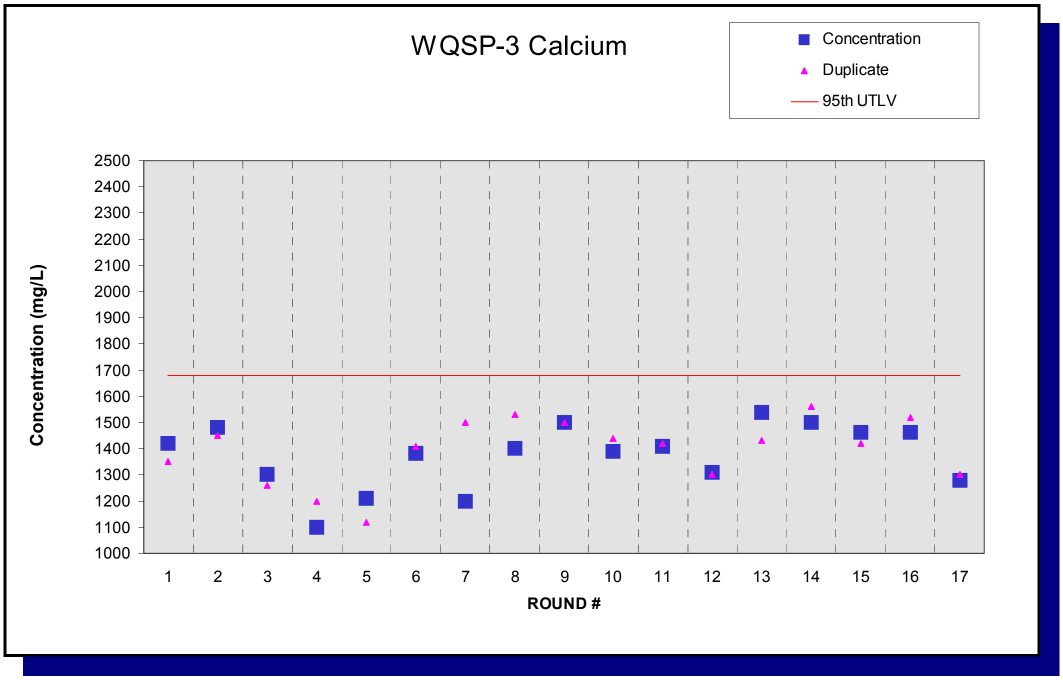

Figure E.30 - Time Trend Plot for Calcium at WQSP-3

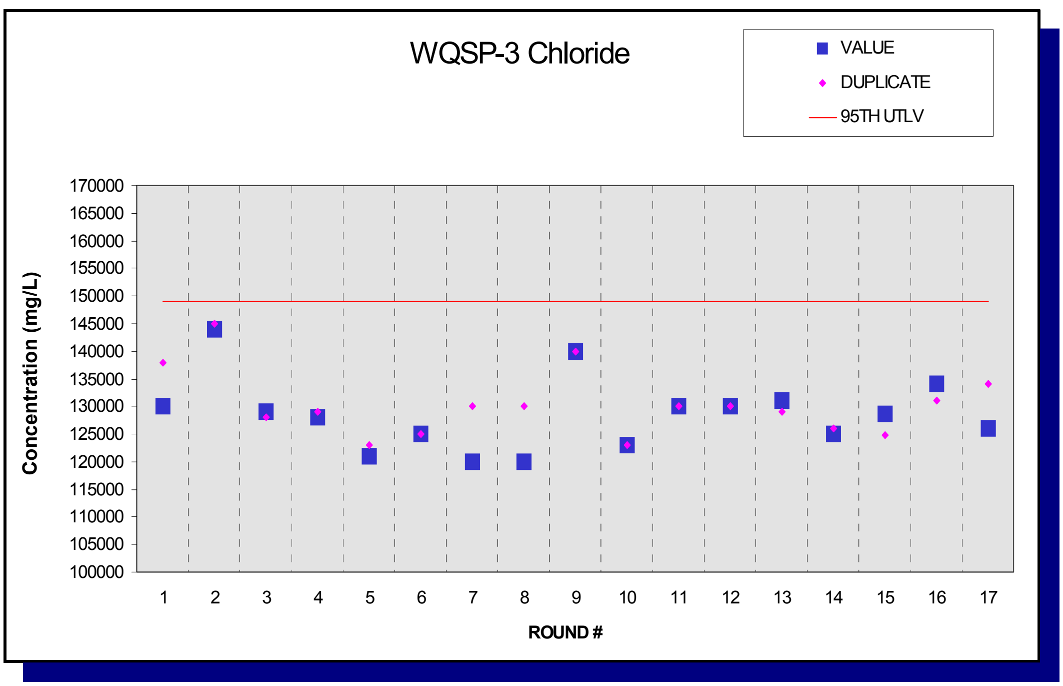

Figure E.31 - Time Trend Plot for Chloride at WQSP-3

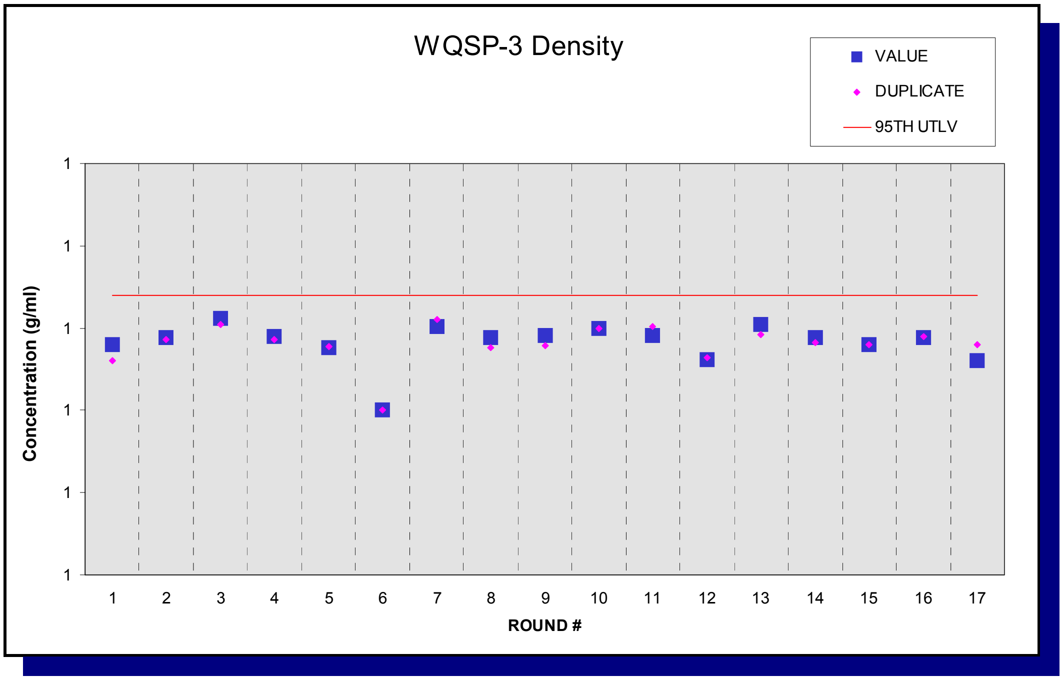

Figure E.32 - Time Trend Plot for Density at WQSP-3

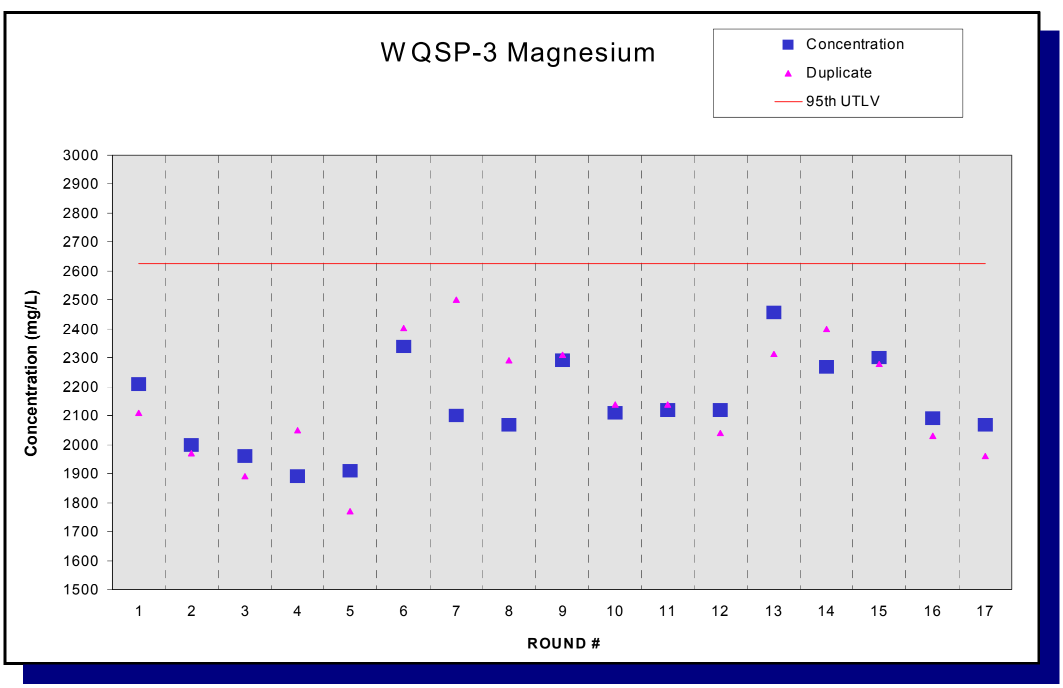

Figure E.33 - Time Trend Plot for Magnesium at WQSP-3

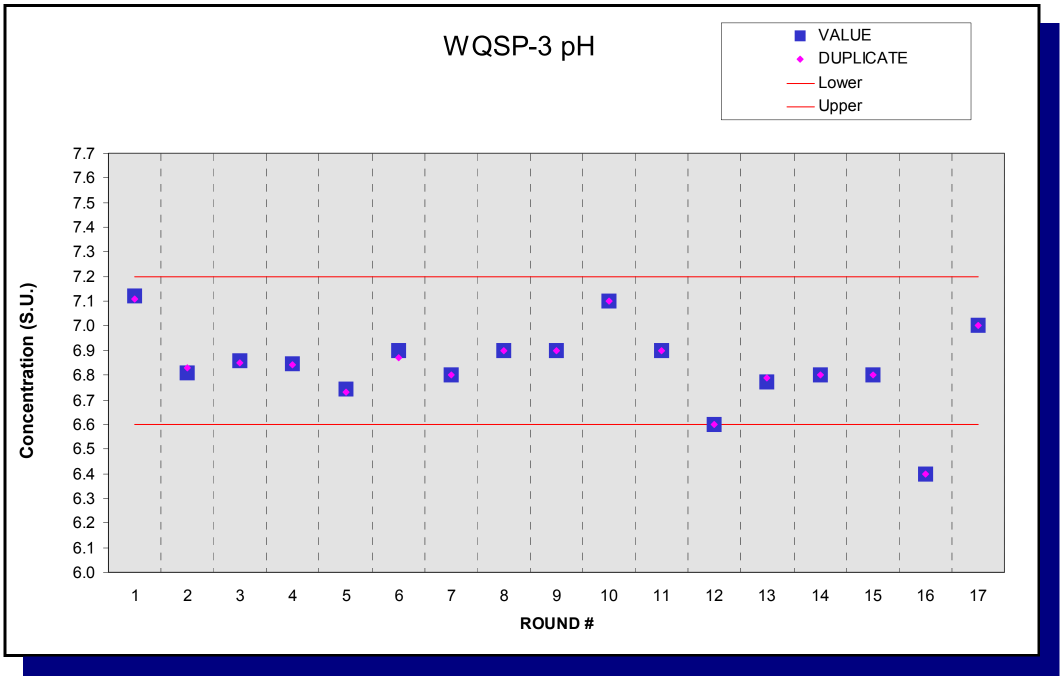

Figure E.34 - Time Trend Plot for pH at WQSP-3

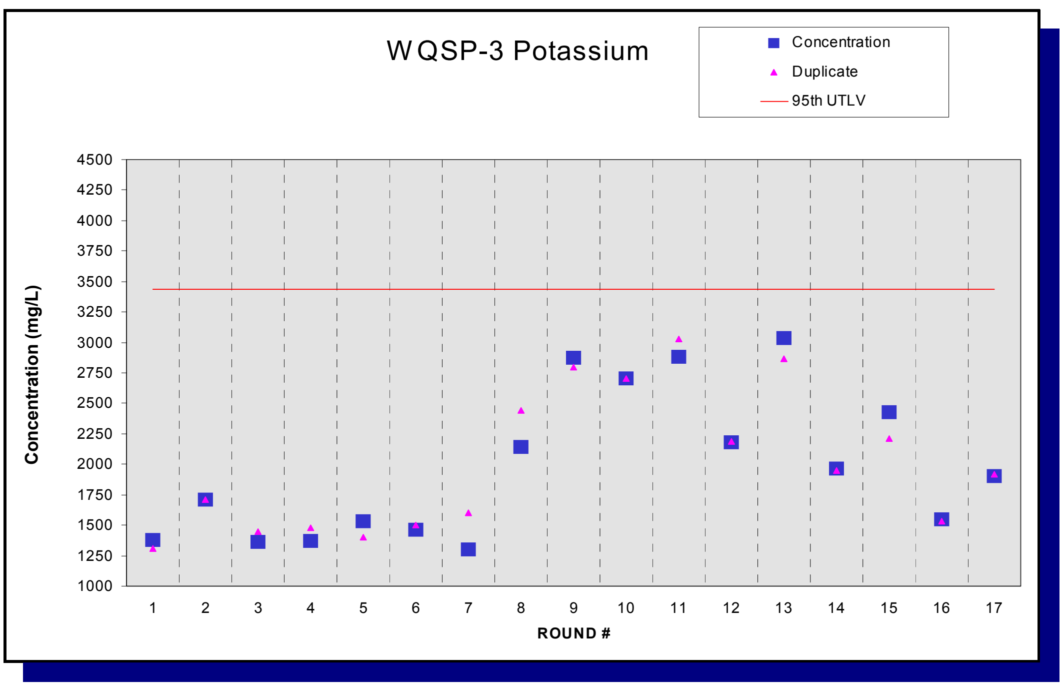

Figure E.35 - Time Trend Plot for Potassium at WQSP-3

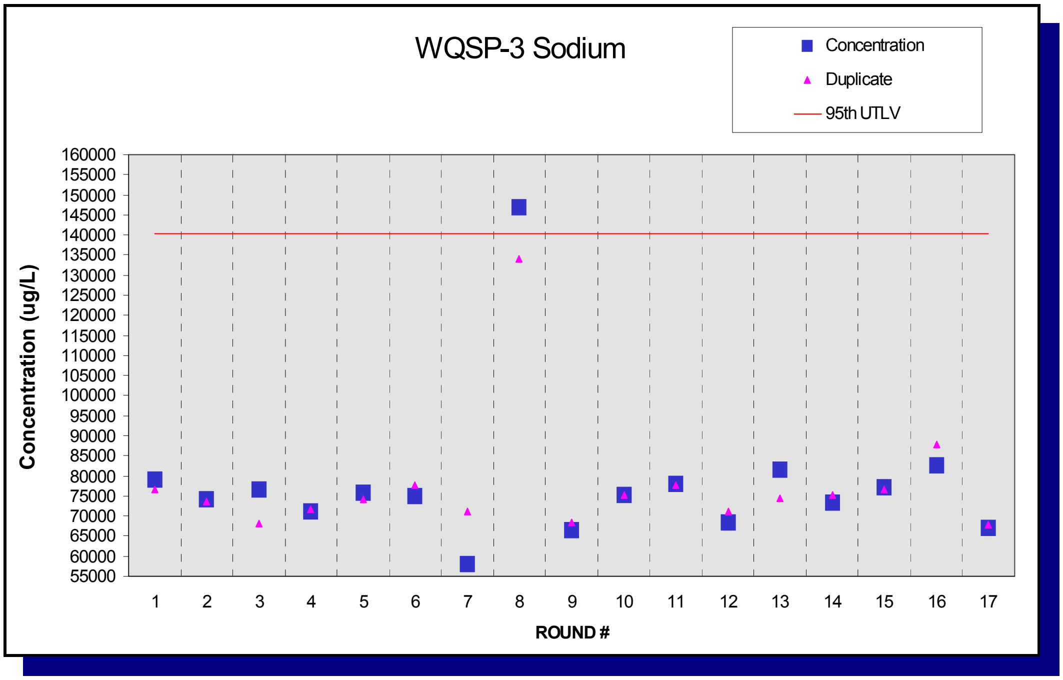

Figure E.36 - Time Trend Plot for Sodium at WQSP-3

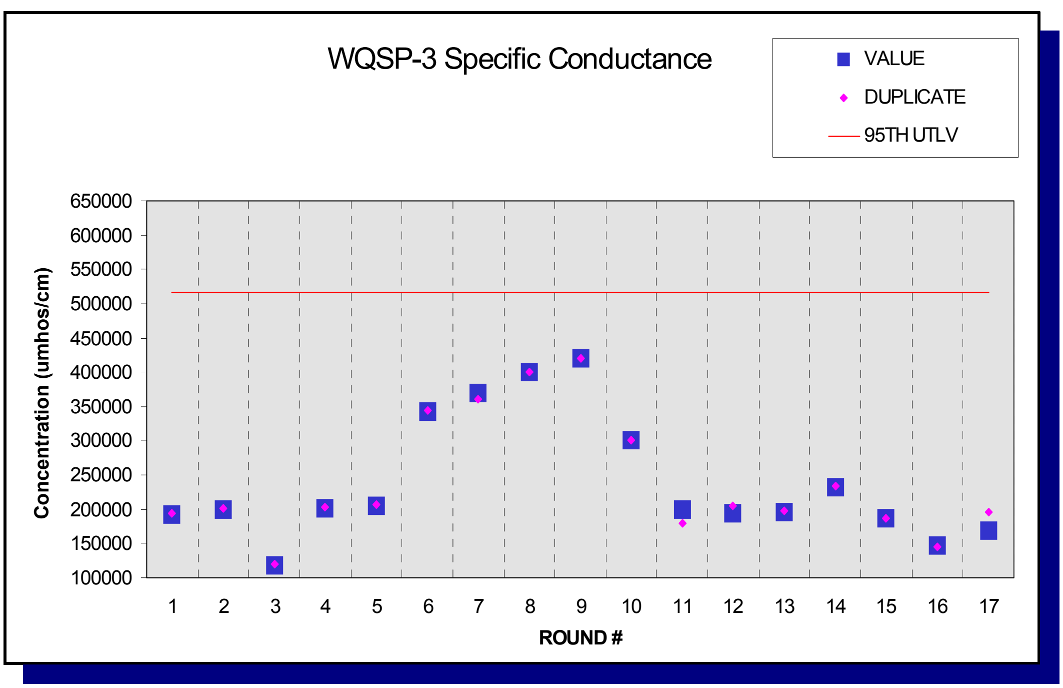

Figure E.37 - Time Trend Plot for Specific Conductance at WQSP-3

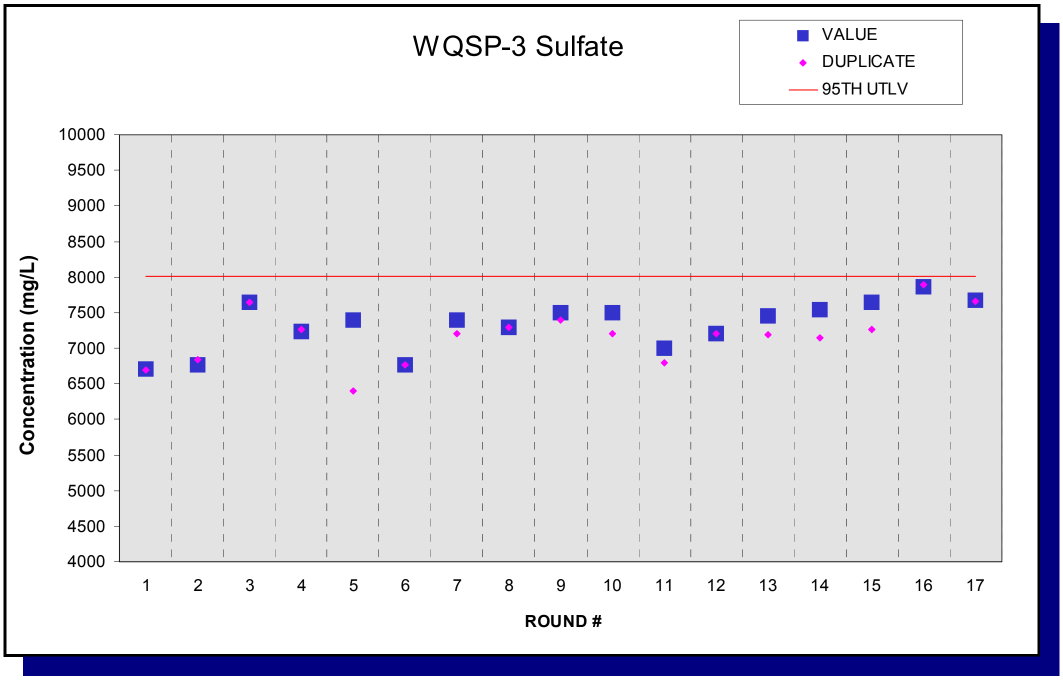

Figure E.38 - Time Trend Plot for Sulfate at WQSP-3

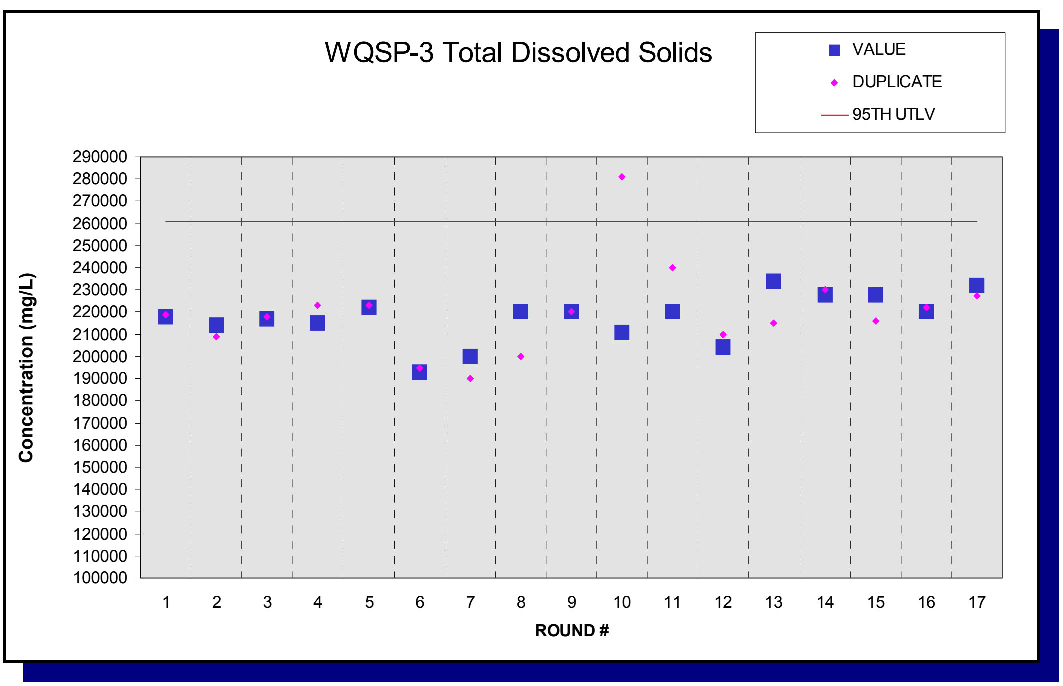

Figure E.39 - Time Trend Plot for Total Dissolved Solids at WQSP-3

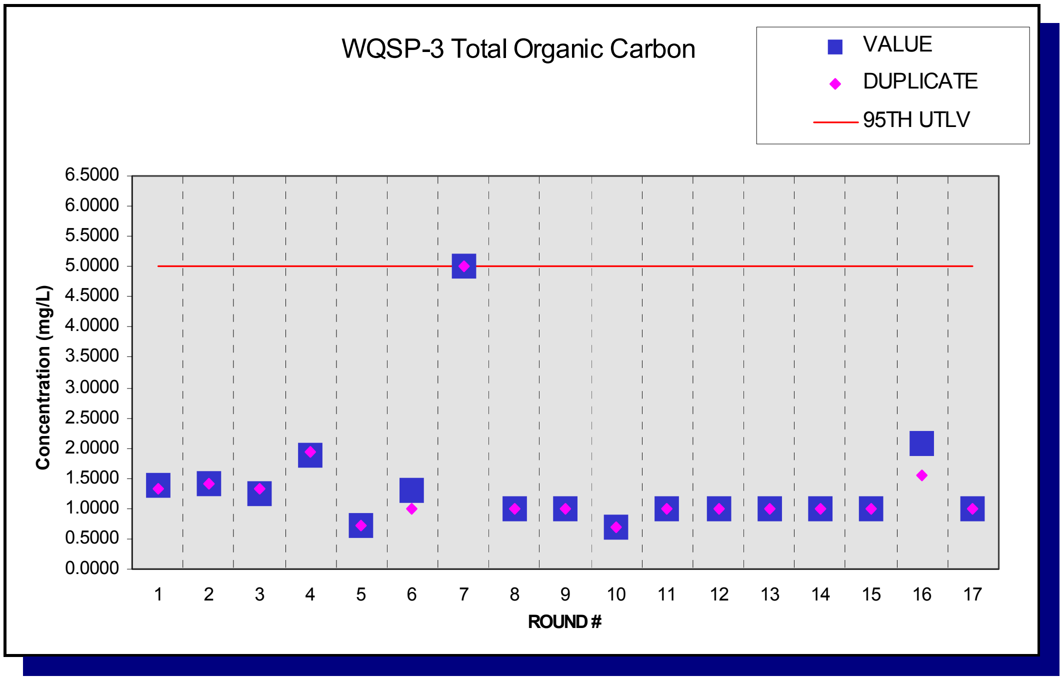

Figure E.40 - Time Trend Plot for Total Organic Carbon at WQSP-3

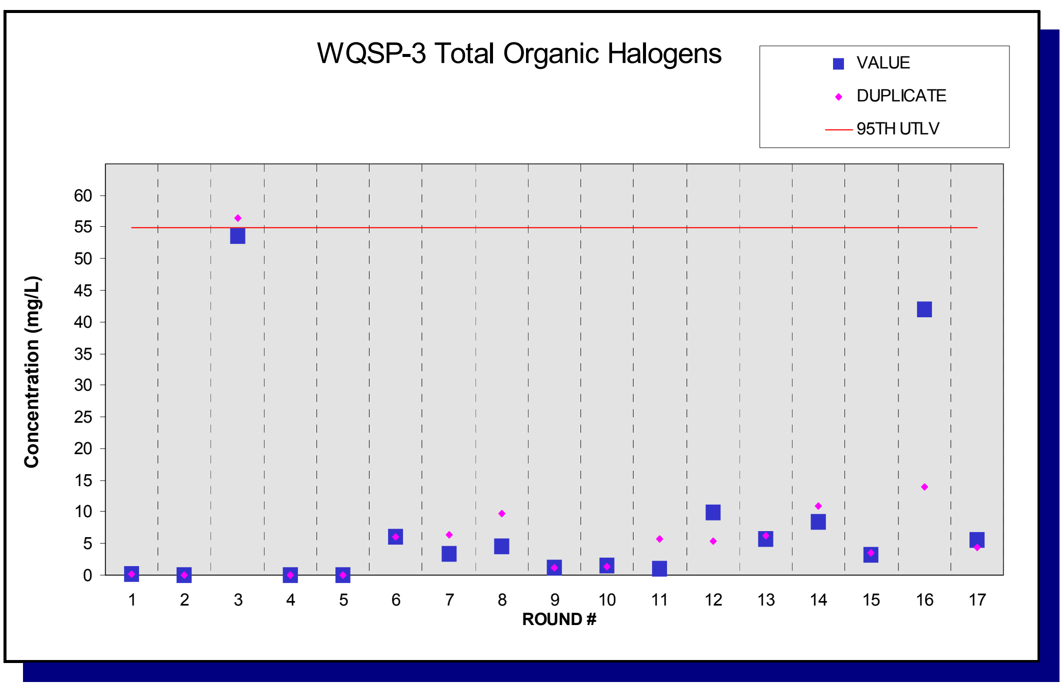

Figure E.41 - Time Trend Plot for Total Organic Halogens at WQSP-3

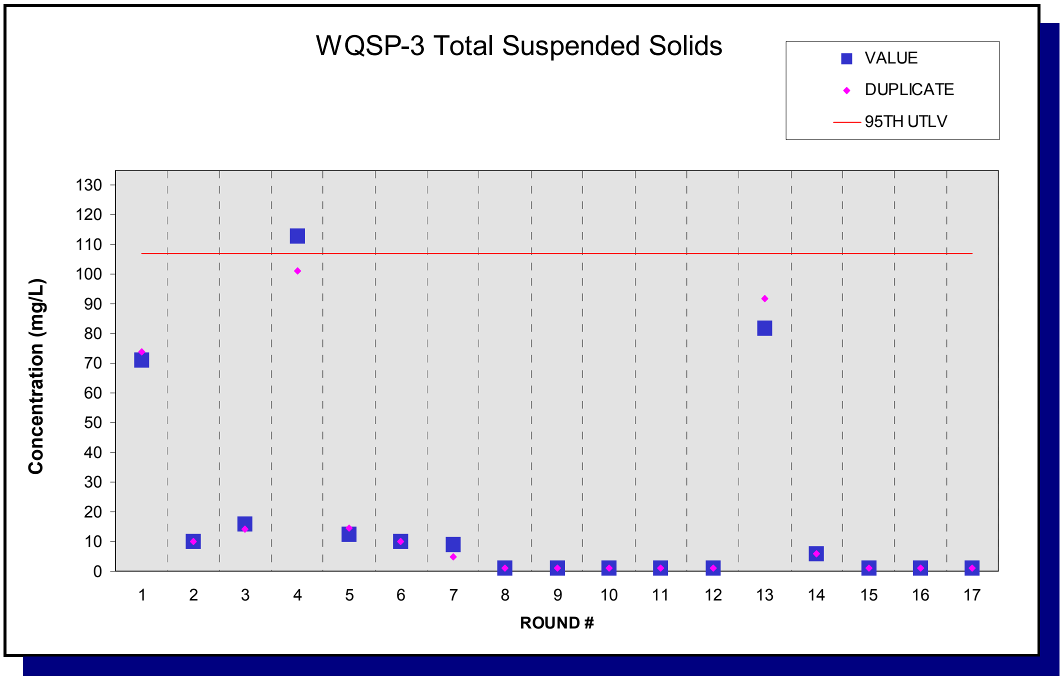

Figure E.42 - Time Trend Plot for Total Suspended Solids at WQSP-3

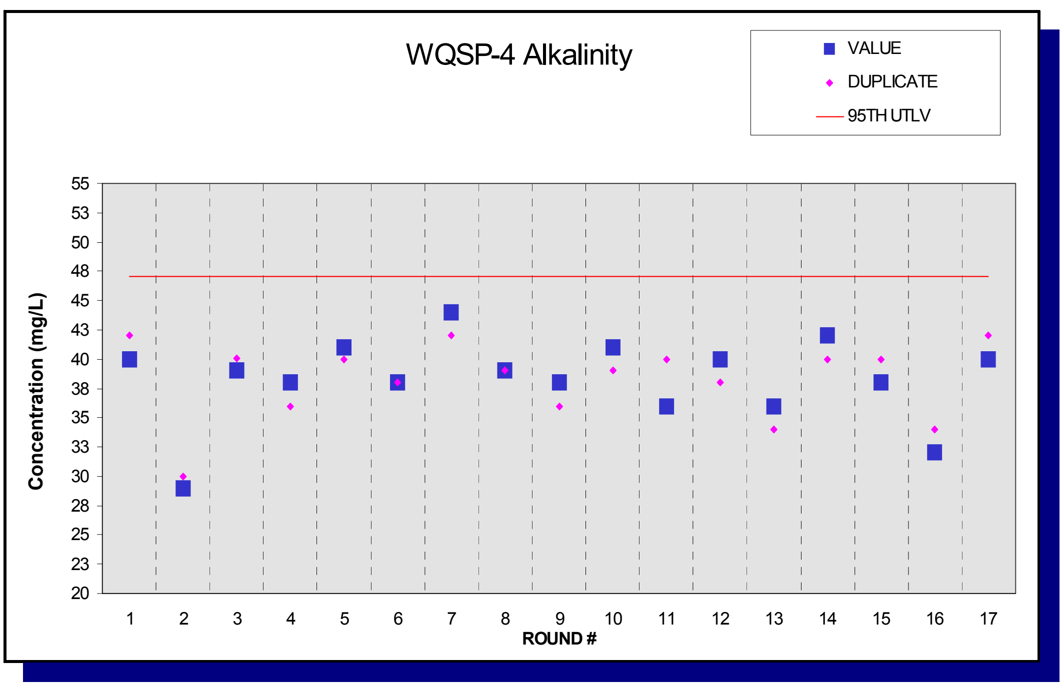

Figure E.43 - Time Trend Plot for Alkalinity at WQSP-4

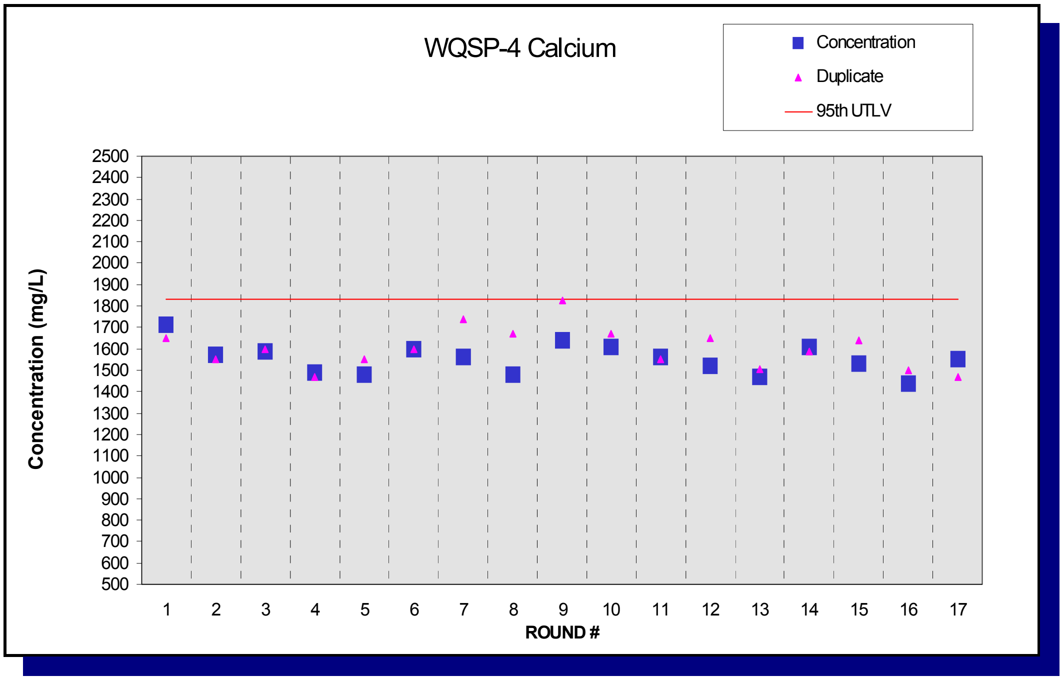

Figure E.44 - Time Trend Plot for Calcium at WQSP-4

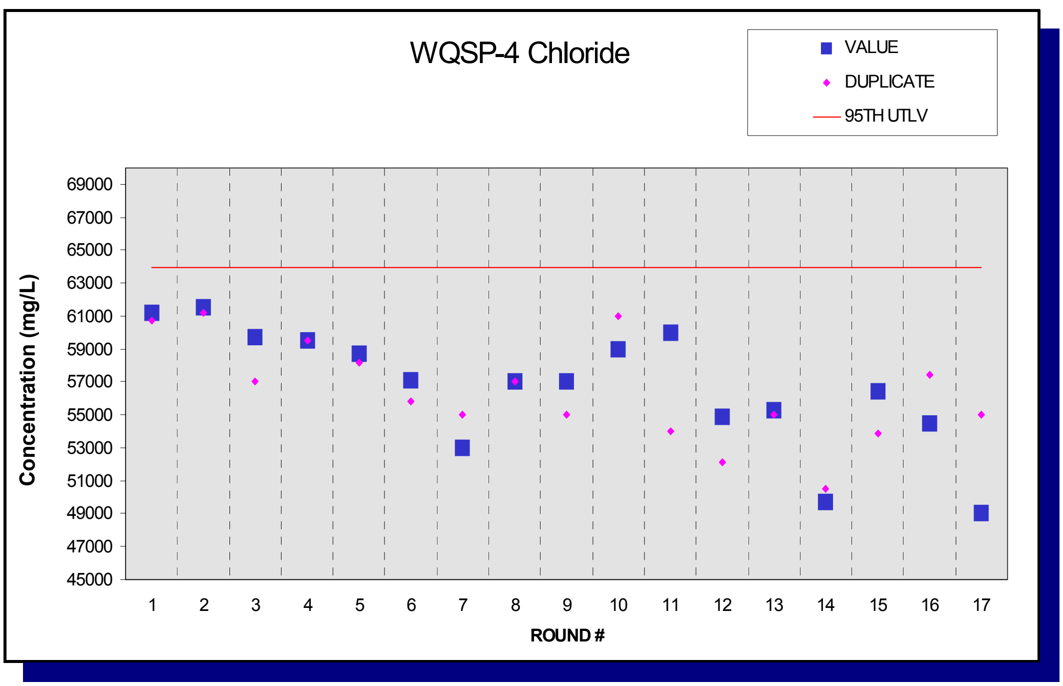

Figure E.45 - Time Trend Plot for Chloride at WQSP-4

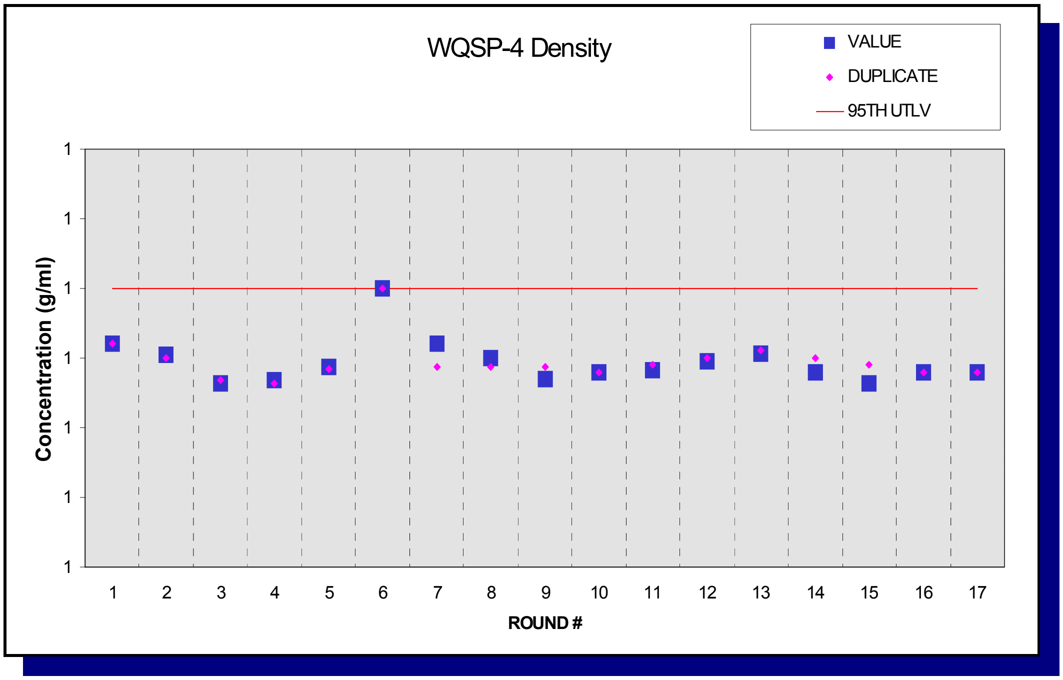

Figure E.46 - Time Trend Plot for Density at WQSP-4

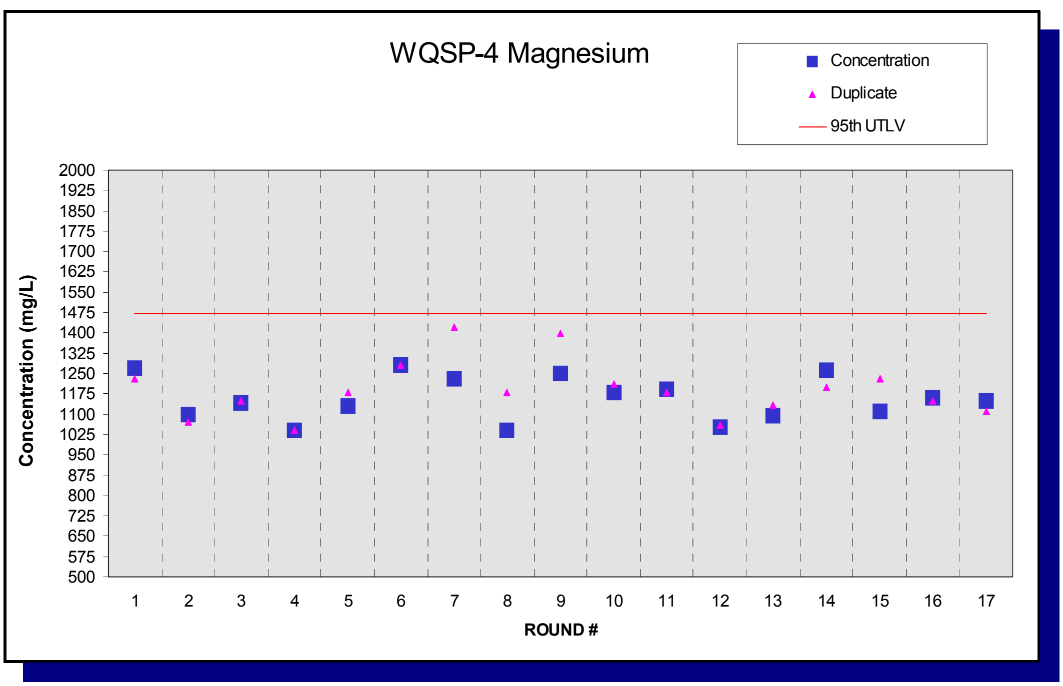

Figure E.47 - Time Trend Plot for Magnesium at WQSP-4

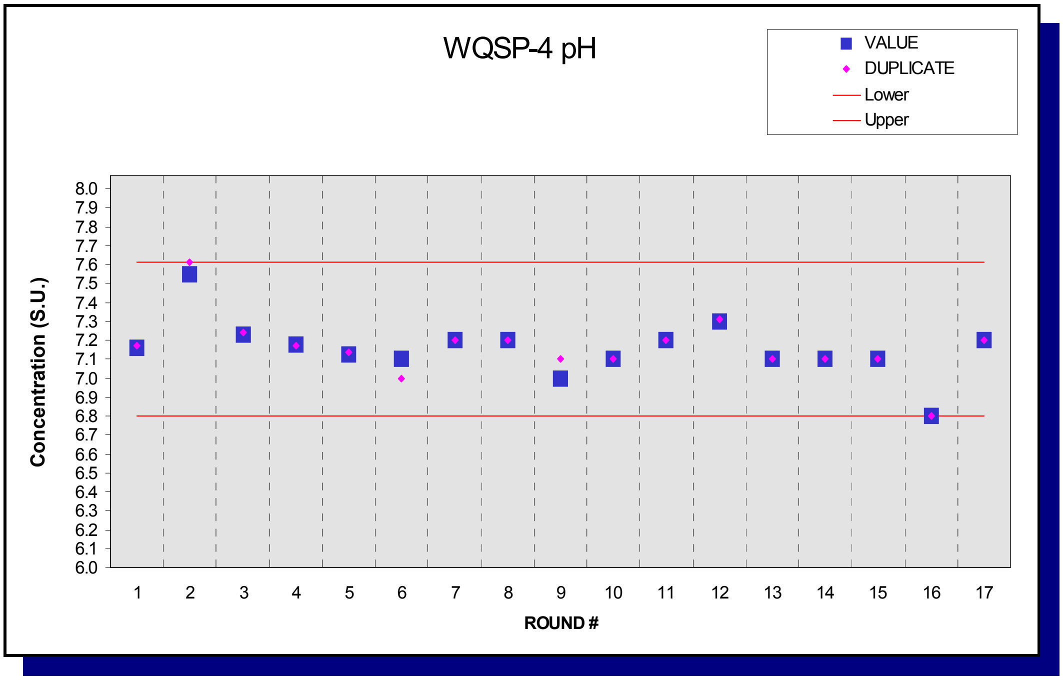

Figure E.48 - Time Trend Plot for pH at WQSP-4

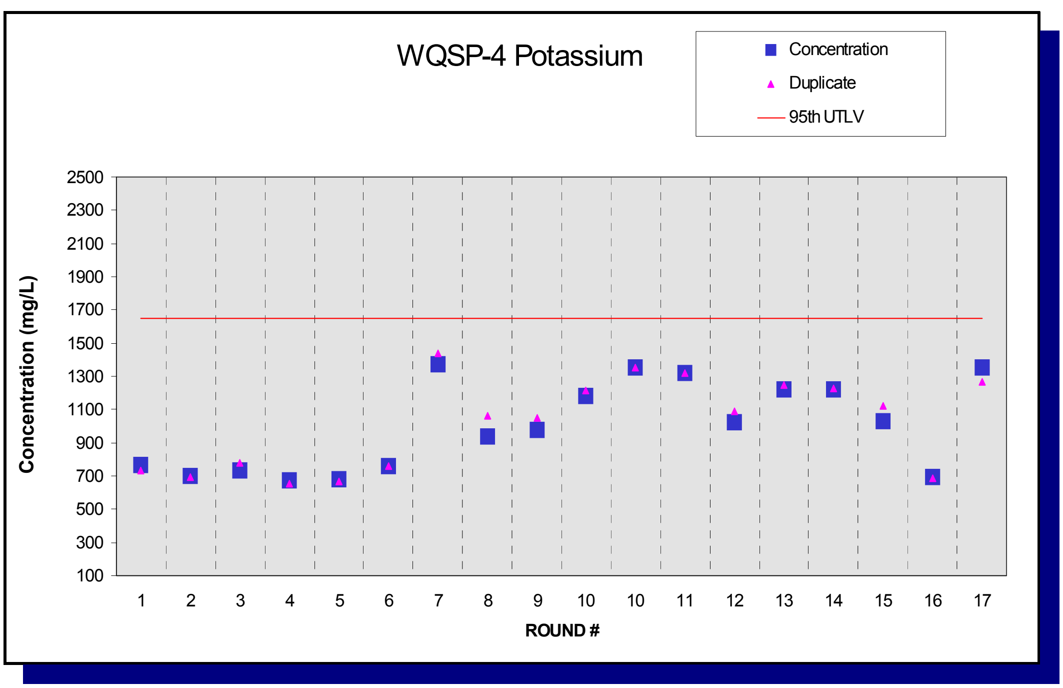

Figure E.49 - Time Trend Plot for Potassium at WQSP-4

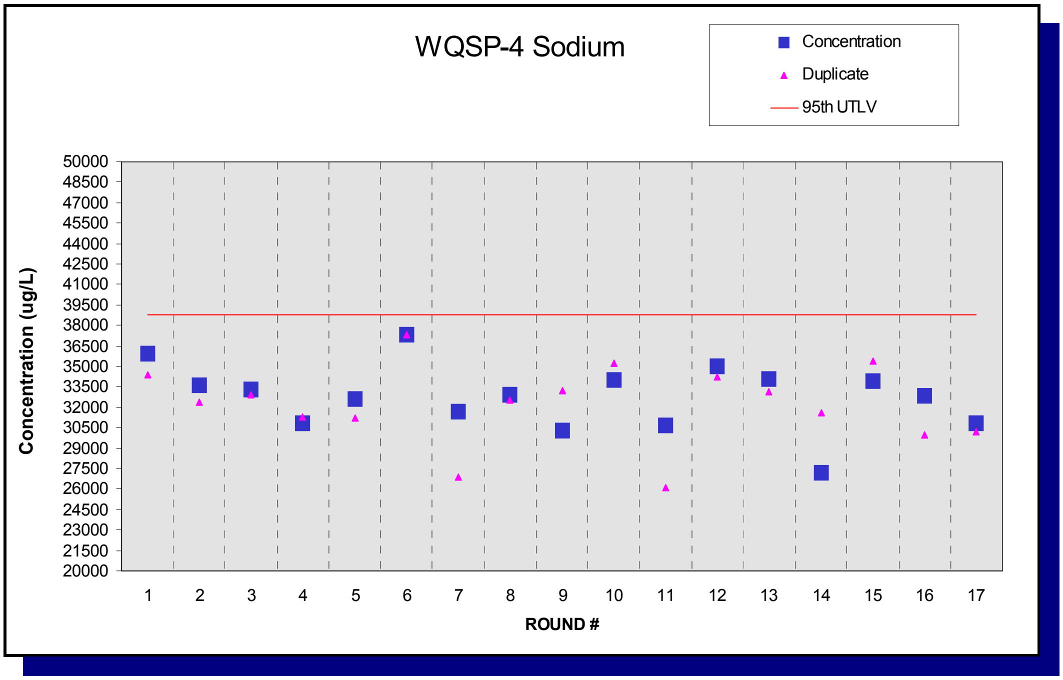

Figure E.50 - Time Trend Plot for Sodium at WQSP-4

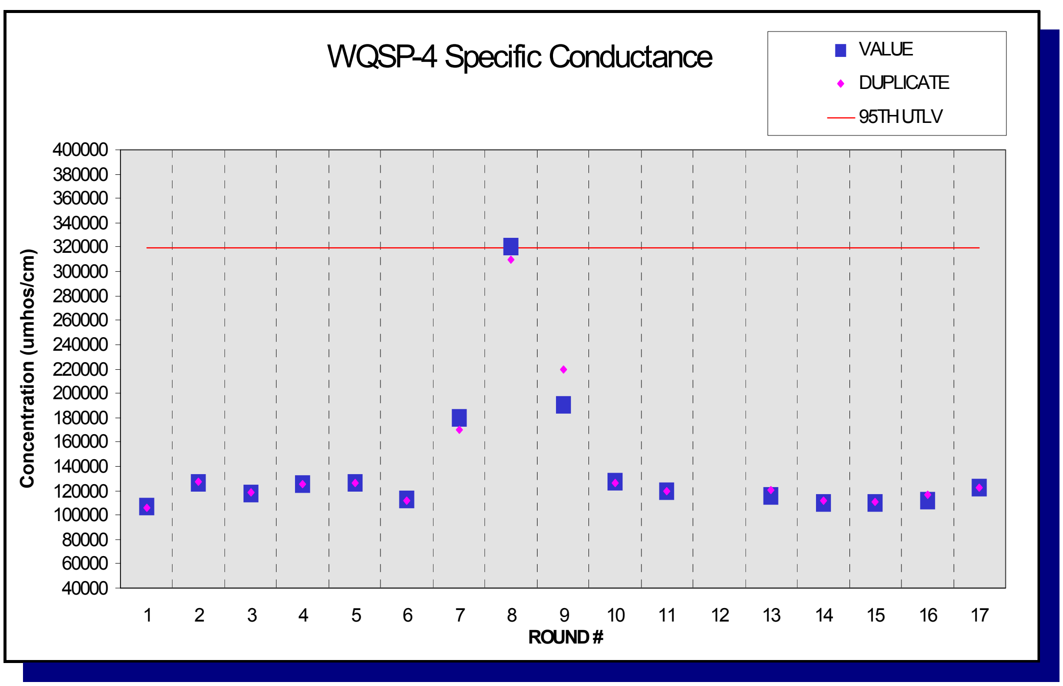

Figure E.51 - Time Trend Plot for Specific Conductance at WQSP-4

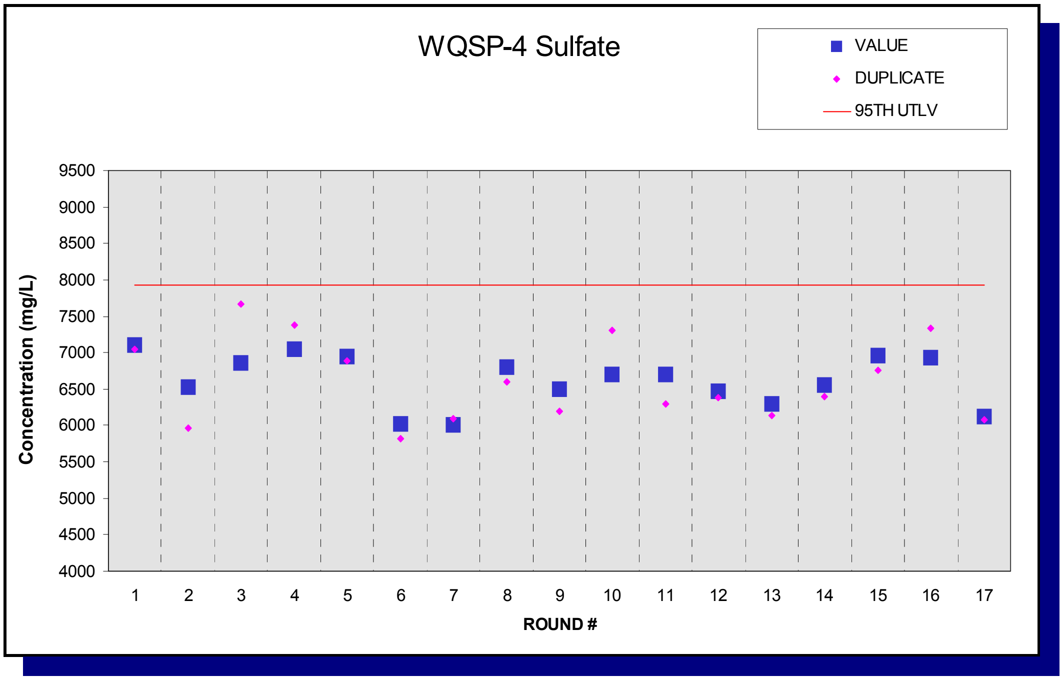

Figure E.52 - Time Trend Plot for Sulfate at WQSP-4

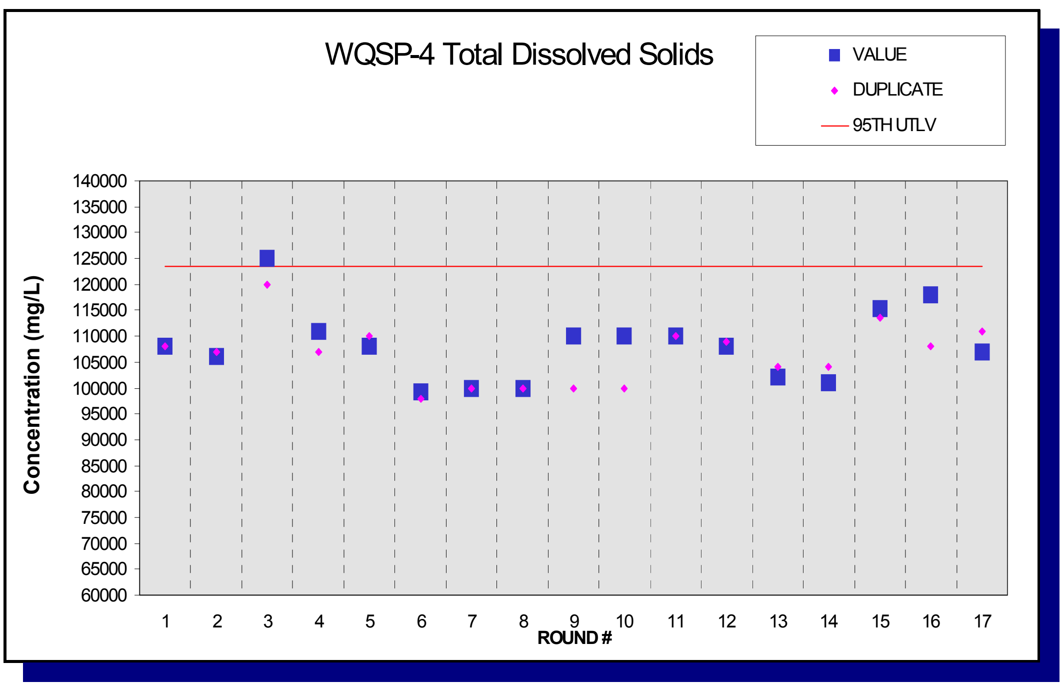

Figure E.53 - Time Trend Plot for Total Dissolved Solids at WQSP-4

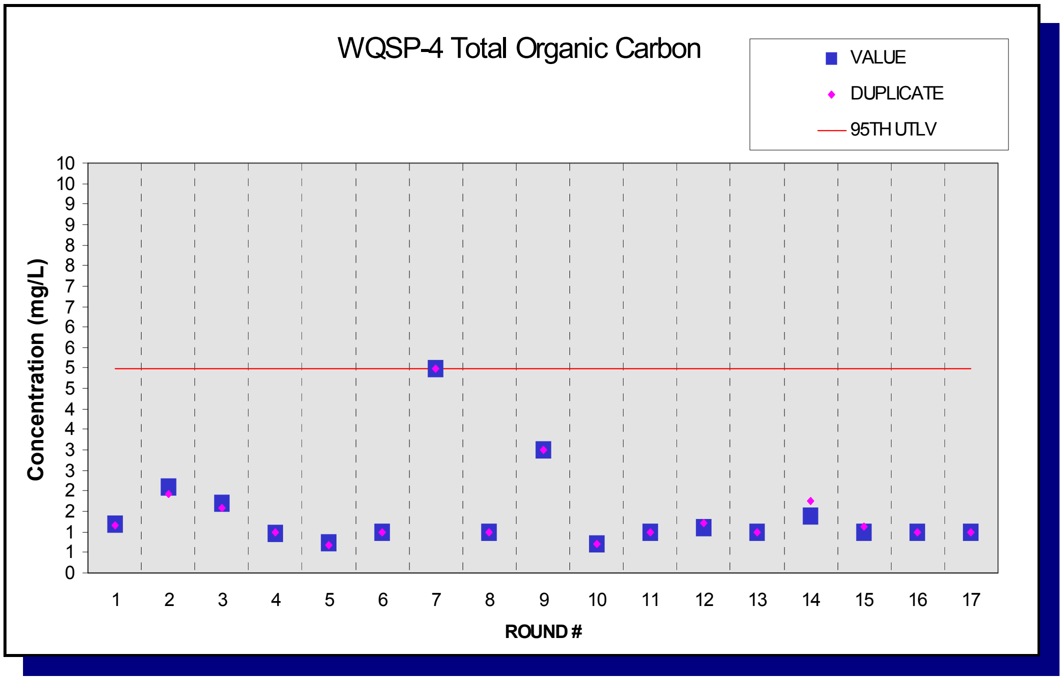

Figure E.54 - Time Trend Plot for Total Organic Carbon at WQSP-4

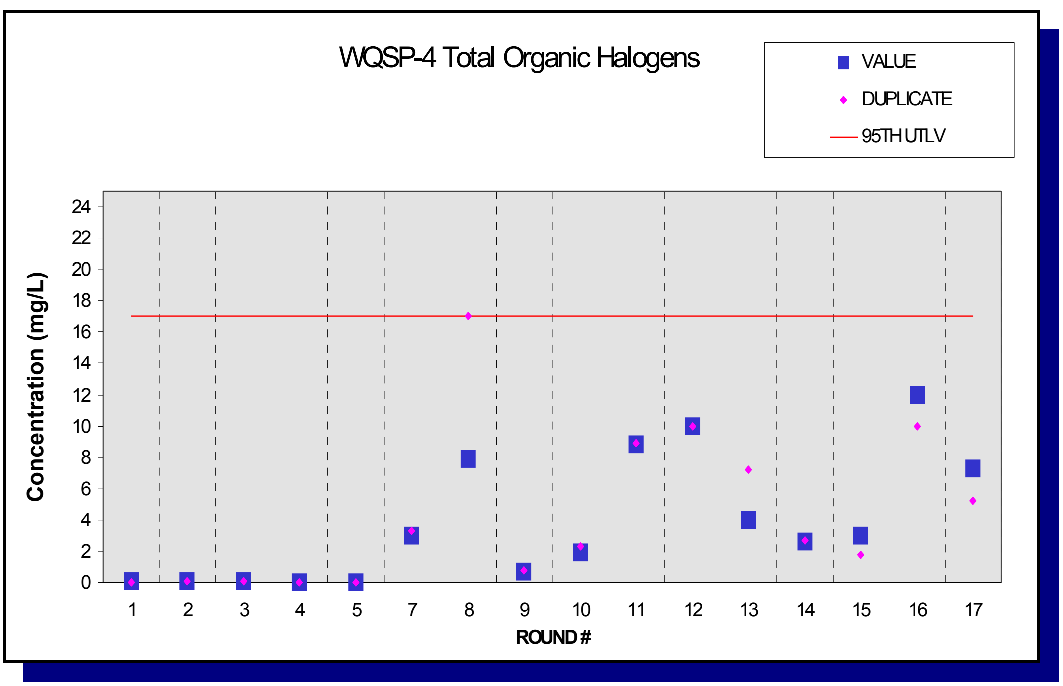

Figure E.55 - Time Trend Plot for Total Organic Halogens at WQSP-4

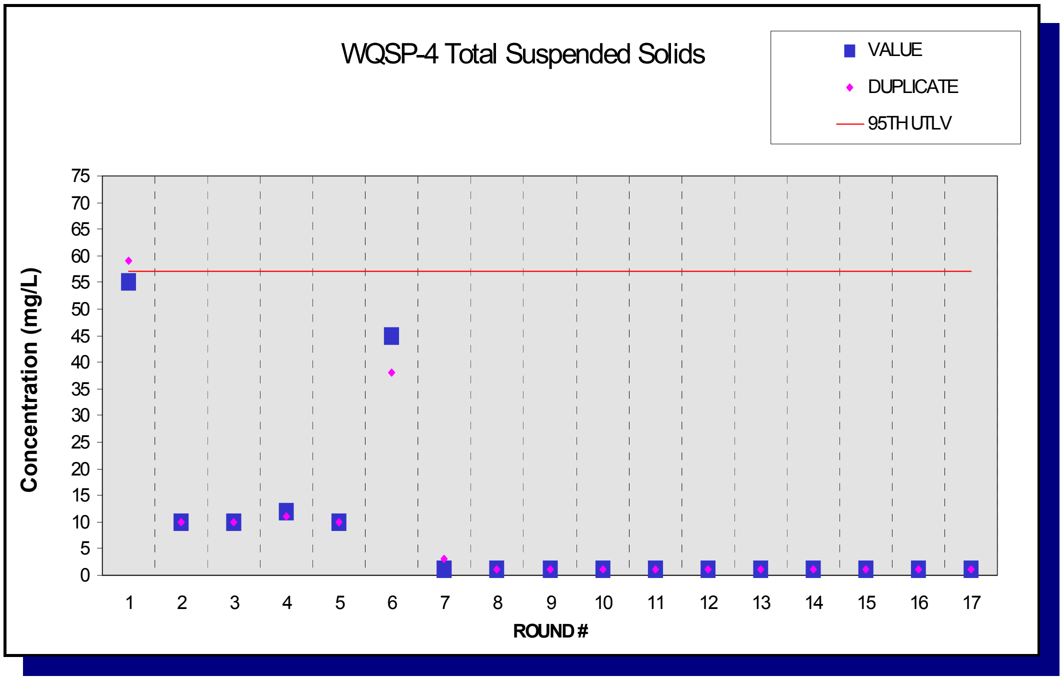

Figure E.56 - Time Trend Plot for Total Suspended Solids at WQSP-4

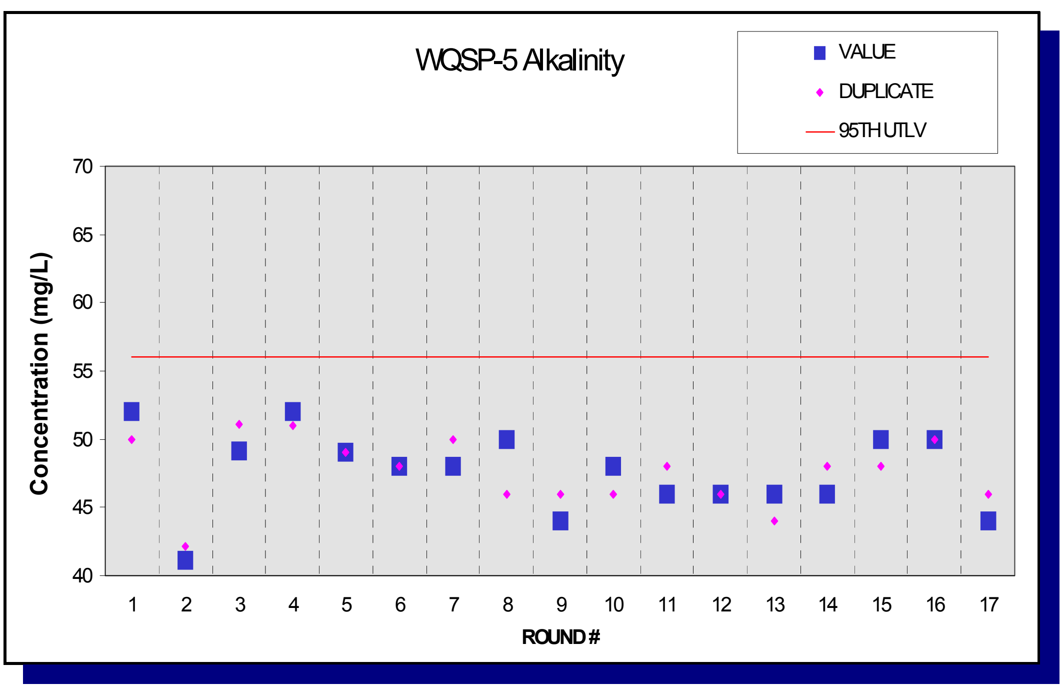

Figure E.57 - Time Trend Plot for Alkalinity at WQSP-5

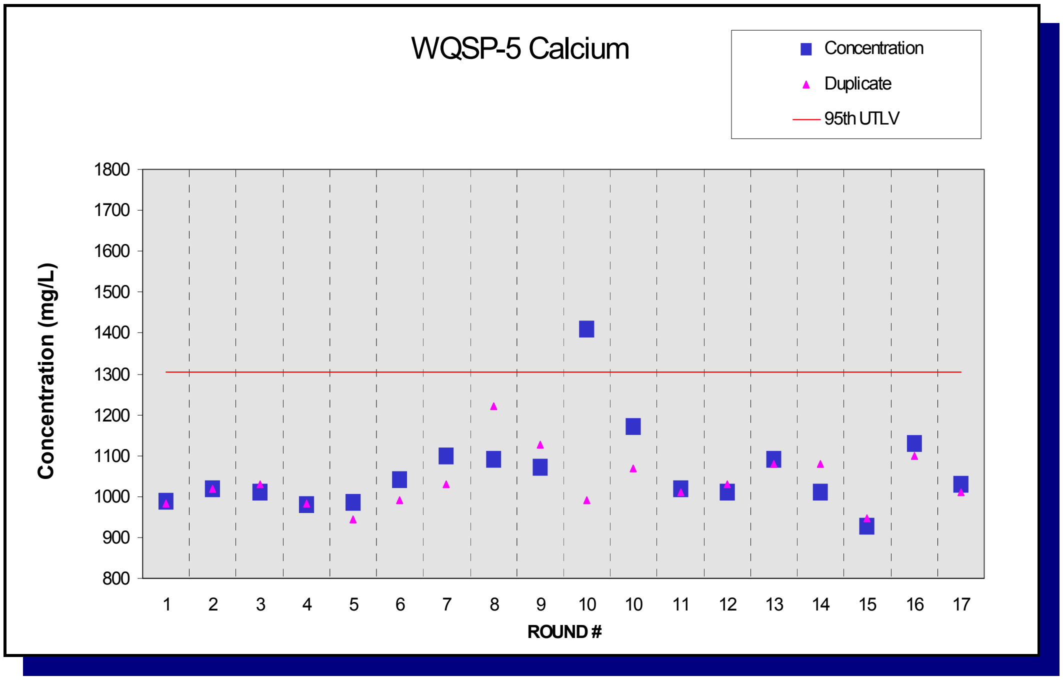

Figure E.58 - Time Trend Plot for Calcium at WQSP-5

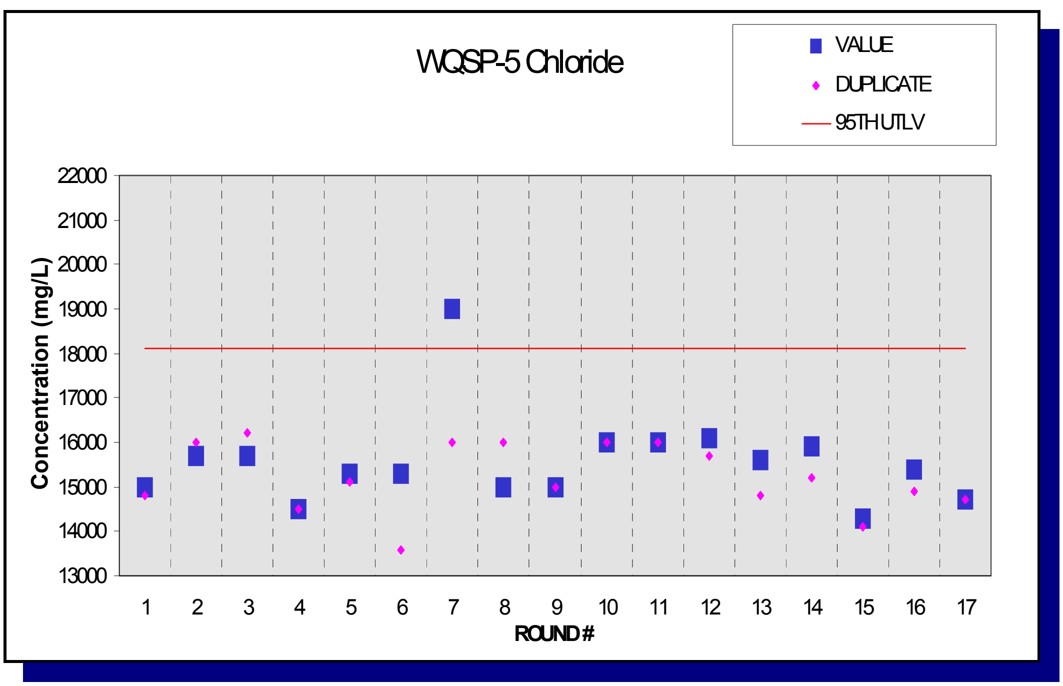

Figure E.58 - Time Trend Plot for Chloride at WQSP-5

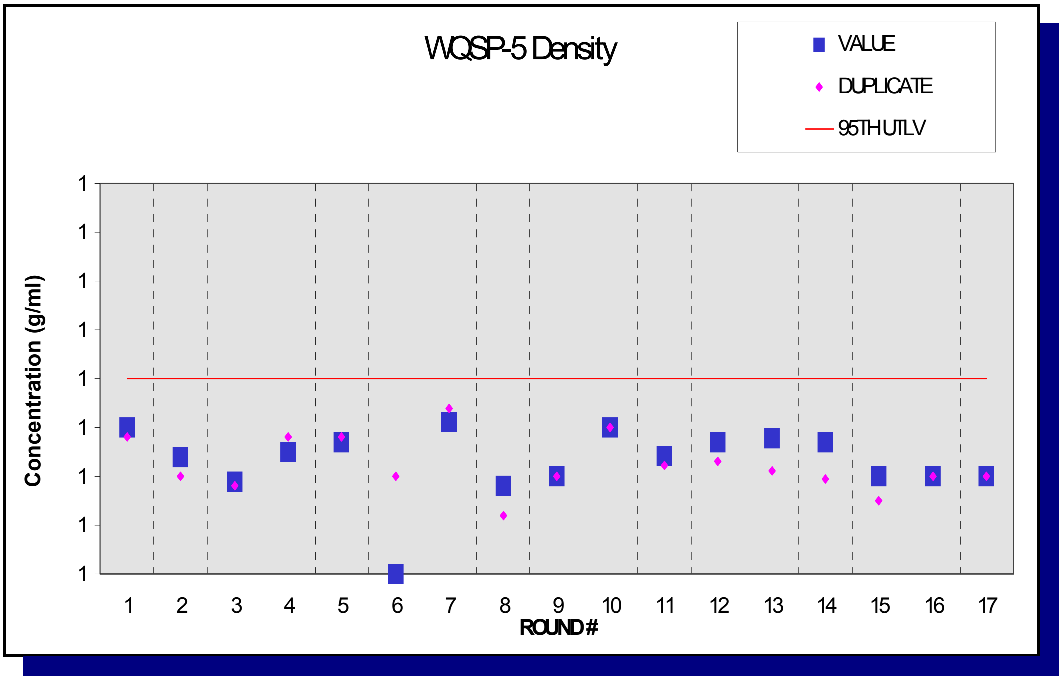

Figure E.60 - Time Trend Plot for Density at WQSP-5

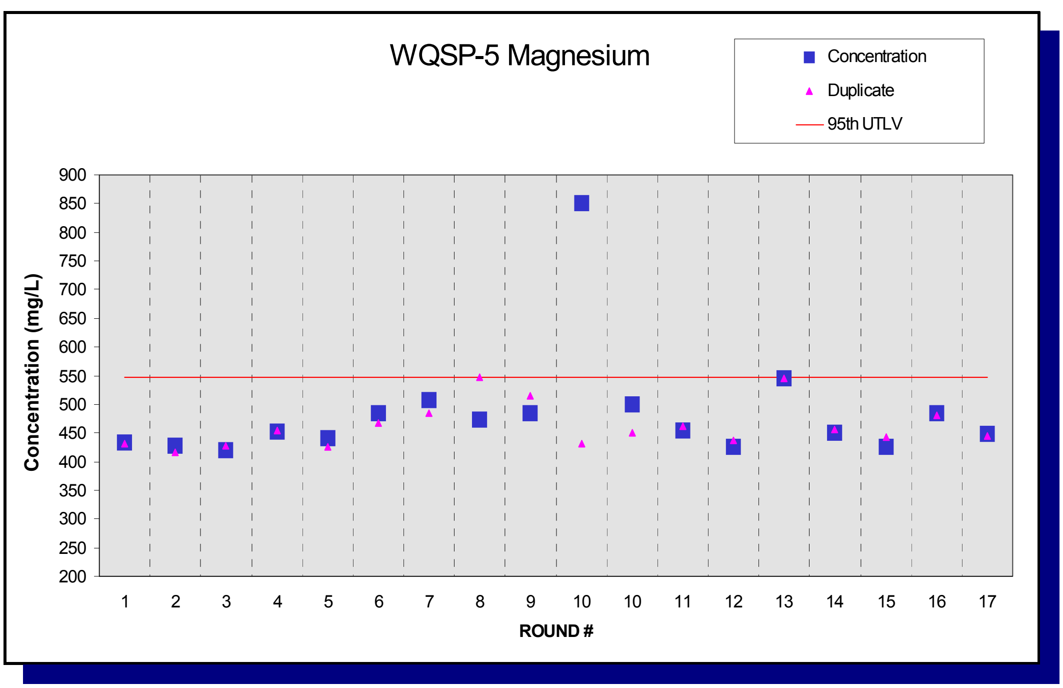

Figure E.61 - Time Trend Plot for Magnesium at WQSP-5

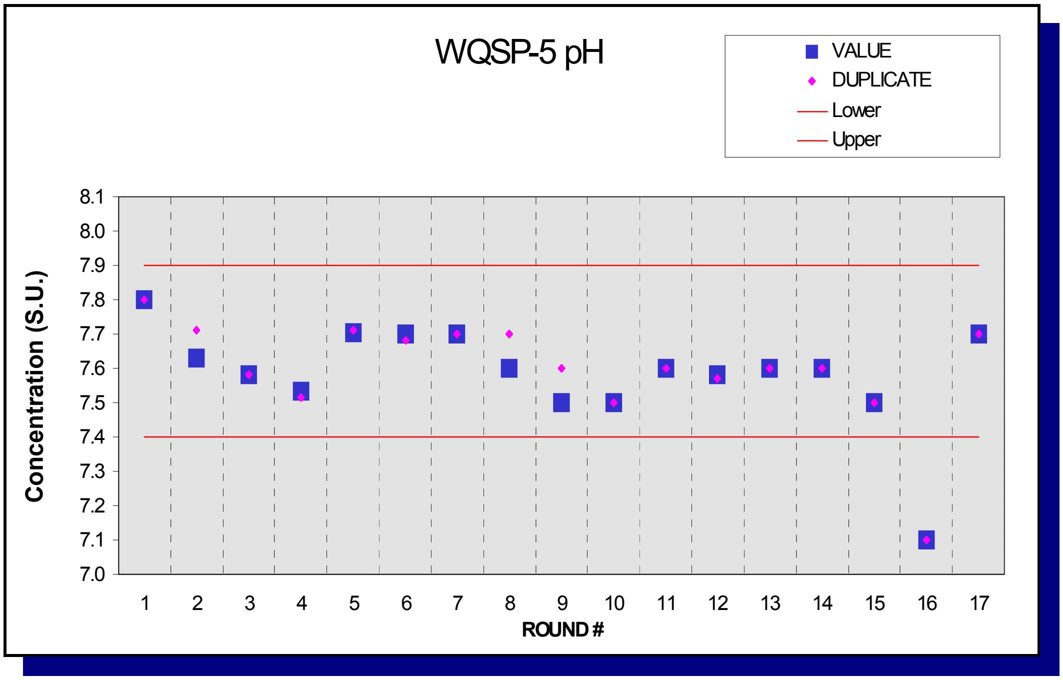

Figure E.62 - Time Trend Plot for pH at WQSP-5

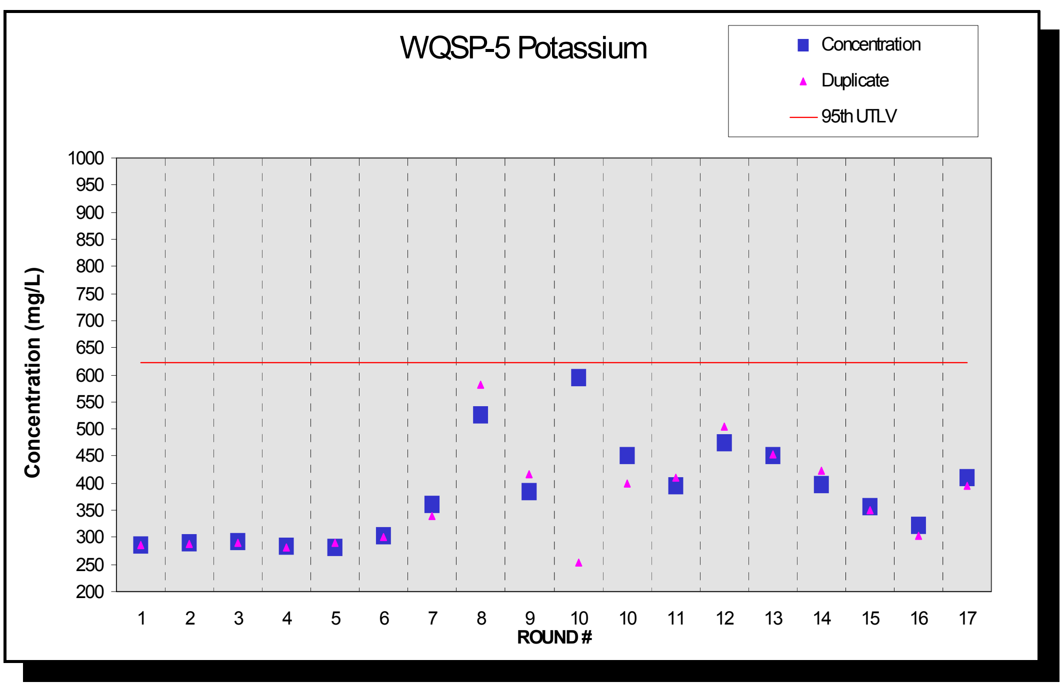

Figure E.63 - Time Trend Plot for Potassium at WQSP-5

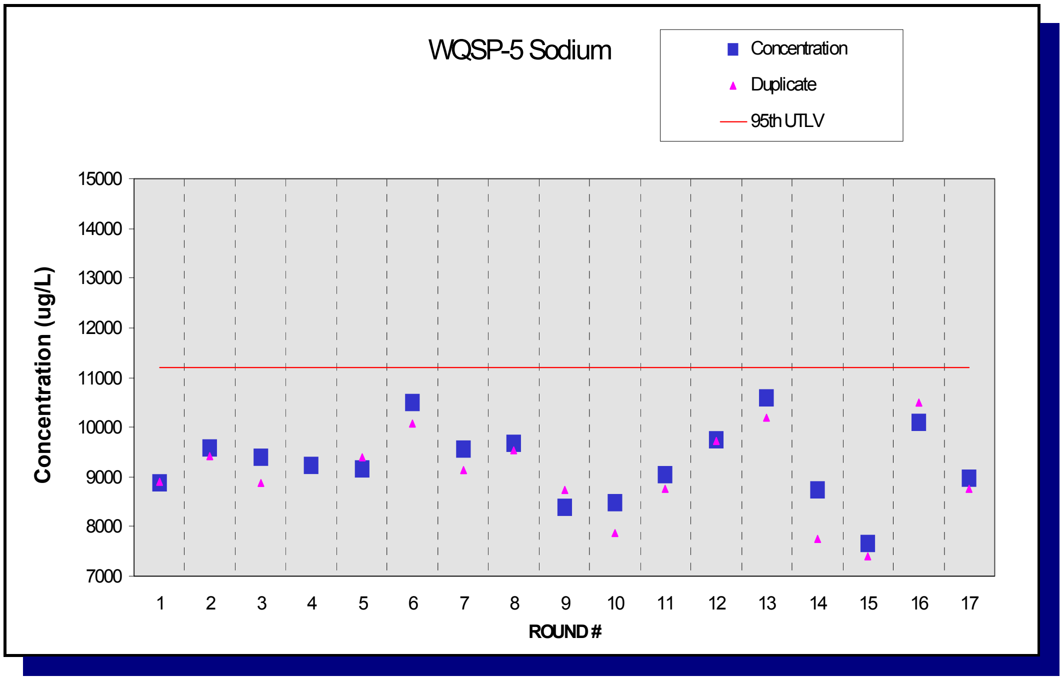

Figure E.64 - Time Trend Plot for Sodium at WQSP-5

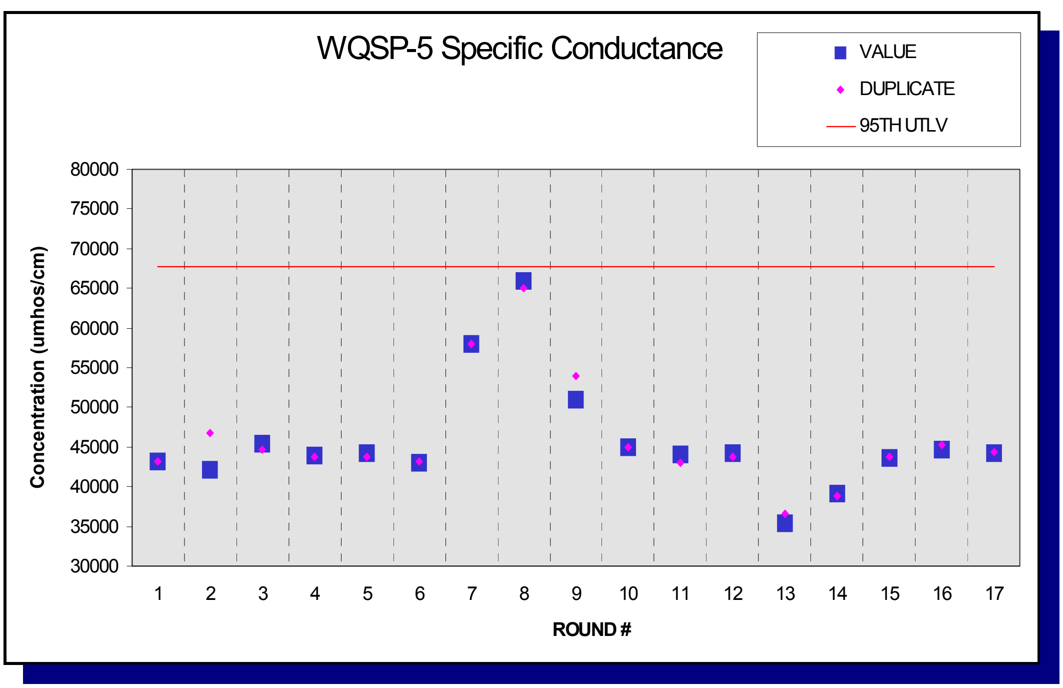

Figure E.65 - Time Trend Plot for Specific Conductance at WQSP-5

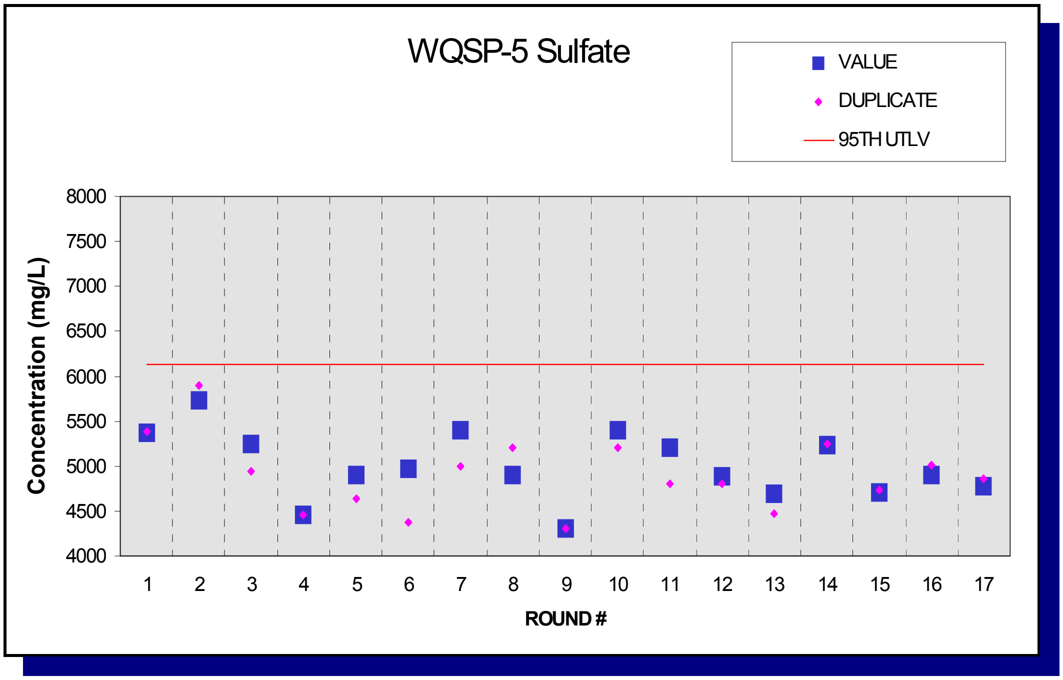

Figure E.66 - Time Trend Plot for Sulfate at WQSP-5

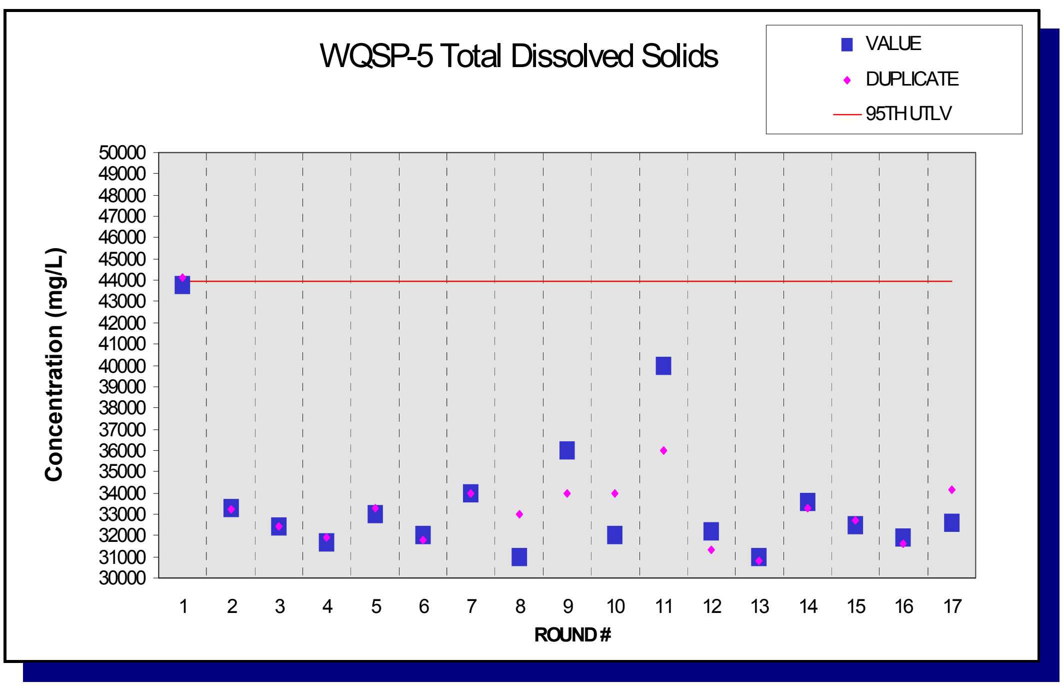

Figure E.67 - Time Trend Plot for Total Dissolved Solids at WQSP-5

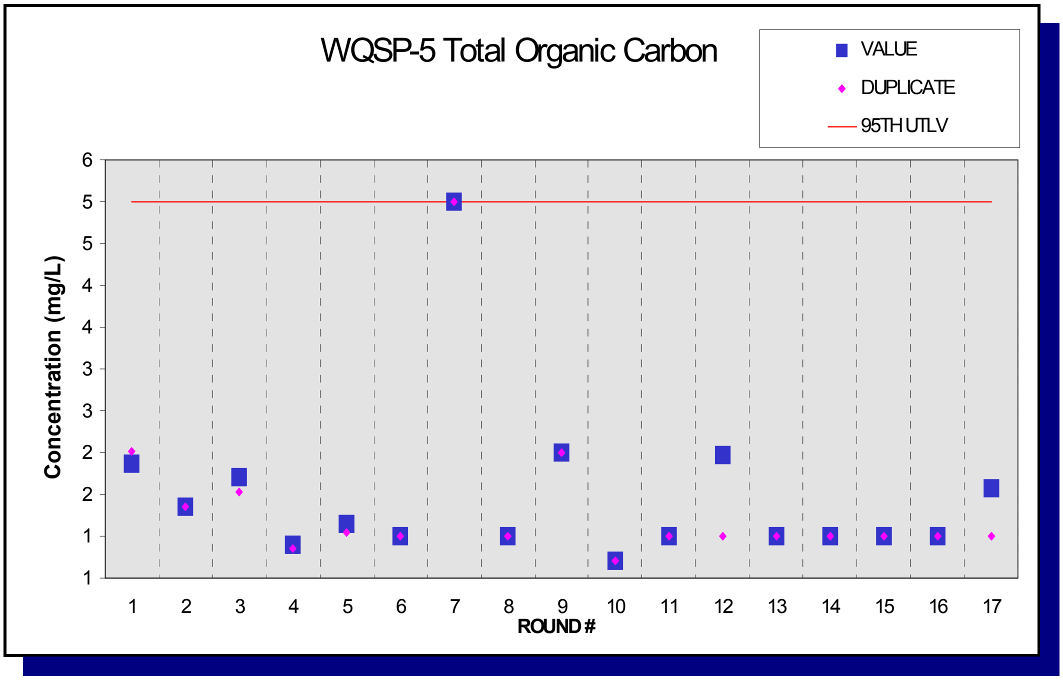

Figure E.68 - Time Trend Plot for Total Organic Carbon at WQSP-5

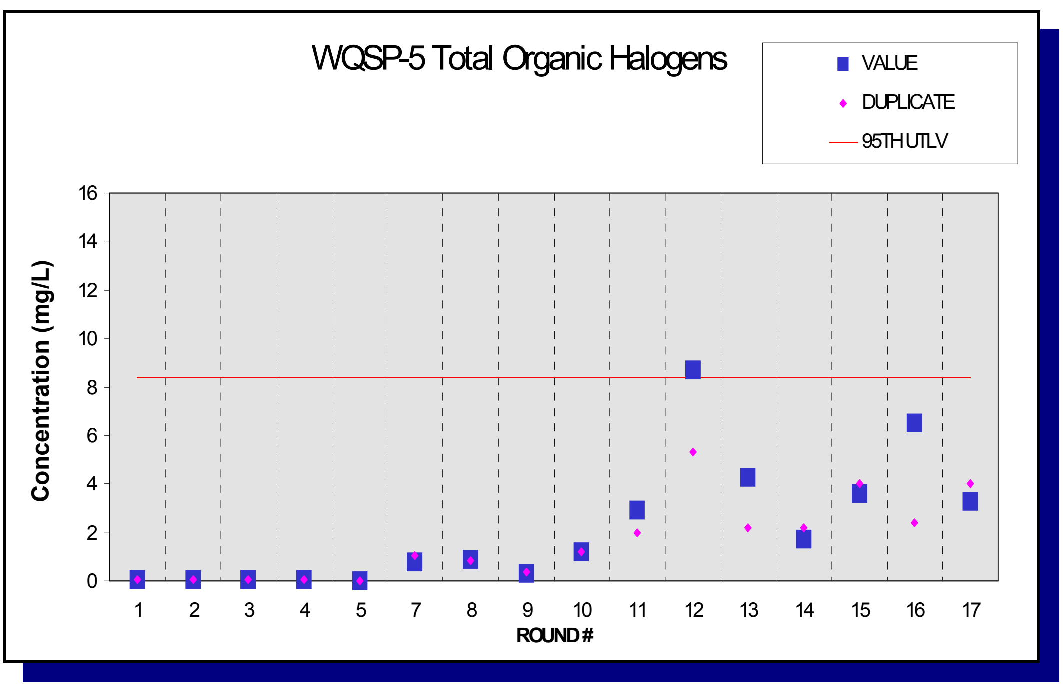

Figure E.69 - Time Trend Plot for Total Organic Halogens at WQSP-5

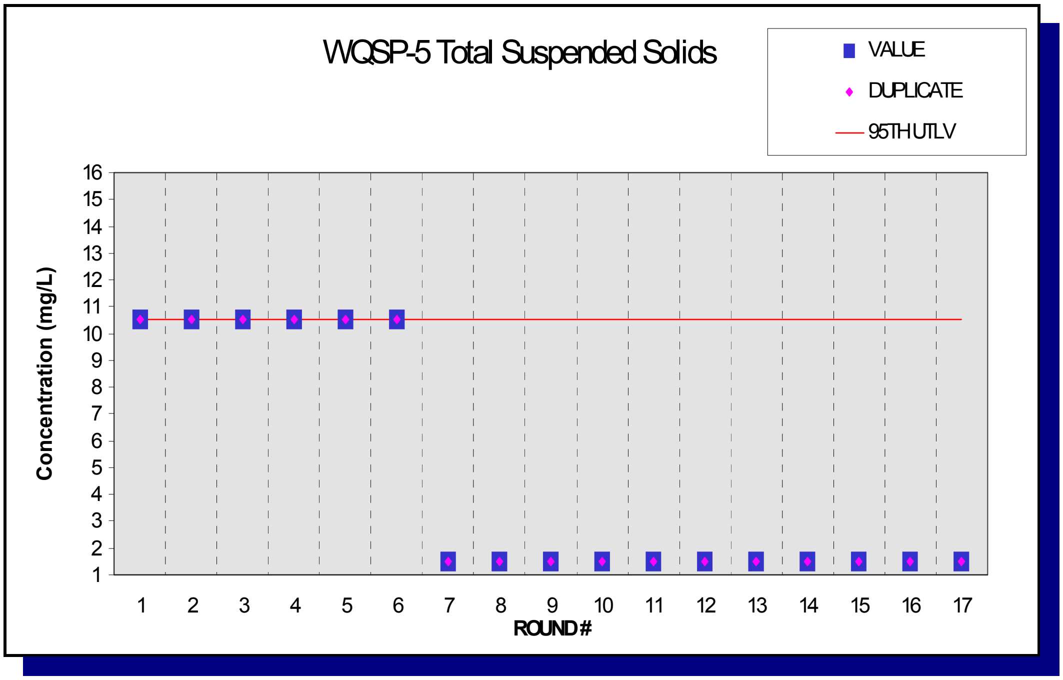

Figure E.70 - Time Trend Plot for Total Suspended Solids at WQSP-5

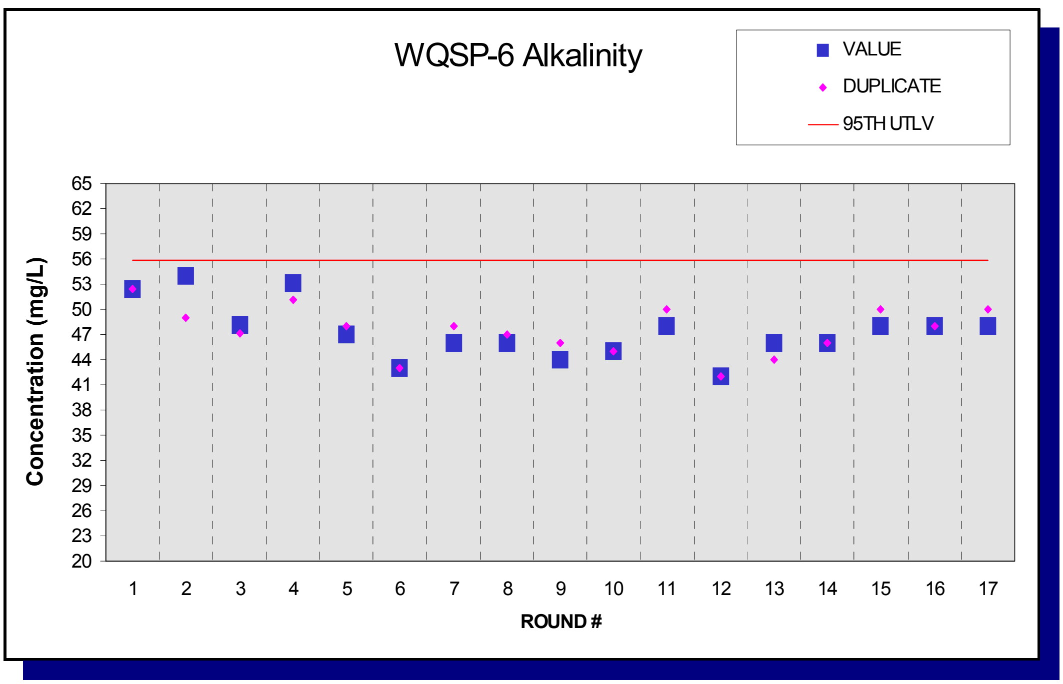

Figure E.71 - Time Trend Plot for Alkalinity at WQSP-6

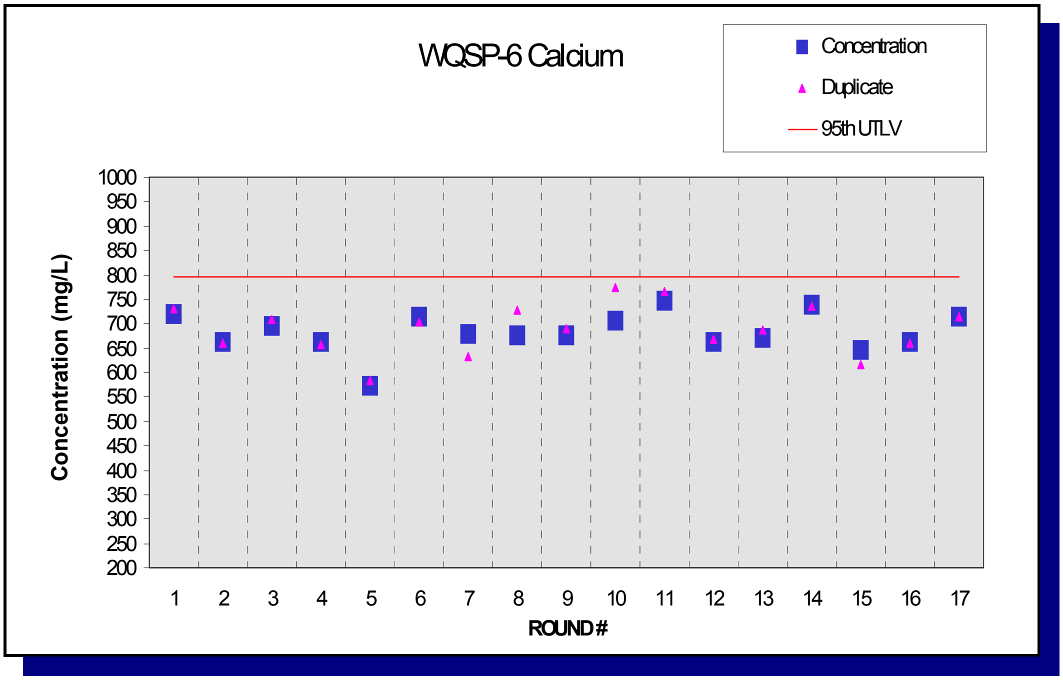

Figure E.72 - Time Trend Plot for Calcium at WQSP-6

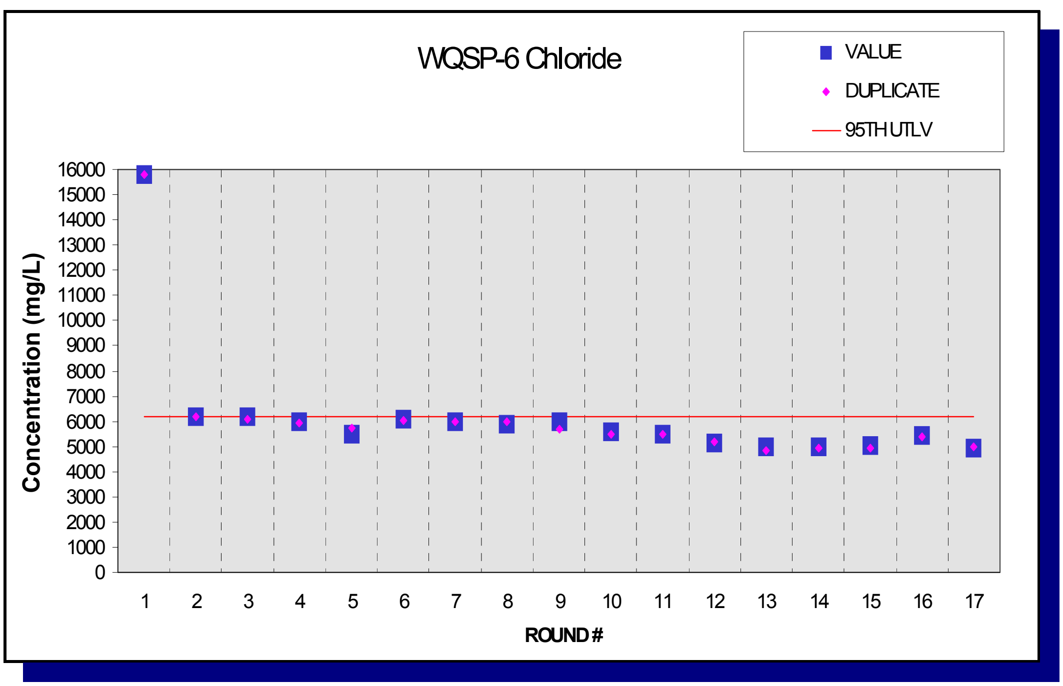

Figure E.73 - Time Trend Plot for Chloride at WQSP-6

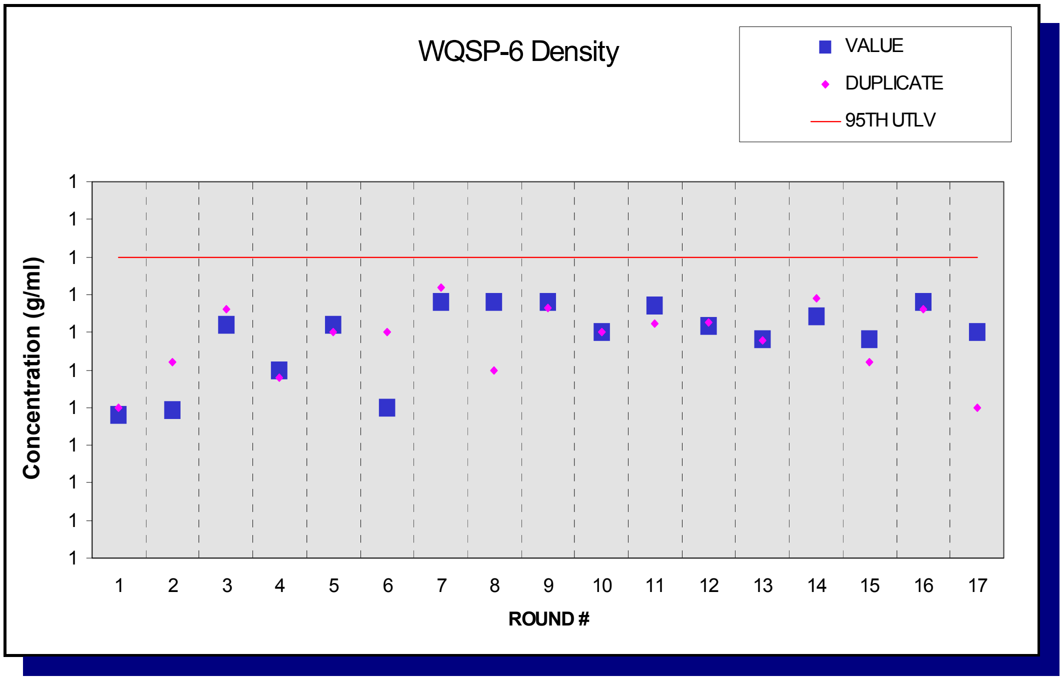

Figure E.74 - Time Trend Plot for Density at WQSP-6

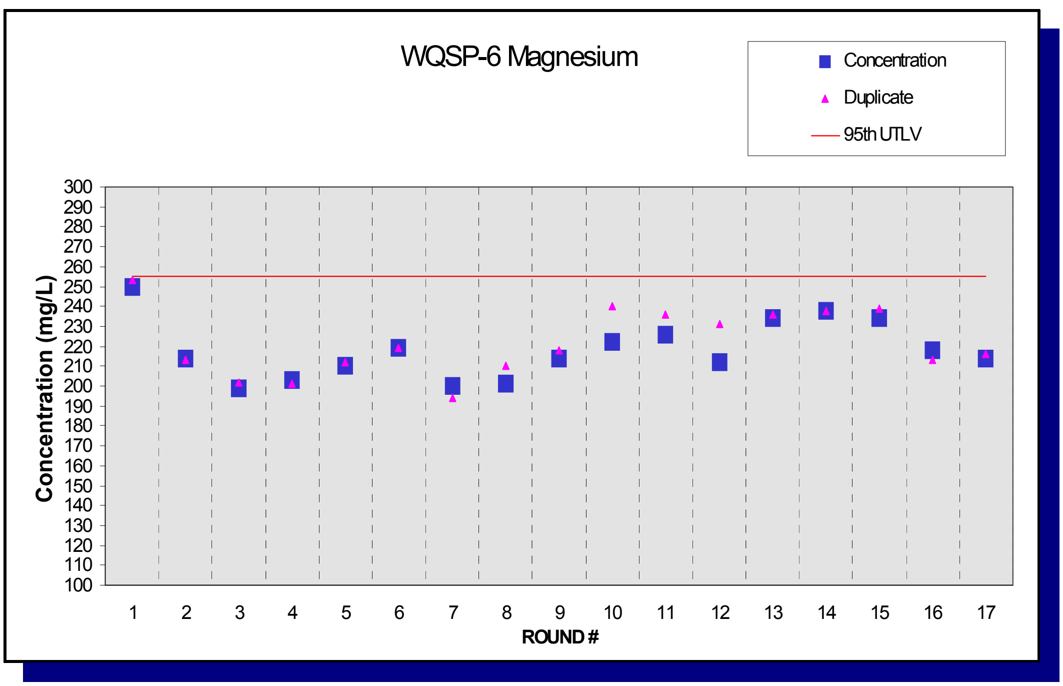

Figure E.75 - Time Trend Plot for Magnesium at WQSP-6

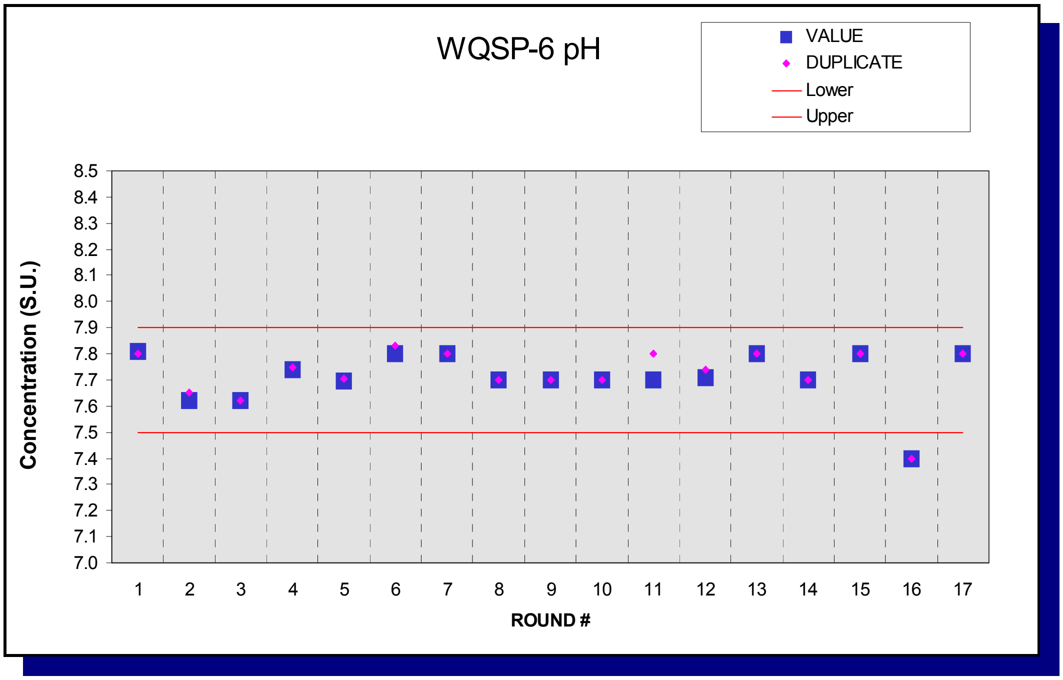

Figure E.76 - Time Trend Plot for pH at WQSP-6

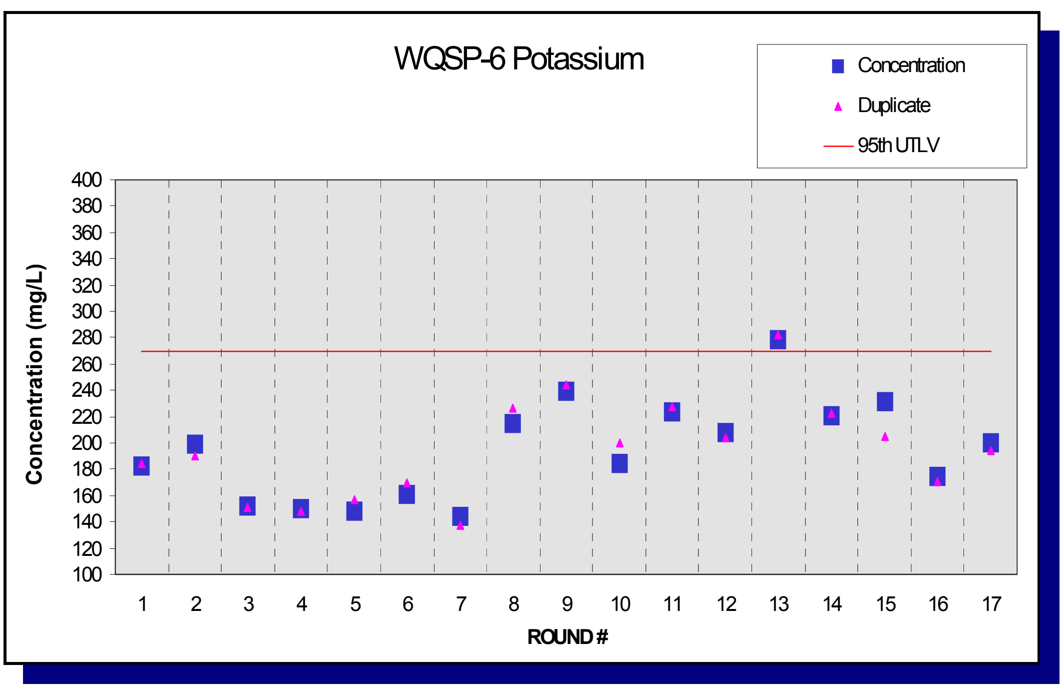

Figure E.77 - Time Trend Plot for Potassium at WQSP-6

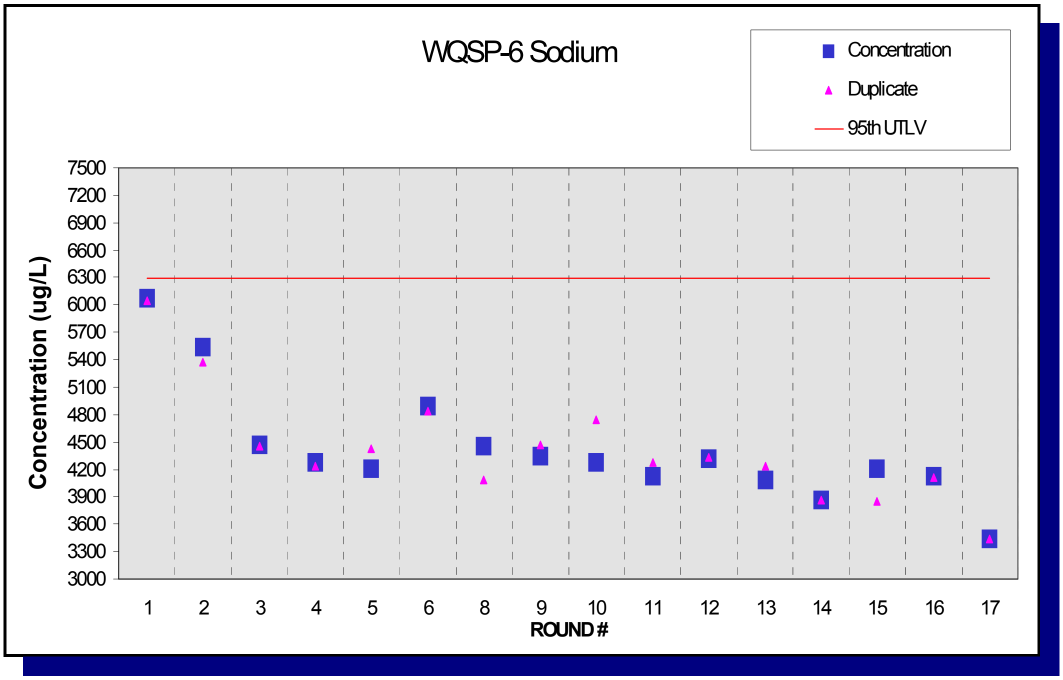

Figure E.78 - Time Trend Plot for Sodium at WQSP-6

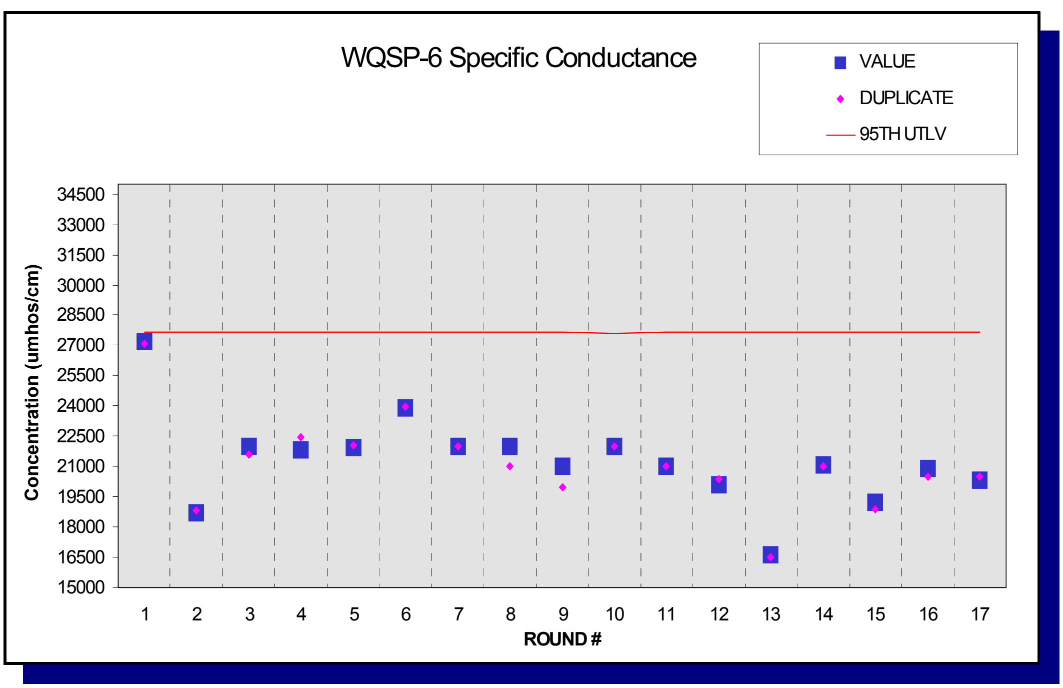

Figure E.79 - Time Trend Plot for Specific Conductance at WQSP-6

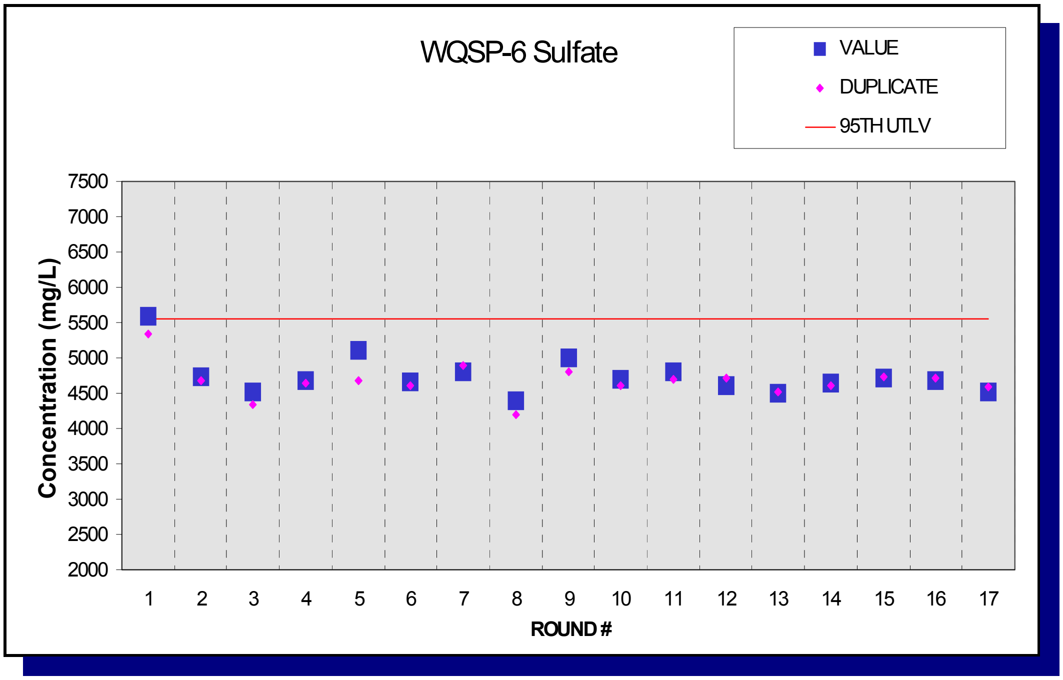

Figure E.80 - Time Trend Plot for Sulfate at WQSP-6

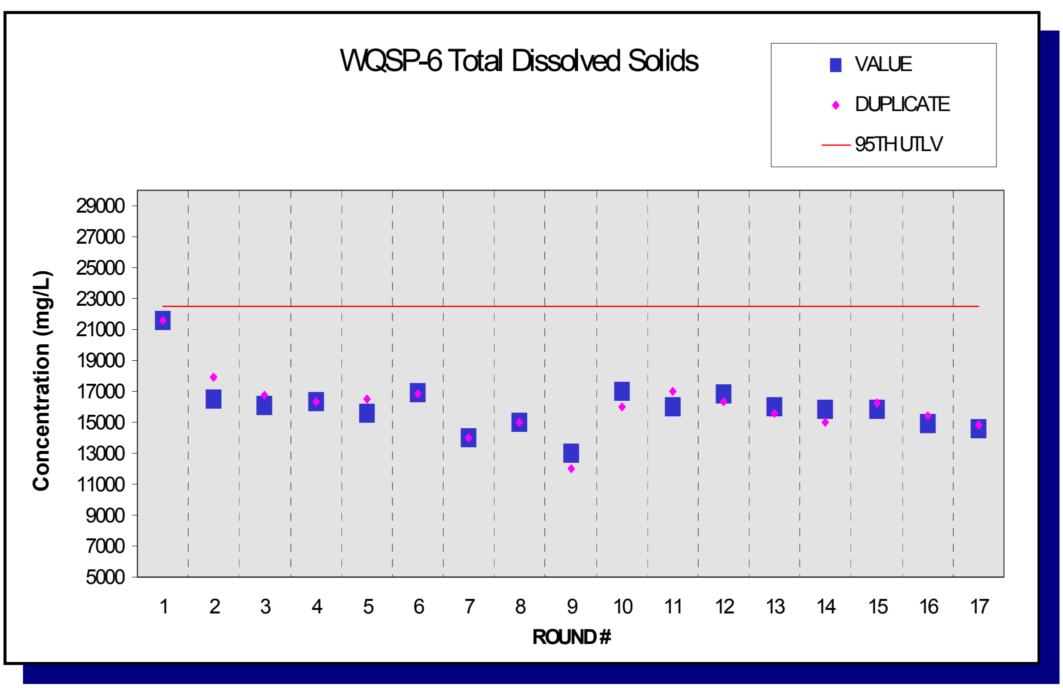

Figure E.81 - Time Trend Plot for Total Dissolved Solids at WQSP-6

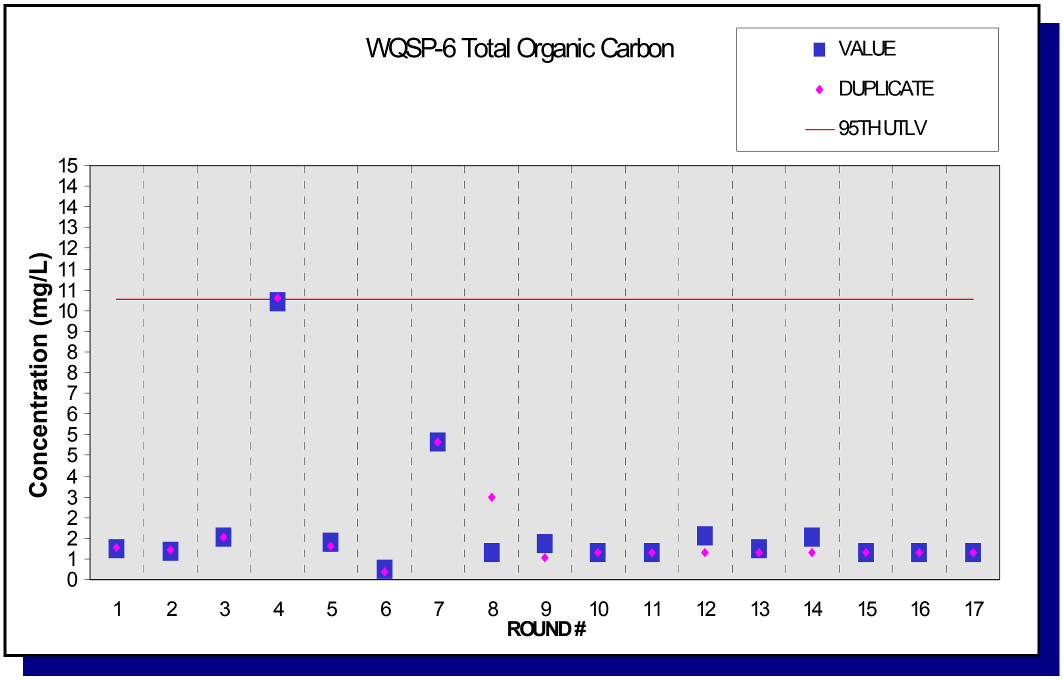

Figure E.82 - Time Trend Plot for Total Organic Carbon at WQSP-6

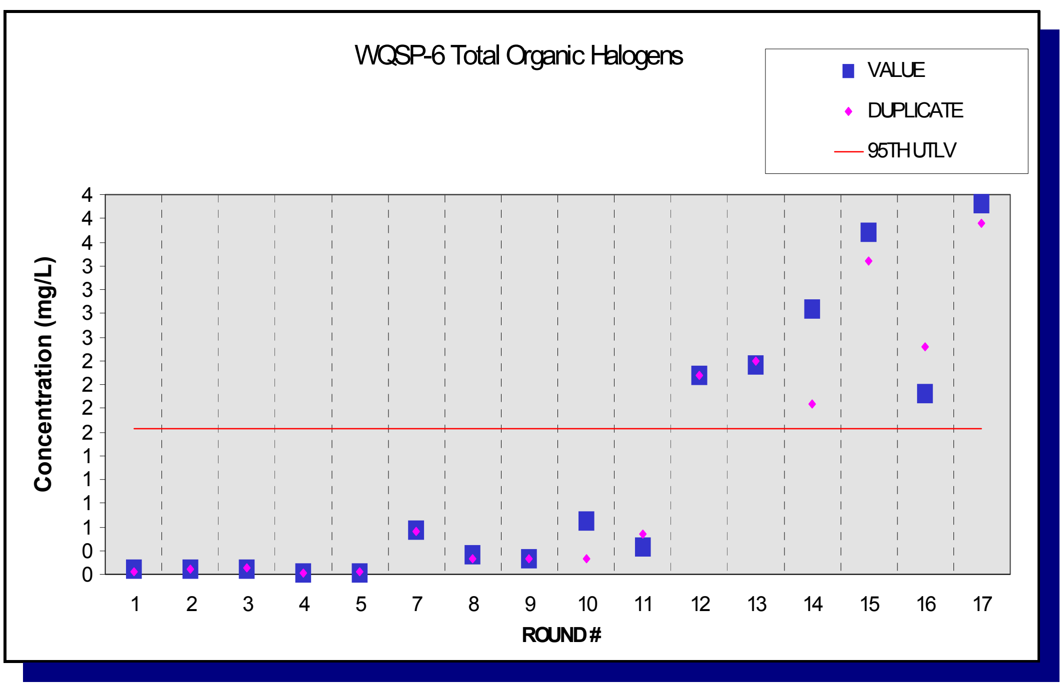

Figure E.83 - Time Trend Plot for Total Organic Halogens at WQSP-6

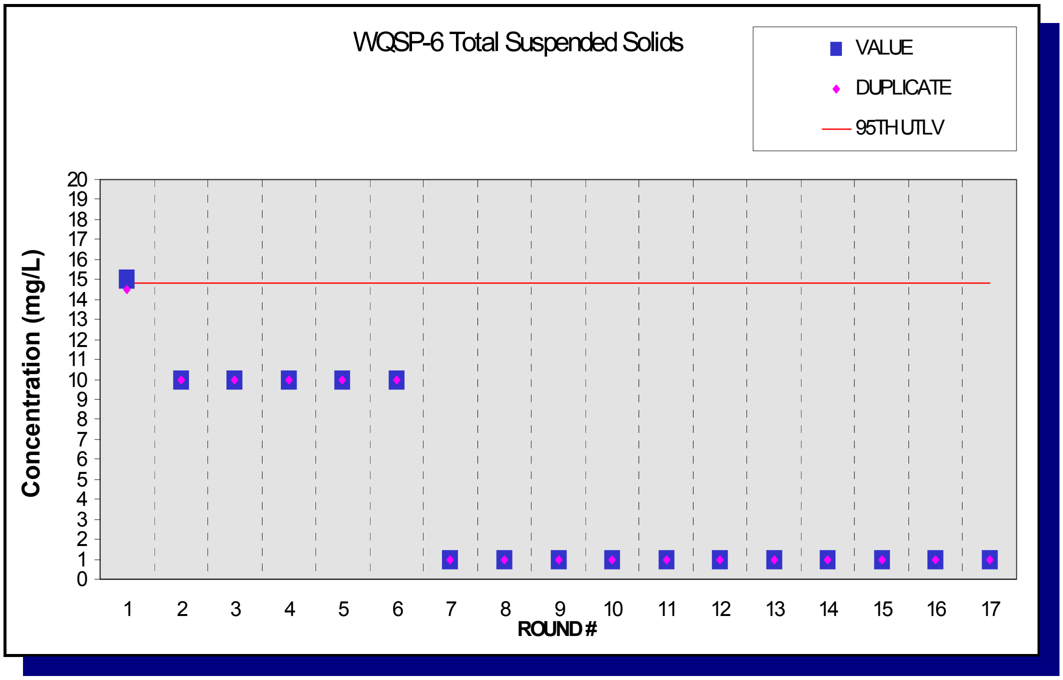

Figure E.84 - Time Trend Plot for Total Suspended Solids at WQSP-6

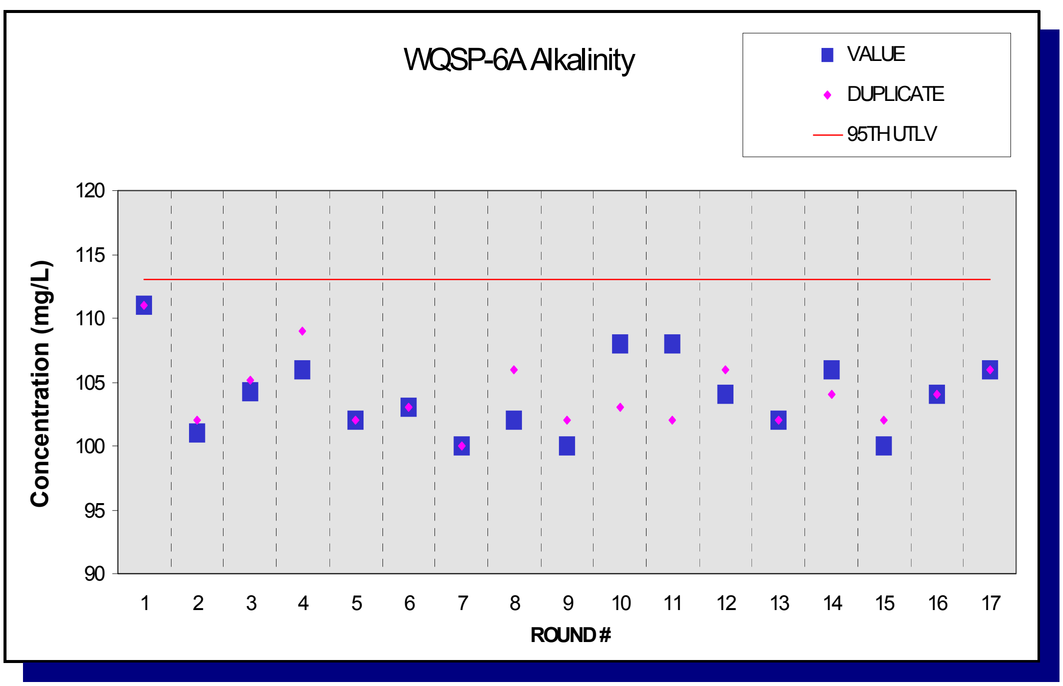

Figure E.85 - Time Trend Plot for Alkalinity at WQSP-6A

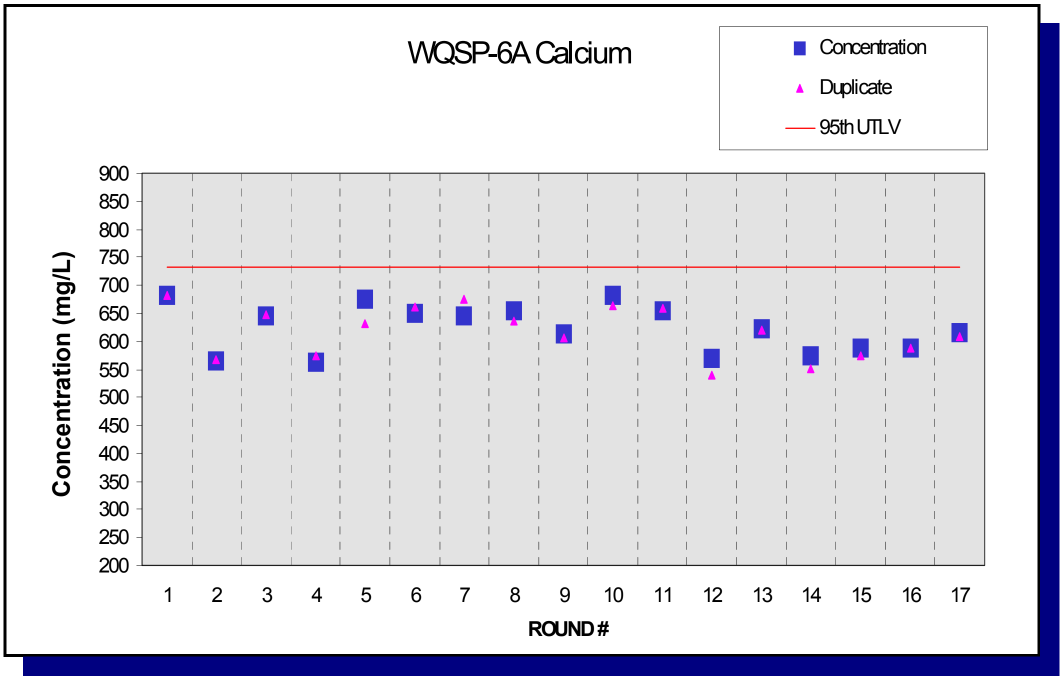

Figure E.86 - Time Trend Plot for Calcium at WQSP-6A

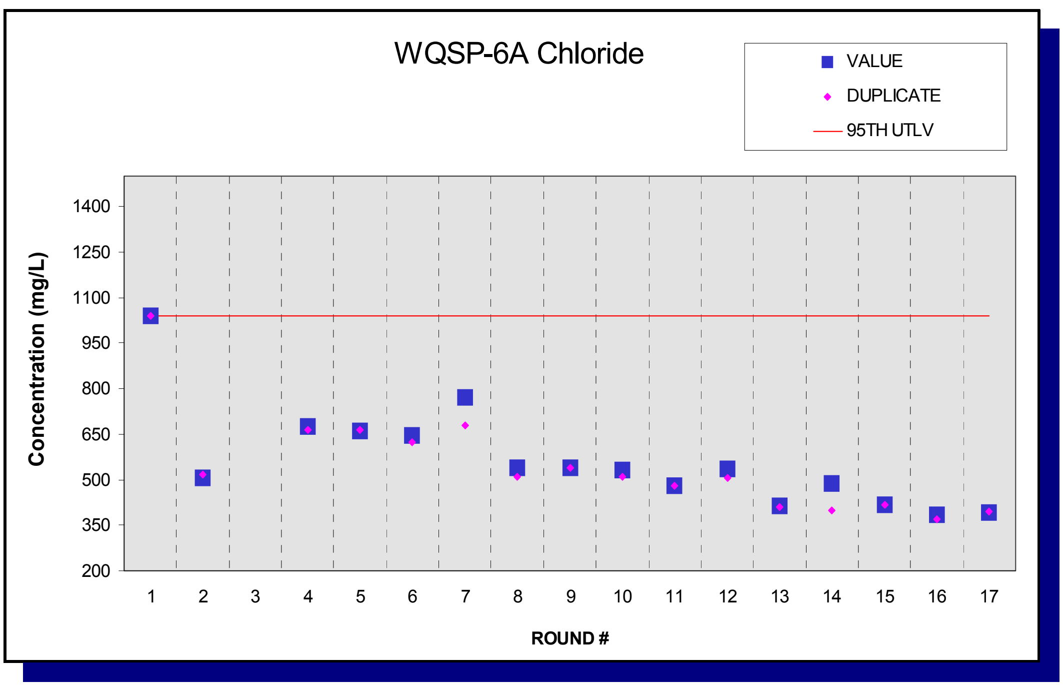

Figure E.87 - Time Trend Plot for Chloride at WQSP-6A

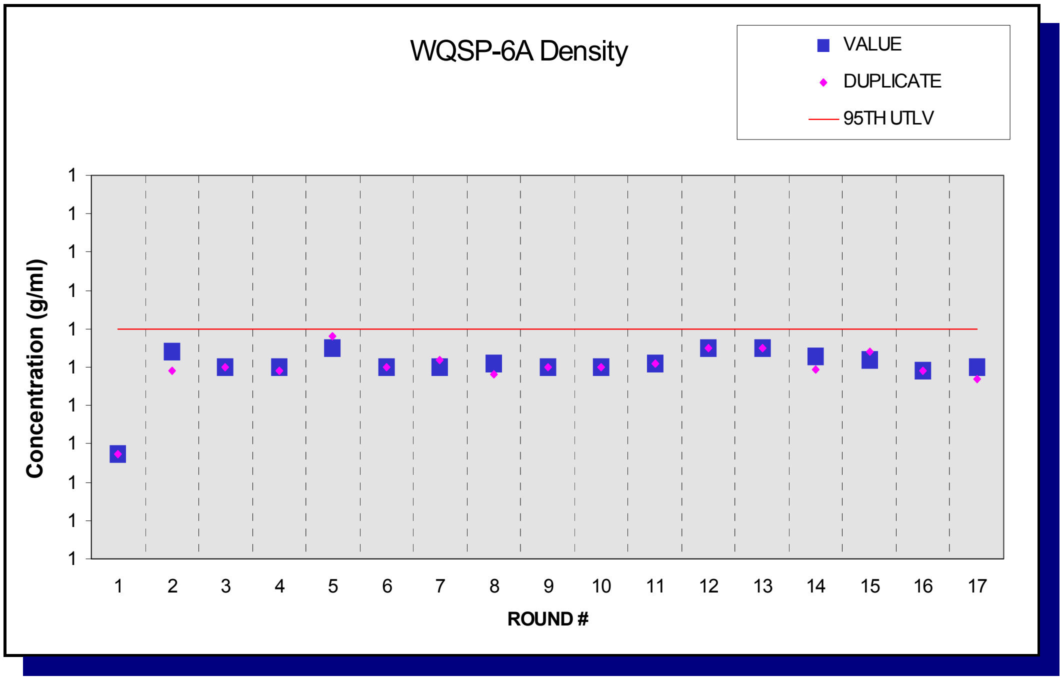

Figure E.88 - Time Trend Plot for Density at WQSP-6A

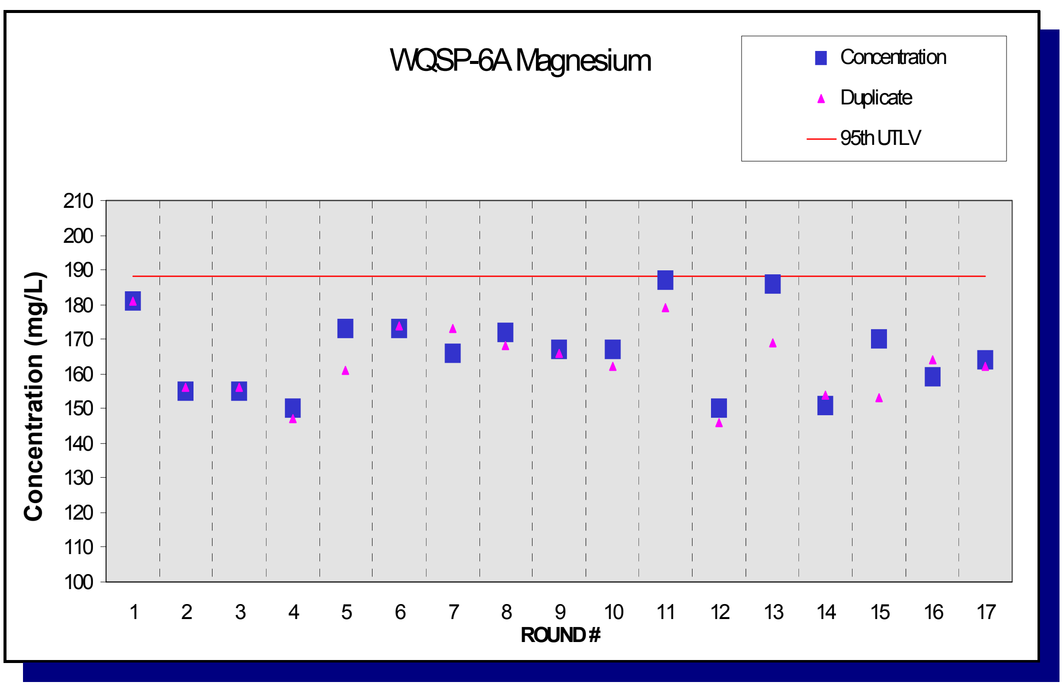

Figure E.89 - Time Trend Plot for Magnesium at WQSP-6A

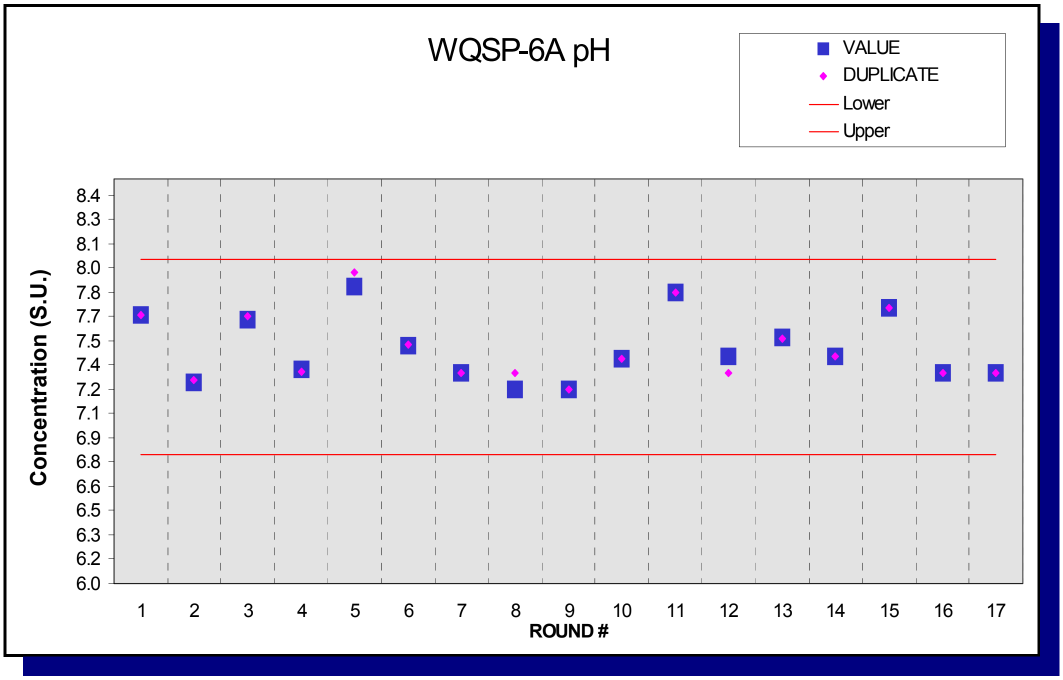

Figure E.90 - Time Trend Plot for pH at WQSP-6A

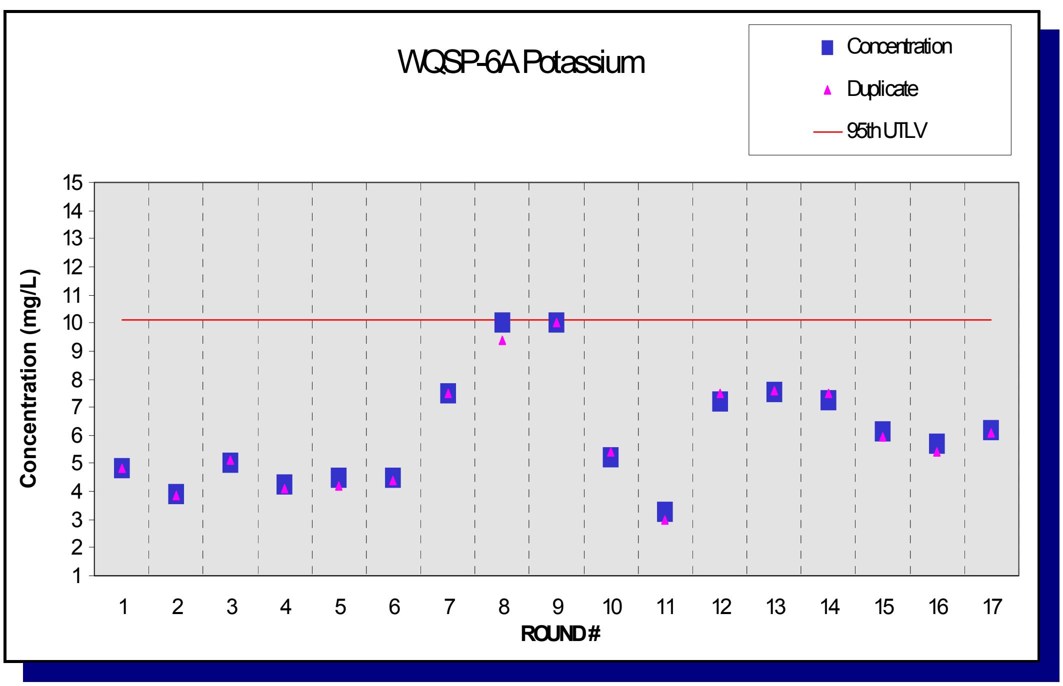

Figure E.91 - Time Trend Plot for Potassium at WQSP-6A

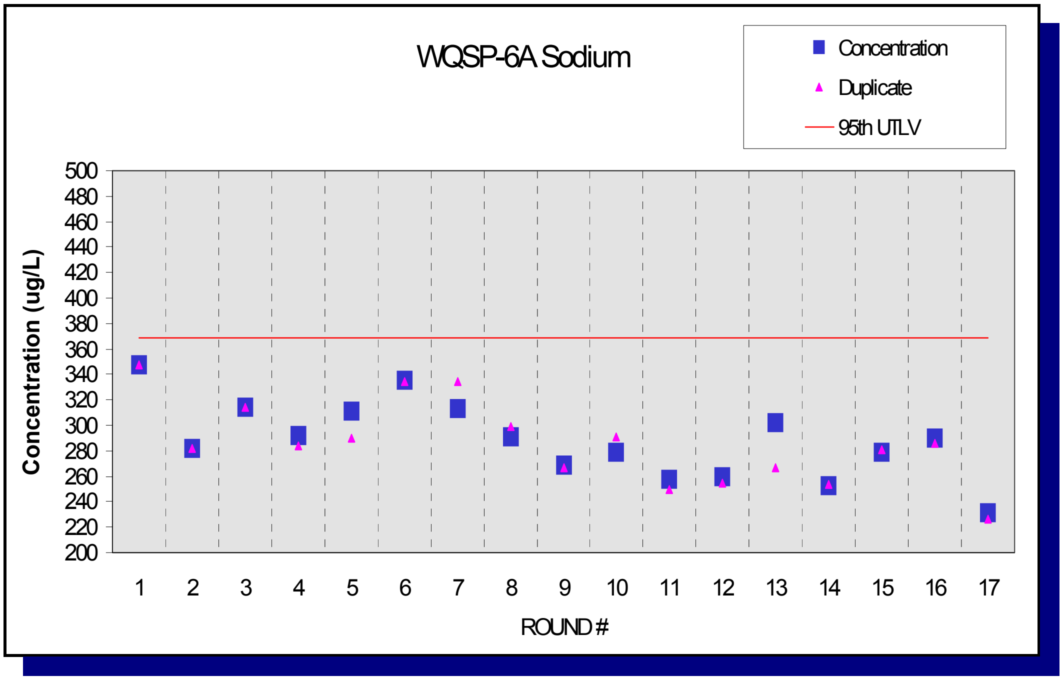

Figure E.92 - Time Trend Plot for Sodium at WQSP-6A

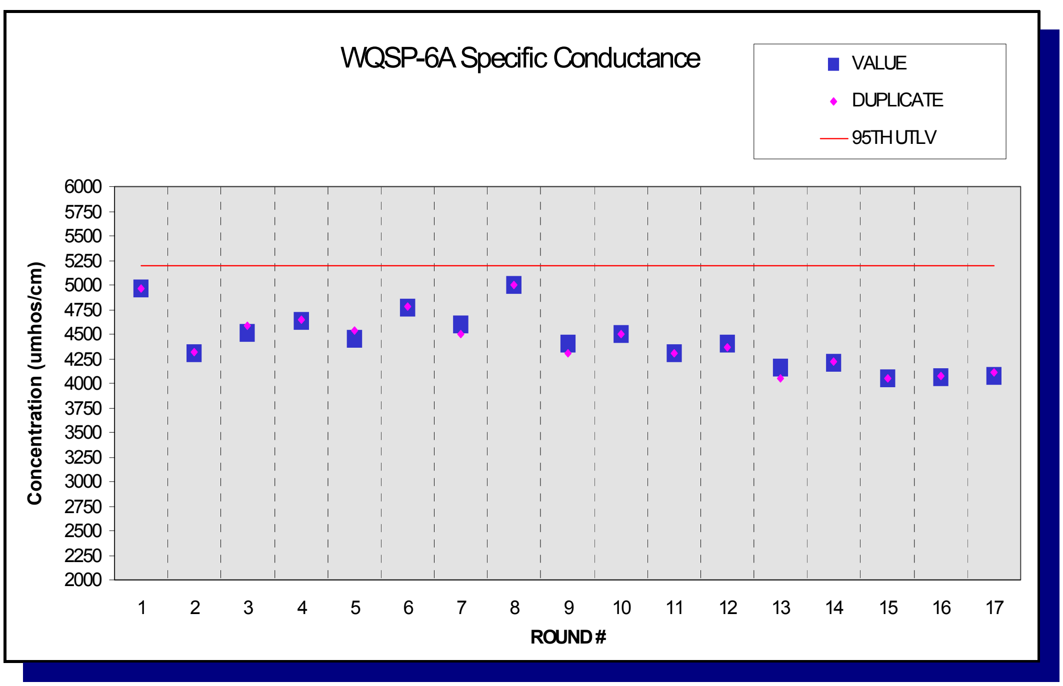

Figure E.93 - Time Trend Plot for Specific Conductance at WQSP-6A

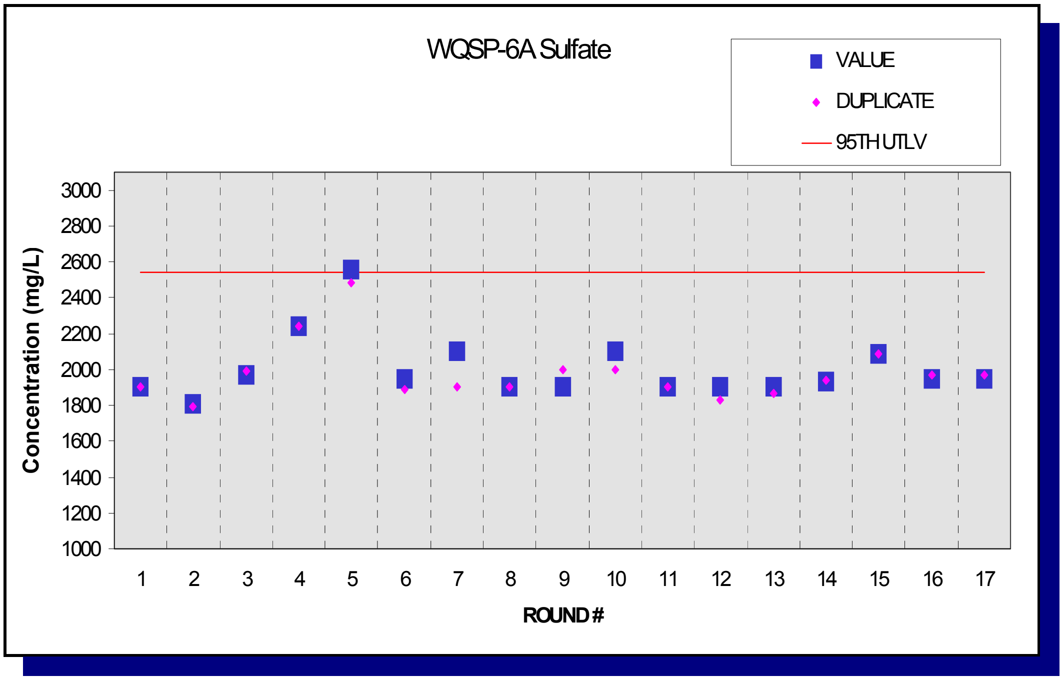

Figure E.94 - Time Trend Plot for Sulfate at WQSP-6A

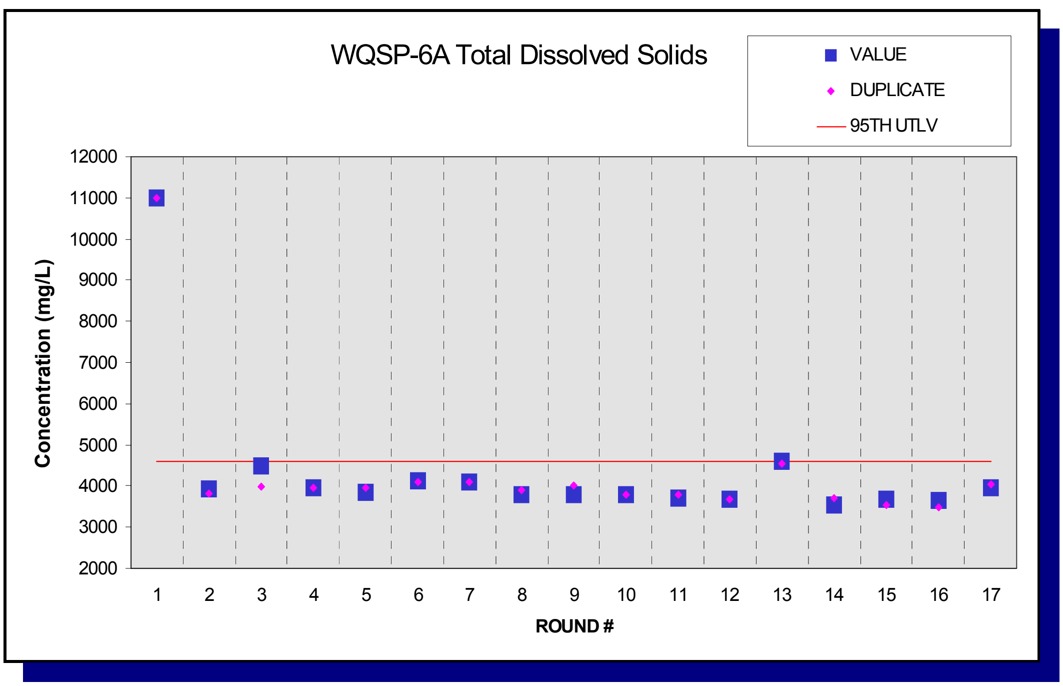

Figure E.95 - Time Trend Plot for Total Dissolved Solids at WQSP-6A

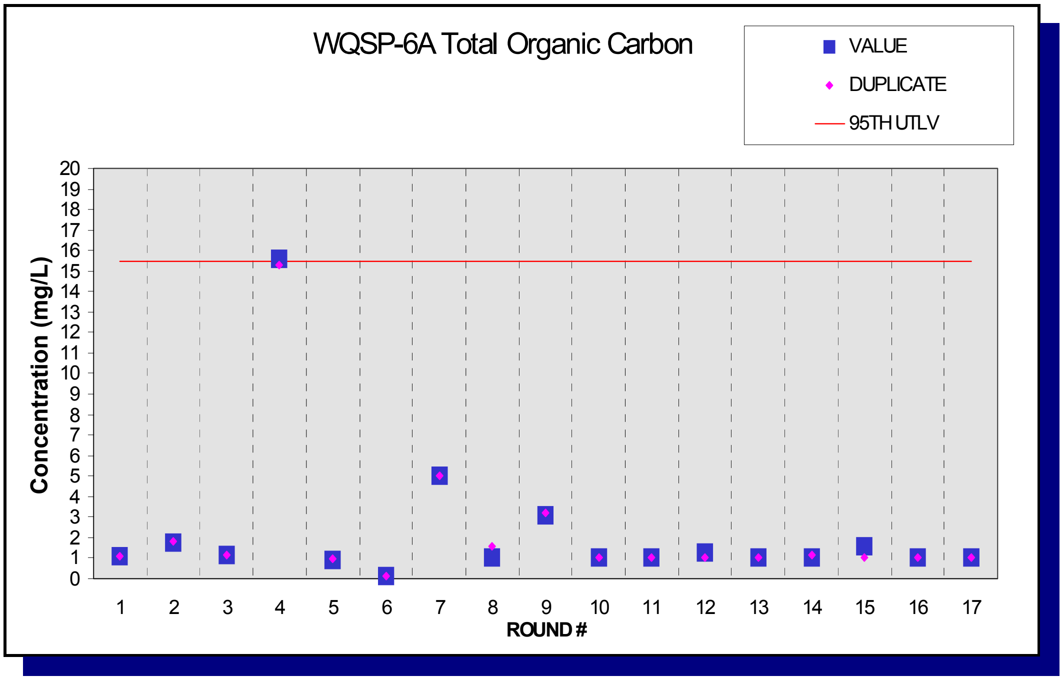

Figure E.96 - Time Trend Plot for Total Organic Carbon at WQSP-6A

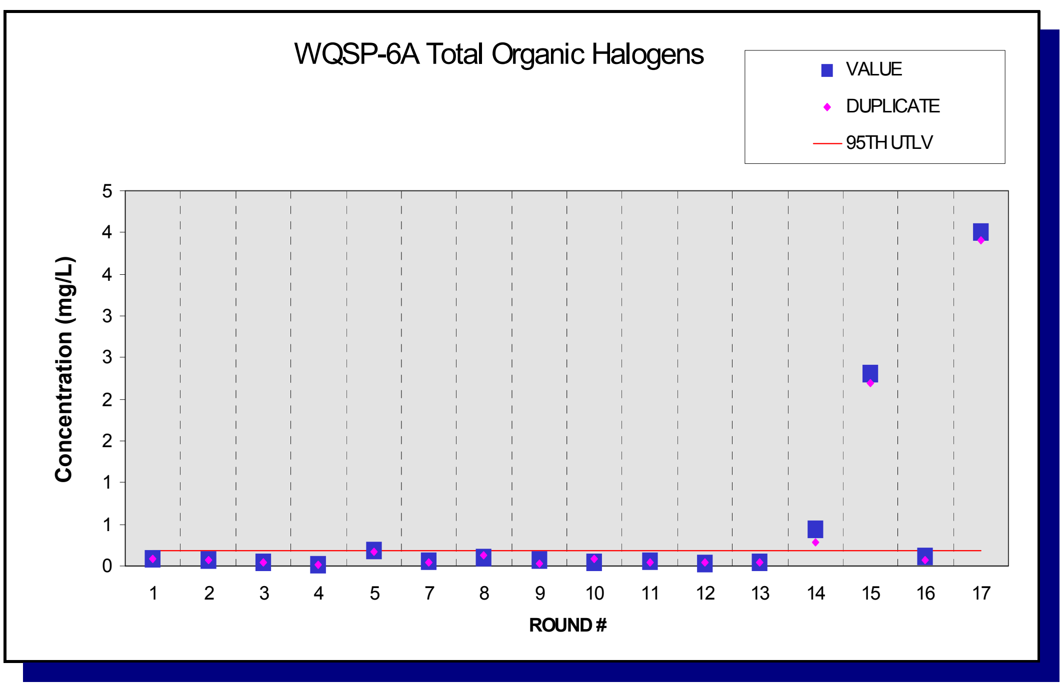

Figure E.97 - Time Trend Plot for Total Organic Halogens at WQSP-6A

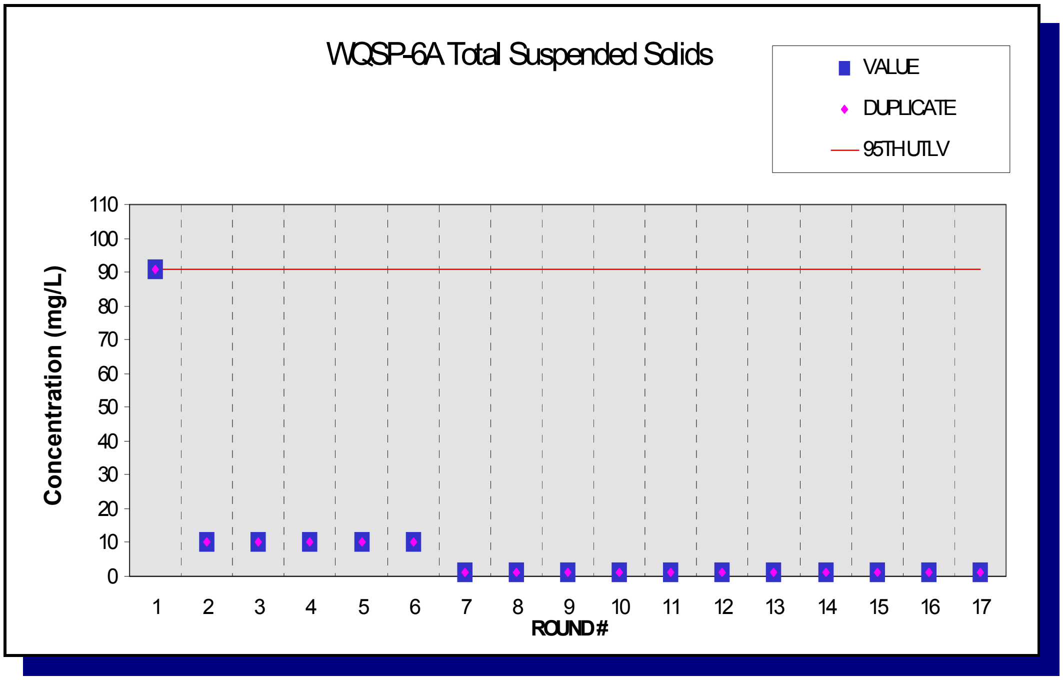

Figure E.98 - Time Trend Plot for Total Suspended Solids at WQSP-6A

Appendix F
Groundwater Data Tables

Table F.1 - Analytical Results for Groundwater Sampled from Well WQSP-1

	Concentration					Reporting Limit		
	Round 16		Round 17					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 16	Round 17	95th UTLV[a]
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1, 2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	52	50	48	48	mg/L	4	4	55.7
Chloride	35100	40100	35000	34200	mg/L	2	2	40472
Density	1.04	1.035	1.04	1.04	g/ml	N/A[d]	N/A[d]	1.072
Nitrate (as N)	0.012	0.012	<.10	<.10	mg/L	0.1	0.1	<10
pH	6.8	6.8	7.1	7.1	SU[c]	N/A[d]	N/A[d]	6.89-7.65
Specific conductance	59800	60200	83000	83400	µmhos/cm	N/A	N/A	175000
Sulfate	4910	4820	4440	4660	mg/L	2	2	5757
Total dissolved solids	65100	66400	66500	66700	mg/L	10	10	80700
Total organic carbon	3.05	2.2	<1.0	<1.0	mg/L	1	1	5

Table F.1 - Analytical Results for Groundwater Sampled from Well WQSP-1

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Total organic halogen	3.4	3.1	3.9	3.1	mg/L	0.01	0.005	14.6
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	33.5
Antimony	<0.025	<0.025	<0.250	<0.250	mg/L	0.025	0.25	0.33
Arsenic	<0.01	<0.01	<0.10	<0.10	mg/L	0.01	0.1	<0.1
Barium	<0.10	<0.10	<0.10	<0.10	mg/L	0.1	0.05	<1.0
Beryllium	<0.0025	<0.0025	<0.01	<0.01	mg/L	0	0.01	<0.02
Cadmium	<0.005	<0.005	<0.01	<0.01	mg/L	0.01	0.01	<0.2
Calcium	1730	1700	1680	1650	mg/L	0.5	0.5	2,087
Chromium	<0.01	<0.01	<0.025	<0.025	mg/L	0.01	0.025	<0.5
Iron	<0.05	<0.05	<0.50	<0.50	mg/L	0.05	0.5	1.32
Lead	<0.01	<0.01	<0.05	<0.05	mg/L	0.01	0.05	0.105
Magnesium	1170	1130	1080	1040	mg/L	0.5	0.5	1,247
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	<0.025	<0.025	<0.05	<0.05	mg/L	0.025	0.05	0.490
Potassium	539	487	825	850	mg/L	0.5	0.5	799
Selenium	<0.05	<0.05	<0.025	<0.025	mg/L	0.05	0.025	0.15
Silver	<0.0125	<0.0125	<0.025	<0.025	mg/L	0.013	0.025	<0.50
Sodium	19600	16400	17800	17800	mg/L	0.5	0.5	22,090
Thallium	<0.05	<0.05	<0.025	<0.025	mg/L	0.05	0.025	0.980
Vanadium	<0.025	<0.025	<0.05	<0.05	mg/L	0.025	0.05	<0.1

[A] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Standard unit
[d] Not applicable

Table F.2 - Analytical Results for Groundwater Sampled from Well WQSP-2

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL

Table F.2 - Analytical Results for Groundwater Sampled from Well WQSP-2

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	44	46	48	50	mg/L	4	4	70.3
Chloride	39000	37900	34300	33100	mg/L	2	2	39670
Density	1.039	1.038	1.04	1.04	g/ml	N/A[c]	N/A[c]	1.06
Nitrate (as N)	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	<10
pH	7.1	7.1	7.2	7.2	SU[d]	N/A[c]	N/A[c]	7.00-7.60
Specific conductance	70200	70200	80800	80900	µmhos/cm	N/A[c]	N/A[c]	124000
Sulfate	6570	7280	5710	5510	mg/L	2	2	6590
Total dissolved solids	66200	67200	64700	65100	mg/L	10	10	80500
Total organic carbon	2.95	1.98	2.11	1.5	mg/L	1	1	7.97
Total organic halogen	3.5	3.5	5.4	4.6	mg/L	0.01	0.01	63.8
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	43
Antimony	<0.016	<0.016	<0.025	<0.025	mg/L	0.016	0.025	<0.50
Arsenic	<0.03	<0.03	<0.05	<0.05	mg/L	0.03	0.05	0.062
Barium	0.058	0.046	<0.05	<0.05	mg/L	0.02	0.05	<1.0
Beryllium	<0.0007	<0.0007	<0.01	<0.01	mg/L	0	0.01	<1.0
Cadmium	<0.001	<0.001	<0.01	<0.01	mg/L	0	0.01	<0.5
Calcium	1350	1540	1460	1440	mg/L	0.5	0.5	1,827
Chromium	0.014	0.01	<0.025	<0.025	mg/L	0.025	0.025	<0.5
Iron	0.08	1.77	<0.50	<0.50	mg/L	0.5	0.5	1.32
Lead	0.183	<0.018	0.233	0.261	mg/L	0.02	0.05	0.163
Magnesium	1130	1120	970	965	mg/L	0.5	0.5	1,244
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	<0.0135	0.044	<0.05	<0.05	mg/L	0.025	0.05	0.490
Potassium	455	501	755	795	mg/L	0.5	0.5	845
Selenium	<0.05	<0.05	0.116	0.118	mg/L	0.05	0.025	0.150

Table F.2 - Analytical Results for Groundwater Sampled from Well WQSP-2

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Silver	<0.006	<0.006	<0.025	<0.025	mg/L	0.01	0.025	<0.50
Sodium	17100	17100	17600	16900	mg/L	0.5	0.5	21,900
Thallium	<0.03	<0.03	0.091	<0.025	mg/L	0.03	0.025	0.98
Vanadium	<0.005	<0.005	<0.05	<0.05	mg/L	0.01	0.05	<0.1

[A] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.3 - Analytical Results for Groundwater Sampled from Well WQSP-3

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<20	<20	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL

Table F.3 - Analytical Results for Groundwater Sampled from Well WQSP-3

	Concentration					Reporting Limit		
	Round 16		Round 17					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 16	Round 17	95th UTLV[a]
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	34	36	36	34	mg/L	4	4	54.5
Chloride	134000	131000	126000	134000	mg/L	2	1	149100
Density	1.144	1.145	1.13	1.14	g/ml	N/A[c]	N/A[c]	1.17
Nitrate (as N)	<0.10	<0.10	<0.10	<0.10	mg/L	0.1	0.1	12
pH	6.4	6.4	7	7	SU[d]	N/A[c]	N/A[c]	6.6-7.2
Specific conductance	147300	145900	169000	196000	µmhos/cm	N/A[c]	N/A[c]	517000
Sulfate	7870	7890	7670	7660	mg/L	2	1	8015
Total dissolved solids	220000	222000	232000	227500	mg/L	10	10	261000
Total organic carbon	2.08	1.54	<1.0	<1.0	mg/L	1	1	5
Total organic halogen	42	14	5.6	4.3	mg/L	0.005	0.005	55
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	107
Antimony	<0.016	<0.016	<0.250	<0.250	mg/L	0.016	0.25	<1.0
Arsenic	<0.03	<0.03	<0.10	<0.10	mg/L	0.03	0.1	0.207
Barium	0.066	0.057	<0.10	<0.10	mg/L	0.02	0.1	<1.0
Beryllium	<0.0007	<0.0007	<0.01	<0.01	mg/L	0	0.01	<0.1
Cadmium	<0.001	<0.001	<0.01	<0.01	mg/L	0.001	0..01	<0.5
Calcium	1460	1520	1280	1300	mg/L	0.5	0.5	1,680
Chromium	0.025	0.033	<0.025	<0.025	mg/L	0.025	0.025	<2.0
Iron	0.092	0.085	<0.50	<0.50	mg/L	0.5	0.5	<1.0
Lead	0.288	0.256	<0.05	<0.05	mg/L	0.02	0.05	0.80
Magnesium	2090	2030	2070	1960	mg/L	0.5	0.5	2,625
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	0.026	0.022	<0.05	<0.05	mg/L	0.025	0.05	<5.00
Potassium	1550	1530	1900	1920	mg/L	0.5	0.5	3,438
Selenium	<0.05	<0.05	0.14	0.139	mg/L	0.05	0.025	<2.00
Silver	<0.006	<0.006	<0.025	<0.025	mg/L	0.006	0.025	0.31
Sodium	82600	87800	67000	67800	mg/L	0.5	0.5	140,400
Thallium	<0.03	<0.03	0.271	0.158	mg/L	0.03	0.025	5.800
Vanadium	<0.005	<0.005	<0.05	<0.05	mg/L	0.005	0.05	<5.00

[a] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.4 - Analytical Results for Groundwater Sampled from Well WQSP-4

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<20	<20	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	32	34	40	42	mg/L	4	4	47.1
Chloride	54500	57400	49000	55000	mg/L	2	2	63960
Density	1.07	1.07	1.07	1.07	g/ml	N/A[c]	N/A[c]	1.1
Nitrate (as N)	<0.10	<0.10	<0.10	<0.10	mg/L	0.1	0.1	10
pH	6.8	6.8	7.2	7.2	SU[d]	N/A[c]	N/A[c]	6.80-7.61
Specific conductance	112000	117000	122000	122000	µmhos/cm	N/A[c]	N/A[c]	319800
Sulfate	6930	7330	6120	6080	mg/L	2	2	7927
Total dissolved solids	118000	108000	107000	111000	mg/L	10	10	123500
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	5
Total organic halogen	12	10	7.3	5.2	mg/L	0.005	0.01	17
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	57
Antimony	<0.016	<0.016	<0.25	<0.25	mg/L	0.016	0.25	0.8

Table F.4 - Analytical Results for Groundwater Sampled from Well WQSP-4

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Arsenic	<0.03	<0.03	<0.10	<0.10	mg/L	0.03	0.1	<0.50
Barium	0.055	0.051	<0.10	<0.10	mg/L	0.2	0.1	<1.0
Beryllium	<0.0007	<0.0007	<0.01	<0.01	mg/L	0	0.01	0.25
Cadmium	<0.001	<0.001	<0.01	<0.01	mg/L	0.001	0.01	<0.50
Calcium	1440	1500	1550	1470	mg/L	0.5	0.5	1,834
Chromium	<0.003	0.024	<0.025	<0.025	mg/L	0.003	0.025	<2.0
Iron	0.155	0.088	<0.50	<0.50	mg/L	0.5	0.5	<4.0
Lead	<0.018	<0.018	<0.05	<0.05	mg/L	0.018	0.05	0.525
Magnesium	1160	1150	1150	1110	mg/L	0.5	0.5	1,472
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	<0.014	<0.014	<0.05	<0.05	mg/L	0.014	0.05	<5.00
Potassium	695	690	1350	1270	mg/L	0.5	0.5	1,648
Selenium	<0.05	<0.05	0.23	0.03	mg/L	0.05	0.025	2.009
Silver	<0.006	<0.006	<0.025	<0.025	mg/L	0.006	0.025	0.519
Sodium	32800	30000	30800	30200	mg/L	0.5	0.5	38,790
Thallium	<0.03	<0.03	<0.025	<0.025	mg/L	0.03	0.025	1.00
Vanadium	<0.005	<0.005	<0.05	<0.05	mg/L	0.005	0.05	<5.00

[A] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.5 - Analytical Results for Groundwater Sampled from Well WQSP-5

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL

Table F.5 - Analytical Results for Groundwater Sampled from Well WQSP-5

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	50	50	44	46	mg/L	4	4	56
Chloride	15400	14900	14700	14700	mg/L	2	2	18100
Density	1.02	1.02	1.02	1.02	g/ml	N/A[c]	N/A[c]	1.04
Nitrate (as N)	<0.10	<0.10	<0.10	<0.10	mg/L	0.1	0.1	10
pH	7.1	7.1	7.7	7.7	SU[d]	N/A[c]	N/A[c]	7.40-7.90
Specific conductance	44700	45200	44200	44400	µmhos/cm	N/A[c]	N/A[c]	67700
Sulfate	4900	5010	4770	4860	mg/L	2	2	6129
Total dissolved solids	31900	31600	32600	34150	mg/L	10	10	43950
Total organic carbon	<1.0	<1.0	1.57	<1.0	mg/L	1	1	5
Total organic halogen	6.5	2.4	3.3	4	mg/L	0.005	0.005	8.37
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	10
Antimony	<0.016	<0.016	<0.025	<0.025	mg/L	0.016	0.025	0.073
Arsenic	<0.03	<0.03	<0.10	<0.10	mg/L	0.03	0.1	0.5
Barium	0.03	0.025	<0.10	<0.10	mg/L	0.2	0.1	1
Beryllium	<0.0007	<0.0007	<0.01	<0.01	mg/L	0	0.01	0.02
Cadmium	<0.001	<0.001	<0.01	<0.01	mg/L	0.001	0.01	0.05
Calcium	1130	1100	1030	1010	mg/L	0.5	0.5	1,303
Chromium	<0.003	<0.003	<0.025	<0.025	mg/L	0.003	0.025	0.50
Iron	0.15	0.125	<0.50	<0.50	mg/L	0.5	0.5	0.795
Lead	<0.018	<0.018	<0.05	<0.05	mg/L	0.018	0.05	0.05
Magnesium	485	481	449	445	mg/L	0.5	0.5	547.0
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	0.002
Nickel	0.046	0.034	<0.05	<0.05	mg/L	0.025	0.05	0.10
Potassium	322	304	411	396	mg/L	0.5	0.5	622.0
Selenium	<0.05	<0.05	<0.025	<0.025	mg/L	0.05	0.025	0.10
Silver	<0.006	<0.006	<0.025	<0.025	mg/L	0.006	0.025	0.50

Table F.5 - Analytical Results for Groundwater Sampled from Well WQSP-5

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
Sodium	10100	10500	8960	8760	mg/L	0.5	0.5	11,190
Thallium	<0.03	<0.03	<0.025	<0.025	mg/L	0.03	0.025	0.209
Vanadium	<0.005	<0.005	<0.05	<0.05	mg/L	0.005	0.05	2.70

[a] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.6 - Analytical Results for Groundwater Sampled from Well WQSP-6

Parameter	Concentration				Units	Reporting LIMIT		95th UTLV[a]
	Round 16		Round 17					
	Sample	Dup.	Sample	Dup.		Round 16	Round 17	
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL

Table F.6 - Analytical Results for Groundwater Sampled from Well WQSP-6

	Concentration							
	Round 16		Round 17			Reporting LIMIT		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 16	Round 17	95th UTLV[a]
Isobutanol	<5	<5	<5	<5	µg/L	5	5	<RL
Alkalinity	48	48	48	50	mg/L	4	4	55.8
Chloride	5410	5360	4910	4980	mg/L	2	2	6200
Density	1.014	1.013	1.01	1	g/ml	N/A[c]	N/A[c]	1.02
Nitrate (as N)	<0.10	<0.10	<0.10	<0.10	mg/L	0.1	0.1	7.45
pH	7.4	7.4	7.8	7.8	SU[d]	N/A[c]	N/A[c]	7.50-7.90
Specific conductance	20900	20500	20300	20500	µmhos/cm	N/A[c]	N/A[c]	27660
Sulfate	4670	4710	4520	4590	mg/L	2	2	5557
Total dissolved solids	14900	15400	14600	14800	mg/L	10	10	22500
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	10.14
Total organic halogen	1.9	2.4	3.9	3.7	mg/L	0.005	0.005	1.54
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	14.8
Antimony	<0.016	0.274	<0.025	<0.025	mg/L	0.016	0.025	0.14
Arsenic	<0.03	<0.03	<0.10	<0.10	mg/L	0.03	0.1	<0.50
Barium	0.013	0.01	<0.10	<0.10	mg/L	0.2	0.1	<1.0
Beryllium	<0.0007	<0.0007	<0.01	<0.01	mg/L	0	0.01	<0.020
Cadmium	<0.001	0	<0.01	<0.01	mg/L	0.001	0.01	<0.050
Calcium	662	659	714	714	mg/L	0.5	0.5	796
Chromium	<0.003	0.017	<0.025	<0.025	mg/L	0.003	0.025	<0.50
Iron	0.088	0.137	<0.50	<0.50	mg/L	0.5	0.5	3.105
Lead	<0.018	<0.018	<0.05	0.05	mg/L	0.018	0.05	0.150
Magnesium	218	213	214	216	mg/L	0.5	0.5	255
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	<0.013	<0.013	<0.05	<0.05	mg/L	0.013	0.05	<0.50
Potassium	175	171	200	194	mg/L	0.5	0.5	270
Selenium	<0.032	0.169	<0.025	<0.025	mg/L	0.032	0.025	<0.10
Silver	0.037	<0.006	<0.025	<0.025	mg/L	0.006	0.025	<0.50
Sodium	4120	4110	3440	3440	mg/L	0.5	0.5	6,290
Thallium	<0.03	<0.03	<0.025	<0.025	mg/L	0.03	0.025	0.560
Vanadium	0.056	0.027	<0.05	<0.05	mg/L	0.025	0.05	<0.10

[A] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.7 - Analytical Results for Groundwater Sampled from Well WQSP-6A

	Concentration							
	Round 16		Round 17			Reporting LIMIT		
Parameter	**Sample**	**Dup.**	**Sample**	**Dup.**	**Units**	**Round 16**	**Round 17**	**95th UTLV[a]**
1,1,1-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL[b]
1,1,2,2-Tetrachloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1,2-Trichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
1,1-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichloroethane	<1	<1	<1	<1	µg/L	1	1	<RL
Carbon tetrachloride	<1	<1	<1	<1	µg/L	1	1	<RL
Chlorobenzene	<1	<1	<1	<1	µg/L	1	1	<RL
Chloroform	<1	<1	<1	<1	µg/L	1	1	<RL
cis-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
trans-1,2-Dichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Methyl ethyl ketone	<5	<5	<5	<5	µg/L	5	5	<RL
Methylene chloride	<5	<5	<5	<5	µg/L	5	5	<RL
Tetrachloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Toluene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichloroethylene	<1	<1	<1	<1	µg/L	1	1	<RL
Trichlorofluoromethane	<1	<1	<1	<1	µg/L	1	1	<RL
Vinyl chloride	<1	<1	<1	<1	µg/L	1	1	<RL
Xylene	<1	<1	<1	<1	µg/L	1	1	<RL
1,2-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
1,4-Dichlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrophenol	<5	<5	<5	<5	µg/L	5	5	<RL
2,4-Dinitrotoluene	<5	<5	<5	<5	µg/L	5	5	<RL
2-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
3-Methylphenol/ 4-Methylphenol	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachlorobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Hexachloroethane	<5	<5	<5	<5	µg/L	5	5	<RL
Nitrobenzene	<5	<5	<5	<5	µg/L	5	5	<RL
Pentachlorophenol	<5	<5	<5	<5	µg/L	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/L	5	5	<RL
Isobutanol	<2	<2	<2	<2	mg/L	2	2	<RL
Alkalinity	104	104	106	106	mg/L	4	4	113
Chloride	384	370	391	394	mg/L	2	2	1040
Density	0.999	0.999	1	0.997	g/ml	N/A[c]	N/A[c]	1.01
Nitrate (as N)	4.74	4.74	<0.01	<0.01	mg/L	0.1	0.01	12.2
pH	7.3	7.3	7.3	7.3	SU[d]	N/A[c]	N/A[c]	6.80-8.00
Specific conductance	4060	4070	4070	4110	µmhos/cm	N/A[c]	N/A[c]	5192
Sulfate	1950	1970	1950	1970	mg/L	2	2	2543
Total dissolved solids	3650	3475	3955	4035	mg/L	10	10	4600
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	15.45
Total organic halogen	0.12	0.073	4	3.9	mg/L	0.01	0.01	0.19
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/L	1	1	91

Table F.7 - Analytical Results for Groundwater Sampled from Well WQSP-6A

Parameter	Concentration Round 16 Sample	Concentration Round 16 Dup.	Concentration Round 17 Sample	Concentration Round 17 Dup.	Units	Reporting LIMIT Round 16	Reporting LIMIT Round 17	95th UTLV[a]
Antimony	<0.124	<0.025	<0.25	<0.25	mg/L	0.025	0.25	0.48
Arsenic	0.25	0.27	<0.10	<0.10	mg/L	0.01	0.1	<0.50
Barium	<0.05	<0.05	<0.10	<0.10	mg/L	0.05	0.1	<0.10
Beryllium	<0.0125	<0.0125	<0.01	<0.01	mg/L	0.013	0.01	<0.01
Cadmium	<0.025	<0.025	<0.01	<0.01	mg/L	0.025	0.01	<0.05
Calcium	588	588	616	608	mg/L	0.5	0.5	733
Chromium	<0.05	<0.05	<0.025	<0.025	mg/L	0.05	0.025	<0.50
Iron	<0.25	<0.25	<0.50	<0.50	mg/L	0.25	0.5	<1.0
Lead	<0.075	<0.015	<0.05	<0.05	mg/L	0.01	0.05	<0.05
Magnesium	159	164	164	162	mg/L	0.5	0.5	188
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0	0	<0.002
Nickel	<0.125	<0.125	<0.05	<0.05	mg/L	0.125	0.05	0.284
Potassium	5.71	5.43	6.16	6.1	mg/L	0.5	0.5	10.1
Selenium	<0.123	<0.063	<0.219	<0.210	mg/L	0.01	0.025	0.220
Silver	<0.0625	<0.0625	<0.025	<0.025	mg/L	0.063	0.025	<0.50
Sodium	290	286	231	226	mg/L	0.5	0.5	369.0
Thallium	<0.229	<0.478	<0.025	<0.025	mg/L	0.01	0.025	0.058
Vanadium	<0.125	<0.125	0.065	0.069	mg/L	0.125	0.05	<0.50

[A] 95th Upper tolerance limit value, equivalent to 95% confidence limit
[b] Reporting limit
[c] Not applicable
[d] Standard unit

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
AEC-7	CUL	01/21/03	619.21	188.74	3038.04	925.99	3060.97
AEC-7	CUL	02/17/03	619.21	188.74	3038.04	925.99	3060.97
AEC-7	CUL	03/11/03	619.05	188.69	3038.20	926.04	3061.15
AEC-7	CUL	04/15/03	619.06	188.69	3038.19	926.04	3061.14
AEC-7	CUL	05/13/03	619.08	188.70	3038.17	926.03	3061.12
AEC-7	CUL	06/09/03	619.02	188.68	3038.23	926.05	3061.18
AEC-7	CUL	07/15/03	619.06	188.69	3038.19	926.04	3061.14
AEC-7	CUL	08/12/03	618.11	188.40	3039.14	926.33	3062.17
AEC-7	CUL	09/10/03	617.38	188.18	3039.87	926.55	3062.97
AEC-7	CUL	10/08/03	617.74	188.29	3039.51	926.44	3062.58
AEC-7	CUL	11/05/03	617.74	188.29	3039.51	926.44	3062.58
AEC-7	CUL	12/09/03	617.78	188.30	3039.47	926.43	3062.53
AEC-8	B/C	01/21/03	472.69	144.08	3064.41	934.03	N/A[b]
AEC-8	B/C	02/17/03	471.02	143.57	3066.08	934.54	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
AEC-8	B/C	03/11/03	469.88	143.22	3067.22	934.89	N/A
AEC-8	B/C	04/15/03	468.66	142.85	3068.44	935.26	N/A
AEC-8	B/C	05/14/03	468.38	142.76	3068.72	935.35	N/A
AEC-8	B/C	06/09/03	468.57	142.82	3068.53	935.29	N/A
AEC-8	B/C	07/15/03	469.46	143.09	3067.64	935.02	N/A
AEC-8	B/C	08/12/03	470.78	143.49	3066.32	934.61	N/A
AEC-8	B/C	09/10/03	472.42	143.99	3064.68	934.11	N/A
AEC-8	B/C	10/08/03	474.04	144.49	3063.06	933.62	N/A
AEC-8	B/C	11/05/03	475.55	144.95	3061.55	933.16	N/A
AEC-8	B/C	12/09/03	476.95	145.37	3060.15	932.73	N/A
C-2505	SR/D	01/23/03	45.61	13.90	3367.44	1026.40	N/A
C-2505	SR/D	02/18/03	45.29	13.80	3367.76	1026.49	N/A
C-2505	SR/D	03/12/03	45.32	13.81	3367.73	1026.48	N/A
C-2505	SR/D	04/16/03	45.52	13.87	3367.53	1026.42	N/A
C-2505	SR/D	05/15/03	45.60	13.90	3367.45	1026.40	N/A
C-2505	SR/D	06/13/03	45.77	13.95	3367.28	1026.35	N/A
C-2505	SR/D	07/16/03	46.02	14.03	3367.03	1026.27	N/A
C-2505	SR/D	09/10/03	45.55	13.88	3367.50	1026.41	N/A
C-2505	SR/D	12/11/03	45.40	13.84	3367.65	1026.46	N/A
C-2506	SR/D	01/23/03	45.02	13.72	3367.85	1026.52	N/A
C-2506	SR/D	02/18/03	44.69	13.62	3368.18	1026.62	N/A
C-2506	SR/D	03/12/03	44.71	13.63	3368.16	1026.62	N/A
C-2506	SR/D	04/16/03	44.89	13.68	3367.98	1026.56	N/A
C-2506	SR/D	05/15/03	44.97	13.71	3367.90	1026.54	N/A
C-2506	SR/D	06/13/03	45.15	13.76	3367.72	1026.48	N/A
C-2506	SR/D	07/16/03	45.40	13.84	3367.47	1026.40	N/A
C-2506	SR/D	09/10/03	45.95	14.01	3366.92	1026.24	N/A
C-2506	SR/D	12/11/03	44.79	13.65	3368.08	1026.59	N/A
C-2507	SR/D	01/23/03	45.66	13.92	3364.35	1025.45	N/A
C-2507	SR/D	02/18/03	45.38	13.83	3364.63	1025.54	N/A
C-2507	SR/D	03/12/03	45.44	13.85	3364.57	1025.52	N/A
C-2507	SR/D	04/16/03	45.64	13.91	3364.37	1025.46	N/A
C-2507	SR/D	05/15/03	45.72	13.94	3364.29	1025.44	N/A
C-2507	SR/D	06/13/03	45.92	14.00	3364.09	1025.37	N/A
C-2507	SR/D	07/16/03	46.14	14.06	3363.87	1025.31	N/A
C-2507	SR/D	09/10/03	45.61	13.90	3364.40	1025.47	N/A
C-2507	SR/D	12/11/03	45.50	13.87	3364.51	1025.50	N/A
C-2737 (ANNULUS)	MAG	01/22/03	258.00	78.64	3141.30	957.47	N/A
C-2737 (ANNULUS)	MAG	02/18/03	258.21	78.70	3141.09	957.40	N/A
C-2737 (ANNULUS)	MAG	03/12/03	258.26	78.72	3141.04	957.39	N/A
C-2737 (ANNULUS)	MAG	04/16/03	258.55	78.81	3140.75	957.30	N/A
C-2737 (ANNULUS)	MAG	05/13/03	256.23	78.10	3143.07	958.01	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
C-2737 (ANNULUS)	MAG	10/09/03	261.08	79.58	3138.22	956.53	N/A
C-2737 (ANNULUS)	MAG	11/10/03	259.07	78.96	3140.23	957.14	N/A
C-2737 (PIP)	CUL	01/22/03	382.28	116.52	3017.02	919.59	3017.02
C-2737 (PIP)	CUL	02/18/03	382.11	116.47	3017.19	919.64	3017.19
C-2737 (PIP)	CUL	03/12/03	382.03	116.44	3017.27	919.66	3017.27
C-2737 (PIP)	CUL	04/16/03	382.16	116.48	3017.14	919.62	3017.14
C-2811	SR/D	01/22/03	60.59	18.47	3338.33	1017.52	N/A
C-2811	SR/D	02/18/03	60.33	18.39	3338.59	1017.60	N/A
C-2811	SR/D	03/12/03	60.24	18.36	3338.68	1017.63	N/A
C-2811	SR/D	04/16/03	60.39	18.41	3338.53	1017.58	N/A
C-2811	SR/D	05/15/03	60.31	18.38	3338.61	1017.61	N/A
C-2811	SR/D	06/13/03	60.30	18.38	3338.62	1017.61	N/A
C-2811	SR/D	07/16/03	60.67	18.49	3338.25	1017.50	N/A
C-2811	SR/D	09/10/03	60.11	18.32	3338.81	1017.67	N/A
C-2811	SR/D	12/11/03	59.78	18.22	3339.14	1017.77	N/A
CB-1	CUL	01/21/03	346.68	105.67	2981.70	908.82	2985.56
CB-1	CUL	02/11/03	338.48	103.17	2989.90	911.32	2994.01
CB-1	CUL	03/11/03	328.25	100.05	3000.13	914.44	3004.56
CB-1	CUL	04/15/03	316.89	96.59	3011.49	917.90	3016.27
CB-1	CUL	05/14/03	308.27	93.96	3020.11	920.53	3025.16
CB-1	CUL	06/12/03	300.22	91.51	3028.16	922.98	3033.46
CB-1	CUL	07/16/03	291.78	88.93	3036.60	925.56	3042.16
CB-1	CUL	08/13/03	285.07	86.89	3043.31	927.60	3049.08
CB-1	CUL	09/10/03	279.03	85.05	3049.35	929.44	3055.30
CB-1	CUL	10/07/03	273.48	83.36	3054.90	931.13	3061.03
CB-1	CUL	11/04/03	268.12	81.72	3060.26	932.77	3066.55
CB-1	CUL	12/10/03	261.69	79.76	3066.69	934.73	3073.18
CB-1 (PIP)	B/C	01/21/03	313.77	95.64	3014.61	918.85	N/A
CB-1 (PIP)	B/C	02/11/03	313.83	95.66	3014.55	918.83	N/A
CB-1 (PIP)	B/C	03/11/03	313.68	95.61	3014.70	918.88	N/A
CB-1 (PIP)	B/C	04/15/03	313.68	95.61	3014.70	918.88	N/A
CB-1 (PIP)	B/C	05/14/03	313.67	95.61	3014.71	918.88	N/A
CB-1 (PIP)	B/C	06/12/03	313.59	95.58	3014.79	918.91	N/A
CB-1 (PIP)	B/C	07/16/03	313.72	95.62	3014.66	918.87	N/A
CB-1 (PIP)	B/C	08/13/03	313.72	95.62	3014.66	918.87	N/A
CB-1 (PIP)	B/C	09/10/03	313.55	95.57	3014.83	918.92	N/A
CB-1 (PIP)	B/C	10/07/03	313.65	95.60	3014.73	918.89	N/A
CB-1 (PIP)	B/C	11/04/03	313.53	95.56	3014.85	918.93	N/A
CB-1 (PIP)	B/C	12/10/03	313.59	95.58	3014.79	918.91	N/A
DOE-1	CUL	01/21/03	487.57	148.61	2978.47	907.84	3007.10
DOE-1	CUL	02/11/03	487.61	148.62	2978.43	907.83	3007.05
DOE-1	CUL	03/12/03	487.73	148.66	2978.31	907.79	3006.92

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
DOE-1	CUL	04/15/03	487.91	148.72	2978.13	907.73	3006.73
DOE-1	CUL	05/14/03	488.04	148.75	2978.00	907.69	3006.59
DOE-1	CUL	06/12/03	487.91	148.72	2978.13	907.73	3006.73
DOE-1	CUL	07/15/03	487.93	148.72	2978.11	907.73	3006.71
DOE-1	CUL	08/12/03	487.82	148.69	2978.22	907.76	3006.82
DOE-1	CUL	09/10/03	487.70	148.65	2978.34	907.80	3006.95
DOE-1	CUL	10/07/03	487.43	148.57	2978.61	907.88	3007.25
DOE-1	CUL	11/03/03	487.04	148.45	2979.00	908.00	3007.67
DOE-1	CUL	12/10/03	486.33	148.23	2979.71	908.22	3008.44
DOE-2	MAG	02/18/03	348.97	106.37	3070.12	935.77	N/A
DOE-2	MAG	03/11/03	348.60	106.25	3070.49	935.89	N/A
ERDA-9	CUL	01/22/03	400.24	121.99	3009.86	917.41	3025.37
ERDA-9	CUL	02/17/03	400.18	121.97	3009.92	917.42	3025.43
ERDA-9	CUL	03/12/03	400.04	121.93	3010.06	917.47	3025.58
ERDA-9	CUL	04/15/03	399.88	121.88	3010.22	917.52	3025.75
ERDA-9	CUL	05/13/03	399.82	121.87	3010.28	917.53	3025.81
ERDA-9	CUL	06/12/03	399.60	121.80	3010.50	917.60	3026.04
ERDA-9	CUL	07/15/03	400.19	121.98	3009.91	917.42	3025.42
ERDA-9	CUL	08/12/03	399.91	121.89	3010.19	917.51	3025.72
ERDA-9	CUL	09/10/03	400.14	121.96	3009.96	917.44	3025.48
ERDA-9	CUL	10/07/03	399.94	121.90	3010.16	917.50	3025.69
ERDA-9	CUL	11/04/03	399.92	121.90	3010.18	917.50	3025.71
ERDA-9	CUL	12/11/03	400.11	121.95	3009.99	917.45	3025.51
H-02a	CUL	03/12/03	339.03	103.34	3039.06	926.31	3042.60
H-02a	CUL	06/12/03	338.68	103.23	3039.41	926.41	3042.96
H-02a	CUL	09/09/03	338.45	103.16	3039.64	926.48	3043.19
H-02a	CUL	12/09/03	338.31	103.12	3039.78	926.52	3043.33
H-02b1	MAG	01/23/03	231.96	70.70	3146.50	959.05	N/A
H-02b1	MAG	02/17/03	231.62	70.60	3146.84	959.16	N/A
H-02b1	MAG	03/12/03	231.73	70.63	3146.73	959.12	N/A
H-02b1	MAG	04/16/03	231.82	70.66	3146.64	959.10	N/A
H-02b1	MAG	05/14/03	231.90	70.68	3146.56	959.07	N/A
H-02b1	MAG	06/12/03	231.98	70.71	3146.48	959.05	N/A
H-02b1	MAG	07/15/03	232.13	70.75	3146.33	959.00	N/A
H-02b1	MAG	08/12/03	232.26	70.79	3146.20	958.96	N/A
H-02b1	MAG	09/09/03	232.39	70.83	3146.07	958.92	N/A
H-02b1	MAG	10/07/03	232.65	70.91	3145.81	958.84	N/A
H-02b1	MAG	11/04/03	232.81	70.96	3145.65	958.79	N/A
H-02b1	MAG	12/09/03	232.96	71.01	3145.50	958.75	N/A
H-02b2	CUL	01/23/03	339.50	103.48	3038.81	926.23	3041.17
H-02b2	CUL	02/17/03	339.11	103.36	3039.20	926.35	3041.56
H-02b2	CUL	03/12/03	338.93	103.31	3039.38	926.40	3041.75

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-02b2	CUL	04/16/03	338.89	103.29	3039.42	926.42	3041.79
H-02b2	CUL	05/14/03	338.87	103.29	3039.44	926.42	3041.81
H-02b2	CUL	06/12/03	338.85	103.28	3039.46	926.43	3041.83
H-02b2	CUL	07/15/03	338.94	103.31	3039.37	926.40	3041.74
H-02b2	CUL	08/12/03	338.95	103.31	3039.36	926.40	3041.73
H-02b2	CUL	09/09/03	338.93	103.31	3039.38	926.40	3041.75
H-02b2	CUL	10/07/03	339.06	103.35	3039.25	926.36	3041.62
H-02b2	CUL	11/04/03	338.96	103.32	3039.35	926.39	3041.72
H-02b2	CUL	12/09/03	339.11	103.36	3039.20	926.35	3041.56
H-02c	CUL	03/12/03	339.03	103.34	3039.38	926.40	3052.35
H-02c	CUL	06/12/03	338.65	103.22	3039.76	926.52	3052.74
H-02c	CUL	09/09/03	339.06	103.35	3039.35	926.39	3052.32
H-02c	CUL	12/09/03	339.22	103.39	3039.19	926.35	3052.15
H-03b1	MAG	01/21/03	260.48	79.39	3130.16	954.07	N/A
H-03b1	MAG	02/17/03	260.00	79.25	3130.64	954.22	N/A
H-03b1	MAG	03/12/03	259.87	79.21	3130.77	954.26	N/A
H-03b1	MAG	04/16/03	258.93	78.92	3131.71	954.55	N/A
H-03b1	MAG	05/14/03	259.17	79.00	3131.47	954.47	N/A
H-03b1	MAG	06/12/03	258.75	78.87	3131.89	954.60	N/A
H-03b1	MAG	07/15/03	258.92	78.92	3131.72	954.55	N/A
H-03b1	MAG	08/12/03	259.11	78.98	3131.53	954.49	N/A
H-03b1	MAG	09/10/03	259.67	79.15	3130.97	954.32	N/A
H-03b1	MAG	10/07/03	260.10	79.28	3130.54	954.19	N/A
H-03b1	MAG	11/04/03	259.83	79.20	3130.81	954.27	N/A
H-03b1	MAG	12/11/03	258.50	78.79	3132.14	954.68	N/A
H-03b2	CUL	01/21/03	389.61	118.75	3000.42	914.53	3011.82
H-03b2	CUL	02/17/03	389.53	118.73	3000.50	914.55	3011.91
H-03b2	CUL	03/12/03	389.41	118.69	3000.62	914.59	3012.03
H-03b2	CUL	04/16/03	389.71	118.78	3000.32	914.50	3011.72
H-03b2	CUL	05/14/03	389.73	118.79	3000.30	914.49	3011.70
H-03b2	CUL	06/12/03	389.62	118.76	3000.41	914.53	3011.81
H-03b2	CUL	07/15/03	389.79	118.81	3000.24	914.47	3011.64
H-03b2	CUL	08/12/03	389.86	118.83	3000.17	914.45	3011.56
H-03b2	CUL	09/10/03	389.91	118.84	3000.12	914.44	3011.51
H-03b2	CUL	10/07/03	390.05	118.89	2999.98	914.39	3011.37
H-03b2	CUL	11/04/03	390.55	119.04	2999.48	914.24	3010.85
H-03b2	CUL	12/11/03	390.12	118.91	2999.91	914.37	3011.29
H-03b3	CUL	03/12/03	383.72	116.96	3004.95	915.91	3014.85
H-03b3	CUL	06/12/03	383.96	117.03	3004.71	915.84	3014.60
H-03b3	CUL	09/10/03	384.26	117.12	3004.41	915.74	3014.29
H-03b3	CUL	12/11/03	384.49	117.19	3004.18	915.67	3014.06
H-03d/DL (PVC)	DL	01/21/03	314.90	95.98	3075.11	937.29	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-03d/DL (PVC)	DL	02/17/03	314.84	95.96	3075.17	937.31	N/A
H-03d/DL (PVC)	DL	03/12/03	314.68	95.91	3075.33	937.36	N/A
H-03d/DL (PVC)	DL	04/16/03	314.47	95.85	3075.54	937.42	N/A
H-03d/DL (PVC)	DL	05/14/03	314.37	95.82	3075.64	937.46	N/A
H-03d/DL (PVC)	DL	06/12/03	314.23	95.78	3075.78	937.50	N/A
H-03d/DL (PVC)	DL	07/15/03	314.11	95.74	3075.90	937.53	N/A
H-03d/DL (PVC)	DL	08/12/03	314.03	95.72	3075.98	937.56	N/A
H-03d/DL (PVC)	DL	09/10/03	313.91	95.68	3076.10	937.60	N/A
H-03d/DL (PVC)	DL	10/07/03	313.83	95.66	3076.18	937.62	N/A
H-03d/DL (PVC)	DL	11/04/03	313.73	95.62	3076.28	937.65	N/A
H-03d/DL (PVC)	DL	12/11/03	313.59	95.58	3076.42	937.69	N/A
H-04b	CUL	01/21/03	331.59	101.07	3001.76	914.94	3005.36
H-04b	CUL	02/17/03	331.58	101.07	3001.77	914.94	3005.37
H-04b	CUL	03/12/03	331.49	101.04	3001.86	914.97	3005.46
H-04b	CUL	04/16/03	331.99	101.19	3001.36	914.81	3004.95
H-04b	CUL	05/14/03	332.14	101.24	3001.21	914.77	3004.80
H-04b	CUL	06/12/03	332.18	101.25	3001.17	914.76	3004.76
H-04b	CUL	07/15/03	332.66	101.39	3000.69	914.61	3004.27
H-04b	CUL	08/12/03	332.82	101.44	3000.53	914.56	3004.10
H-04b	CUL	09/09/03	332.84	101.45	3000.51	914.56	3004.08
H-04b	CUL	10/07/03	332.91	101.47	3000.44	914.53	3004.01
H-04b	CUL	11/04/03	332.80	101.44	3000.55	914.57	3004.12
H-04b	CUL	12/10/03	332.88	101.46	3000.47	914.54	3004.04
H-04c	MAG	01/21/03	191.19	58.27	3142.85	957.94	N/A
H-04c	MAG	02/17/03	191.12	58.25	3142.92	957.96	N/A
H-04c	MAG	03/12/03	191.08	58.24	3142.96	957.97	N/A
H-04c	MAG	04/16/03	191.27	58.30	3142.77	957.92	N/A
H-04c	MAG	05/14/03	191.38	58.33	3142.66	957.88	N/A
H-04c	MAG	06/12/03	191.41	58.34	3142.63	957.87	N/A
H-04c	MAG	07/15/03	191.49	58.37	3142.55	957.85	N/A
H-04c	MAG	08/12/03	191.64	58.41	3142.40	957.80	N/A
H-04c	MAG	09/09/03	191.77	58.45	3142.27	957.76	N/A
H-04c	MAG	10/07/03	191.88	58.49	3142.16	957.73	N/A
H-04c	MAG	11/04/03	191.82	58.47	3142.22	957.75	N/A
H-04c	MAG	12/10/03	192.02	58.53	3142.02	957.69	N/A
H-05a	CUL	03/11/03	474.35	144.58	3031.89	924.12	3071.89
H-05a	CUL	06/12/03	474.05	144.49	3032.19	924.21	3072.22
H-05a	CUL	09/10/03	473.99	144.47	3032.25	924.23	3072.29
H-05a	CUL	12/11/03	473.85	144.43	3032.39	924.27	3072.44
H-05b	CUL	01/21/03	477.08	145.41	3028.96	923.23	3073.90
H-05b	CUL	02/17/03	476.98	145.38	3029.06	923.26	3074.01
H-05b	CUL	03/11/03	476.86	145.35	3029.18	923.29	3074.14

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-05b	CUL	04/16/03	476.74	145.31	3029.30	923.33	3074.27
H-05b	CUL	05/14/03	476.68	145.29	3029.36	923.35	3074.34
H-05b	CUL	06/12/03	476.48	145.23	3029.56	923.41	3074.56
H-05b	CUL	07/15/03	476.56	145.26	3029.48	923.39	3074.47
H-05b	CUL	08/12/03	476.54	145.25	3029.50	923.39	3074.49
H-05b	CUL	09/10/03	476.40	145.21	3029.64	923.43	3074.65
H-05b	CUL	10/08/03	476.46	145.23	3029.58	923.42	3074.58
H-05b	CUL	11/05/03	476.35	145.19	3029.69	923.45	3074.70
H-05b	CUL	12/11/03	476.38	145.20	3029.66	923.44	3074.67
H-05c	MAG	01/21/03	349.12	106.41	3156.92	962.23	N/A
H-05c	MAG	02/17/03	349.03	106.38	3157.01	962.26	N/A
H-05c	MAG	03/11/03	349.06	106.39	3156.98	962.25	N/A
H-05c	MAG	04/16/03	349.08	106.40	3156.96	962.24	N/A
H-05c	MAG	05/14/03	349.10	106.41	3156.94	962.24	N/A
H-05c	MAG	06/12/03	349.04	106.39	3157.00	962.25	N/A
H-05c	MAG	07/15/03	349.23	106.45	3156.81	962.20	N/A
H-05c	MAG	08/12/03	349.28	106.46	3156.76	962.18	N/A
H-05c	MAG	09/10/03	349.23	106.45	3156.81	962.20	N/A
H-05c	MAG	10/08/03	349.30	106.47	3156.74	962.17	N/A
H-05c	MAG	11/05/03	349.26	106.45	3156.78	962.19	N/A
H-05c	MAG	12/11/03	349.30	106.47	3156.74	962.17	N/A
H-06a	CUL	03/10/03	293.05	89.32	3055.06	931.18	3067.35
H-06a	CUL	06/09/03	292.97	89.30	3055.14	931.21	3067.43
H-06a	CUL	09/08/03	293.77	89.54	3054.34	930.96	3066.60
H-06a	CUL	12/08/03	295.03	89.93	3053.08	930.58	3065.29
H-06b	CUL	01/22/03	294.00	89.61	3054.25	930.94	3066.49
H-06b	CUL	02/18/03	293.80	89.55	3054.45	931.00	3066.70
H-06b	CUL	03/10/03	293.95	89.60	3054.30	930.95	3066.54
H-06b	CUL	04/14/03	293.88	89.57	3054.37	930.97	3066.62
H-06b	CUL	05/12/03	294.03	89.62	3054.22	930.93	3066.46
H-06b	CUL	06/09/03	293.89	89.58	3054.36	930.97	3066.61
H-06b	CUL	07/14/03	294.19	89.67	3054.06	930.88	3066.30
H-06b	CUL	08/11/03	294.52	89.77	3053.73	930.78	3065.95
H-06b	CUL	09/08/03	294.66	89.81	3053.59	930.73	3065.81
H-06b	CUL	10/06/03	294.93	89.89	3053.32	930.65	3065.53
H-06b	CUL	11/03/03	294.93	89.89	3053.32	930.65	3065.53
H-06b	CUL	12/08/03	295.94	90.20	3052.31	930.34	3064.48
H-06c	MAG	01/22/03	282.99	86.26	3065.53	934.37	N/A
H-06c	MAG	02/18/03	282.82	86.20	3065.70	934.43	N/A
H-06c	MAG	03/10/03	282.84	86.21	3065.68	934.42	N/A
H-06c	MAG	04/14/03	282.78	86.19	3065.74	934.44	N/A
H-06c	MAG	05/12/03	282.85	86.21	3065.67	934.42	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-06c	MAG	06/09/03	282.64	86.15	3065.88	934.48	N/A
H-06c	MAG	07/14/03	282.61	86.14	3065.91	934.49	N/A
H-06c	MAG	08/11/03	282.66	86.15	3065.86	934.47	N/A
H-06c	MAG	09/08/03	282.56	86.12	3065.96	934.50	N/A
H-06c	MAG	10/06/03	282.57	86.13	3065.95	934.50	N/A
H-06c	MAG	11/03/03	282.40	86.08	3066.12	934.55	N/A
H-06c	MAG	12/08/03	282.19	86.01	3066.33	934.62	N/A
H-07b1	CUL	03/10/03	166.42	50.72	2997.75	913.71	2998.20
H-07b1	CUL	06/09/03	166.45	50.73	2997.72	913.71	2998.17
H-07b1	CUL	09/08/03	166.48	50.74	2997.69	913.70	2998.14
H-07b1	CUL	12/08/03	166.29	50.69	2997.88	913.75	2998.33
H-07b2	CUL	01/20/03	167.66	51.10	2997.41	913.61	2997.32
H-07b2	CUL	02/11/03	167.60	51.08	2997.47	913.63	2997.38
H-07b2	CUL	03/10/03	167.60	51.08	2997.47	913.63	2997.38
H-07b2	CUL	04/14/03	167.64	51.10	2997.43	913.62	2997.34
H-07b2	CUL	05/12/03	167.79	51.14	2997.28	913.57	2997.19
H-07b2	CUL	06/09/03	167.60	51.08	2997.47	913.63	2997.38
H-07b2	CUL	07/14/03	167.59	51.08	2997.48	913.63	2997.39
H-07b2	CUL	08/11/03	167.69	51.11	2997.38	913.60	2997.29
H-07b2	CUL	09/08/03	167.61	51.09	2997.46	913.63	2997.37
H-07b2	CUL	10/06/03	167.70	51.12	2997.37	913.60	2997.28
H-07b2	CUL	11/03/03	167.62	51.09	2997.45	913.62	2997.36
H-07b2	CUL	12/08/03	167.44	51.04	2997.63	913.68	2997.54
H-08a	MAG	01/20/03	406.02	123.75	3026.97	922.62	N/A
H-08a	MAG	02/11/03	405.99	123.75	3027.00	922.63	N/A
H-08a	MAG	03/11/03	405.98	123.74	3027.01	922.63	N/A
H-08a	MAG	04/14/03	405.91	123.72	3027.08	922.65	N/A
H-08a	MAG	05/12/03	405.91	123.72	3027.08	922.65	N/A
H-08a	MAG	06/09/03	405.83	123.70	3027.16	922.68	N/A
H-08a	MAG	07/14/03	405.83	123.70	3027.16	922.68	N/A
H-08a	MAG	08/11/03	405.83	123.70	3027.16	922.68	N/A
H-08a	MAG	09/08/03	405.87	123.71	3027.12	922.67	N/A
H-08a	MAG	10/07/03	405.93	123.73	3027.06	922.65	N/A
H-08a	MAG	11/03/03	405.89	123.72	3027.10	922.66	N/A
H-08a	MAG	12/09/03	405.93	123.73	3027.06	922.65	N/A
H-08c	R/S	01/20/03	453.00	138.07	2979.90	908.27	N/A
H-08c	R/S	02/11/03	452.94	138.06	2979.96	908.29	N/A
H-08c	R/S	03/11/03	452.87	138.03	2980.03	908.31	N/A
H-08c	R/S	04/14/03	452.75	138.00	2980.15	908.35	N/A
H-08c	R/S	05/12/03	452.69	137.98	2980.21	908.37	N/A
H-08c	R/S	06/09/03	452.55	137.94	2980.35	908.41	N/A
H-08c	R/S	07/14/03	452.46	137.91	2980.44	908.44	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-08c	R/S	08/11/03	452.39	137.89	2980.51	908.46	N/A
H-08c	R/S	09/08/03	452.35	137.88	2980.55	908.47	N/A
H-08c	R/S	10/07/03	452.38	137.89	2980.52	908.46	N/A
H-08c	R/S	11/03/03	452.35	137.88	2980.55	908.47	N/A
H-08c	R/S	12/09/03	452.35	137.88	2980.55	908.47	N/A
H-09c (ANNULUS)	MAG	01/20/03	273.21	83.27	3134.09	955.27	N/A
H-09c (ANNULUS)	MAG	02/11/03	273.13	83.25	3134.17	955.30	N/A
H-09c (ANNULUS)	MAG	04/14/03	273.32	83.31	3133.98	955.24	N/A
H-09c (ANNULUS)	MAG	05/12/03	273.28	83.30	3134.02	955.25	N/A
H-09c (ANNULUS)	MAG	06/09/03	272.97	83.20	3134.33	955.34	N/A
H-09c (ANNULUS)	MAG	07/14/03	272.97	83.20	3134.33	955.34	N/A
H-09c (ANNULUS)	MAG	08/13/03	273.03	83.22	3134.27	955.33	N/A
H-09c (ANNULUS)	MAG	09/08/03	272.85	83.16	3134.45	955.38	N/A
H-09c (ANNULUS)	MAG	10/07/03	272.85	83.16	3134.45	955.38	N/A
H-09c (ANNULUS)	MAG	11/03/03	272.76	83.14	3134.54	955.41	N/A
H-09c (ANNULUS)	MAG	12/09/03	272.66	83.11	3134.64	955.44	N/A
H-09c (PIP)	CUL	04/14/03	415.74	126.72	2991.56	911.83	2991.81
H-09c (PIP)	CUL	05/20/03	415.32	126.59	2991.98	911.96	2992.23
H-09c (PIP)	CUL	06/09/03	415.52	126.65	2991.78	911.89	2992.03
H-09c (PIP)	CUL	07/14/03	415.71	126.71	2991.59	911.84	2991.84
H-09c (PIP)	CUL	08/13/03	417.82	127.35	2989.48	911.19	2989.72
H-09c (PIP)	CUL	09/08/03	416.03	126.81	2991.27	911.74	2991.52
H-09c (PIP)	CUL	10/07/03	418.63	127.60	2988.67	910.95	2988.91
H-09c (PIP)	CUL	11/03/03	414.60	126.37	2992.70	912.18	2992.95
H-09c (PIP)	CUL	12/09/03	415.54	126.66	2991.76	911.89	2992.01
H-10a	MAG	01/20/03	468.53	142.81	3220.14	981.50	N/A
H-10a	MAG	02/17/03	468.44	142.78	3220.23	981.53	N/A
H-10a	MAG	03/11/03	468.35	142.75	3220.32	981.55	N/A
H-10a	MAG	04/14/03	468.31	142.74	3220.36	981.57	N/A
H-10a	MAG	05/14/03	468.26	142.73	3220.41	981.58	N/A
H-10a	MAG	06/09/03	468.13	142.69	3220.54	981.62	N/A
H-10a	MAG	07/15/03	468.17	142.70	3220.50	981.61	N/A
H-10a	MAG	08/13/03	468.22	142.71	3220.45	981.59	N/A
H-10a	MAG	09/09/03	468.13	142.69	3220.54	981.62	N/A
H-10a	MAG	10/07/03	468.15	142.69	3220.52	981.61	N/A
H-10a	MAG	11/03/03	468.10	142.68	3220.57	981.63	N/A
H-10a	MAG	12/08/03	467.13	142.38	3221.54	981.93	N/A
H-10c	CUL	01/20/03	663.04	202.09	3025.60	922.20	3025.60
H-10c	CUL	02/17/03	662.75	202.01	3025.89	922.29	3025.89
H-10c	CUL	03/11/03	662.71	201.99	3025.93	922.30	3025.93
H-10c	CUL	04/14/03	662.99	202.08	3025.65	922.22	3025.65
H-10c	CUL	05/14/03	663.20	202.14	3025.44	922.15	3025.44

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-10c	CUL	06/09/03	663.29	202.17	3025.35	922.13	3025.35
H-10c	CUL	07/15/03	663.51	202.24	3025.13	922.06	3025.13
H-10c	CUL	08/13/03	663.54	202.25	3025.10	922.05	3025.10
H-10c	CUL	09/09/03	663.58	202.26	3025.06	922.04	3025.06
H-10c	CUL	10/07/03	663.72	202.30	3024.92	922.00	3024.92
H-10c	CUL	11/03/03	663.73	202.30	3024.91	921.99	3024.91
H-10c	CUL	12/08/03	659.43	200.99	3029.21	923.30	3029.21
H-11b1	CUL	03/11/03	418.68	127.61	2992.94	912.25	3016.98
H-11b1	CUL	06/12/03	419.49	127.86	2992.13	912.00	3016.11
H-11b1	CUL	09/10/03	420.16	128.06	2991.46	911.80	3015.40
H-11b1	CUL	12/10/03	420.19	128.07	2991.43	911.79	3015.36
H-11b2	MAG	07/16/03	280.29	85.43	3131.35	954.44	N/A
H-11b2	MAG	08/13/03	279.65	85.24	3131.99	954.63	N/A
H-11b2	MAG	09/11/03	280.80	85.59	3130.84	954.28	N/A
H-11b2	MAG	10/07/03	279.22	85.11	3132.42	954.76	N/A
H-11b2	MAG	11/04/03	278.96	85.03	3132.68	954.84	N/A
H-11b2	MAG	12/10/03	279.02	85.05	3132.62	954.82	N/A
H-11b4	CUL	01/21/03	426.40	129.97	2984.49	909.67	3004.58
H-11b4	CUL	02/11/03	426.43	129.98	2984.46	909.66	3004.55
H-11b4	CUL	03/11/03	426.14	129.89	2984.75	909.75	3004.86
H-11b4	CUL	04/15/03	426.69	130.06	2984.20	909.58	3004.28
H-11b4	CUL	05/14/03	426.83	130.10	2984.06	909.54	3004.13
H-11b4	CUL	06/12/03	426.84	130.10	2984.05	909.54	3004.12
H-11b4	CUL	07/16/03	427.32	130.25	2983.57	909.39	3003.60
H-11b4	CUL	08/13/03	427.49	130.30	2983.40	909.34	3003.42
H-11b4	CUL	09/10/03	427.40	130.27	2983.49	909.37	3003.52
H-11b4	CUL	10/07/03	427.48	130.30	2983.41	909.34	3003.43
H-11b4	CUL	11/04/03	427.35	130.26	2983.54	909.38	3003.57
H-11b4	CUL	12/10/03	427.32	130.25	2983.57	909.39	3003.60
H-12	CUL	01/20/03	456.40	139.11	2970.79	905.50	3008.16
H-12	CUL	02/17/03	456.23	139.06	2970.96	905.55	3008.35
H-12	CUL	03/11/03	456.20	139.05	2970.99	905.56	3008.38
H-12	CUL	04/15/03	456.13	139.03	2971.06	905.58	3008.45
H-12	CUL	05/14/03	456.21	139.05	2970.98	905.55	3008.37
H-12	CUL	06/09/03	456.21	139.05	2970.98	905.55	3008.37
H-12	CUL	07/15/03	456.28	139.07	2970.91	905.53	3008.29
H-12	CUL	08/12/03	456.03	139.00	2971.16	905.61	3008.56
H-12	CUL	09/09/03	455.90	138.96	2971.29	905.65	3008.71
H-12	CUL	10/07/03	456.07	139.01	2971.12	905.60	3008.52
H-12	CUL	11/03/03	455.96	138.98	2971.23	905.63	3008.64
H-14	MAG	02/18/03	238.94	72.83	3108.17	947.37	N/A
H-14	MAG	04/16/03	238.41	72.67	3108.70	947.53	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-14	MAG	05/14/03	238.94	72.83	3108.17	947.37	N/A
H-14	MAG	06/12/03	238.32	72.64	3108.79	947.56	N/A
H-14	MAG	07/15/03	238.09	72.57	3109.02	947.63	N/A
H-14	MAG	08/12/03	237.94	72.52	3109.17	947.68	N/A
H-14	MAG	09/09/03	237.82	72.49	3109.29	947.71	N/A
H-14	MAG	10/07/03	237.77	72.47	3109.34	947.73	N/A
H-14	MAG	11/04/03	237.65	72.44	3109.46	947.76	N/A
H-14	MAG	12/09/03	238.09	72.57	3109.02	947.63	N/A
H-15	MAG	07/15/03	371.81	113.33	3109.82	947.87	N/A
H-15	MAG	08/12/03	371.86	113.34	3109.77	947.86	N/A
H-15	MAG	09/09/03	371.93	113.36	3109.70	947.84	N/A
H-15	MAG	10/07/03	372.43	113.52	3109.20	947.68	N/A
H-15	MAG	11/04/03	372.61	113.57	3109.02	947.63	N/A
H-17	CUL	01/21/03	422.05	128.64	2963.26	903.20	3012.70
H-17	CUL	02/11/03	422.02	128.63	2963.29	903.21	3012.74
H-17	CUL	03/11/03	421.86	128.58	2963.45	903.26	3012.92
H-17	CUL	04/15/03	422.10	128.66	2963.21	903.19	3012.64
H-17	CUL	05/14/03	422.35	128.73	2962.96	903.11	3012.35
H-17	CUL	06/12/03	422.29	128.71	2963.02	903.13	3012.42
H-17	CUL	07/16/03	422.72	128.85	2962.59	903.00	3011.92
H-17	CUL	08/13/03	422.88	128.89	2962.43	902.95	3011.73
H-17	CUL	09/10/03	422.87	128.89	2962.44	902.95	3011.75
H-17	CUL	10/07/03	422.95	128.92	2962.36	902.93	3011.65
H-17	CUL	11/04/03	422.80	128.87	2962.51	902.97	3011.83
H-17	CUL	12/10/03	422.77	128.86	2962.54	902.98	3011.86
H-18	MAG	07/14/03	336.79	102.65	3077.42	938.00	N/A
H-18	MAG	08/11/03	336.86	102.67	3077.35	937.98	N/A
H-18	MAG	09/08/03	336.73	102.64	3077.48	938.02	N/A
H-18	MAG	11/03/03	338.89	103.29	3075.32	937.36	N/A
H-18	MAG	12/08/03	338.94	103.31	3075.27	937.34	N/A
H-19b0	CUL	01/23/03	427.44	130.28	2990.94	911.64	3012.79
H-19b0	CUL	02/17/03	427.02	130.16	2991.36	911.77	3013.24
H-19b0	CUL	03/12/03	426.88	130.11	2991.50	911.81	3013.39
H-19b0	CUL	04/15/03	427.23	130.22	2991.15	911.70	3013.01
H-19b0	CUL	05/13/03	427.39	130.27	2990.99	911.65	3012.84
H-19b0	CUL	06/12/03	427.15	130.20	2991.23	911.73	3013.10
H-19b0	CUL	07/15/03	427.38	130.27	2991.00	911.66	3012.85
H-19b0	CUL	08/12/03	427.48	130.30	2990.90	911.63	3012.75
H-19b0	CUL	09/10/03	427.50	130.30	2990.88	911.62	3012.72
H-19b0	CUL	10/07/03	427.70	130.36	2990.68	911.56	3012.51
H-19b0	CUL	11/04/03	427.92	130.43	2990.46	911.49	3012.28
H-19b0	CUL	12/10/03	427.86	130.41	2990.52	911.51	3012.34

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
H-19b2	CUL	03/12/03	428.21	130.52	2990.80	911.60	3012.74
H-19b2	CUL	06/12/03	428.49	130.60	2990.52	911.51	3012.44
H-19b2	CUL	09/10/03	428.84	130.71	2990.17	911.40	3012.07
H-19b2	CUL	12/10/03	429.22	130.83	2989.79	911.29	3011.66
H-19b3	CUL	03/12/03	428.41	130.58	2990.68	911.56	3012.51
H-19b3	CUL	06/12/03	428.71	130.67	2990.38	911.47	3012.19
H-19b3	CUL	09/10/03	429.05	130.77	2990.04	911.36	3011.83
H-19b3	CUL	12/10/03	429.42	130.89	2989.67	911.25	3011.44
H-19b4	CUL	03/12/03	427.65	130.35	2991.38	911.77	3013.11
H-19b4	CUL	06/12/03	427.95	130.44	2991.08	911.68	3012.79
H-19b4	CUL	09/10/03	428.28	130.54	2990.75	911.58	3012.44
H-19b4	CUL	12/10/03	428.65	130.65	2990.38	911.47	3012.04
H-19b5	CUL	03/12/03	427.75	130.38	2990.88	911.62	3012.52
H-19b5	CUL	06/12/03	428.02	130.46	2990.61	911.54	3012.23
H-19b5	CUL	09/10/03	428.39	130.57	2990.24	911.43	3011.83
H-19b5	CUL	12/10/03	428.74	130.68	2989.89	911.32	3011.46
H-19b6	CUL	03/12/03	428.32	130.55	2990.75	911.58	3012.52
H-19b6	CUL	06/12/03	428.63	130.65	2990.44	911.49	3012.19
H-19b6	CUL	09/10/03	428.96	130.75	2990.11	911.39	3011.84
H-19b6	CUL	12/10/03	429.33	130.86	2989.74	911.27	3011.44
H-19b7	CUL	03/12/03	428.44	130.59	2990.55	911.52	3012.35
H-19b7	CUL	06/12/03	428.72	130.67	2990.27	911.43	3012.05
H-19b7	CUL	09/10/03	429.07	130.78	2989.92	911.33	3011.68
H-19b7	CUL	12/10/03	429.43	130.89	2989.56	911.22	3011.30
P-17	CUL	01/21/03	352.71	107.51	2984.53	909.68	2998.78
P-17	CUL	02/11/03	352.70	107.50	2984.54	909.69	2998.79
P-17	CUL	03/11/03	352.49	107.44	2984.75	909.75	2999.02
P-17	CUL	04/15/03	352.64	107.48	2984.60	909.71	2998.86
P-17	CUL	05/14/03	352.89	107.56	2984.35	909.63	2998.59
P-17	CUL	06/12/03	352.90	107.56	2984.34	909.63	2998.58
P-17	CUL	07/16/03	353.30	107.69	2983.94	909.50	2998.15
P-17	CUL	08/13/03	353.49	107.74	2983.75	909.45	2997.95
P-17	CUL	09/10/03	353.49	107.74	2983.75	909.45	2997.95
P-17	CUL	10/07/03	353.64	107.79	2983.60	909.40	2997.79
P-17	CUL	11/04/03	353.53	107.76	2983.71	909.43	2997.91
P-17	CUL	12/10/03	353.58	107.77	2983.66	909.42	2997.86
PZ-01	SR/D	01/23/03	42.62	12.99	3370.79	1027.42	N/A
PZ-01	SR/D	02/18/03	42.26	12.88	3371.15	1027.53	N/A
PZ-01	SR/D	03/12/03	42.21	12.87	3371.20	1027.54	N/A
PZ-01	SR/D	04/16/03	42.29	12.89	3371.12	1027.52	N/A
PZ-01	SR/D	05/15/03	42.26	12.88	3371.15	1027.53	N/A
PZ-01	SR/D	06/13/03	42.30	12.89	3371.11	1027.51	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
PZ-01	SR/D	07/16/03	42.54	12.97	3370.87	1027.44	N/A
PZ-01	SR/D	09/10/03	42.37	12.91	3371.04	1027.49	N/A
PZ-01	SR/D	12/11/03	42.28	12.89	3371.13	1027.52	N/A
PZ-02	SR/D	01/23/03	44.00	13.41	3369.42	1027.00	N/A
PZ-02	SR/D	02/18/03	43.48	13.25	3369.94	1027.16	N/A
PZ-02	SR/D	03/12/03	43.44	13.24	3369.98	1027.17	N/A
PZ-02	SR/D	04/16/03	43.52	13.26	3369.90	1027.15	N/A
PZ-02	SR/D	05/15/03	43.50	13.26	3369.92	1027.15	N/A
PZ-02	SR/D	06/13/03	43.50	13.26	3369.92	1027.15	N/A
PZ-02	SR/D	07/16/03	43.88	13.37	3369.54	1027.04	N/A
PZ-02	SR/D	09/10/03	43.63	13.30	3369.79	1027.11	N/A
PZ-02	SR/D	12/11/03	43.49	13.26	3369.93	1027.15	N/A
PZ-03	SR/D	01/23/03	45.59	13.90	3370.56	1027.35	N/A
PZ-03	SR/D	02/18/03	45.15	13.76	3371.00	1027.48	N/A
PZ-03	SR/D	03/12/03	45.11	13.75	3371.04	1027.49	N/A
PZ-03	SR/D	04/16/03	45.14	13.76	3371.01	1027.48	N/A
PZ-03	SR/D	05/15/03	45.07	13.74	3371.08	1027.51	N/A
PZ-03	SR/D	06/13/03	44.97	13.71	3371.18	1027.54	N/A
PZ-03	SR/D	07/16/03	45.20	13.78	3370.95	1027.47	N/A
PZ-03	SR/D	09/10/03	44.92	13.69	3371.23	1027.55	N/A
PZ-03	SR/D	12/11/03	44.83	13.66	3371.32	1027.58	N/A
PZ-04	SR/D	01/23/03	47.70	14.54	3364.40	1025.47	N/A
PZ-04	SR/D	02/18/03	47.31	14.42	3364.79	1025.59	N/A
PZ-04	SR/D	03/12/03	47.35	14.43	3364.75	1025.58	N/A
PZ-04	SR/D	04/16/03	47.54	14.49	3364.56	1025.52	N/A
PZ-04	SR/D	05/15/03	47.58	14.50	3364.52	1025.51	N/A
PZ-04	SR/D	06/13/03	47.78	14.56	3364.32	1025.44	N/A
PZ-04	SR/D	07/16/03	47.98	14.62	3364.12	1025.38	N/A
PZ-04	SR/D	09/10/03	47.52	14.48	3364.58	1025.52	N/A
PZ-04	SR/D	12/11/03	47.34	14.43	3364.76	1025.58	N/A
PZ-05	SR/D	01/23/03	43.30	13.20	3372.01	1027.79	N/A
PZ-05	SR/D	02/18/03	42.84	13.06	3372.47	1027.93	N/A
PZ-05	SR/D	03/12/03	42.77	13.04	3372.54	1027.95	N/A
PZ-05	SR/D	04/16/03	42.80	13.05	3372.51	1027.94	N/A
PZ-05	SR/D	05/15/03	42.73	13.02	3372.58	1027.96	N/A
PZ-05	SR/D	06/13/03	42.70	13.02	3372.61	1027.97	N/A
PZ-05	SR/D	07/16/03	42.94	13.09	3372.37	1027.90	N/A
PZ-05	SR/D	09/10/03	42.71	13.02	3372.60	1027.97	N/A
PZ-05	SR/D	12/11/03	42.59	12.98	3372.72	1028.01	N/A
PZ-06	SR/D	01/23/03	43.71	13.32	3369.78	1027.11	N/A
PZ-06	SR/D	02/18/03	43.48	13.25	3370.01	1027.18	N/A
PZ-06	SR/D	03/12/03	43.47	13.25	3370.02	1027.18	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
PZ-06	SR/D	04/16/03	43.64	13.30	3369.85	1027.13	N/A
PZ-06	SR/D	05/15/03	43.70	13.32	3369.79	1027.11	N/A
PZ-06	SR/D	06/13/03	43.82	13.36	3369.67	1027.08	N/A
PZ-06	SR/D	07/16/03	44.07	13.43	3369.42	1027.00	N/A
PZ-06	SR/D	09/10/03	43.78	13.34	3369.71	1027.09	N/A
PZ-06	SR/D	12/11/03	43.70	13.32	3369.79	1027.11	N/A
PZ-07	SR/D	01/23/03	37.82	11.53	3376.17	1029.06	N/A
PZ-07	SR/D	02/18/03	37.26	11.36	3376.73	1029.23	N/A
PZ-07	SR/D	03/12/03	37.25	11.35	3376.74	1029.23	N/A
PZ-07	SR/D	04/16/03	37.36	11.39	3376.63	1029.20	N/A
PZ-07	SR/D	05/15/03	37.36	11.39	3376.63	1029.20	N/A
PZ-07	SR/D	06/13/03	37.34	11.38	3376.65	1029.20	N/A
PZ-07	SR/D	07/16/03	37.74	11.50	3376.25	1029.08	N/A
PZ-07	SR/D	09/10/03	37.60	11.46	3376.39	1029.12	N/A
PZ-07	SR/D	12/11/03	37.49	11.43	3376.50	1029.16	N/A
PZ-09	SR/D	01/23/03	57.56	17.54	3363.65	1025.24	N/A
PZ-09	SR/D	02/18/03	56.96	17.36	3364.25	1025.42	N/A
PZ-09	SR/D	03/12/03	56.90	17.34	3364.31	1025.44	N/A
PZ-09	SR/D	04/16/03	56.94	17.36	3364.27	1025.43	N/A
PZ-09	SR/D	05/15/03	56.85	17.33	3364.36	1025.46	N/A
PZ-09	SR/D	06/13/03	56.73	17.29	3364.48	1025.49	N/A
PZ-09	SR/D	07/16/03	57.10	17.40	3364.11	1025.38	N/A
PZ-09	SR/D	09/10/03	57.87	17.64	3363.34	1025.15	N/A
PZ-09	SR/D	12/10/03	56.79	17.31	3364.42	1025.48	N/A
PZ-10	SR/D	01/23/03	38.08	11.61	3367.72	1026.48	N/A
PZ-10	SR/D	02/18/03	37.80	11.52	3368.00	1026.57	N/A
PZ-10	SR/D	03/12/03	37.80	11.52	3368.00	1026.57	N/A
PZ-10	SR/D	04/16/03	37.95	11.57	3367.85	1026.52	N/A
PZ-10	SR/D	05/15/03	38.16	11.63	3367.64	1026.46	N/A
PZ-10	SR/D	06/13/03	38.49	11.73	3367.31	1026.36	N/A
PZ-10	SR/D	07/16/03	38.85	11.84	3366.95	1026.25	N/A
PZ-10	SR/D	09/10/03	38.58	11.76	3367.22	1026.33	N/A
PZ-10	SR/D	12/11/03	38.35	11.69	3367.45	1026.40	N/A
PZ-11	SR/D	01/23/03	45.74	13.94	3373.21	1028.15	N/A
PZ-11	SR/D	02/18/03	45.13	13.76	3373.82	1028.34	N/A
PZ-11	SR/D	03/12/03	45.03	13.73	3373.92	1028.37	N/A
PZ-11	SR/D	04/16/03	45.12	13.75	3373.83	1028.34	N/A
PZ-11	SR/D	05/15/03	45.01	13.72	3373.94	1028.38	N/A
PZ-11	SR/D	06/13/03	45.00	13.72	3373.95	1028.38	N/A
PZ-11	SR/D	07/16/03	45.41	13.84	3373.54	1028.26	N/A
PZ-11	SR/D	09/10/03	45.23	13.79	3373.72	1028.31	N/A
PZ-11	SR/D	12/11/03	45.23	13.79	3373.72	1028.31	N/A

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
PZ-12	SR/D	01/23/03	53.51	16.31	3355.48	1022.75	N/A
PZ-12	SR/D	02/18/03	53.14	16.20	3355.85	1022.86	N/A
PZ-12	SR/D	03/12/03	53.25	16.23	3355.74	1022.83	N/A
PZ-12	SR/D	04/16/03	53.52	16.31	3355.47	1022.75	N/A
PZ-12	SR/D	05/15/03	53.76	16.39	3355.23	1022.67	N/A
PZ-12	SR/D	06/13/03	54.07	16.48	3354.92	1022.58	N/A
PZ-12	SR/D	07/16/03	54.42	16.59	3354.57	1022.47	N/A
PZ-12	SR/D	09/10/03	53.55	16.32	3355.44	1022.74	N/A
PZ-12	SR/D	12/11/03	53.36	16.26	3355.63	1022.80	N/A
SNL-2	CUL	06/09/03	266.70	81.29	3056.33	931.57	3069.59
SNL-2	CUL	07/14/03	266.93	81.36	3056.10	931.50	3069.34
SNL-2	CUL	08/11/03	267.08	81.41	3055.95	931.45	3069.18
SNL-2	CUL	09/08/03	259.25	79.02	3063.78	933.84	3077.52
SNL-2	CUL	10/06/03	259.68	79.15	3063.35	933.71	3077.06
SNL-2	CUL	12/08/03	258.32	78.74	3064.71	934.12	3078.51
SNL-3	CUL	10/07/03	435.98	132.89	3054.36	930.97	3068.27
SNL-3	CUL	11/03/03	434.39	132.40	3055.95	931.45	3069.92
SNL-3	CUL	12/08/03	433.09	132.01	3057.25	931.85	3071.28
SNL-9	CUL	07/14/03	321.82	98.09	3039.13	926.33	3047.86
SNL-9	CUL	08/11/03	321.81	98.09	3039.14	926.33	3047.87
SNL-9	CUL	09/11/03	319.86	97.49	3041.09	926.92	3049.89
SNL-9	CUL	10/06/03	319.00	97.23	3041.95	927.19	3050.78
SNL-9	CUL	11/03/03	318.15	96.97	3042.80	927.45	3051.66
SNL-12	CUL	09/09/03	344.24	104.92	2995.20	912.94	2999.70
SNL-12	CUL	10/07/03	343.59	104.73	2995.85	913.14	3000.36
SNL-12	CUL	11/03/03	343.31	104.64	2996.13	913.22	3000.65
SNL-12	CUL	12/09/03	343.14	104.59	2996.30	913.27	3000.82
WIPP-12	CUL	01/22/03	438.66	133.70	3033.40	924.58	3070.32
WIPP-12	CUL	02/11/03	438.57	133.68	3033.49	924.61	3070.42
WIPP-12	CUL	03/12/03	438.43	133.63	3033.63	924.65	3070.57
WIPP-12	CUL	04/15/03	438.55	133.67	3033.51	924.61	3070.44
WIPP-12	CUL	05/13/03	438.58	133.68	3033.48	924.60	3070.41
WIPP-12	CUL	06/12/03	438.50	133.65	3033.56	924.63	3070.50
WIPP-12	CUL	07/14/03	438.63	133.69	3033.43	924.59	3070.35
WIPP-12	CUL	08/12/03	438.73	133.72	3033.33	924.56	3070.24
WIPP-12	CUL	09/09/03	438.85	133.76	3033.21	924.52	3070.11
WIPP-12	CUL	10/08/03	439.02	133.81	3033.04	924.47	3069.93
WIPP-12	CUL	11/04/03	439.13	133.85	3032.93	924.44	3069.81
WIPP-12	CUL	12/10/03	439.39	133.93	3032.67	924.36	3069.52
WIPP-13	CUL	01/22/03	347.72	105.99	3057.99	932.08	3068.58
WIPP-13	CUL	02/17/03	347.62	105.95	3058.09	932.11	3068.68
WIPP-13	CUL	03/11/03	347.54	105.93	3058.17	932.13	3068.76

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
WIPP-13	CUL	04/15/03	347.54	105.93	3058.17	932.13	3068.76
WIPP-13	CUL	05/14/03	347.62	105.95	3058.09	932.11	3068.68
WIPP-13	CUL	06/12/03	347.62	105.95	3058.09	932.11	3068.68
WIPP-13	CUL	07/15/03	347.95	106.06	3057.76	932.01	3068.34
WIPP-13	CUL	08/12/03	348.14	106.11	3057.57	931.95	3068.15
WIPP-13	CUL	09/08/03	348.25	106.15	3057.46	931.91	3068.03
WIPP-13	CUL	10/06/03	348.54	106.24	3057.17	931.83	3067.74
WIPP-13	CUL	11/03/03	348.59	106.25	3057.12	931.81	3067.68
WIPP-13	CUL	12/08/03	348.98	106.37	3056.73	931.69	3067.28
WIPP-18	MAG	02/18/03	318.41	97.05	3140.35	957.18	N/A
WIPP-18	MAG	04/15/03	317.44	96.76	3141.32	957.47	N/A
WIPP-18	MAG	05/13/03	317.05	96.64	3141.71	957.59	N/A
WIPP-18	MAG	06/12/03	316.65	96.51	3142.11	957.72	N/A
WIPP-18	MAG	07/15/03	316.91	96.59	3141.85	957.64	N/A
WIPP-18	MAG	08/12/03	316.71	96.53	3142.05	957.70	N/A
WIPP-18	MAG	09/09/03	316.53	96.48	3142.23	957.75	N/A
WIPP-18	MAG	10/08/03	316.43	96.45	3142.33	957.78	N/A
WIPP-18	MAG	11/04/03	316.27	96.40	3142.49	957.83	N/A
WIPP-18	MAG	12/10/03	316.19	96.37	3142.57	957.86	N/A
WIPP-19	CUL	01/22/03	393.92	120.07	3041.22	926.96	3079.15
WIPP-19	CUL	02/17/03	393.81	120.03	3041.33	927.00	3079.28
WIPP-19	CUL	03/12/03	393.69	120.00	3041.45	927.03	3079.41
WIPP-19	CUL	04/15/03	393.65	119.98	3041.49	927.05	3079.45
WIPP-19	CUL	05/13/03	393.76	120.02	3041.38	927.01	3079.33
WIPP-19	CUL	06/12/03	393.50	119.94	3041.64	927.09	3079.62
WIPP-19	CUL	07/15/03	393.87	120.05	3041.27	926.98	3079.21
WIPP-19	CUL	08/12/03	393.78	120.02	3041.36	927.01	3079.31
WIPP-19	CUL	09/09/03	393.89	120.06	3041.25	926.97	3079.19
WIPP-19	CUL	10/08/03	393.97	120.08	3041.17	926.95	3079.10
WIPP-19	CUL	11/04/03	393.96	120.08	3041.18	926.95	3079.11
WIPP-19	CUL	12/10/03	394.15	120.14	3040.99	926.89	3078.90
WIPP-21	CUL	01/22/03	401.58	122.40	3017.38	919.70	3041.62
WIPP-21	CUL	02/17/03	401.69	122.44	3017.27	919.66	3041.50
WIPP-21	CUL	03/12/03	401.50	122.38	3017.46	919.72	3041.70
WIPP-21	CUL	04/15/03	401.36	122.33	3017.60	919.76	3041.85
WIPP-21	CUL	05/13/03	401.32	122.32	3017.64	919.78	3041.90
WIPP-21	CUL	06/12/03	401.03	122.23	3017.93	919.87	3042.21
WIPP-21	CUL	07/15/03	401.73	122.45	3017.23	919.65	3041.46
WIPP-21	CUL	08/12/03	401.49	122.37	3017.47	919.72	3041.71
WIPP-21	CUL	09/09/03	401.70	122.44	3017.26	919.66	3041.49
WIPP-21	CUL	10/08/03	401.45	122.36	3017.51	919.74	3041.76
WIPP-21	CUL	11/04/03	401.38	122.34	3017.58	919.76	3041.83

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
WIPP-21	CUL	12/10/03	401.65	122.42	3017.31	919.68	3041.54
WIPP-22	CUL	01/22/03	396.60	120.88	3031.52	924.01	3062.71
WIPP-22	CUL	02/17/03	396.59	120.88	3031.53	924.01	3062.72
WIPP-22	CUL	03/12/03	396.39	120.82	3031.73	924.07	3062.94
WIPP-22	CUL	04/15/03	396.36	120.81	3031.76	924.08	3062.97
WIPP-22	CUL	05/13/03	396.40	120.82	3031.72	924.07	3062.93
WIPP-22	CUL	06/12/03	396.13	120.74	3031.99	924.15	3063.22
WIPP-22	CUL	07/15/03	396.60	120.88	3031.52	924.01	3062.71
WIPP-22	CUL	08/12/03	396.40	120.82	3031.72	924.07	3062.93
WIPP-22	CUL	09/09/03	396.60	120.88	3031.52	924.01	3062.71
WIPP-22	CUL	10/08/03	396.50	120.85	3031.62	924.04	3062.82
WIPP-22	CUL	11/04/03	396.50	120.85	3031.62	924.04	3062.82
WIPP-22	CUL	12/10/03	396.66	120.90	3031.46	923.99	3062.65
WIPP-25 (ANNULUS)	MAG	01/24/03	162.40	49.50	3051.99	930.25	N/A
WIPP-25 (ANNULUS)	MAG	02/10/03	162.36	49.49	3052.03	930.26	N/A
WIPP-25 (ANNULUS)	MAG	03/10/03	162.25	49.45	3052.14	930.29	N/A
WIPP-25 (ANNULUS)	MAG	04/14/03	162.13	49.42	3052.26	930.33	N/A
WIPP-25 (ANNULUS)	MAG	05/12/03	162.13	49.42	3052.26	930.33	N/A
WIPP-25 (ANNULUS)	MAG	06/09/03	162.20	49.44	3052.19	930.31	N/A
WIPP-25 (ANNULUS)	MAG	07/14/03	162.61	49.56	3051.78	930.18	N/A
WIPP-25 (ANNULUS)	MAG	08/11/03	163.11	49.72	3051.28	930.03	N/A
WIPP-25 (PIP)	CUL	01/20/03	152.04	46.34	3062.35	933.40	3059.26
WIPP-25 (PIP)	CUL	02/10/03	152.18	46.38	3062.21	933.36	3059.12
WIPP-25 (PIP)	CUL	03/10/03	152.00	46.33	3062.39	933.42	3059.30
WIPP-25 (PIP)	CUL	04/14/03	151.87	46.29	3062.52	933.46	3059.42
WIPP-25 (PIP)	CUL	05/12/03	152.01	46.33	3062.38	933.41	3059.29
WIPP-25 (PIP)	CUL	06/09/03	151.99	46.33	3062.40	933.42	3059.31
WIPP-25 (PIP)	CUL	07/14/03	152.44	46.46	3061.95	933.28	3058.86
WIPP-25 (PIP)	CUL	08/11/03	153.13	46.67	3061.26	933.07	3058.18
WIPP-25 (PIP)	CUL	09/08/03	153.42	46.76	3060.97	932.98	3057.89
WIPP-25 (PIP)	CUL	10/06/03	153.78	46.87	3060.61	932.87	3057.53
WIPP-25 (PIP)	CUL	11/03/03	153.95	46.92	3060.44	932.82	3057.37
WIPP-25 (PIP)	CUL	12/08/03	154.63	47.13	3059.76	932.61	3056.69
WIPP-26	CUL	01/20/03	130.21	39.69	3022.99	921.41	3023.13
WIPP-26	CUL	02/11/03	130.22	39.69	3022.98	921.40	3023.12
WIPP-26	CUL	03/10/03	130.21	39.69	3022.99	921.41	3023.13
WIPP-26	CUL	04/14/03	130.21	39.69	3022.99	921.41	3023.13
WIPP-26	CUL	05/12/03	130.50	39.78	3022.70	921.32	3022.84
WIPP-26	CUL	06/09/03	130.38	39.74	3022.82	921.36	3022.96
WIPP-26	CUL	07/14/03	130.55	39.79	3022.65	921.30	3022.79
WIPP-26	CUL	08/11/03	130.90	39.90	3022.30	921.20	3022.44
WIPP-26	CUL	09/08/03	131.07	39.95	3022.13	921.15	3022.27

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
WIPP-26	CUL	10/06/03	131.16	39.98	3022.04	921.12	3022.18
WIPP-26	CUL	11/03/03	131.00	39.93	3022.20	921.17	3022.34
WIPP-26	CUL	12/08/03	130.96	39.92	3022.24	921.18	3022.38
WIPP-27 (PIP)	CUL	01/20/03	96.09	29.29	3082.89	939.66	3089.00
WIPP-27 (PIP)	CUL	02/10/03	96.13	29.30	3082.85	939.65	3088.96
WIPP-27 (PIP)	CUL	03/10/03	96.03	29.27	3082.95	939.68	3089.06
WIPP-27 (PIP)	CUL	04/14/03	96.18	29.32	3082.80	939.64	3088.91
WIPP-27 (PIP)	CUL	05/12/03	96.75	29.49	3082.23	939.46	3088.32
WIPP-27 (PIP)	CUL	06/09/03	97.38	29.68	3081.60	939.27	3087.67
WIPP-27 (PIP)	CUL	07/14/03	97.67	29.77	3081.31	939.18	3087.38
WIPP-27 (PIP)	CUL	08/11/03	98.08	29.89	3080.90	939.06	3086.95
WIPP-27 (PIP)	CUL	09/08/03	98.64	30.07	3080.34	938.89	3086.38
WIPP-27 (PIP)	CUL	10/06/03	98.98	30.17	3080.00	938.78	3086.03
WIPP-27 (PIP)	CUL	11/03/03	98.86	30.13	3080.12	938.82	3086.15
WIPP-27 (PIP)	CUL	12/08/03	98.60	30.05	3080.38	938.90	3086.42
WIPP-29	CUL	01/20/03	11.17	3.40	2967.09	904.37	2970.26
WIPP-29	CUL	02/10/03	11.22	3.42	2967.04	904.35	2970.20
WIPP-29	CUL	03/10/03	11.19	3.41	2967.07	904.36	2970.24
WIPP-29	CUL	04/14/03	11.14	3.40	2967.12	904.38	2970.30
WIPP-29	CUL	05/12/03	11.35	3.46	2966.91	904.31	2970.05
WIPP-29	CUL	06/09/03	11.18	3.41	2967.08	904.37	2970.25
WIPP-29	CUL	07/16/03	11.26	3.43	2967.00	904.34	2970.15
WIPP-29	CUL	08/11/03	11.19	3.41	2967.07	904.36	2970.24
WIPP-29	CUL	09/08/03	11.09	3.38	2967.17	904.39	2970.36
WIPP-29	CUL	10/06/03	11.08	3.38	2967.18	904.40	2970.37
WIPP-29	CUL	11/03/03	11.25	3.43	2967.01	904.34	2970.17
WIPP-29	CUL	12/08/03	11.40	3.47	2966.86	904.30	2969.99
WIPP-30 (PIP)	CUL	01/22/03	358.42	109.25	3070.63	935.93	3077.76
WIPP-30 (PIP)	CUL	02/17/03	358.21	109.18	3070.84	935.99	3077.97
WIPP-30 (PIP)	CUL	03/11/03	358.05	109.13	3071.00	936.04	3078.14
WIPP-30 (PIP)	CUL	04/15/03	357.93	109.10	3071.12	936.08	3078.26
WIPP-30 (PIP)	CUL	05/14/03	358.04	109.13	3071.01	936.04	3078.15
WIPP-30 (PIP)	CUL	06/12/03	357.85	109.07	3071.20	936.10	3078.34
WIPP-30 (PIP)	CUL	07/15/03	358.00	109.12	3071.05	936.06	3078.19
WIPP-30 (PIP)	CUL	08/11/03	358.06	109.14	3070.99	936.04	3078.13
WIPP-30 (PIP)	CUL	09/09/03	358.05	109.13	3071.00	936.04	3078.14
WIPP-30 (PIP)	CUL	10/08/03	358.26	109.20	3070.79	935.98	3077.92
WIPP-30 (PIP)	CUL	11/05/03	358.40	109.24	3070.65	935.93	3077.78
WIPP-30 (PIP)	CUL	12/11/03	358.52	109.28	3070.53	935.90	3077.66
WQSP-1	CUL	01/22/03	363.89	110.91	3055.31	931.26	3072.07
WQSP-1	CUL	02/17/03	363.81	110.89	3055.39	931.28	3072.16
WQSP-1	CUL	03/12/03	363.77	110.88	3055.43	931.30	3072.20

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
WQSP-1	CUL	04/14/03	363.84	110.90	3055.36	931.27	3072.12
WQSP-1	CUL	05/13/03	363.96	110.94	3055.24	931.24	3072.00
WQSP-1	CUL	06/12/03	363.76	110.87	3055.44	931.30	3072.21
WQSP-1	CUL	07/15/03	364.01	110.95	3055.19	931.22	3071.95
WQSP-1	CUL	08/12/03	364.17	111.00	3055.03	931.17	3071.78
WQSP-1	CUL	09/09/03	364.15	110.99	3055.05	931.18	3071.80
WQSP-1	CUL	10/08/03	364.48	111.09	3054.72	931.08	3071.45
WQSP-1	CUL	11/04/03	364.58	111.12	3054.62	931.05	3071.35
WQSP-1	CUL	12/10/03	365.05	111.27	3054.15	930.90	3070.86
WQSP-2	CUL	01/22/03	402.71	122.75	3061.19	933.05	3081.01
WQSP-2	CUL	02/17/03	402.46	122.67	3061.44	933.13	3081.28
WQSP-2	CUL	03/12/03	402.34	122.63	3061.56	933.16	3081.40
WQSP-2	CUL	04/15/03	403.02	122.84	3060.88	932.96	3080.69
WQSP-2	CUL	05/13/03	403.13	122.87	3060.77	932.92	3080.57
WQSP-2	CUL	06/12/03	402.80	122.77	3061.10	933.02	3080.92
WQSP-2	CUL	07/15/03	402.89	122.80	3061.01	933.00	3080.83
WQSP-2	CUL	08/12/03	402.87	122.79	3061.03	933.00	3080.85
WQSP-2	CUL	09/09/03	402.98	122.83	3060.92	932.97	3080.73
WQSP-2	CUL	10/08/03	404.06	123.16	3059.84	932.64	3079.60
WQSP-2	CUL	11/04/03	404.04	123.15	3059.86	932.65	3079.62
WQSP-2	CUL	12/10/03	404.33	123.24	3059.57	932.56	3079.32
WQSP-3	CUL	01/22/03	467.25	142.42	3013.05	918.38	3070.36
WQSP-3	CUL	02/17/03	467.07	142.36	3013.23	918.43	3070.57
WQSP-3	CUL	03/12/03	466.75	142.27	3013.55	918.53	3070.94
WQSP-3	CUL	04/15/03	468.28	142.73	3012.02	918.06	3069.18
WQSP-3	CUL	05/13/03	467.54	142.51	3012.76	918.29	3070.03
WQSP-3	CUL	06/12/03	467.03	142.35	3013.27	918.44	3070.61
WQSP-3	CUL	07/15/03	467.02	142.35	3013.28	918.45	3070.63
WQSP-3	CUL	08/12/03	466.93	142.32	3013.37	918.48	3070.73
WQSP-3	CUL	09/09/03	466.88	142.31	3013.42	918.49	3070.79
WQSP-3	CUL	10/08/03	469.39	143.07	3010.91	917.73	3067.91
WQSP-3	CUL	11/04/03	467.58	142.52	3012.72	918.28	3069.98
WQSP-3	CUL	12/10/03	467.43	142.47	3012.87	918.32	3070.16
WQSP-4	CUL	01/23/03	444.64	135.53	2988.36	910.85	3013.38
WQSP-4	CUL	02/17/03	444.27	135.41	2988.73	910.96	3013.77
WQSP-4	CUL	03/12/03	444.14	135.37	2988.86	911.00	3013.91
WQSP-4	CUL	04/15/03	444.48	135.48	2988.52	910.90	3013.55
WQSP-4	CUL	05/13/03	444.68	135.54	2988.32	910.84	3013.33
WQSP-4	CUL	06/12/03	444.49	135.48	2988.51	910.90	3013.54
WQSP-4	CUL	07/15/03	444.64	135.53	2988.36	910.85	3013.38
WQSP-4	CUL	08/12/03	444.76	135.56	2988.24	910.82	3013.25
WQSP-4	CUL	09/09/03	444.77	135.57	2988.23	910.81	3013.24

Table F.8 - Groundwater Level Measurement Results for 2003

Well Number	Zone	Date	Measured Depth From Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL[a]	Elevation in Meters	Elevation in Feet AMSL Adjusted to Equivalent Fresh Water Head
WQSP-4	CUL	10/08/03	444.94	135.62	2988.06	910.76	3013.05
WQSP-4	CUL	11/04/03	445.19	135.69	2987.81	910.68	3012.79
WQSP-4	CUL	12/10/03	445.15	135.68	2987.85	910.70	3012.83
WQSP-5	CUL	01/23/03	380.41	115.95	3003.99	915.62	3011.07
WQSP-5	CUL	02/17/03	379.96	115.81	3004.44	915.75	3011.54
WQSP-5	CUL	03/12/03	379.84	115.78	3004.56	915.79	3011.66
WQSP-5	CUL	04/15/03	379.91	115.80	3004.49	915.77	3011.59
WQSP-5	CUL	05/13/03	380.33	115.92	3004.07	915.64	3011.16
WQSP-5	CUL	06/12/03	380.03	115.83	3004.37	915.73	3011.46
WQSP-5	CUL	07/15/03	380.12	115.86	3004.28	915.70	3011.37
WQSP-5	CUL	08/12/03	380.11	115.86	3004.29	915.71	3011.38
WQSP-5	CUL	09/09/03	380.18	115.88	3004.22	915.69	3011.31
WQSP-5	CUL	10/08/03	380.34	115.93	3004.06	915.64	3011.15
WQSP-5	CUL	11/04/03	381.19	116.19	3003.21	915.38	3010.28
WQSP-5	CUL	12/10/03	380.67	116.03	3003.73	915.54	3010.81
WQSP-6	CUL	01/23/03	346.72	105.68	3017.08	919.61	3020.83
WQSP-6	CUL	02/17/03	346.27	105.54	3017.53	919.74	3021.28
WQSP-6	CUL	03/12/03	346.06	105.48	3017.74	919.81	3021.50
WQSP-6	CUL	04/15/03	345.96	105.45	3017.84	919.84	3021.60
WQSP-6	CUL	05/13/03	348.95	106.36	3014.85	918.93	3018.56
WQSP-6	CUL	06/12/03	346.27	105.54	3017.53	919.74	3021.28
WQSP-6	CUL	07/15/03	346.14	105.50	3017.66	919.78	3021.42
WQSP-6	CUL	08/12/03	346.10	105.49	3017.70	919.80	3021.46
WQSP-6	CUL	09/09/03	345.99	105.46	3017.81	919.83	3021.57
WQSP-6	CUL	10/08/03	346.13	105.50	3017.67	919.79	3021.43
WQSP-6	CUL	11/04/03	346.06	105.48	3017.74	919.81	3021.50
WQSP-6	CUL	12/10/03	346.97	105.76	3016.83	919.53	3020.57
WQSP-6a	DL	01/23/03	166.86	50.86	3197.84	974.70	N/A
WQSP-6a	DL	02/17/03	166.56	50.77	3198.14	974.79	N/A
WQSP-6a	DL	03/12/03	166.51	50.75	3198.19	974.81	N/A
WQSP-6a	DL	04/15/03	166.48	50.74	3198.22	974.82	N/A
WQSP-6a	DL	05/13/03	166.69	50.81	3198.01	974.75	N/A
WQSP-6a	DL	06/12/03	166.51	50.75	3198.19	974.81	N/A
WQSP-6a	DL	07/15/03	166.67	50.80	3198.03	974.76	N/A
WQSP-6a	DL	08/12/03	166.65	50.79	3198.05	974.77	N/A
WQSP-6a	DL	09/09/03	166.49	50.75	3198.21	974.81	N/A
WQSP-6a	DL	10/08/03	166.57	50.77	3198.13	974.79	N/A
WQSP-6a	DL	11/04/03	166.53	50.76	3198.17	974.80	N/A
WQSP-6a	DL	12/10/03	166.71	50.81	3197.99	974.75	N/A

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Appendix G
Air Sampling Data: Concentrations of Radionuclides

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix B for the sampling location codes.

Location	Quarter	[RN][a]	2xTPU[b]	MDC[c]	[RN]	2xTPU	MDC
			^{241}Am			^{238}Pu	
CBD	1	5.62×10^{-8}	8.94×10^{-8}	1.52×10^{-7}	0.00×10^{0}	N/A[e]	1.81×10^{-7}
CBD	2	1.52×10^{-8}	5.26×10^{-8}	1.12×10^{-7}	-4.83×10^{-8}	1.68×10^{-7}	4.46×10^{-7}
CBD	3	2.77×10^{-8}	3.94×10^{-8}	3.74×10^{-8}	1.44×10^{-7}	1.53×10^{-7}	2.21×10^{-7}
CBD	4	4.65×10^{-8}	4.97×10^{-8}	7.12×10^{-8}	-1.58×10^{-8}	5.46×10^{-8}	1.51×10^{-7}
MLR	1	3.13×10^{-8}	7.68×10^{-8}	1.45×10^{-7}	0.00×10^{0}	N/A[e]	4.09×10^{-8}
MLR	2	0.00×10^{0}	N/A[e]	1.86×10^{-7}	5.88×10^{-8}	8.38×10^{-8}	7.91×10^{-8}
MLR	3	-1.96×10^{-8}	6.78×10^{-8}	1.82×10^{-7}	0.00×10^{0}	N/A[e]	1.05×10^{-7}
MLR	4	7.13×10^{-8}	6.20×10^{-8}	7.80×10^{-8}	3.12×10^{-8}	1.40×10^{-7}	2.98×10^{-7}
SEC	1	8.03×10^{-8}	7.29×10^{-8}	4.35×10^{-8}	-2.00×10^{-8}	6.92×10^{-8}	1.85×10^{-7}
SEC	2	8.80×10^{-8}	8.93×10^{-8}	5.95×10^{-8}	4.52×10^{-8}	9.09×10^{-8}	1.22×10^{-7}
SEC	3	8.45×10^{-8}	7.02×10^{-8}	3.81×10^{-8}	6.68×10^{-8}	7.80×10^{-8}	6.00×10^{-8}
SEC	4	4.14×10^{-8}	6.58×10^{-8}	1.15×10^{-7}	0.00×10^{0}	0.00×10^{0}	1.09×10^{-7}
SMR	1	7.69×10^{-8}	8.22×10^{-8}	1.13×10^{-7}	0.00×10^{0}	0.00×10^{0}	1.68×10^{-7}
SMR	2	4.73×10^{-8}	5.51×10^{-8}	4.27×10^{-8}	4.82×10^{-8}	9.70×10^{-8}	1.30×10^{-7}
SMR	3	4.29×10^{-8}	5.00×10^{-8}	3.87×10^{-8}	-7.16×10^{-8}	1.02×10^{-7}	3.31×10^{-7}
SMR	4	0.00×10^{0}	0.00×10^{0}	1.46×10^{-7}	-4.60×10^{-8}	6.56×10^{-8}	2.20×10^{-7}
WEE	1	3.75×10^{-8}	1.06×10^{-7}	2.02×10^{-7}	0.00×10^{0}	0.00×10^{0}	4.95×10^{-8}
WEE	2	8.65×10^{-8}	9.22×10^{-8}	1.34×10^{-7}	0.00×10^{0}	0.00×10^{0}	3.78×10^{-7}
WEE	3	7.34×10^{-8}	7.44×10^{-8}	4.97×10^{-8}	8.48×10^{-8}	1.71×10^{-7}	2.29×10^{-7}
WEE	4	5.22×10^{-8}	7.57×10^{-8}	1.29×10^{-7}	7.75×10^{-8}	1.11×10^{-7}	1.16×10^{-7}
WFF	1	2.93×10^{-8}	7.18×10^{-8}	1.36×10^{-7}	0.00×10^{0}	N/A[e]	4.80×10^{-8}
WFF	2	3.21×10^{-8}	7.89×10^{-8}	1.49×10^{-7}	0.00×10^{0}	N/A[e]	7.98×10^{-8}
WFF	3	6.01×10^{-8}	7.04×10^{-8}	5.43×10^{-8}	7.82×10^{-8}	1.11×10^{-7}	1.81×10^{-7}
WFF	4	0.00×10^{0}	N/A[e]	1.39×10^{-7}	5.61×10^{-8}	1.13×10^{-7}	2.14×10^{-7}
WSS	1	4.65×10^{-8}	1.14×10^{-7}	2.16×10^{-7}	0.00×10^{0}	N/A[e]	5.74×10^{-8}
WSS	2	3.25×10^{-8}	4.63×10^{-8}	4.40×10^{-8}	1.13×10^{-7}	1.15×10^{-7}	7.63×10^{-8}
WSS	3	5.80×10^{-8}	5.87×10^{-8}	3.92×10^{-8}	1.90×10^{-7}	2.25×10^{-7}	1.71×10^{-7}
WSS	4	4.19×10^{-8}	8.39×10^{-8}	1.51×10^{-7}	3.00×10^{-8}	6.03×10^{-8}	8.97×10^{-8}
WAB	1	6.10×10^{-5}	2.73×10^{-4}	5.67×10^{-4}	1.75×10^{-4}	3.52×10^{-4}	4.73×10^{-4}
WAB	2	1.69×10^{-4}	2.38×10^{-4}	2.26×10^{-4}	-1.26×10^{-4}	1.74×10^{-4}	5.66×10^{-4}
WAB	3	1.07×10^{-4}	1.52×10^{-4}	1.45×10^{-4}	1.78×10^{-4}	2.54×10^{-4}	2.40×10^{-4}
WAB	4	3.38×10^{-4}	4.17×10^{-4}	6.47×10^{-4}	1.13×10^{-4}	2.26×10^{-4}	3.37×10^{-4}
Minimum		-1.96×10^{-8}	0.00×10^{0}	3.74×10^{-8}	-7.16×10^{-8}	N/A[e]	4.09×10^{-8}
Maximum		8.80×10^{-8}	1.14×10^{-7}	2.16×10^{-7}	1.90×10^{-7}	2.25×10^{-7}	4.46×10^{-7}
Mean[d]		4.43×10^{-8}	5.56×10^{-8}	1.07×10^{-7}	2.94×10^{-8}	1.15×10^{-7}	1.62×10^{-7}
			$^{239+240}Pu$			^{234}U	
CBD	1	1.23×10^{-7}	1.32×10^{-7}	1.81×10^{-7}	2.62×10^{-6}	5.65×10^{-7}	3.78×10^{-8}
CBD	2	4.79×10^{-8}	9.65×10^{-8}	1.30×10^{-7}	3.69×10^{-6}	7.53×10^{-7}	4.14×10^{-8}
CBD	3	-2.38×10^{-8}	4.78×10^{-8}	1.75×10^{-7}	2.62×10^{-6}	5.58×10^{-7}	3.80×10^{-8}
CBD	4	0.00×10^{0}	N/A[e]	1.20×10^{-7}	2.88×10^{-6}	5.63×10^{-7}	3.26×10^{-8}
MLR	1	2.26×10^{-7}	1.29×10^{-7}	1.11×10^{-7}	2.46×10^{-6}	5.51×10^{-7}	4.25×10^{-8}
MLR	2	5.84×10^{-8}	1.17×10^{-7}	2.15×10^{-7}	2.90×10^{-6}	6.26×10^{-7}	1.15×10^{-7}
MLR	3	7.75×10^{-8}	1.11×10^{-7}	1.05×10^{-7}	2.14×10^{-6}	4.99×10^{-7}	1.13×10^{-7}
MLR	4	0.00×10^{0}	N/A[e]	9.34×10^{-8}	3.38×10^{-6}	7.81×10^{-7}	1.48×10^{-8}
SEC	1	1.39×10^{-7}	1.08×10^{-7}	5.39×10^{-8}	2.05×10^{-6}	5.11×10^{-7}	1.25×10^{-7}

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix B for the sampling location codes.

Location	Quarter	[RN][a]	2xTPU[b]	MDC[c]	[RN]	2xTPU	MDC
SEC	2	4.49×10^{-8}	9.04×10^{-8}	1.22×10^{-7}	2.18×10^{-6}	5.01×10^{-7}	1.09×10^{-7}
SEC	3	-4.43×10^{-8}	6.31×10^{-8}	2.06×10^{-7}	2.28×10^{-6}	5.90×10^{-7}	5.52×10^{-7}
SEC	4	4.26×10^{-8}	4.96×10^{-8}	4.26×10^{-8}	3.41×10^{-6}	7.20×10^{-7}	5.01×10^{-8}
SMR	1	6.71×10^{-8}	7.84×10^{-8}	6.06×10^{-8}	2.28×10^{-6}	5.50×10^{-7}	4.61×10^{-8}
SMR	2	4.79×10^{-8}	9.64×10^{-8}	1.30×10^{-7}	3.07×10^{-6}	6.50×10^{-7}	4.02×10^{-8}
SMR	3	-3.56×10^{-8}	1.24×10^{-7}	3.31×10^{-7}	2.72×10^{-6}	5.85×10^{-7}	1.04×10^{-7}
SMR	4	4.58×10^{-8}	6.53×10^{-8}	6.87×10^{-8}	2.60×10^{-6}	5.28×10^{-7}	9.08×10^{-8}
WEE	1	1.10×10^{-7}	9.15×10^{-8}	4.95×10^{-8}	1.93×10^{-6}	4.77×10^{-7}	1.17×10^{-7}
WEE	2	0.00×10^{0}	N/A[e]	1.39×10^{-7}	2.86×10^{-6}	5.95×10^{-7}	3.79×10^{-8}
WEE	3	8.43×10^{-8}	1.71×10^{-7}	2.29×10^{-7}	2.22×10^{-6}	4.79×10^{-7}	3.75×10^{-8}
WEE	4	3.86×10^{-8}	1.34×10^{-7}	2.96×10^{-7}	3.10×10^{-6}	6.84×10^{-7}	1.51×10^{-7}
WFF	1	5.31×10^{-8}	6.20×10^{-8}	4.80×10^{-8}	2.05×10^{-6}	4.72×10^{-7}	1.08×10^{-7}
WFF	2	2.95×10^{-8}	1.02×10^{-7}	2.17×10^{-7}	2.28×10^{-6}	5.35×10^{-7}	4.41×10^{-8}
WFF	3	1.95×10^{-8}	3.91×10^{-8}	5.27×10^{-8}	2.21×10^{-6}	5.17×10^{-7}	4.44×10^{-8}
WFF	4	5.59×10^{-8}	7.97×10^{-8}	8.39×10^{-8}	2.64×10^{-6}	5.33×10^{-7}	3.40×10^{-8}
WSS	1	8.48×10^{-8}	8.59×10^{-8}	5.74×10^{-8}	2.40×10^{-6}	5.72×10^{-7}	4.90×10^{-8}
WSS	2	0.00×10^{0}	N/A[e]	2.08×10^{-7}	2.76×10^{-6}	5.82×10^{-7}	3.69×10^{-8}
WSS	3	0.00×10^{0}	N/A[e]	4.65×10^{-7}	2.36×10^{-6}	5.20×10^{-7}	3.81×10^{-8}
WSS	4	2.99×10^{-8}	1.04×10^{-7}	2.29×10^{-7}	2.28×10^{-6}	5.14×10^{-7}	1.32×10^{-7}
WAB	1	2.27×10^{-3}	1.41×10^{-3}	1.29×10^{-3}	1.38×10^{-2}	3.25×10^{-3}	2.83×10^{-4}
WAB	2	6.09×10^{-5}	1.22×10^{-4}	1.65×10^{-4}	5.64×10^{-3}	1.60×10^{-3}	1.93×10^{-4}
WAB	3	0.00×10^{0}	N/A[e]	6.53×10^{-4}	5.76×10^{-3}	1.66×10^{-3}	2.03×10^{-4}
WAB	4	0.00×10^{0}	N/A[e]	3.37×10^{-4}	7.44×10^{-3}	1.94×10^{-3}	5.58×10^{-4}
Minimum		-4.43×10^{-8}	N/A[e]	4.26×10^{-8}	1.93×10^{-6}	4.72×10^{-7}	1.48×10^{-8}
Maximum		2.26×10^{-7}	1.71×10^{-7}	4.65×10^{-7}	3.69×10^{-6}	7.81×10^{-7}	5.52×10^{-7}
Mean[d]		4.72×10^{-8}	1.11×10^{-7}	1.51×10^{-7}	2.58×10^{-6}	8.81×10^{-7}	8.51×10^{-8}
			^{235}U			^{238}U	
CBD	1	8.60×10^{-8}	7.81×10^{-8}	4.66×10^{-8}	2.60×10^{-6}	5.62×10^{-6}	1.02×10^{-7}
CBD	2	2.08×10^{-7}	1.29×10^{-7}	5.11×10^{-8}	3.53×10^{-6}	7.27×10^{-7}	4.13×10^{-8}
CBD	3	1.04×10^{-7}	8.63×10^{-8}	4.69×10^{-8}	2.29×10^{-6}	5.03×10^{-7}	3.79×10^{-8}
CBD	4	1.61×10^{-7}	1.03×10^{-7}	1.03×10^{-7}	2.64×10^{-6}	5.25×10^{-7}	3.24×10^{-8}
MLR	1	2.51×10^{-7}	1.45×10^{-7}	5.24×10^{-8}	2.03×10^{-6}	4.78×10^{-7}	4.23×10^{-8}
MLR	2	1.35×10^{-7}	1.04×10^{-7}	5.21×10^{-8}	2.58×10^{-6}	5.70×10^{-7}	4.20×10^{-8}
MLR	3	1.88×10^{-8}	6.53×10^{-8}	1.39×10^{-7}	2.42×10^{-6}	5.44×10^{-7}	4.12×10^{-8}
MLR	4	9.52×10^{-8}	1.18×10^{-7}	1.82×10^{-7}	3.38×10^{-6}	7.85×10^{-7}	2.13×10^{-7}
SEC	1	1.88×10^{-7}	1.42×10^{-7}	1.54×10^{-7}	2.35×10^{-6}	5.63×10^{-7}	1.25×10^{-7}
SEC	2	2.74×10^{-7}	1.48×10^{-7}	4.96×10^{-8}	1.89×10^{-6}	4.49×10^{-7}	4.00×10^{-8}
SEC	3	1.01×10^{-7}	1.02×10^{-7}	6.81×10^{-8}	2.33×10^{-6}	6.02×10^{-7}	1.49×10^{-7}
SEC	4	8.25×10^{-8}	1.02×10^{-7}	1.58×10^{-7}	2.83×10^{-6}	6.25×10^{-7}	1.27×10^{-7}
SMR	1	3.36×10^{-7}	1.77×10^{-7}	5.69×10^{-8}	2.12×10^{-6}	5.21×10^{-7}	4.59×10^{-8}
SMR	2	9.14×10^{-8}	8.30×10^{-8}	4.95×10^{-8}	3.13×10^{-6}	6.61×10^{-7}	1.09×10^{-7}
SMR	3	2.09×10^{-7}	1.25×10^{-7}	4.72×10^{-8}	2.46×10^{-6}	5.39×10^{-7}	3.81×10^{-8}
SMR	4	2.19×10^{-7}	1.18×10^{-7}	4.39×10^{-8}	2.85×10^{-6}	5.65×10^{-7}	3.54×10^{-8}
WEE	1	4.30×10^{-7}	1.97×10^{-7}	5.29×10^{-8}	2.29×10^{-6}	5.37×10^{-7}	4.27×10^{-8}
WEE	2	1.90×10^{-7}	1.28×10^{-7}	1.27×10^{-7}	2.64×10^{-6}	5.60×10^{-7}	1.03×10^{-7}
WEE	3	1.03×10^{-7}	9.78×10^{-8}	1.26×10^{-7}	2.22×10^{-6}	4.82×10^{-7}	1.28×10^{-7}
WEE	4	2.14×10^{-7}	1.34×10^{-7}	5.83×10^{-8}	2.67×10^{-6}	6.05×10^{-7}	4.71×10^{-8}
WFF	1	1.44×10^{-7}	1.04×10^{-7}	4.89×10^{-8}	2.50×10^{-6}	5.45×10^{-7}	3.95×10^{-8}
WFF	2	3.01×10^{-7}	1.73×10^{-7}	1.48×10^{-7}	2.38×10^{-6}	5.52×10^{-7}	4.39×10^{-8}

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix B for the sampling location codes.

Location	Quarter	[RN][a]	2xTPU[b]	MDC[c]	[RN]	2xTPU	MDC
WFF	3	4.04×10^{-8}	5.75×10^{-8}	5.47×10^{-8}	2.36×10^{-6}	5.43×10^{-7}	4.42×10^{-8}
WFF	4	8.39×10^{-8}	6.97×10^{-8}	4.20×10^{-8}	2.43×10^{-6}	4.99×10^{-7}	3.39×10^{-8}
WSS	1	2.01×10^{-7}	1.51×10^{-7}	1.64×10^{-7}	2.38×10^{-6}	5.67×10^{-7}	4.88×10^{-8}
WSS	2	1.85×10^{-7}	1.25×10^{-7}	1.24×10^{-7}	2.21×10^{-6}	4.90×10^{-7}	3.67×10^{-8}
WSS	3	1.21×10^{-7}	9.37×10^{-8}	4.70×10^{-8}	2.38×10^{-6}	5.22×10^{-7}	3.79×10^{-8}
WSS	4	3.41×10^{-8}	4.85×10^{-8}	5.11×10^{-8}	2.49×10^{-6}	5.46×10^{-7}	4.13×10^{-8}
WAB	1	2.58×10^{-4}	3.67×10^{-4}	3.49×10^{-4}	1.39×10^{-2}	3.27×10^{-3}	2.82×10^{-4}
WAB	2	2.64×10^{-4}	3.08×10^{-4}	2.39×10^{-4}	6.61×10^{-3}	1.80×10^{-3}	5.24×10^{-4}
WAB	3	1.85×10^{-4}	2.63×10^{-4}	2.50×10^{-4}	4.92×10^{-3}	1.50×10^{-3}	5.49×10^{-4}
WAB	4	2.70×10^{-4}	4.05×10^{-4}	6.89×10^{-4}	8.35×10^{-3}	2.10×10^{-3}	5.56×10^{-4}
Minimum		1.88×10^{-8}	4.85×10^{-8}	4.20×10^{-8}	1.89×10^{-6}	4.49×10^{-7}	3.24×10^{-8}
Maximum		4.30×10^{-7}	1.97×10^{-7}	1.82×10^{-7}	3.53×10^{-6}	5.62×10^{-6}	2.13×10^{-7}
Mean[d]		1.65×10^{-7}	1.88×10^{-7}	8.37×10^{-8}	2.51×10^{-6}	7.21×10^{-7}	6.67×10^{-8}
			^{40}K			^{60}Co	
CBD	1	2.30×10^{-4}	1.71×10^{-4}	2.21×10^{-4}	2.41×10^{-6}	1.83×10^{-5}	2.12×10^{-5}
CBD	2	1.51×10^{-4}	1.70×10^{-4}	2.71×10^{-4}	1.08×10^{-5}	2.28×10^{-5}	2.80×10^{-5}
CBD	3	3.21×10^{-4}	1.32×10^{-4}	1.68×10^{-4}	8.96×10^{-6}	2.04×10^{-5}	2.44×10^{-5}
CBD	4	2.81×10^{-4}	2.02×10^{-4}	3.11×10^{-4}	3.67×10^{-5}	2.44×10^{-5}	2.79×10^{-5}
MLR	1	2.10×10^{-4}	1.85×10^{-4}	2.33×10^{-4}	-3.56×10^{-6}	2.07×10^{-5}	2.30×10^{-5}
MLR	2	3.13×10^{-4}	3.90×10^{-4}	4.30×10^{-4}	3.97×10^{-5}	3.95×10^{-5}	4.52×10^{-5}
MLR	3	5.24×10^{-4}	3.30×10^{-4}	3.79×10^{-4}	-1.01×10^{-5}	3.61×10^{-5}	3.85×10^{-5}
MLR	4	4.15×10^{-4}	2.06×10^{-4}	2.64×10^{-4}	8.46×10^{-6}	1.89×10^{-5}	2.26×10^{-5}
SEC	1	2.63×10^{-4}	1.16×10^{-4}	1.45×10^{-4}	1.26×10^{-5}	2.30×10^{-5}	2.81×10^{-5}
SEC	2	2.47×10^{-4}	3.55×10^{-4}	3.91×10^{-4}	-1.86×10^{-6}	3.66×10^{-5}	4.02×10^{-5}
SEC	3	5.24×10^{-4}	3.20×10^{-4}	3.70×10^{-4}	2.92×10^{-6}	3.56×10^{-5}	3.91×10^{-5}
SEC	4	2.91×10^{-4}	1.62×10^{-4}	2.05×10^{-4}	-1.15×10^{-5}	1.85×10^{-5}	1.94×10^{-5}
SMR	1	2.21×10^{-4}	1.22×10^{-4}	1.71×10^{-4}	1.64×10^{-5}	2.25×10^{-5}	2.82×10^{-5}
SMR	2	7.43×10^{-4}	3.51×10^{-4}	3.98×10^{-4}	4.63×10^{-6}	3.65×10^{-5}	4.04×10^{-5}
SMR	3	1.83×10^{-4}	1.14×10^{-4}	1.65×10^{-4}	2.07×10^{-5}	2.17×10^{-5}	2.67×10^{-5}
SMR	4	1.55×10^{-4}	1.50×10^{-4}	2.37×10^{-4}	1.96×10^{-5}	1.76×10^{-5}	2.24×10^{-5}
WEE	1	1.43×10^{-4}	1.04×10^{-4}	1.53×10^{-4}	-2.09×10^{-6}	2.34×10^{-5}	2.68×10^{-5}
WEE	2	5.86×10^{-4}	3.58×10^{-4}	4.03×10^{-4}	6.01×10^{-6}	3.63×10^{-5}	4.03×10^{-5}
WEE	3	5.21×10^{-4}	3.31×10^{-4}	3.81×10^{-4}	5.30×10^{-6}	3.47×10^{-5}	3.82×10^{-5}
WEE	4	4.67×10^{-4}	2.04×10^{-4}	2.66×10^{-4}	2.22×10^{-5}	1.82×10^{-5}	2.34×10^{-5}
WFF	1	2.58×10^{-4}	1.75×10^{-4}	2.26×10^{-4}	-1.19×10^{-7}	1.91×10^{-5}	2.17×10^{-5}
WFF	2	1.63×10^{-4}	1.26×10^{-4}	1.88×10^{-4}	1.75×10^{-5}	2.53×10^{-5}	3.17×10^{-5}
WFF	3	1.00×10^{-4}	1.02×10^{-4}	1.60×10^{-4}	1.99×10^{-6}	2.37×10^{-5}	2.73×10^{-5}
WFF	4	1.88×10^{-4}	1.70×10^{-4}	2.08×10^{-4}	8.37×10^{-6}	1.69×10^{-5}	2.00×10^{-5}
WSS	1	1.77×10^{-4}	2.17×10^{-4}	2.68×10^{-4}	1.38×10^{-5}	2.35×10^{-5}	2.82×10^{-5}
WSS	2	2.36×10^{-4}	1.34×10^{-4}	1.86×10^{-4}	9.22×10^{-6}	2.54×10^{-5}	3.04×10^{-5}
WSS	3	4.17×10^{-4}	2.21×10^{-4}	3.05×10^{-4}	4.74×10^{-6}	4.24×10^{-5}	4.90×10^{-5}
WSS	4	7.41×10^{-4}	3.15×10^{-4}	3.45×10^{-4}	1.89×10^{-5}	2.93×10^{-5}	3.28×10^{-5}
WAB	1	5.50×10^{0}	2.34×10^{0}	2.71×10^{0}	1.60×10^{-2}	2.45×10^{-1}	2.71×10^{-1}
WAB	2	1.51×10^{-4}	1.70×10^{-4}	2.71×10^{-4}	1.08×10^{-5}	2.28×10^{-5}	2.80×10^{-5}
WAB	3	1.29×10^{0}	7.66×10^{-1}	1.08×10^{0}	7.28×10^{-2}	1.51×10^{-1}	1.81×10^{-1}
WAB	4	1.61×10^{0}	1.71×10^{0}	2.72×10^{0}	1.97×10^{-1}	2.27×10^{-1}	2.54×10^{-1}
Minimum		1.00×10^{-4}	1.02×10^{-4}	1.45×10^{-4}	-1.15×10^{-5}	1.69×10^{-5}	1.94×10^{-5}
Maximum		7.43×10^{-4}	3.90×10^{-4}	4.30×10^{-4}	3.97×10^{-5}	4.24×10^{-5}	4.90×10^{-5}
Mean[d]		3.24×10^{-4}	3.50×10^{-4}	2.66×10^{-4}	9.38×10^{-6}	2.34×10^{-5}	3.02×10^{-5}

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix B for the sampling location codes.

Location	Quarter	[RN][a]	2xTPU[b]	MDC[c]	[RN]	2xTPU	MDC
		^{90}Sr			^{137}Cs		
CBD	1	1.43×10^{-6}	2.80×10^{-6}	4.74×10^{-3}	-3.75×10^{-6}	1.55×10^{-5}	1.78×10^{-5}
CBD	2	-1.19×10^{-6}	3.00×10^{-6}	5.23×10^{-6}	7.82×10^{-6}	2.05×10^{-5}	2.29×10^{-5}
CBD	3	1.59×10^{-6}	3.74×10^{-6}	6.44×10^{-6}	1.30×10^{-6}	1.46×10^{-5}	1.73×10^{-5}
CBD	4	-2.68×10^{-3}	6.26×10^{-3}	1.30×10^{-2}	-3.79×10^{-5}	2.93×10^{-5}	2.80×10^{-5}
MLR	1	5.04×10^{-7}	2.74×10^{-6}	4.70×10^{-6}	-4.34×10^{-6}	1.58×10^{-5}	1.81×10^{-5}
MLR	2	-2.32×10^{-6}	3.28×10^{-6}	5.78×10^{-6}	-6.17×10^{-5}	4.12×10^{-5}	3.81×10^{-5}
MLR	3	3.82×10^{-6}	3.91×10^{-6}	6.58×10^{-6}	-1.63×10^{-6}	3.25×10^{-5}	3.61×10^{-5}
MLR	4	-8.19×10^{-3}	6.76×10^{-3}	1.39×10^{-2}	6.75×10^{-6}	1.72×10^{-5}	1.90×10^{-5}
SEC	1	-9.03×10^{-7}	2.64×10^{-6}	4.63×10^{-6}	-2.26×10^{-5}	2.31×10^{-5}	2.33×10^{-5}
SEC	2	-2.18×10^{-6}	2.99×10^{-6}	5.26×10^{-6}	-3.06×10^{-5}	3.62×10^{-5}	3.61×10^{-5}
SEC	3	-1.36×10^{-7}	3.66×10^{-6}	6.43×10^{-6}	-4.94×10^{-5}	3.50×10^{-5}	3.46×10^{-5}
SEC	4	-8.20×10^{-3}	6.77×10^{-3}	1.39×10^{-2}	1.03×10^{-5}	1.24×10^{-5}	1.51×10^{-5}
SMR	1	-1.05×10^{-6}	2.60×10^{-6}	4.57×10^{-6}	-1.65×10^{-5}	2.32×10^{-5}	2.41×10^{-5}
SMR	2	-1.91×10^{-6}	2.94×10^{-6}	5.18×10^{-6}	-3.79×10^{-5}	3.68×10^{-5}	3.59×10^{-5}
SMR	3	-3.44×10^{-7}	3.74×10^{-6}	6.60×10^{-6}	1.29×10^{-6}	1.45×10^{-5}	1.72×10^{-5}
SMR	4	-5.98×10^{-3}	6.85×10^{-3}	1.38×10^{-2}	1.30×10^{-5}	1.69×10^{-5}	1.91×10^{-5}
WEE	1	-4.11×10^{-7}	2.73×10^{-6}	4.76×10^{-6}	-7.92×10^{-6}	2.25×10^{-5}	2.44×10^{-5}
WEE	2	-1.54×10^{-6}	3.18×10^{-6}	5.58×10^{-6}	-5.53×10^{-5}	3.79×10^{-5}	3.56×10^{-5}
WEE	3	2.39×10^{-6}	3.90×10^{-6}	6.68×10^{-6}	-1.09×10^{-5}	3.27×10^{-5}	3.56×10^{-5}
WEE	4	-2.04×10^{-3}	6.43×10^{-3}	1.32×10^{-2}	1.22×10^{-5}	1.74×10^{-5}	1.95×10^{-5}
WFF	1	-7.64×10^{-7}	2.72×10^{-6}	4.76×10^{-6}	-4.70×10^{-6}	1.59×10^{-5}	1.82×10^{-5}
WFF	2	5.17×10^{-7}	3.32×10^{-6}	5.66×10^{-6}	5.06×10^{-6}	2.36×10^{-5}	2.58×10^{-5}
WFF	3	-1.49×10^{-6}	4.00×10^{-6}	7.11×10^{-6}	-6.72×10^{-6}	1.76×10^{-5}	2.00×10^{-5}
WFF	4	4.71×10^{-3}	6.24×10^{-3}	1.29×10^{-2}	2.47×10^{-6}	1.23×10^{-5}	1.46×10^{-5}
WSS	1	8.20×10^{-7}	3.28×10^{-6}	5.61×10^{-6}	1.10×10^{-5}	1.75×10^{-5}	2.15×10^{-5}
WSS	2	-5.38×10^{-7}	3.05×10^{-6}	5.27×10^{-6}	1.43×10^{-5}	2.07×10^{-5}	2.36×10^{-5}
WSS	3	1.94×10^{-6}	3.76×10^{-6}	6.45×10^{-6}	-1.05×10^{-5}	3.17×10^{-5}	3.61×10^{-5}
WSS	4	1.40×10^{-3}	6.55×10^{-3}	1.32×10^{-2}	-6.85×10^{-5}	3.33×10^{-5}	2.95×10^{-5}
WAB	1	-4.47×10^{-4}	2.06×10^{-2}	3.57×10^{-2}	-2.79×10^{-1}	2.53×10^{-1}	2.52×10^{-1}
WAB	2	5.37×10^{-3}	1.17×10^{-2}	2.00×10^{-2}	7.82×10^{-6}	2.05×10^{-5}	2.29×10^{-5}
WAB	3	3.60×10^{-3}	1.37×10^{-2}	2.37×10^{-2}	2.40×10^{-2}	1.15×10^{-1}	1.37×10^{-1}
WAB	4	-5.80×10^{-3}	6.58×10^{-3}	1.34×10^{-2}	-1.44×10^{-1}	2.21×10^{-1}	2.35×10^{-1}
Minimum		-8.20×10^{-3}	2.60×10^{-6}	4.57×10^{-6}	-6.85×10^{-5}	1.23×10^{-5}	1.46×10^{-5}
Maximum		4.71×10^{-3}	6.85×10^{-3}	1.39×10^{-2}	1.43×10^{-5}	4.12×10^{-5}	3.81×10^{-5}
Mean[d]		-7.49×10^{-4}	5.20×10^{-3}	3.53×10^{-3}	-1.23×10^{-5}	4.71×10^{-5}	2.53×10^{-5}

[a] Radionuclide concentration
[b] Total Propagated uncertainty
[c] Minimum detectable concentration
[d] Arithmetic average concentration and MDC; TPU equals the standard deviation of the mean.
[e] Not applicable