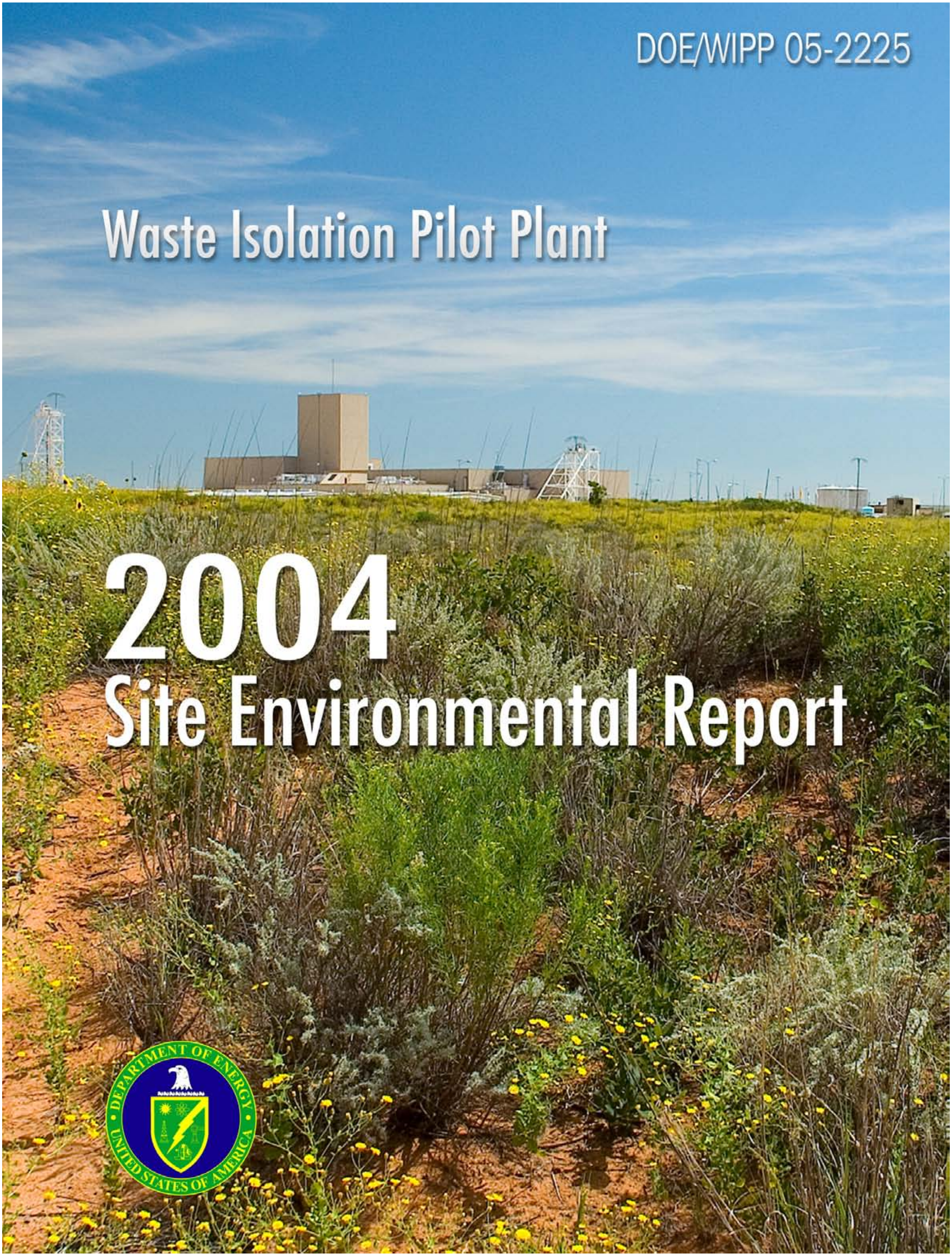
DOE/WIPP 05-2225

Waste Isolation Pilot Plant

2004 Site Environmental Report



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EXECUTIVE SUMMARY

The mission of Waste Isolation Pilot Plant (WIPP) is to safely and permanently dispose of transuranic (TRU) radioactive waste generated by the production of nuclear weapons and other activities related to the national defense of the United States (U.S.). In 2004, 8,839 cubic meters (m^3) of TRU waste were emplaced at WIPP. From the first receipt of waste in March 1999 through the end of 2004, 25,809 m^3 of TRU waste had 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*; DOE Order 231.1A, *Environment, Safety, and Health Reporting*; and DOE Order 5400.5, *Radiation Protection of the Public and Environment*, 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 2004 Site Environmental Report* (SER) summarizes environmental data from 2004 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 2004* (DOE, 2005). The order and the 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. These are accomplished through a 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. 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.

As part of its environmental monitoring programs, WIPP conducts effluent surveillance monitoring to collect, assess, and document environmental data to determine if WIPP operations have caused adverse impacts to the public and the environment. These programs are also used to ensure that WIPP operations comply with DOE and other applicable federal and state standards and requirements. The Environmental Monitoring Program is designed to monitor potential 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, or is being, impacted by WIPP operations and if so, to evaluate the geographic extent and the effects on the environment.

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, National Defense Authorization Act for Fiscal Year 1997). This plan identifies resource values, promotes multiple-use management, and identifies long-term goals for the management of WIPP lands. The LMP includes a land reclamation program that addresses both the short-term and long-term effects of WIPP operations. 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 the DOE to assess field environmental program performance and confirm compliance with environmental standards and requirements. This report also provides information about WIPP's environmental performance to stakeholders and members of the public. The 2004 SER also outlines significant environmental programs and efforts of environmental merit at WIPP for 2004:

- Performance of radiation protection programs including controlling radiological doses and releases.
- Implementation of the WIPP environmental performance measures program.
- Implementation of the WIPP Groundwater Monitoring Program.
- Integration of the WIPP Environmental Management System (EMS) within the framework of the Integrated Safety Management System (ISMS).
- Development of WIPP site-specific P2 goals and the WIPP Affirmative Procurement Program.

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 fiscal year (FY) 2004 have been met and new performance goals have been established for FY 2005. WIPP's practice of establishing, implementing, tracking, trending, analyzing, and reporting environmental performance measures is consistent with the ISMS fifth core function, Feedback and Continuous Improvement.

Environmental Management System

The WIPP EMS continues to provide the framework and roadmap for achieving its environmental policy within the context of the WIPP ISMS. The system has been in place and functioning since at least 1998. Relative to implementation, the system can be viewed as being in a continual improvement stage for the majority, if not all, of its elements. The EMS is anticipated to be ready for self-declaration as meeting DOE Order 450.1, *Environmental Protection Program*, requirements in October 2005.

The WIPP EMS conforms to the guiding principles of the International Organization for Standardization (ISO) 14001, *Environmental Management Systems – Specification With Guidance for Use* (ISO, 1996). WIPP's ISMS is integrated with the EMS, and provides the structure for 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 the WIPP environmental policy. The *WIPP Environmental Management System Description* (WP 02-EC.0) document has been revised and made the EMS applicable to a broader range of activities.

As a result of the continual improvement process, the following actions were taken in 2004:

- A new environmental policy statement was developed and signed by CBFO and WTS.

- The EMS description document underwent significant revisions to continue the process of integration with the WIPP ISMS. These included adding a crosswalk between the two systems, additional discussion of the CBFO's role in the EMS and the creation of an ISMS-EMS Procedural Integration Table.

- Aspects and Impacts were updated to include an additional Central Characterization Project activity.

- Assessment results continued to be analyzed and categorized in terms of ISMS Core Functions in order to better understand which areas of the system need focus for improvement.

- WIPP-specific annual environment performance goals and measures were established to continue to work toward accomplishment of the Secretary of Energy's 2010 sanitary waste reduction goal and to progress WIPP beyond the Secretary of Energy's remaining 2005 goals.

Pollution Prevention

Noteworthy P2 activities in 2004 included the following:

- Completion of pollution prevention opportunity assessments (PPOAs). The first was to evaluate eliminating the provision of individual plastic water bottles in the underground which led to recycling of these plastic bottles in 2005 rather than not providing the bottled water. The second was to evaluate the substitution of bio-diesel fuel in place of diesel fuel in underground vehicles.

- Recycling used fluorescent lamps.

- Considerable emphasis was placed on improving communications to employees related to environmental awareness and pollution prevention including articles in internal newsletters, creation and distribution of a comprehensive recycling brochure, enhanced labeling information on recycling centers, and presentation of environmental topics at staff safety meetings.

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 2004:

NMED Submittals

A. Hazardous Waste Facility Permit (HWFP)

- 2003 Site Environmental Report

- Annual Volatile Organic Compounds (VOCs) Monitoring and Mine Ventilation Report

- Quarterly Solid Waste Management Unit (SWMU) Activities Progress Reports

- Biennial Treatment, Storage, and Disposal (TSDF) Report

- Waste Minimization Statement

- Detection Monitoring Program Statistical Comparison Report

- Round 18 Water Quality Sampling Program (WQSP) Groundwater Report

- Round 19 WQSP Groundwater Report

- Geotechnical Analysis Report

- Monthly Water Level Report

B. New Mexico Water Quality Act

- Semiannual Discharge Monitoring Reports

<u>Environmental Protection Agency Submittals</u>

- 2004 Annual Change Report
- WIPP Compliance Recertification Application
- Toxic Chemical Release Inventory Report

Other correspondence, regulatory submittals, monitoring reports, and the results of the EPA Annual Inspection are described in Chapter 3 of this report.

<u>Federal Acquisition and Recycling</u>

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 acquisition and recycling programs in 2004.

<u>Internal Environmental Compliance Assessments</u>

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 (1) protect human health and the environment, and (2) are in compliance with applicable federal, state, and local requirements; permit conditions and requirements; and best management practices. During 2004, WTS performed four internal environmental compliance assessments. Each assessment confirmed that there were no instances of regulatory noncompliance. However, as expected, the assessments identified items for continuous improvement of the programs. The individual assessments along with selected improvement items from each are noted below.

- Underground Fuel Storage Tanks. Areas for improvement included record keeping, awareness of procedures, and communications with UST vendor.

- Pollution prevention, energy efficiency, and affirmative procurement programs. Four areas of improvement were identified, with two of these being the need to improve employee awareness of these programs, and improving recycling. Both of these have been focused on extensively during 2005.

- Compliance Configuration Management. Two areas for improvement were identified. These were related to procedural consistency and consistency in training between the HWFP screening procedure and training.

- Polychlorinated biphenyl (PCB) waste receipt and disposal readiness. Of the three improvement areas identified, one related to the improving procedural adequacy for reporting and notifications and another the delineation of organizational responsibility.

More detail concerning each of these assessments is included in Section 3.3.1. Areas for continuous improvement from all audits have been addressed though appropriate avenues of action planning with many of the improvements having been addressed successfully as of the publishing of this report. Any outstanding items continue to have actions taken so that improvements will be realized.

Volatile Organic Compound Monitoring

In 2004, VOC samples were collected twice weekly. The measured VOC concentrations upstream and downstream of the active waste disposal area and the differences between the concentrations at 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. There were no Tentatively Identified Compounds that exceeded concentrations that would warrant further investigation. All applicable HWFP requirements were met and no exceedance notifications to the NMED were required in 2004.

Groundwater Monitoring

In 2004, each of the seven water quality sampling wells was sampled twice. Samples were analyzed for 18 metals, 31 organic compounds, and 11 general chemistry parameters. Analytical results from the samples were below regulatory limits. The analytical data set from each well was compared to the groundwater baseline. Analytical values for the groundwater samples were within the statistical range established in the baseline. Therefore, HWFP groundwater monitoring requirements were met and no exceedance notifications to the NMED or the U.S. Environmental Protection Agency (EPA) were required in 2004.

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. The WIPP Environmental Monitoring Program monitors air, surface and groundwater, soils, sediments, and biota in the vicinity of WIPP. Plutonium (^{238}Pu and $^{239+240}$Pu), americium (^{241}Am), cobalt (^{60}Co), strontium (^{90}Sr), cesium (^{137}Cs), and uranium (^{234}U, ^{235}U, and ^{238}U) are monitored because they are likely components of TRU waste. Potassium-40 (^{40}P) is monitored because of its association with potash ore. Radionuclide concentrations observed were very small. These data indicate that there has been no adverse impact to the public or the environment due to WIPP operations in 2004.

Dose Limits

The regulatory basis for the WIPP Program is in Title 40 *Code of Federal Regulations* (CFR) Part 191, Subpart A, "Environmental Standards for Management and Storage." The referenced standard specifies that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 millirem (mrem) to the whole body and 75 mrem to any critical organ. In addition, in a 1995 Memorandum of Understanding between the EPA and the DOE, the DOE agreed that WIPP would comply with 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," hereafter referred to as the NESHAP (National Emissions Standards for Hazardous Air Pollutants), where it is appropriate. The NESHAP standard states that the 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 effective dose equivalent (EDE) of 10 mrem per year.

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). Site-specific background gamma measurements on the surface, conducted by Sandia National Laboratories at WIPP, showed average dose rate of 7.65 microR/hour (Minnema and Brewer, 1983) which would equate to the background gamma radiation dose of 0.153 mSv (15.3 mrem) per year assuming 2000 work hours in a year. A comprehensive radiological baseline study before WIPP operations was also documented in DOE/WIPP 92-037, *Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant,* which provides the basis for environmental background comparison after the WIPP operation commenced (DOE/WIPP 92-037, 1992).

Dose from Air Emissions

In 40 CFR Part 191, Subpart A, the EPA emphasized doses from releases by means of the air pathway, because WIPP has identified air emissions as the major pathway of concern for potential radionuclide transport during the receipt and emplacement of waste at the WIPP through the underground exhaust shaft. To determine the potential radiation dose received by members of the public from WIPP, WIPP used the emission monitoring and test procedure for DOE facilities (40 CFR §61.93, "Emission Monitoring and Test Procedure"), which requires the use of the EPA-approved 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 dose to an individual from the potential ingestion of WIPP-related radionuclides transported in water is nonexistent because 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 2004 were mule deer and quail. The only radionuclides detected were not different from baseline levels. By extrapolation, no dose from WIPP-related radionuclides have been received by any individual from this pathway (e.g., the ingestion of meat from game animals) during 2004.

Based on the results of the WIPP Effluent Monitoring Program, concentrations of radionuclides in air emissions did not exceed regulatory dose limits set by 40 CFR Part 191, Subpart A, and with 40 CFR Part 61, Subpart H. The results indicate that the hypothetical maximally exposed individual (MEI) that resides year-round at the WIPP fence line is less than 1.27E-06 mSv (1.27E-04 mrem) per year for the whole body, and is less than 2.11E-05 mSv (2.11E-03 mrem) per year for the critical organ. These values are in compliance with the Subpart A requirements specified in 40 CFR §191.03(b). For NESHAP (40 CFR §61.92) standards, the EDE potentially received by the MEI residing 7.5 km (4.66 miles) west-northwest of WIPP was calculated to be 5.69E-08 mSv (5.69E-06 mrem) per year whole body. This value is in compliance with the 40 CFR §61.92 requirements.

Chapter 4 of this report presents figures and tables that provide the EDE values from 1999 through 2004. Note that these EDE values are below the EPA limit specified in 40 CFR Part 191, Subpart A, and 40 CFR Part 61, Subpart H.

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 2004. 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 2004. 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, evaluation methods, and data verification and validation. The WIPP Laboratories, of Carlsbad, New Mexico; Carlsbad Environmental Monitoring and Research Center, of Carlsbad, New Mexico; 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
gpm	gallons per minute
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 Solids
TOC	Total Organic Compound
TOX	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 make WIPP environmental information available 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 2004.

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 defense activities and programs. TRU waste is defined, in the WIPP LWA, as radioactive waste containing more than 100 nanocuries (3,700 becquerels [Bq]) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years except for 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; sludges from solidified liquids; glass; metal; and other materials from dismantled buildings.

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 disposal rooms in the Salado Formation, a thick sequence of evaporite beds deposited approximately 250 million years ago (Figure 1.1). After each panel of seven rooms 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. One of the main attributes of salt, as a rock formation in which to isolate radioactive waste, is the ability of the salt to creep, that is, to deform continuously over time. Excavations into which the waste-filled drums are placed will close eventually, flowing around the drums and sealing them within the formation.

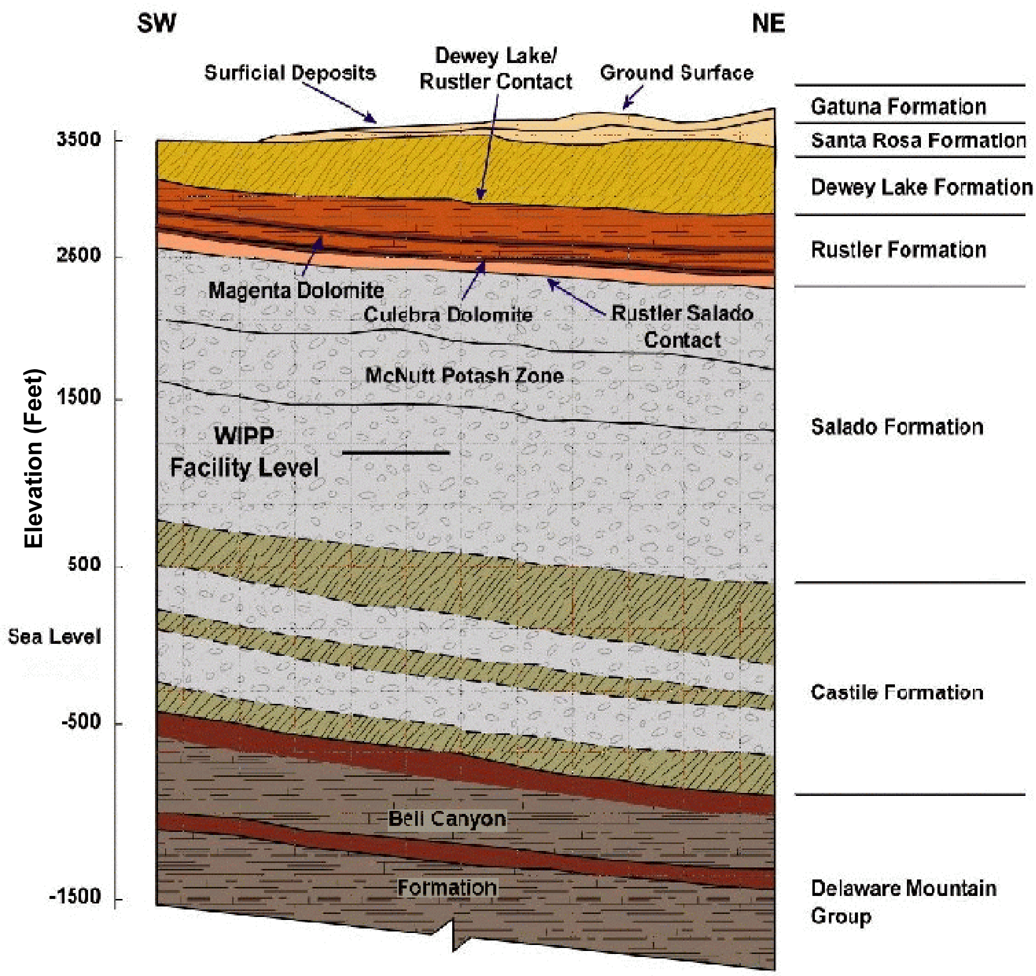

Figure 1.1 - WIPP Stratigraphy

1.1 WIPP's Mission

Current radioactive waste storage facilities at 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 planned 35-year 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 initiated an evaluation of stable geological formations to contain radioactive 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 biosphere.

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 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 geologic environment that has been stable for more than 200 million years. This proven stability over such a long time span suggests the likelihood that the salt will remain stable.

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 effort. 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 the WIPP HWFP, which allows WIPP to manage, store, and dispose of contact-handled (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).

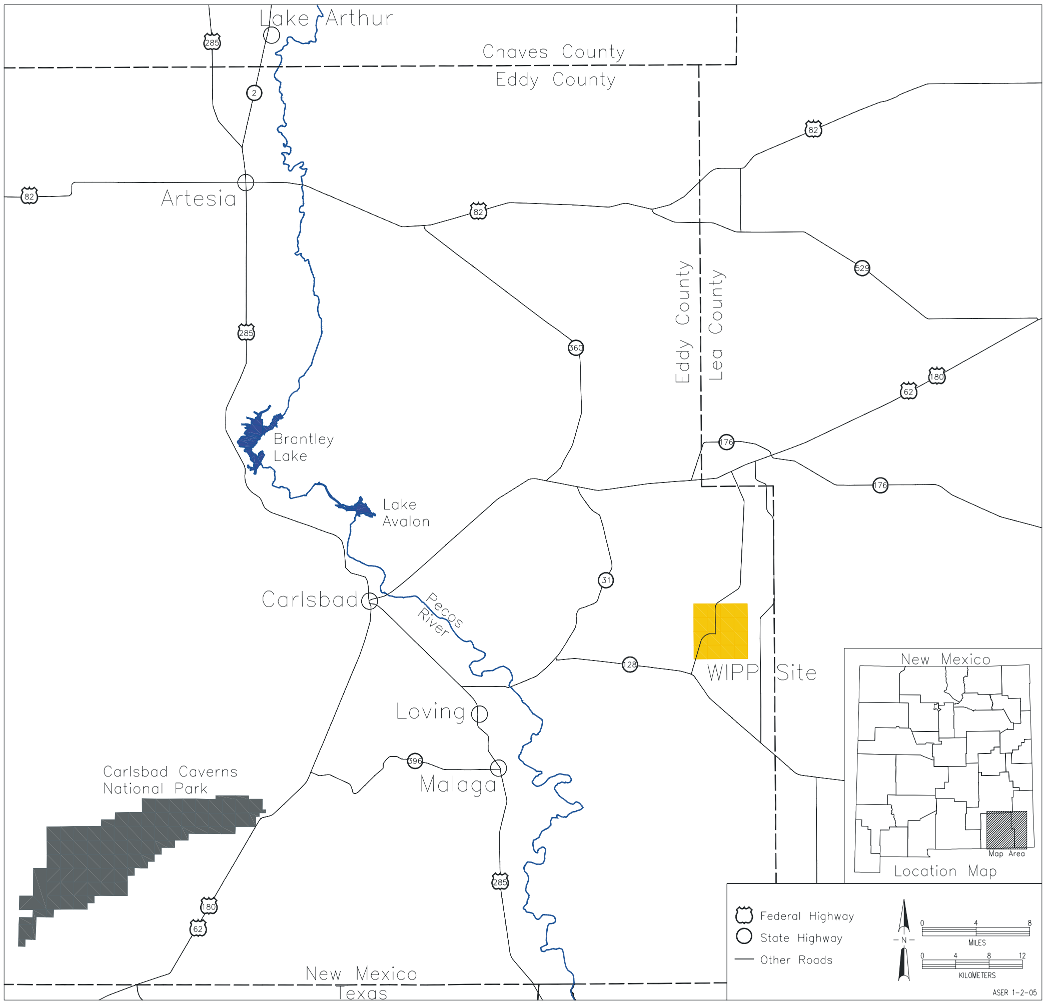

Figure 1.2 - WIPP Location

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 1.2 km^2 (.463 mi^2) Exclusive Use 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.

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) (approximately 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) (approximately 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 consequences of potential accidents 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 the 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) (approximately1,421 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 activities or use.

WIPP Land Withdrawal Area

The WIPP site boundary delineates the perimeter of the 41.4 km^2 (16 mi^2) (approximately10,240 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.

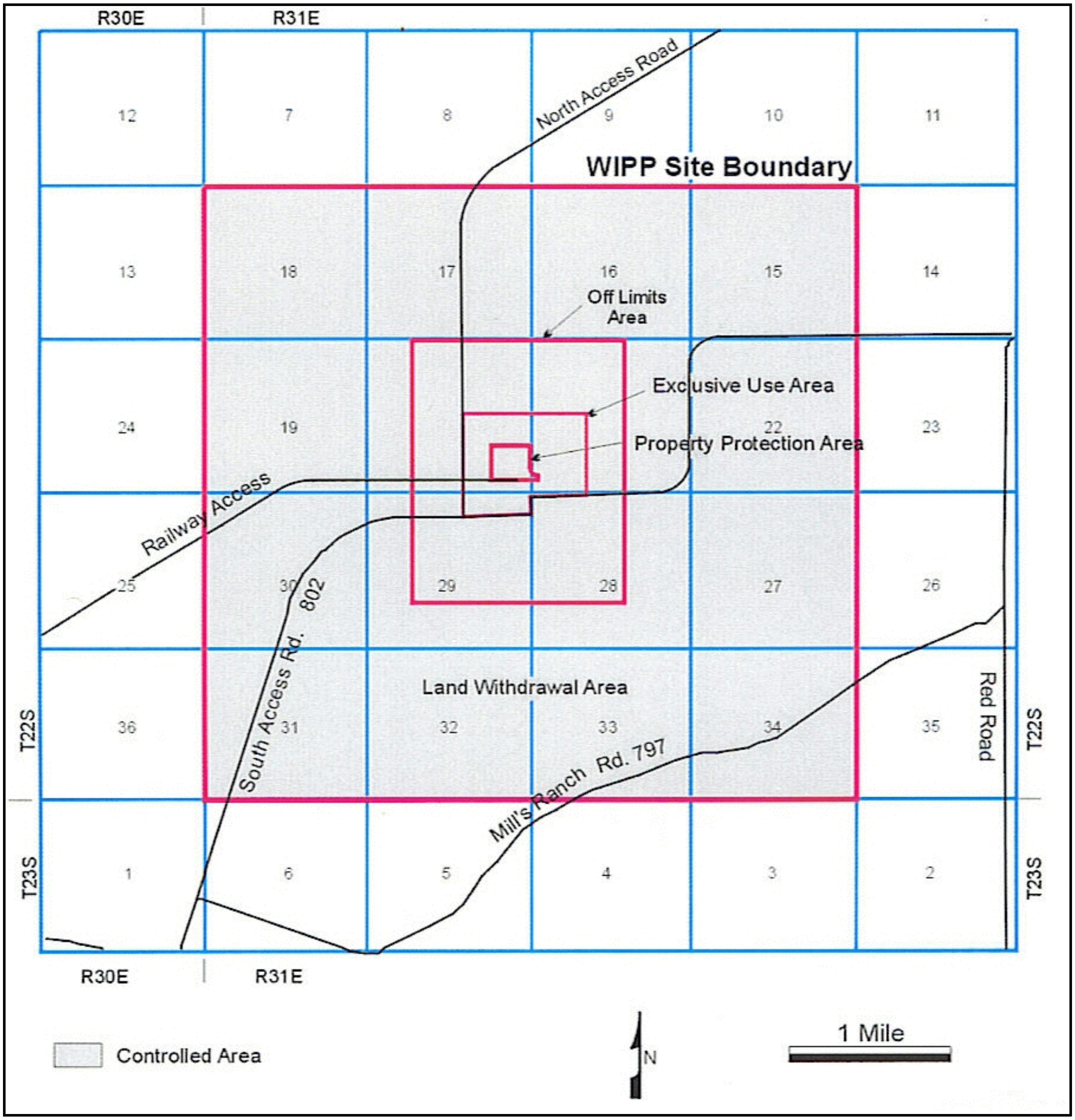

Figure 1.3 - WIPP Property Areas

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 (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 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. The provisions of DOE Order 450.1 are implemented by the WIPP environmental policy and the EMS. It also commits that the DOE will meet or exceed compliance with applicable environmental requirements.

In 2004, 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.

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 disposed of 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 (minimum)	(DP 831 permit[a]) Semiannual
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).

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 that operations comply with applicable federal and state requirements.

WIPP's Environmental Monitoring Program includes 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 and nearby populations 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. 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 adversely 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 was approved by Congress. 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 Memoranda 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) (42 U.S.C. §§4321-4335) 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 2004, three LURs were submitted for review and approval; all met applicable criteria and were approved.

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 (USFWS), 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 DOE/BLM MOU, the Joint Powers Agreement with the state of New Mexico, and 50 CFR Part 17, "Endangered and Threatened Plants and Wildlife."

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, and plugging and abandonment of wells.

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), beginning at a depth of 6000 feet 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 2004, WIPP surveillance teams conducted 24 scheduled surveillances and more than 100 field inspections.

Field personnel drove onto approximately 95 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 2004, 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 site, are field verified. This ensures that the proposed location is of sufficient distance from the WIPP boundary to protect the WIPP site 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 2004, daily logs were transmitted to WIPP for six new wells. Deviation calculations showed that there were no conditions to warrant suspicion of trespass.

2.4 Environmental Management System

WIPP has had an implemented Environmental Management System (EMS) since the mid-1990's and received its third-party registration to the ISO 14001 EMS standard in July of 1998. Although the site discontinued its registration in 2003, the commitment to maintain its EMS in accordance with the guiding principles of ISO 14001 has continued. Accordingly, CBFO and Washington TRU Solutions management continue to be committed, through the WIPP Environmental Policy (DOE/WIPP 04-3310) to

(1) continual improvement of environmental activities, (2) prevention of pollution and (3) compliance with applicable legal requirements.

Further discussion of the EMS, including its description, key elements, conformity declaration to DOE Order 450.1 and integration with the ISMS is included in Chapter 3.3.

As noted, the WIPP EMS is the system through which policy is achieved. An integral means for achieving policy occurs as WIPP's significant environmental aspects and impacts are appropriately addressed through implementation of environmental protection programs. These programs are discussed in more detail in this, and other, chapters of this report. Environmental protection programs are identified in the EMS Description Document (DOE/WIPP 05-3318) and in the ISMS/EMS procedural integration table available on the WIPPnet intranet site.

Key environmental programs with a brief description and/or reference to the location of more detailed discussion are included below.

The WIPP Land Management Plan addresses natural resources protection including environmental restoration (Section 2.3).

Safe, environmentally sound and compliant waste management of site generated wastes is achieved through implementation of the Hazardous and Universal Waste Management Plan (WP 02-RC.01), the Special Waste Management plan (WP 02-EC.02) and the Low-Level and Mixed Low-Level Waste Management Plan (WP 02-RC.05). More detailed information on compliance and results of these programs in included in Sections 3.2.3 and 3.3.2.

The WIPP Environmental Monitoring Plan (DOE/WIPP 99-2194) and program, directing the monitoring of radiological constituents in air effluent and in the ambient environment, are described more fully in Sections 2.1 and 2.2 of this chapter. The implementation and results of this program are included in Chapter 4. Data from the 2004 program indicates there is no impact to human health or the environment from WIPP and no changes to operations are needed.

Nonradiological monitoring is accomplished through implementation of several specific programs and procedures. These are identified in Chapter 5 of this site environmental report. The results of 2004 implementation indicate:

- Meteorological data has been successfully gathered to support atmospheric dispersion modeling.
- All VOC sample results were well below the concentrations of concern specified by the HWFP.
- Seismic activity has successfully been monitored and seismic events had no effect on WIPP structures.

- Discharge monitoring has been conducted to meet to meet the inspection monitoring and reporting requirements identified in the discharge permit with results summarized in Section 5.5.

Groundwater Protection and monitoring is directed by the WIPP Groundwater Monitoring Program Plan (WP 02-1) and supporting procedures as discussed in more detail in Chapters 3.2.7 and Chapter 6.

2.5 Environmental Performance

Performance measures/indicators for 2004 were focused on maintaining the sites achievement of the Secretary of Energy's goals. Sections 3.3.2 and 3.3.3 provide a more detailed summary of environmental performance. However, highlights for 2004 environmental performance include:

- WIPP met the Secretary of Energy's goals for decreases in all waste categories applicable to the site for 2004. These are hazardous (RCRA-regulated), low-level radioactive, low-level mixed radioactive, and sanitary wastes which had 90 percent, 80 percent, 80 percent, and 75 percent reduction goals compared to the baseline, respectively.

- A significant reduction in site-generated hazardous (RCRA-regulated waste) compared to the baseline was achieved (approximately 98 percent) due to the absence of characteristically hazardous brine waters in the WIPP underground.

- Although the quantity of paper, cardboard and plastic recyclables diminished as result of several challenges, the increased recycling of scrap metals resulted in the total recycling rate for sanitary and hazardous (RCRA-regulated) wastes for FY 2004 of 58.9 percent which is slightly higher than the FY 2003 rate of 51.8 percent.

- With the accomplishment of the Secretary of Energy's 2005 goals, WIPP established internal specific annual environmental performance goals and measures for 2005 and 2006.

WIPP internal procedures continue to control acquisition of chemicals and hazardous materials and to include periodic checks for the presence of ozone-depleting substances (ODSs) at the site in the internal assessment program. These actions provide assurance the site will continue to maintain its status of having eliminated ODS usage at the site.

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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 2004, WIPP maintained compliance with applicable federal and state environmental regulations. The following sections describe the site compliance posture for 2004. 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, et seq.), 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, "Designation, Reportable Quantities, and Notification." Hazardous substance cleanup procedures are specified in 40 CFR Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan." 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. §§11101, 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 was submitted to the EPA and to the SERC prior to the July 1, 2005, reporting deadline. Table 3.1 presents the 2004 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	Further Notification Not Required
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 2004, 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 pollution prevention (P2) programs are mandated by the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §6901, et seq.). Executive Order 13101, *Greening the Government Through Waste Prevention, Recycling, and*

Federal Acquisition; and EPA guidelines in 40 CFR Part 247, "Comprehensive Procurement Guideline for Products Containing Recovered Materials," 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.

For 2004, WIPP purchases of coated printing papers and commercial sanitary tissue products met the EPA's recycled content requirements. Historically, construction items purchased at WIPP (fly ash and concrete) have met the recycled content requirements and have been, tracked and reported. In 2004, the WIPP site did not purchase construction items applicable to the construction requirements and thus did not report in this category.

Although the site purchases environmentally preferable products, the ability to track and quantify all purchases of these products has been identified as an area for improvement. Site Environmental Compliance and Procurement personnel are initiating an effort to improve this system.

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. 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, et seq., 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, which became 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.

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 2004. This inspection occurred on January 22 and 23. One violation relating to an open container was identified. The violation was rescinded by the NMED in a letter dated August 26, 2004.

On August 24, 2004, the NMED issued a compliance order to the Permittees alleging violations of state hazardous waste management regulations. These violations concerned shipments of radioactive waste from the Idaho National Laboratory (INL) to WIPP between March and July 2004. DOE/WTS and the NMED signed a settlement agreement concluding the matter on February 11, 2005.

In 2004, 12 HWFP modifications were submitted to the NMED in accordance with 20.4.1.900 NMAC (incorporating 40 CFR Part 270), including six Class 1 notifications, four Class 2 requests, and two Class 3 requests (Table 3.2). The Class 1 notifications made necessary corrections/updates to information in the HWFP, such as key personnel names, update of Attachment A, and roof addition. The Class 2 requests provided operational flexibility, including equipment upgrades, drum-age criteria for approved waste containers, and a procedure for the consideration of tank waste. The Class 3 request will provide for container management improvements and a new waste analysis plan.

Table 3.2 - Permit Modification Requests Submitted During Calendar Year 2004

No.	Submittal Date	Class	Name	Number of Items
1	1/9/04	1	New CBFO Manager	1
2	1/16/04	1	New CBFO Manager 2	1
3	9/16/04	1*	Update Attachment A of the HWFP	1
4	9/30/04	1	Addition of a Roof to the Parking Area Container Storage Unit	1
5	11/5/04	1	Change in the DOE Field Office Department Manager	1
6	12/29/04	1	Change in the DOE Field Office Department Manager 2	1
7	1/7/04	2	Allow the Use of Track or Non-Track Conveyance Cars	1
8	1/7/04	2	Packaging Specific Drum-Age Criteria for New Approved Waste Containers	1
9	7/23/04	2	Procedure for the consideration of Tank Waste	1
10	11/23/04	2	Remove Trade Name on the Underground Push-Pull Attachment	1
11	1/7/04	3	Container Management Improvements	1
12	1/9/04	3	New Waste Analysis Plan	1

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, "Standards Applicable to Generators of Hazardous Waste."

WIPP Solid Waste Management Units and Areas of Concern

Module VII of the HWFP contains corrective action requirements for the WIPP Solid Waste Management Units (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 2004.

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 2004, 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 was used to produce a No Further Action (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.

WIPP is also in compliance with the HWFP conditions related to reporting as noted below:

- The Biennial Report was filed in 2004 for calendar year 2003. The report was transmitted to the NMED by the CBFO by letter dated February 25, 2004.

- The annual Waste Minimization Certification Statement was completed and placed in the operating record as of November 2004 and was transmitted by the CBFO to the NMED.

- HWFP Module IV, Section F, Maintenance and Monitoring, requires annual reports evaluating the geomechanical monitoring program and describing the implementation and results (data and analysis) of the Confirmatory VOC Monitoring Program and the Mine Ventilation Rate Monitoring Plan. WIPP continued to comply with these requirements by preparation and submission of these annual reports in October of 2004, representing 2003 results.

- HWFP Module V, Section V.J.2.a, requires reports of the analytical results for the semi-annual DMP sample and duplicate as well as results of the statistical analysis of the sample DMWs in which the determination was made that there is or is no statistically significant evidence of contamination. WIPP completed these requirements and submitted them to the CBFO for provision to the NMED as required.

3.2.4 National Environmental Policy Act

The NEPA (42 U.S.C. §§4321, et seq,) 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. The first WIPP Mitigation Action Plan was prepared in 1991. Additionally, the CBFO tracks the performance of mitigation commitments in WIPP's annual mitigation report. This report is issued in July of each year.

Day-to-day operational compliance with the NEPA at WIPP is achieved through implementation of a NEPA compliance plan and procedure. Sixty-three projects were reviewed and approved through the NEPA screening process in 2004. 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, et seq.) 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 waste waters generated at WIPP are either disposed of off-site or 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. WIPP does not have any discharges to surface water but does have a discharge permit for discharges that could impact groundwater.

WIPP was initially issued a permit from the NMED Ground Water Quality Bureau for the operation of the WIPP sewage treatment facility in January 1992. The discharge permit was renewed and modified to include the H-19 Evaporation Pond in July 1997. The H-19 Evaporation Pond is used for the treatment of wastewater generated during groundwater monitoring activities, mine dewatering and condensation from the mine ventilation system's duct work. This permit was last renewed in April of 2003.

A discharge permit modification application was submitted to the Ground Water Quality Bureau in April 2003. The discharge permit modification application was approved on December 22, 2003. The Ground Water Quality Bureau approved the infiltration control measures the DOE proposed to minimize the potential of the subsurface shallow water impacting naturally occurring groundwater in the region. Those controls consist of the following:

- The construction of a new salt storage area with a 60-millimeter synthetic liner and an associated double lined evaporation pond to contain and evaporate salt contact storm water runoff.

- Changes to the shape and the addition of a cap consisting of a synthetic liner and soil cover to the existing salt pile to prevent or minimize, the infiltration of stormwater into the salt pile.

- Construction of a lined evaporation pond to minimize the infiltration of stormwater from the covered salt pile into the subsurface.

- Lining three stormwater detention ponds that receive runoff from the WIPP site and parking lot area to minimize the infiltration of storm water to the subsurface.

- Monitoring the subsurface shallow water levels and water chemistry to determine if the infiltration controls are effective.

Construction of the infiltration controls began in September 2003. As of January 2005 all infiltration controls have been constructed with exception of the installation of a synthetic liner in Storm Water Infiltration Control Pond A. Completion of the installation of the liner in this pond has been delayed by unusually high precipitation.

Two semiannual discharge monitoring reports were submitted to the NMED for the 2004 reporting period to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in the discharge plan. As shown by the monitoring results, located in Chapter 5, Tables 5.3 and 5.4, the sample results were below action levels.

The NMED was notified of the release of an estimated 300 gallons of sewage from a damaged sewer line on June 3, 2004. The release was the result of heavy equipment driving over the buried sewer line during the construction of Storm Water Infiltration Control Pond A. The broken sewer line was promptly repaired and the area decontaminated using calcium hypochlorite.

The Ground Water Quality Bureau conducted an inspection of the WIPP facility for compliance with the Discharge Permit requirements and Ground and Surface Water Protection Regulations set forth in 20.6.2 NMAC on August 11, 2004. During the inspection, WIPP was requested to provide an inspection plan for the sewage lagoon liners to determine their integrity and information regarding the replacement of a geotextile cushion in the conceptual design of the salt pile with a cushion of screened native soil, and information related to the paved and unpaved portions of the WIPP facility. This information was provided to the Ground Water Quality Bureau as requested. WIPP proposed to establish a contract with a specialist in synthetic liner leak detection and location using an electronic method that meets the requirements of ASTM Standard D-6747-04, "Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembrane."

The Ground Water Quality Bureau issued letter on September 8, 2004, requiring WIPP to submit within 120 days an application for the modification of the discharge permit that included:

- An evaluation of all options for the ultimate disposition of salt piles
- A more comprehensive closure plan addressing the final disposition of all active and inactive salt piles
- Full disclosure of other potential sources of groundwater contamination addressing other sources of potential groundwater contamination, namely the solid waste management units outlined in the RCRA Facility Assessment and Hazardous Waste Facility Permit.

On October 19, 2004, the DOE and the WIPP Management and Operating Contractor met with the Ground Water Quality Bureau and explained:

- The reclamation of the Site Preliminary Design and Validation Salt Pile, which consisted largely of soil and salt from the initial excavation of the Salt Shaft and Waste Shaft.
- The Closure Plans WIPP is subject to pursuant to the Hazardous Waste Facility Permit, the Compliance Certification Application.
- The WIPP Land Withdrawal Act requirements that all mined salt be dispositioned in accordance with the Materials Act of 1947 (30 U.S.C. §§602, 603).
- The status of Solid Waste Management Units and WIPP's No Further Action Petition for Solid Waste Management Units presented to the Hazardous Waste Bureau.

A permit modification application was submitted by WIPP to the Ground Water Quality Bureau on March 4, 2005.

During this reporting period, the Ground Water Quality Bureau was notified on two occasions (October 28, 2004, and November 23, 2004) of the loss of freeboard in the sewage lagoons and once (December 10, 2004) for the loss of freeboard in the H-19 Evaporation Pond due to high rates of precipitation with reference to the discharge permit condition to maintain two feet of freeboard at all times. The Ground Water Quality Bureau approved WIPP's corrective actions for the loss of freeboard and no releases occurred as the result of the loss of freeboard in these ponds.

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 samples will be collected between June and September 2005.

Bacterial samples were collected and residual chlorine levels were tested monthly throughout 2004. Chlorine levels were reported to the NMED monthly. 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. No archaeological investigations were conducted during 2004.

3.2.10 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) (15 U.S.C. §2601, 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 the 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, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." 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, EPA Region VI approved the disposal of waste containing PCBs per the Initial Report. No waste containing PCBs above the TSCA regulatory threshold of 50 ppm was shipped to the site in 2004. The required PCB annual report was submitted to EPA Region VI on July 15, 2004.

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 USFWS. A biological assessment and "formal consultation," followed by the issuance of a "biological opinion" by the USFWS, 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, et seq.) 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, "Migratory Bird Hunting"), 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 2004.

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, et seq.) 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. A list of WIPP active rights-of-way is included in Appendix B of this report.

3.2.15 Federal Facilities Compliance Act

The Federal Facilities Compliance Act (FFCA) of 1992 (42 U.S.C. §§6912, et seq.) 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 FFCA 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 FFCA 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 exempted from the land disposal restriction treatment requirements found in 42 U.S.C. §6924(m), pursuant to Section 9 of the WIPP Land Withdrawal Act of 1992 (Pub. L. 102-579, as amended by Pub. L. 104-201).

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 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 and are addressed in further detail in Chapter 4.

The EPA conducted its annual inspection of the WIPP monitoring programs during the week of June 28, 2004, in accordance with 40 CFR §194.21 and 40 CFR Part 191, Subpart A. The WIPP programs inspected included waste management and storage, waste emplacement, and certification monitoring parameters. The EPA determined that the activities related to emissions monitoring of waste management and storage complied with the requirements of 40 CFR Part 191, Subpart A. In addition, the EPA determined waste emplacement and monitoring activities were consistent with the Compliance Certification Application. The EPA identified one concern related to waste emplacement. The total amount of magnesium oxide (MgO) could not be verified because the DOE did not appear to have a system to track and calculate the MgO emplaced with WIPP waste in the repository. The response, provided on September 29, 2004, stated that the DOE will take necessary measures to ensure, per 40 CFR §191.14 and the EPA's certification of WIPP, that sufficient amounts of MgO are emplaced within the repository. On October 20, 2004, the DOE provided the EPA a description of their approach for tracking MgO. Specific plans to meet present requirements are being developed by the CBFO.

The EPA's authority over WIPP, and the basis for the EPA's certification and recertification of WIPP as a TRU waste disposal facility, were established by Section 8 of the WIPP LWA, which required the EPA to issue final disposal regulations (40 CFR Part 191) and WIPP specific criteria (40 CFR Part 194). The DOE demonstrated compliance with the EPA's final disposal regulations in a Compliance Certification Application (CCA) submitted to the EPA in October 1996. The EPA certified WIPP as a TRU waste disposal facility on May 18, 1998. Section 8 of the LWA also requires the EPA, subsequent to the initial certification, to conduct periodic recertifications of compliance beginning five years after the initial receipt of TRU waste for disposal (March 26, 1999) and at five year intervals thereafter until the end of the decommissioning phase. The DOE submitted a Compliance Recertification Application to the EPA on March 26, 2004, and it is currently being reviewed.

The WIPP-specific criteria also established reporting requirements for the DOE. The criterion of 40 CFR §194.4 provides requirements and schedules for reporting planned and unplanned changes that are significant or nonsignificant to the certification/recertification. This section also addresses reporting requirements for a release or expected release and the required reporting schedules. In calendar year 2004, the DOE did not report any releases or expected releases nor did they submit any reports on significant planned or unplanned changes to the EPA. The DOE did, however, receive approval on March 26, 2004, to proceed with a planned change submitted to the EPA in December of 2002 to dispose of compressed waste from the Idaho National Environmental and Engineering Laboratory's Advanced Mixed Waste Treatment Facility in the WIPP repository. On November 10, 2004, the DOE submitted the *Annual Change Report - 2004-2005*, DOE/WIPP 04-3317, documenting nonsignificant changes to the certification. This report also provided copies of the following monitoring reports that are of interest to the EPA.

- *Delaware Basin Monitoring Annual Report*, DOE/WIPP 99-2308
- *Geotechnical Analysis Report for July 2002 – June 2003*, DOE/WIPP 04-3177, Volumes 1 & 2, March 2004
- Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2003, Revision 1, June 2004

- *Waste Isolation Pilot Plant Site Environmental Report Calendar Year 2002*, DOE/WIPP 03-2225, September 2003

- *Waste Isolation Pilot Plant Subsidence Monument Leveling Survey 2003*, DOE/WIPP 04-2293, October 2003

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 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 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. 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 EMSs into ISMSs 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, and procedures, which are discussed in more detail in Sections 2.4 and 3.3.2.

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.

3.2.17.9 DOE Order 5480.4, *Environmental Protection, Safety and Health Protection Standards (Portions)*

This order specifies and provides requirements for the application of the mandatory environmental protection, safety, and health standards applicable to all DOE and contractor operations, contains a listing of those standards, and identifies the sources of the mandatory and reference standards. The standards are implemented through the RCRA Contingency Plan; the MOC transportation program, and the hazardous waste management plan. Portions of this order have been replaced by DOE Order 440.1A, Worker Protection Management for DOE Federal and Contractor Employees.

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.

The DOE adopted and implemented its Environmentally Preferable Products (EPP) Program. This program requires all of its facilities to develop and institute affirmative procurement and P2 plans.

WIPP has implemented the WIPP Affirmative Procurement Plan (WP 02-EC.07) and the WIPP Pollution Prevention Program Plan (WP 02-EC.11) to comply with EO 13101. In keeping with the leadership commitment of continuous improvement, an internal assessment of these programs was completed in 2004 as noted in Section 3.3.1. As a result of this assessment, efforts are ongoing to strengthen these programs by updating the program documents, revalidating the methods for quantifying recycled materials, establishing a more effective means for routinely getting materials to the local recycling vendor, reestablishing the P2 website, and improving employee awareness.

Sections 3.2.2, 3.3.2, and 3.3.3 of this chapter further discuss compliance with this order.

3.2.19 Executive Order 13123, *Greening the Government Through Efficient Energy Management*

This executive order recognizes that the federal government is the nation's largest energy consumer. Consequently, all federal government agencies are required to significantly improve energy management in all federal facilities in order to save taxpayer dollars and reduce emissions that contribute to air pollution and global climate change. Federal government agencies are expected to adopt energy efficiency (E2) in building design, construction, and operation. Federal government agencies are expected to promote E2, water conservation, and the use of renewable energy products, and help foster markets for emerging technologies.

WIPP implements the requirements of this order through the WIPP Energy Management Plan. The plan, which is updated and provided to the DOE's CBFO semiannually, summarizes the significant progress the WIPP site has made in this arena and demonstrates compliance with this order. Examples of progress made in energy management include:

- Greenhouse gas emissions attributable to facility energy usage did not increase between completion of the construction phase and the operational phases. In addition, emissions did not increase even though the site is achieving throughput rates beyond the original design.

- Building energy consumption shifted from an overall FY 1991 Baseline of 245.5 MBTU/SQFT/YR to 119 MBTU/SQFT/YR in FY 2004. This change includes both completion of the primary power metering system and prudent conservation practices.

3.2.20 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's requirements with the exception of environmentally and economically beneficial landscaping and reductions in ozone depleting substances. Environmentally beneficial landscaping practices were not relevant to the site as there was no new construction or redesign work that generated landscaping projects during the year. Reductions in ODSs is also not relevant to this site in 2004 as were confirmed as being eliminated through assessments. Future acquisition of ODS is restricted through internal procedures.

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 2004.

An assessment of compliance with Underground Fuel Storage Tanks requirements was conducted on March 15-16, 2004. No instances of regulatory noncompliance were identified during the assessment. Concerns identified during the assessment pertained to record keeping, procedural awareness, data transcription, communications with the UST vendor, and task training.

An assessment of pollution prevention, energy efficiency, and affirmative procurement programs was conducted May 17-25, 2004. No instances of regulatory noncompliance were identified during the assessment. Changes were proposed by the assessment team to improve the effectiveness of the assessed programs, including updating a procedure, revalidating the amount of waste that is recycled, improving recycling, and improving employee awareness.

An assessment of Compliance Configuration Management was performed August 9-12, 2004, to evaluate processes used to ensure compliance with environmental regulatory requirements as new actions/activities are proposed, facility modifications are proposed, and/or implementing documents are revised. No instances of regulatory noncompliance were identified during the assessment. Concerns identified during the assessment pertained to procedural consistency for NEPA compliance, and consistency between the HWFP screening training and HWFP screening procedure.

An assessment of PCB receipt and disposal readiness was conducted October 27-29, 2004. The assessment evaluated the processes used to ensure compliance with the requirements of handling and disposal of PCBs mixed with TRU waste at WIPP. No instances of regulatory noncompliance were identified during the assessment. Concerns identified during the assessment included delineation of organizational responsibility, procedural adequacy for reporting and notifications, and personnel access to the current EPA Conditions of Approval document.

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 EMS into their ISMS by December 31, 2005. As noted in Section 2.4, WIPP has had the EMS in place since the mid 1990's and has continued to improve the system since that time. Based on integration activities since issuance of the order and internal review, WIPP has established that EMS integration into the ISMS is nearing completion. The CBFO anticipates self-declaration by October 2005.

The Environmental Management System Description (WP 02-EC.0) describes the EMS at WIPP. The EMS description document is available to employees through the WIPP Q&MIS® (Quality and Manufacturing Integrated Systems) electronic document control system. The document also serves as a road map for the implementation of the EMS and clarifies how ISMS/EMS integration is achieved. The ISMS description document, *Integrated Safety Management System* (DOE/CBFO 98-2276), also describes how the EMS is integrated into the ISMS.

The EMS Description document was revised extensively in 2004 in response to 2003 ISMS Annual Review comments. Similarly, in response to the 2004 ISMS Annual Review, the EMS Description document will be reformatted and reissued in 2005 as a CBFO-level document. This signifies the DOE's commitment to fully integrate the EMS into the ISMS. In addition, an ISMS/EMS procedural integration table has been developed to provide a guide that describes how programs, plans and procedures are related to the ISMS and EMS.

Policy

The WTS General Manager issued Management Policy (MP) 1.14, Environmental Management, to communicate senior management commitment to the WIPP environmental policy and to establish performance expectations. MP 1.14 was revised and reissued in March 2004. However, in November 2004, the CBFO and WTS issued the *WIPP Environmental Policy Statement* (DOE/WIPP 04-3310), which supercedes MP 1.14. This new policy constitutes the basis 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 new policy statement reflects the CBFO and WTS commitment to environmental excellence and stewardship through joint ownership.

The WIPP Environmental Policy Statement 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 (including identification of Aspects and Impacts)

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 maintains 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. Beginning in 2004, alpha numeric codes were applied to the aspects and impacts listed in Attachment 1 as a means to track performance relative to EMS goals and targets in the Complexwide Integration Tool (CWIT) project management system.

Objectives and Targets

WIPP has established environmental objectives and targets that support the site 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 P2 and E2 goals.

In December 2004, WTS and the CBFO developed a comprehensive list of P2 and E2 goals for FY 2005 and FY 2006 (see also the discussion on EMS Performance Measures, below). These goals are accessible to employees through the WIPP intranet site. The current goals may be viewed on the WIPP Internet Homepage at www.wipp.ws.

Implementation and Operation

Successful implementation of an EMS needs the support of all employees, especially demonstrated senior management commitment. 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. Training specific to the WIPP Environmental Policy Statement, the EMS, P2 goals, and affirmative procurement is included in both the General Employee Training (GET) and GET Refresher modules which are updated annually.

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, and WIPP environmental permits; and (3) embody good management practices.

Assessments that were conducted in 2004 are summarized in Section 3.3.1.

Senior Management Review Process

To ensure that the WIPP EMS remains suitable, adequate, and effective, an annual report that evaluates the EMS is submitted to senior management. Beginning in 2004, the Annual EMS Report to Senior Management was submitted to both the CBFO and WTS Senior management for review. The report includes information from both compliance and EMS assessments/audits, facility changes, and progress toward meeting the site objectives and targets. When appropriate, the report includes recommendations regarding the need for changes to the Environmental Policy Statement, 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 2004, and the percent reduction relative to the 1993 baseline (2000 baseline for radioactive and mixed wastes) are listed in Table 3.3.

Table 3.3 - 2004 WIPP Waste Volumes and Reduction Goals for FY 2005

Waste Type	Baseline (Metric Tons)	2004 Actual (Metric Tons)	% Reduction From Baseline
RCRA (Hazardous)	5.14	1.09	78
RCRA leaded brine (1995 baseline)	58.63	0	100
Low-level radioactive (2000 baseline)	0.8	0	100
Low-level mixed radioactive (2000 baseline)	0.02	0	100
Sanitary	1,224	91.2	92
Medical	0.03	0.0359	N/A, No required waste stream reduction

The Secretary of Energy is currently developing new P2 policy and performance-based goals to supplement those in effect through 2010. In the interim, WIPP will continue to adopt the existing DOE goals for sanitary waste but will also implement the WIPP-specific P2 and E2 goals developed in 2004.

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 has been insignificant.

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, scrap metal, fire extinguishers, wet batteries, ethylene glycol, Safety-Kleen® solvent, computer equipment, aluminum cans, toner cartridges, cardboard and paper.

<u>Pollution Prevention Activities</u>

Two Pollution Prevention Opportunity Assessments (PPOAs) were prepared and submitted to the CBFO in 2004 for review and approval:

- *SEC-PPOA-2004-002 - Bio-Diesel Use in WIPP Underground Vehicles*. This PPOA proposed the substitution of bio-diesel fuel in place of diesel fuel in underground vehicles to support the use of bio-based products. This PPOA was not implemented since it was believed that the reduction in particulate emissions was insufficient to meet new MSHA standards.

- *SEC-PPOA-2004-003 - Elimination of Plastic Water Bottles in the WIPP Underground*. This PPOA recommended the elimination of individually packaged plastic water bottles in the WIPP underground. The bottles were not being recycled and were often carelessly disposed of as litter. In addition, bottled water was already being provided in large five-gallon carboys. This PPOA was not implemented. As a result of conducting this PPOA, recycling of the plastic bottles in the underground was identified as an opportunity for improvement. This is scheduled to occur in 2005.

Beginning in 2005, three PPOAs will be prepared and submitted to the CBFO for evaluation and possible implementation.

In 2004, WIPP continued its mandatory recycling program. Table 3.4 identifies the volume of materials recycled at WIPP in 2004.

Table 3.4 - Materials Recycled at WIPP in 2004

Recycled Material	2004 Actual (Metric Tons)
Paper	0.08
Aluminum cans	0.29
Cardboard	4.72
Toner cartridges	0.00
Wooden Pallets	0.00
Oil	5.81
Fluorescent bulbs/high-pressure sodium bulbs	0.27
Wet batteries	12.09
Silver	0.00
Ethylene glycol	4.54
Scrap metal	100.4
Plastic	0.00
Computer equipment	3.90
Total Recycled - Sanitary & RCRA	132.1
Total Generated - Sanitary & RCRA	224.39
% Recycled - Sanitary & RCRA	58.9%

Note: RCRA waste does not include oil and ethylene glycol totals.

The WIPP recycling program is under revision to obtain better estimates of recycled materials, and to identify recycling vendors for additional waste streams. Amounts of plastics, cardboard, toner cartridges, and paper not included in Table 3.3, above were recycled; however, actual recycling vendor receipts were often unavailable. Due to the uncertainty regarding the actual amounts of recycled sanitary waste, a restructuring of the P2 recycling vendors is under way. This restructuring represents a significant effort which began in 2004 and is planned for completion in late 2005 or early 2006.

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 GET. The GET and GET Refresher courses address general site information, safety, environmental (including environmental compliance, the WIPP EMS, P2, and recycling), radiation protection, emergency response, and other topics.

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. In addition, the EMS integration into the ISMS (in accordance with DOE Order 450.1) will be completed in 2005.

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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 baseline conditions, identify any releases, and determine their effects, should they occur.

The WIPP Environmental Monitoring Program describes 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 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 purpose of WIPP Effluent Monitoring Program is to determine whether radionuclides are being released from WIPP operations, including the underground storage areas and the Waste Handling Building. The WIPP Effluent Monitoring Program requires the monitoring of air to detect potential releases of radioactivity from WIPP activities into the environment. The regulatory basis for the WIPP Effluent Monitoring Program can be found in Title 40 *Code of Federal Regulations* (CFR) Part 191, Subpart A, "Environmental Standards for Management and Storage." The referenced standard specifies that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ. In addition, in a 1995 Memorandum of Understanding between the EPA and the DOE, the DOE agreed that WIPP would comply with 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (NESHAP). The NESHAP standard states that the emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts which would cause any member of the public to receive in any year an EDE of 10 mrem per year.

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 mi) 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. Appendix H presents figures which compare the highest concentrations of radionuclides detected from the WIPP environmental monitoring program to the baseline data.

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 × 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. For radionuclides determined by gamma spectrometry (^{137}Cs, ^{60}CO, and ^{40}K), an additional factor considered in the determination of detectability is the confidence level with which the peak or peaks associated with the particular radionuclide can be identified by the gamma spectroscopy software. In accordance with the Statement of Work for the laboratory analyses, gamma spectroscopy samples with confidence levels less than 90 percent are not considered "detects," regardless of their magnitudes compared to the MDC and TPU. 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.

Effluent Monitoring

The WIPP Effluent Monitoring Program has three effluent air monitoring stations. These monitoring stations are known as Effluent Monitoring Stations A, B, and C. Each station employs one or more fixed air samplers, collecting particulate from the effluent air stream using a Versapor® 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, filter samples from all three effluent air monitoring stations are typically analyzed for ^{238}Pu, $^{239+240}$Pu, ^{241}Am, and ^{90}Sr. These five radionuclides account for approximately 98 percent of the EDE resulting from the WIPP facility air emissions (DOE/WIPP 95-2065). The five radionuclides, which make up 98 percent of the total repository radioactivity, are based upon the TRU inventory expected to be emplaced at the WIPP. Plutonium-239 and ^{240}Pu are difficult to distinguish by alpha spectrometry because their peak energies are separated by less than 0.02 MeV. As a result, these two peaks appear to overlap on the spectrum and are reported as $^{239+240}$Pu.

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 (see Appendix H for comparison graphs). 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 association with potash mining.

4.1 Effluent Monitoring

4.1.1 Sample Collection

Stations A, B, and C are monitored with one or more fixed air samplers. The volume of air sampled at each station varies depending on the sampling location and configuration. Each system is designed to provide a representative sample using a 3.0 µm, 47-mm diameter Versapor® membrane filter.

Daily (24-hours) filter samples were collected from Station A from the unfiltered underground exhaust stream. Each day at Station A, approximately 84 m^3 (2,982 ft^3) of air was filtered through the Versapor® filter.

Weekly (24 hours/seven days per week) filter samples were collected at Stations B and C. Station B represents the underground exhaust air after HEPA filtration and, sometimes, nonfiltered air during maintenance. Each week at Station B, approximately 578 m^3 (20,402 ft^3) of air was filtered through the Versapor® filter. Weekly filter samples were also collected at Station C, which represents the air from the Waste Handling Building after HEPA filtration. Each week at Station C, approximately 234 m^3 (8,280 ft^3) of air was filtered through the Versapor® filter. Based on the indicated sampling periods, these air volumes are within ±10 percent of the volume derived using the flow rate set point of 2 ft^3/min for Stations A and B. The air volume for Station C is within ±10 percent of the volume derived using the flow rate required for isokinetic sampling conditions and the indicated sampling period. The sample flow rate for Station C varies according to the exhaust air flow in the Waste Handling Building in order to maintain isokinetic sampling conditions.

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, none of the composite samples had detectable radioactivity (Table 4.1). In all cases, either the 2 sigma TPU or the MDC was found to be greater than the estimated activity values, with the exception of two monthly composites for Station A, and two quarterly composites for Station B. During the month of April 2004, the Station A ^{90}Sr estimated activity and 2 sigma TPU were greater than the MDC. Also, in August 2004, the Station A ^{238}Pu estimated activity and 2 sigma TPU were greater than the MDC. However, the April and August 2004, Station A composites, the 2 sigma TPU values was greater than the estimated activities, therefore, the 2 sigma TPU values were used as input nuclide data in the CAP88-PC computer model. During the third quarter of 2004, the Station B ^{238}Pu and ^{90}Sr estimated activities and 2 sigma TPU values were also greater than the MDC. The Station B, 2 sigma TPU values for ^{238}Pu and ^{90}Sr were used as input nuclide data in the CAP88-PC computer model. In all other cases, either the 2 sigma TPU values or the MDC values were used as input nuclide data in the CAP88-PC computer model to calculate the EDEs to members of the public.

Sampling was routinely performed in the underground using fixed air samplers and continuous air monitors. Evaluation of the filter sample results indicate that there were no detectable releases that exceeded 25 mrem to the whole body and 75 mrem to any critical organ in accordance with the provisions of 40 CFR §191.03(b), from the WIPP facility. In addition, 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.

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2004

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				1.80E-04	1.20E-03	1.57E-03	0.00E+00	N/A[d]	1.59E-03
^{238}Pu		See below [c]		9.92E-05	6.59E-04	9.51E-04	-1.18E-04	3.05E-02	3.05E-02
$^{239+240}$Pu				9.88E-05	3.43E-04	9.47E-04	1.17E-04	2.35E-04	1.12E-03
^{90}Sr				-5.92E-03	2.05E-02	9.88E-03	-2.19E-02	2.04E-02	9.25E-03
					2nd Quarter				
^{241}Am				3.51E-04	4.07E-04	9.51E-04	-1.42E-04	6.36E-04	1.15E-03
^{238}Pu		See below		0.00E+00	NA[d]	1.52E-03	2.85E-04	4.07E-04	1.09E-03
$^{239+240}$Pu				3.96E-04	5.66E-04	1.52E-03	-1.42E-04	2.85E-04	1.09E-03
^{90}Sr				-1.05E-04	2.29E-02	1.76E-02	-4.11E-04	2.32E-02	1.11E-02
					3rd Quarter				
^{241}Am				2.19E-05	3.00E-04	4.59E-04	2.58E-05	3.04E-04	4.63E-04
^{238}Pu		See below		5.40E-04	6.85E-04	3.85E-04	1.90E-05	4.44E-04	5.22E-04
$^{239+240}$Pu				3.96E-04	4.77E-04	4.07E-04	6.99E-05	4.07E-04	5.48E-04
^{90}Sr				8.73E-03	3.31E-02	6.07E-03	-3.92E-03	3.21E-02	6.07E-03
					4th Quarter				
^{241}Am				-7.07E-05	4.92E-04	4.77E-04	2.11E-04	4.33E-04	4.59E-04
^{238}Pu		See below		7.88E-05	1.55E-02	6.92E-04	1.05E-04	4.48E-04	5.88E-04
$^{239+240}$Pu				-1.05E-04	3.03E-04	7.14E-04	-1.12E-04	2.86E-04	6.11E-04
^{90}Sr				1.32E-02	3.03E-02	1.61E-02	-1.30E-02	2.87E-02	1.46E-02
				Station A	1st Quarter	Monthly[c]			
		January			February			March	
^{241}Am	1.19E-04	6.29E-04	1.47E-03	7.47E-05	2.59E-04	5.77E-04	0.00E+00	N/A[d]	1.67E-03
^{238}Pu	-4.88E-04	4.96E-04	1.03E-03	-1.19E-04	4.14E-04	1.60E-03	1.62E-04	1.07E-03	1.55E-03
$^{239+240}$Pu	3.66E-04	4.26E-04	1.17E-03	-1.19E-04	5.33E-04	5.33E-04	1.61E-04	3.24E-04	1.55E-03
^{90}Sr	-3.10E-02	2.55E-02	1.21E-02	-1.49E-02	2.47E-02	1.86E-02	-5.70E-03	2.22E-02	1.09E-02
				Station A	2nd Quarter	Monthly			
		April			May			June	
^{241}Am	-1.44E-04	5.00E-04	1.78E-03	2.73E-04	3.89E-04	1.20E-03	-1.66E-04	5.74E-04	1.35E-03
^{238}Pu	0.00E+00	N/A[d]	1.08E-03	1.33E-04	5.96E-04	1.01E-03	0.00E+00	N/A[d]	1.09E-03
$^{239+240}$Pu	0.00E+00	N/A[d]	1.38E-03	-1.33E-04	2.67E-04	8.40E-04	5.70E-04	5.77E-04	1.09E-03
^{90}Sr	1.25E-02	2.92E-02	9.81E-03	-9.07E-03	2.92E-02	9.81E-03	5.85E-03	2.42E-02	1.15E-02

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2004

Nuclide	Activity	2 × TPU[a]	MDC[b]	Activity	2 × TPU	MDC	Activity	2 × TPU	MDC
	Station A 3rd Quarter Monthly								
	July			August			September		
^{241}Am	2.82E-04	5.66E-04	1.74E-03	1.51E-04	4.00E-04	4.70E-04	4.29E-04	5.51E-04	4.55E-04
^{238}Pu	-2.59E-04	3.69E-04	3.89E-04	5.25E-04	6.96E-04	5.03E-04	-6.33E-05	4.63E-04	3.74E-04
$^{239+240}$Pu	0.00E+00	NA[d]	9.92E-04	2.43E-04	5.03E-04	5.62E-04	3.92E-04	4.59E-04	4.00E-04
^{90}Sr	5.14E-03	2.81E-02	5.51E-03	-9.36E-03	2.46E-02	1.93E-02	3.96E-06	3.18E-02	5.85E-03
	Station A 4th Quarter Monthly								
	October			November			December		
^{241}Am	2.72E-04	5.74E-04	5.77E-04	1.69E-04	5.03E-04	6.59E-04	1.23E-04	5.33E-04	5.74E-04
^{238}Pu	-1.49E-05	3.68E-04	4.26E-04	2.25E-04	8.81E-04	7.77E-04	2.92E-04	1.04E-03	8.95E-04
$^{239+240}$Pu	1.94E-04	4.00E-04	4.11E-04	-1.27E-04	3.52E-04	7.73E-04	1.63E-04	7.18E-04	9.21E-04
^{90}Sr	-1.20E-02	2.18E-02	6.07E-03	7.92E-03	1.88E-02	8.95E-03	-1.61E-02	3.07E-02	1.69E-02

[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 (LVASs). 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 were filtered through a 4.7-cm (1.85-in.) diameter glass microfiber filter using a low-volume continuous air sampler.

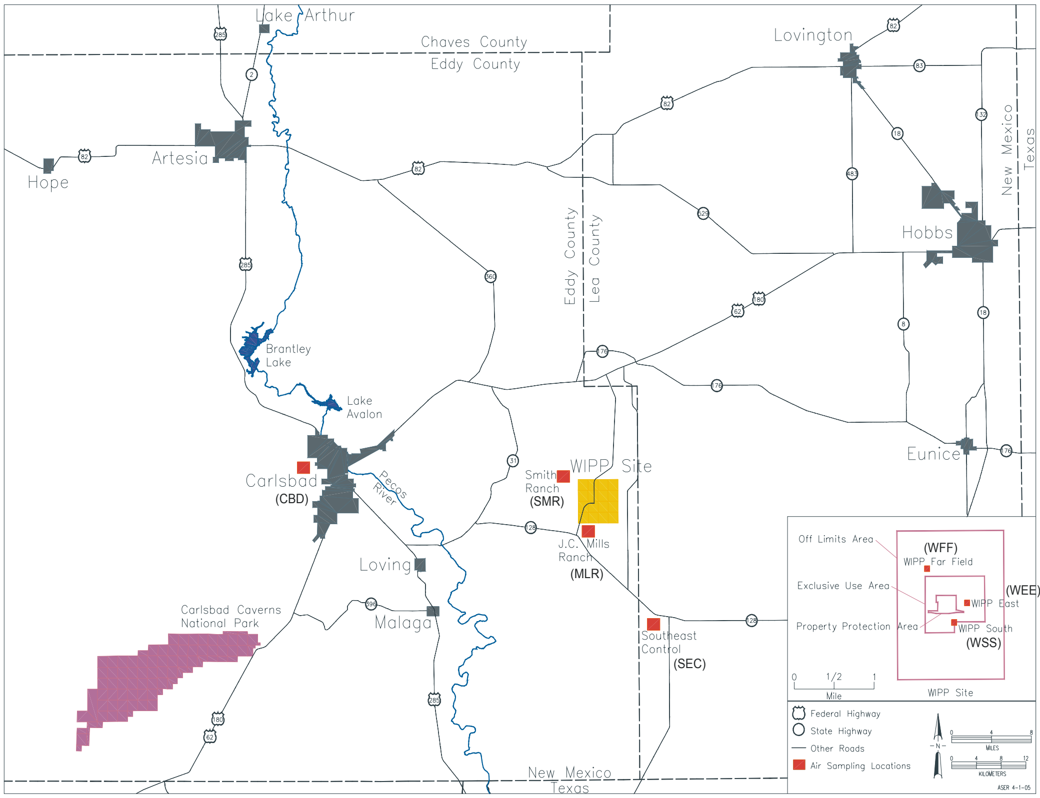

Figure 4.1 - Air Sampling Locations on and near the WIPP Facility

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) 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 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.

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-235 was detected in one of the samples. Uranium-234 and ^{238}U were detected in approximately 33 percent of the samples, mostly in the first quarter, and due to very low MDCs (Rosman and Taylor, 1998).

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

Radionuclide		[RN][a]	2 × TPU[b]	MDC[c]
^{241}Am	Minimum[d]	-6.25E-09	2.21E-08	1.49E-04
	Maximum[d]	5.51E-08	6.05E-08	1.98E-04
	Average[e]	1.63E-08	4.32E-08	1.49E-04
^{238}Pu	Minimum	-9.16E-09	7.62E-08	6.19E-05
	Maximum	7.17E-08	1.98E-07	8.68E-05
	Average	6.46E-09	6.80E-08	6.20E-05
$^{239+240}Pu$	Minimum	-8.23E-09	3.17E-08	7.43E-05
	Maximum	1.42E-07	2.44E-07	9.92E-05
	Average	2.51E-08	7.72E-08	7.11E-05
^{234}U	Minimum	1.88E-06	3.70E-07	7.92E-04
	Maximum	3.27E-06	4.92E-07	1.05E-03
	Average	2.43E-06	6.70E-07	7.16E-04
^{235}U	Minimum	3.87E-08	5.51E-08	1.75E-07
	Maximum	2.72E-07	1.87E-07	1.73E-04
	Average	1.36E-07	1.43E-07	1.27E-04
^{238}U	Minimum	1.91E-06	3.42E-07	3.71E-04
	Maximum	3.22E-06	4.93E-07	4.83E-04
	Average	2.41E-06	7.43E-07	3.40E-04
^{40}K	Minimum	8.79E-05	2.06E-04	2.45E-04
	Maximum	9.58E-04	3.56E-04	4.10E-04
	Average	3.92E-04	4.79E-04	3.20E-04
^{60}Co	Minimum	-1.82E-07	2.11E-05	2.41E-05
	Maximum	4.87E-05	3.75E-05	4.31E-05
	Average	9.04E-06	3.25E-05	3.27E-05

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

Radionuclide		[RN][a]	2 × TPU[b]	MDC[c]
^{90}Sr	Minimum	-9.17E-07	4.22E-06	2.73E-06
	Maximum	5.37E-07	2.65E-06	8.84E-07
	Average	-1.34E-06	2.23E-06	2.13E-06
^{137}Cs	Minimum	-7.39E-07	1.58E-05	1.85E-05
	Maximum	2.62E-05	3.21E-05	4.03E-05
	Average	-6.87E-06	3.53E-05	2.80E-05

[a] Radionuclide concentration, values are for eight locations, four quarterly composites (Appendix G).
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] Minimum and maximum reported for each radionuclide are based on [RN] while the associated 2 x TPU and MDC values are inherited with the specific [RN].
[e] Arithmetic average for concentration and MDC; TPU represents the standard deviation of the mean in this cell.

Concentrations of ^{234}U and ^{238}U were compared, using analysis of variance, to determine if they were statistically different between 2003 and 2004. No such comparisons were possible for the other isotopes, with the exception of ^{40}K, because of an insufficient number of detections to allow a valid statistical analysis. There was no significant difference among sampling locations for ^{234}U (ANOVA, p = 0.057) or between 2003 and 2004 (ANOVA, p = 0.140). This was also the case for ^{238}U (locations: ANOVA, p = 0.430; years: ANOVA, p = 0.243). Concentrations of all three uranium isotopes in 2004 fell within the 99 percent confidence interval ranges of radiological baseline data covering the period from 1985 to 1989 (DOE/WIPP 92-037).

Plutonium-238, $^{239+240}$Pu, and ^{241}Am were not detected in any LVAS samples in 2004.

Concentrations of ^{40}K (Table G.1) were detected in approximately two thirds of the samples. Potassium-40 is ubiquitous in the earth's crust and thus would be expected to show up in environmental air samples. There was no significant difference in the concentrations of ^{40}K detected among locations (ANOVA, p = 0.314) or between 2003 and 2004 (ANOVA, p = 0.547). The highest concentration of ^{40}K observed (9.58E-04 Bq/m^3) was somewhat higher than the baseline values (upper 99th percentile: 3.2E-04 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.

Cesium-137 and ^{90}Sr were not detected in any samples in 2004. Cobalt-60 was detected in one sample at 4.87E-05 Bq/m^3, which was slightly greater than the baseline value (upper 99th percentile 2.7E-05 Bq/m^3).

Duplicate air particulate samples were collected by rotating the portable sampler from one location to another every quarter: SEC in the first quarter, WFF in the second quarter, WEE in the third quarter, and WSS 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 detectable 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. One RER was greater than one, ^{234}U at SEC indicating poor reproducibility. This 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 sampling location codes.

Location	Quarter		Sample			Duplicate			
			[RN][a]	2 × TPU[b]	MDC[c]	RN	2 × TPU	MDC	RER[d]
SEC	1	^{234}U	2.51E-06	5.72E-07	1.93E-07	2.41E-06	6.30E-07	2.54E-07	2.83
SEC	1	^{238}U	2.45E-06	5.61E-07	1.87E-07	1.97E-06	5.43E-07	2.45E-07	0.61

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

4.3 Groundwater

4.3.1 Sample Collection

Groundwater samples were collected twice in 2004 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 2004 (Table 4.4). The concentrations of uranium isotopes were compared between 2003 and 2004 and also among sampling locations using ANOVA. Although significant variability was observed among sampling locations for uranium isotopes, there was no significant difference in the concentrations of uranium isotopes between 2003 and 2004 (ANOVA, ^{234}U $p = 0.444$, ^{235}U $p = 0.0564$, ^{238}U $p = 0.571$). 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.

Concentrations of uranium isotopes were also compared with baseline levels observed between 1985 and 1989. Concentrations of ^{238}U were within the 99 percent confidence interval ranges of baseline levels (DOE/WIPP 92-037). Both ^{234}U and ^{235}U were somewhat higher than the 99 percent confidence interval ranges of baseline levels. The highest concentration of ^{234}U observed (1.46 Bq/l) and the highest concentration of ^{235}U observed (3.30E-02 Bq/l) were barely higher than baseline values (upper 99th percentiles = 1.30 Bq/l and 3.10E-02 Bq/l, respectively). However, these are both extremely small concentrations and no increase was observed between the years 2003 and 2004. 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-238 and ^{241}Am were not detected in any of the wells. Plutonium-239+240 was detected in one sample (Sampling Round 18 from well WQSP-1) at a concentration of 3.46E-03 Bq/l. However, this level is small and the MDC falls within the total error associated with the indicated results (Table 4.4). Since ^{238}Pu and ^{241}Am were not detected and $^{239+240}$Pu was only detected in one sample, there were insufficient data for ANOVA comparisons between years or among locations.

The detected concentration of $^{239+240}$Pu was compared to baseline levels. Results of this comparison showed that the $^{239+240}$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.

Cesium-137, ^{90}Sr, and ^{60}Co were not detected in any of the samples.

Potassium-40 was detected in all samples except for one sample taken from well WQSP-6 and from 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 a significant difference in ^{40}K concentrations among sampling locations (ANOVA p=1.06E-08), but not between 2003 and 2004 (ANOVA p=0.966). The difference in ^{40}K concentrations is because this isotope is naturally occurring in the earth's crust and the concentration varies in different locations.

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 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
		^{241}Am			^{238}Pu			$^{239+240}Pu$		
WQSP-1	18	2.49E-03	1.12E-02	2.39E-02	0.00E+00	N/A[d]	7.37E-04	3.46E-03	1.17E-03	5.89E-04
	19	1.79E-04	4.75E-04	5.42E-04	1.74E-04	1.04E-03	6.91E-04	2.82E-04	7.59E-04	7.40E-04
WQSP-2	18	1.92E-04	3.85E-04	7.35E-04	2.36E-04	4.73E-04	9.84E-04	0.00E+00	N/A[d]	1.13E-03
	19	1.13E-04	3.85E-04	4.56E-04	5.66E-04	6.63E-04	4.50E-04	-5.34E-05	1.69E-04	4.87E-04
WQSP-3	18	5.47E-04	9.52E-04	1.11E-03	2.31E-04	7.06E-04	3.79E-04	2.03E-04	2.89E-04	1.94E-04
	19	9.38E-04	1.11E-03	8.83E-04	1.17E-04	9.61E-04	6.44E-04	1.25E-04	4.88E-04	6.31E-04
WQSP-4	18	0.00E+00	N/A[d]	2.44E-03	-6.71E-05	3.91E-04	1.39E-03	1.34E-04	2.69E-04	4.91E-04
	19	2.59E-04	8.80E-04	8.63E-04	-2.22E-04	5.42E-04	1.02E-03	-6.85E-05	1.97E-04	5.24E-04
WQSP-5	18	5.47E-04	1.10E-03	2.50E-03	0.00E+00	N/A[d]	3.01E-03	-1.96E-04	1.15E-03	1.43E-03
	19	1.74E-04	7.46E-04	7.39E-04	6.77E-04	9.42E-04	6.63E-04	9.19E-05	5.35E-04	6.50E-04
WQSP-6	18	-1.51E-03	1.63E-03	2.32E-03	3.65E-04	7.34E-04	2.79E-03	0.00E+00	N/A[d]	2.79E-03
	19	7.19E-04	7.24E-04	5.79E-04	-9.74E-05	2.12E-04	4.01E-04	5.57E-05	2.93E-04	4.01E-04
WQSP-6A	18	9.57E-04	9.16E-04	1.22E-03	-1.81E-04	3.64E-04	1.39E-03	1.81E-04	3.64E-04	1.39E-03
	19	-1.93E-04	4.01E-04	8.50E-04	1.38E-04	3.81E-04	4.01E-04	-6.69E-05	1.73E-04	3.88E-04
		^{234}U			^{235}U			^{238}U		
WQSP-1	18	1.35E+00	2.21E-01	3.54E-04	3.27E-02	6.88E-03	4.36E-04	2.25E-01	3.80E-02	3.52E-04
	19	1.46E+00	5.82E-02	1.44E-03	2.02E-02	3.84E-03	7.30E-04	2.45E-01	1.45E-02	8.82E-04
WQSP-2	18	1.25E+00	1.89E-01	8.81E-04	1.64E-02	3.69E-03	8.76E-04	1.90E-01	2.99E-02	7.01E-04
	19	1.30E+00	4.99E-02	1.38E-03	1.60E-02	3.10E-03	6.21E-04	1.97E-01	1.16E-02	8.14E-04
WQSP-3	18	2.68E-01	4.32E-02	4.95E-04	3.44E-03	1.43E-03	4.92E-04	3.98E-02	7.42E-03	6.08E-04
	19	2.53E-01	1.40E-02	1.42E-03	2.48E-03	1.25E-03	6.26E-04	3.70E-02	4.44E-03	8.77E-04
WQSP-4	18	5.67E-01	9.79E-02	1.22E-03	9.27E-03	2.90E-03	1.20E-03	1.02E-01	1.87E-02	1.43E-03
	19	6.02E-01	2.64E-02	1.39E-03	1.08E-02	2.58E-03	6.19E-04	9.99E-02	7.70E-03	8.10E-04
WQSP-5	18	6.11E-01	1.07E-01	1.59E-03	1.33E-02	3.84E-03	1.36E-03	9.45E-02	1.79E-02	1.64E-03
	19	7.22E-01	3.39E-02	1.52E-03	9.12E-03	2.70E-03	7.50E-04	1.01E-01	8.80E-03	9.77E-04
WQSP-6	18	5.86E-01	9.48E-02	1.94E-03	9.65E-03	2.96E-03	1.47E-03	7.68E-02	1.38E-02	1.29E-03
	19	6.47E-01	2.99E-02	1.46E-03	1.21E-02	2.97E-03	7.02E-04	8.87E-02	7.81E-03	9.39E-04
WQSP-6A	18	2.15E-01	3.53E-02	1.64E-03	9.39E-03	2.76E-03	1.24E-03	1.14E-01	1.95E-02	1.09E-03
	19	2.49E-01	1.40E-02	1.36E-03	6.09E-03	1.97E-03	6.10E-04	1.28E-01	9.13E-03	8.73E-04

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 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
		^{40}K			^{60}Co			^{137}Cs		
WQSP-1	18	1.81E+01	5.17E+00	6.29E+00	1.98E-01	3.03E-01	5.06E-01	-2.18E-01	4.23E-01	4.65E-01
	19	1.69E+01	4.08E+00	3.77E+00	9.43E-02	3.26E-01	3.81E-01	9.40E-02	2.50E-01	2.99E-01
WQSP-2	18	1.50E+01	3.61E+00	3.48E+00	3.05E-02	2.66E-01	3.04E-01	1.16E-01	2.01E-01	2.41E-01
	19	1.77E+01	3.93E+00	3.00E+00	-7.63E-02	3.27E-01	3.62E-01	1.14E-01	2.38E-01	2.87E-01
WQSP-3	18	4.96E+01	8.74E+00	3.45E+00	7.63E-02	2.91E-01	3.35E-01	1.22E-01	2.20E-01	2.63E-01
	19	5.09E+01	9.17E+00	4.11E+00	-7.71E-03	3.53E-01	4.00E-01	-6.01E-02	2.00E-01	3.14E-01
WQSP-4	18	2.42E+01	6.05E+00	6.50E+00	-5.54E-01	5.62E-01	5.56E-01	-3.43E-01	5.07E-01	5.38E-01
	19	2.77E+01	5.39E+00	2.88E+00	7.61E-02	3.31E-01	3.84E-01	3.87E-02	2.41E-01	2.87E-01
WQSP-5	18	1.07E+01	2.97E+00	3.04E+00	-2.13E-01	3.36E-01	3.51E-01	-9.22E-02	2.41E-01	2.74E-01
	19	1.18E+01	3.04E+00	2.82E+00	1.60E-01	3.14E-01	3.74E-01	3.54E-02	2.35E-01	2.79E-01
WQSP-6	18	6.02E+00	2.23E+00	2.73E+00	3.57E-02	3.10E-01	3.58E-01	2.19E-01	2.26E-01	2.79E-01
	19	3.01E+00	2.36E+00	3.63E+00	-2.53E-01	3.50E-01	3.61E-01	6.70E-02	2.30E-01	2.76E-01
WQSP-6A	18	1.30E+00	1.30E+00	2.04E+00	1.86E-01	3.05E-01	3.67E-01	1.36E-01	2.26E-01	2.75E-01
	19	3.64E+00	5.03E+00	5.66E+00	6.24E-02	5.13E-01	5.63E-01	-6.02E-01	5.14E-01	5.34E-01
		^{90}Sr								
WQSP-1	18	7.50E-02	6.26E-02	9.99E-02						
	19	-2.45E-03	2.16E-02	1.41E-02						
WQSP-2	18	2.12E-02	2.12E-02	3.95E-03						
	19	-3.83E-03	2.00E-02	5.74E-03						
WQSP-3	18	-6.55E-03	1.44E-02	1.19E-02						
	19	1.12E-02	2.39E-02	1.29E-02						
WQSP-4	18	7.12E-03	1.72E-02	8.85E-03						
	19	-1.54E-02	3.56E-02	2.67E-02						
WQSP-5	18	8.96E-03	1.14E-02	1.50E-02						
	19	6.01E-03	1.92E-02	9.03E-03						
WQSP-6	18	-3.64E-02	2.31E-02	2.11E-02						
	19	1.64E-02	2.04E-02	8.43E-03						
WQSP-6A	18	-1.27E-02	2.39E-02	2.24E-02						
	19	-1.48E-02	2.14E-02	1.41E-02						

[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 18 and in Table 4.6 for Sampling Round 19. Most of the RER values were less than one, indicating no difference between duplicate samples and good reproducibility. However, one duplicate from WQSP-1 for $^{239+240}$Pu from Round 18 had an RER greater than 1, indicating poor reproducibility. This is most likely due to inhomogeneities in the distributions of the radioisotope within the wells.

Table 4.5 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 18. Units are Bq/l. See Chapter 6 for sampling locations.

Location		Sample			Duplicate			
		[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
WQSP-1	$^{239+240}Pu$	3.46E-03	1.17E-03	5.89E-04	6.64E-04	4.80E-04	2.49E-04	2.21
	^{234}U	1.35E+00	2.21E-01	3.54E-04	1.19E+00	1.94E-01	9.85E-04	0.54
	^{235}U	3.27E-02	6.88E-03	4.36E-04	2.59E-02	5.66E-03	9.82E-04	0.76
	^{238}U	2.25E-01	3.80E-02	3.52E-04	2.11E-01	3.56E-02	7.93E-04	0.27
	^{40}K	1.81E+01	5.17E+00	6.29E+00	1.69E+01	3.74E+00	3.11E+00	0.19
WQSP-2	^{234}U	1.25E+00	1.89E-01	8.81E-04	1.30E+00	1.95E-01	9.67E-04	0.18
	^{235}U	1.64E-02	3.69E-03	8.76E-04	2.02E-02	4.38E-03	9.62E-04	0.66
	^{238}U	1.90E-01	2.99E-02	7.01E-04	2.04E-01	3.16E-02	7.70E-04	0.32
	^{40}K	1.50E+01	3.61E+00	3.48E+00	1.80E+01	4.05E+00	3.60E+00	0.55
WQSP-3	^{234}U	2.68E-01	4.32E-02	4.95E-04	2.43E-01	3.91E-02	4.91E-04	0.43
	^{235}U	3.44E-03	1.43E-03	4.92E-04	3.10E-03	1.29E-03	4.88E-04	0.18
	^{238}U	3.98E-02	7.42E-03	6.08E-04	3.76E-02	6.96E-03	6.03E-04	0.22
	^{40}K	4.96E+01	8.74E+00	3.45E+00	4.96E+01	9.25E+00	6.06E+00	0.00
WQSP-4	^{234}U	5.67E-01	9.79E-02	1.22E-03	6.50E-01	1.14E-01	1.36E-03	0.55
	^{235}U	9.27E-03	2.90E-03	1.20E-03	1.03E-02	3.23E-03	1.34E-03	0.24
	^{238}U	1.02E-01	1.87E-02	1.43E-03	1.07E-01	2.01E-02	1.60E-03	0.18
	^{40}K	2.42E+01	6.05E+00	6.50E+00	2.46E+01	6.11E+00	6.54E+00	0.05
WQSP-5	^{234}U	6.11E-01	1.07E-01	1.59E-03	6.22E-01	1.12E-01	1.80E-03	0.07
	^{235}U	1.33E-02	3.84E-03	1.36E-03	1.23E-02	3.85E-03	1.54E-03	0.18
	^{238}U	9.45E-02	1.79E-02	1.64E-03	9.97E-02	1.94E-02	1.86E-03	0.20
	^{40}K	1.07E+01	2.97E+00	3.04E+00	1.47E+01	4.81E+00	6.17E+00	0.71
WQSP-6	^{234}U	5.86E-01	9.48E-02	1.94E-03	6.58E-01	1.21E-01	2.41E-03	0.47
	^{235}U	9.65E-03	2.96E-03	1.47E-03	1.15E-02	3.76E-03	1.82E-03	0.39
	^{238}U	7.68E-02	1.38E-02	1.29E-03	8.62E-02	1.73E-02	1.59E-03	0.42
	^{40}K	6.02E+00	2.23E+00	2.73E+00	5.09E+00	3.97E+00	6.18E+00	0.02
WQSP-6A	^{234}U	2.15E-01	3.53E-02	1.64E-03	2.21E-01	3.60E-02	1.58E-03	0.12
	^{235}U	9.39E-03	2.76E-03	1.24E-03	1.08E-02	2.96E-03	1.20E-03	0.35
	^{238}U	1.14E-01	1.95E-02	1.09E-03	1.21E-01	2.03E-02	1.05E-03	0.25

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

Table 4.6 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 19. Units are Bq/l. See Chapter 6 for sampling locations.

Location		Sample			Duplicate			
		[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
WQSP-1	^{234}U	1.46E+00	5.82E-02	1.44E-03	1.44E+00	5.65E-02	1.46E-03	0.25
	^{235}U	2.02E-02	3.84E-03	7.30E-04	2.03E-02	3.91E-03	7.49E-04	0.02
	^{238}U	2.45E-01	1.45E-02	8.82E-04	2.39E-01	1.43E-02	8.98E-04	0.29
WQSP-2	^{234}U	1.25E+00	1.89E-01	8.81E-04	1.30E+00	1.95E-01	9.67E-04	0.18
	^{235}U	1.64E-02	3.69E-03	8.76E-04	2.02E-02	4.38E-03	9.62E-04	0.66
	^{238}U	1.90E-01	2.99E-02	7.01E-04	2.04E-01	3.16E-02	7.70E-04	0.32
WQSP-3	^{234}U	2.68E-01	4.32E-02	4.95E-04	2.43E-01	3.91E-02	4.91E-04	0.43
	^{235}U	3.44E-03	1.43E-03	4.92E-04	3.10E-03	1.29E-03	4.88E-04	0.18
	^{238}U	3.98E-02	7.42E-03	6.08E-04	3.76E-02	6.96E-03	6.03E-04	0.22
WQSP-4	^{234}U	5.67E-01	9.79E-02	1.22E-03	6.50E-01	1.14E-01	1.36E-03	0.55
	^{235}U	9.27E-03	2.90E-03	1.20E-03	1.03E-02	3.23E-03	1.34E-03	0.24
	^{238}U	1.02E-01	1.87E-02	1.43E-03	1.07E-01	2.01E-02	1.60E-03	0.18
WQSP-5	^{234}U	6.11E-01	1.07E-01	1.59E-03	6.22E-01	1.12E-01	1.80E-03	0.07
	^{235}U	1.33E-02	3.84E-03	1.36E-03	1.23E-02	3.85E-03	1.54E-03	0.18
	^{238}U	9.45E-02	1.79E-02	1.64E-03	9.97E-02	1.94E-02	1.86E-03	0.20
WQSP-6	^{234}U	5.86E-01	9.48E-02	1.94E-03	6.58E-01	1.21E-01	2.41E-03	0.47
	^{235}U	9.65E-03	2.96E-03	1.47E-03	1.15E-02	3.76E-03	1.82E-03	0.39
	^{238}U	7.68E-02	1.38E-02	1.29E-03	8.62E-02	1.73E-02	1.59E-03	0.42
	^{40}K	6.02E+00	2.23E+00	2.73E+00	5.09E+00	3.97E+00	6.18E+00	0.20
WQSP-6A	^{234}U	2.15E-01	3.53E-02	1.64E-03	2.21E-01	3.60E-02	1.58E-03	0.12
	^{235}U	9.39E-03	2.76E-03	1.24E-03	1.08E-02	2.96E-03	1.20E-03	0.35
	^{238}U	1.14E-01	1.95E-02	1.09E-03	1.21E-01	2.03E-02	1.05E-03	0.25

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

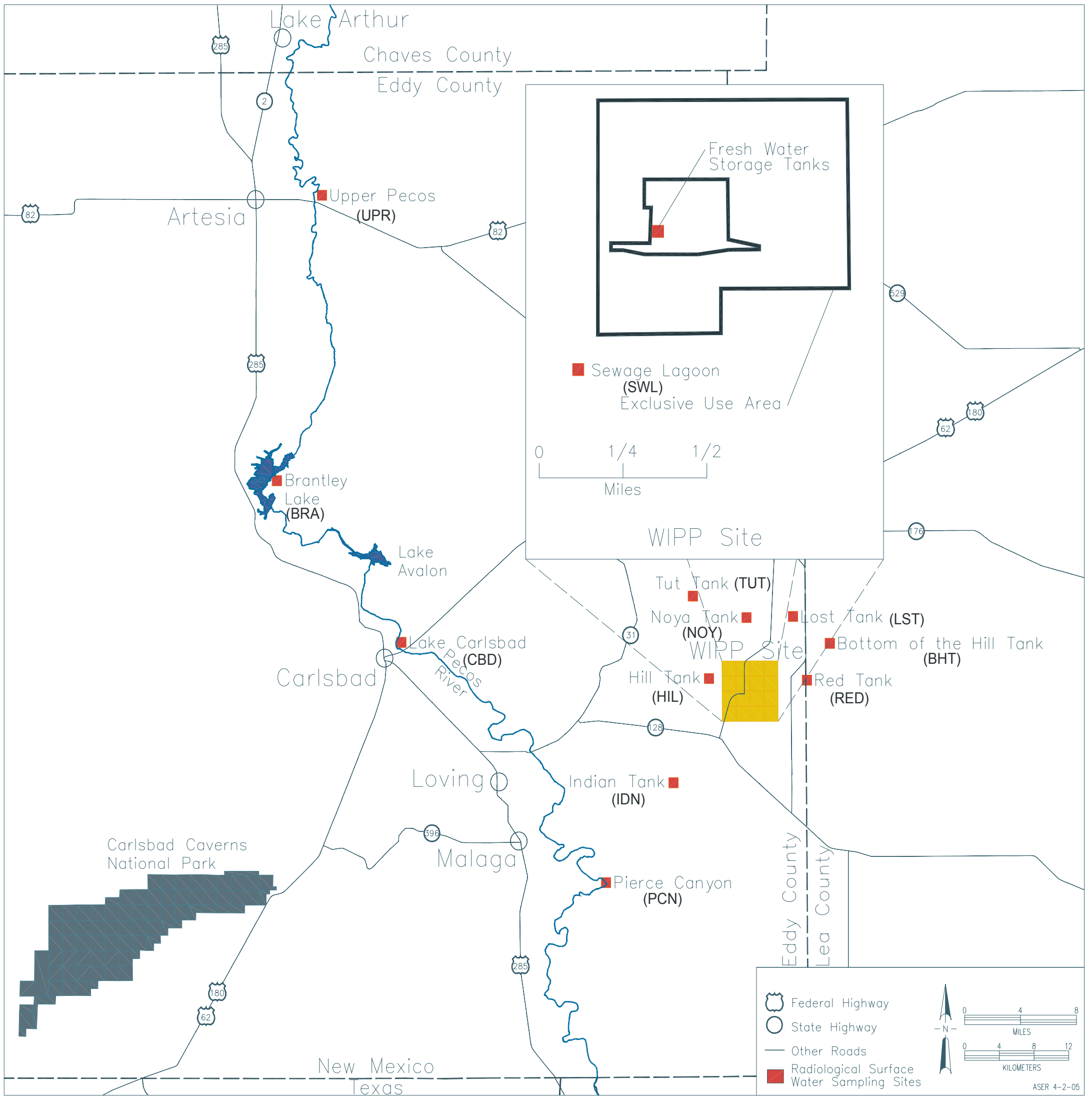

Figure 4.2 - Routine Surface Water Sampling Locations

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.

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, which is a deionized water blank (Table 4.7). Uranium-235 was detected in all samples except BHT, COW, and IDN. The concentrations of uranium isotopes were compared between 2003 and 2004 and also among sampling locations using ANOVA for those sites sampled and detected in both years. ANOVA results showed no statistically significant difference among sampling locations or between 2003 and 2004. ANOVA p values for locations were as follows: ^{234}U (ANOVA, p=0.239), ^{235}U (ANOVA, p = 0.0554), and ^{238}U (ANOVA, p = 0.503). ANOVA p values for years were as follows: ^{234}U (ANOVA, p=0.917), ^{235}U (ANOVA, p = 0.858), and ^{238}U (ANOVA, p = 0.624).

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	2.03E-02	4.41E-03	8.18E-04	5.27E-04	5.34E-04	1.17E-03	2.02E-02	4.38E-03	1.02E-03
BRA	1.21E-01	2.45E-02	3.77E-03	4.64E-03	2.21E-03	6.63E-04	5.41E-02	1.19E-02	2.89E-03
CBD	8.97E-02	1.62E-02	2.56E-03	3.91E-03	1.66E-03	4.51E-04	4.16E-02	8.21E-03	1.96E-03
COW	2.84E-03	1.36E-03	2.99E-03	3.50E-04	4.99E-04	5.25E-04	8.48E-04	8.12E-04	2.29E-03
COY[d]	4.01E-02	8.43E-03	1.07E-03	2.41E-03	1.36E-03	1.53E-03	4.69E-02	9.62E-03	1.33E-03
FWT	4.36E-02	8.60E-03	2.54E-03	1.19E-03	8.65E-04	4.47E-04	1.87E-02	4.35E-03	1.94E-03
HIL	3.23E-02	7.14E-03	3.30E-03	1.93E-03	1.27E-03	5.79E-04	2.53E-02	5.90E-03	2.52E-03
IDN	2.17E-02	4.91E-03	9.55E-04	7.69E-04	8.24E-01	1.36E-03	2.35E-02	5.21E-03	1.19E-03
LST	6.81E-02	1.32E-02	1.05E-03	5.91E-03	2.29E-03	1.50E-03	8.27E-02	1.57E-02	1.31E-03
NOY	2.57E-02	5.89E-03	1.09E-03	1.76E-03	1.16E-03	1.56E-03	2.79E-02	6.24E-03	1.36E-03
PCN	1.44E-01	2.58E-02	1.04E-03	9.00E-03	2.88E-03	1.48E-03	7.13E-02	1.35E-02	1.29E-03
COY 7/1[e]	2.57E-02	5.36E-03	8.44E-04	8.15E-04	6.79E-04	1.20E-03	2.73E-02	5.63E-03	1.05E-03
RED	2.62E-02	5.41E-03	8.20E-04	1.59E-03	9.50E-04	1.17E-03	2.10E-02	4.53E-03	1.02E-03
SWL	4.33E-01	1.08E-01	7.95E-03	6.53E-03	3.83E-03	1.40E-03	1.19E-01	3.18E-02	6.09E-03
TUT	5.93E-02	1.15E-02	2.73E-03	2.40E-03	1.31E-03	4.80E-04	6.38E-02	1.23E-02	2.09E-03
UPR	1.25E-01	2.40E-02	3.14E-03	3.87E-03	1.82E-03	5.53E-04	7.73E-02	1.54E-02	2.41E-03

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
[d] COY is a duplicate of sample LST (Lost Tank).
[e] COY 7/1 is a sample blank.

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 9.00E-03 to 4.33E-01 Bq/l, and when taken together with the fact that no increases were observed between the years 2003 and 2004, 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). None of these isotopes were detected so ANOVA comparisons between years and among locations were not performed.

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	-2.55E-04	5.11E-04	9.75E-04	3.97E-04	5.65E-04	1.47E-03	5.95E-04	8.93E-04	1.52E-03
BRA	-2.25E-04	1.01E-03	2.49E-03	0.00E+00	N/A[d]	1.60E-03	-2.44E-04	4.91E-04	1.76E-03
CBD	-1.38E-04	4.80E-04	1.53E-03	0.00E+00	N/A[d]	8.18E-04	-1.25E-04	2.51E-04	9.02E-04
COW[e]	0.00E+00	N/A[d]	1.31E-03	0.00E+00	N/A[d]	8.89E-04	1.36E-04	2.72E-04	9.80E-04
COY	1.72E-04	3.45E-04	1.32E-03	3.49E-04	4.06E-04	8.59E-04	4.65E-04	4.70E-04	8.90E-04
FWT	5.12E-04	5.19E-04	1.42E-03	-3.67E-04	4.27E-04	7.99E-04	0.00E+00	N/A[d]	8.81E-04
HIL	0.00E+00	N/A[d]	1.37E-03	3.50E-04	1.57E-03	2.29E-03	0.00E+00	N/A[d]	2.52E-03
IDN	4.34E-04	4.39E-04	8.32E-04	1.15E-04	3.98E-04	8.48E-04	3.44E-04	4.01E-01	8.78E-04
LST	4.56E-04	9.16E-04	1.17E-03	1.22E-04	2.45E-04	9.01E-04	4.87E-04	4.94E-04	9.33E-04
NOY	2.09E-04	4.20E-04	8.01E-04	1.12E-04	2.25E-04	8.30E-04	2.25E-04	3.20E-04	8.60E-04
PCN	0.00E+00	N/A[d]	2.06E-03	1.69E-04	5.88E-04	1.25E-03	1.69E-04	3.40E-04	1.30E-03
COY 7/1[f]	1.06E-04	2.13E-04	8.14E-04	-1.14E-04	2.28E-04	8.41E-04	2.27E-04	3.24E-04	8.71E-04
RED	-1.11E-04	3.86E-04	8.53E-04	4.14E-04	8.30E-04	1.02E-03	5.51E-04	5.58E-04	1.05E-03
SWL	6.75E-04	7.90E-04	2.49E-03	0.00E+00	N/A[d]	2.35E-03	3.59E-04	1.25E-03	2.59E-03
TUT	2.78E-04	3.96E-04	1.54E-03	0.00E+00	N/A[d]	1.42E-03	-2.18E-04	4.37E-04	1.57E-03
UPR	2.75E-04	3.91E-04	1.52E-03	-1.94E-04	3.90E-04	1.27E-03	3.88E-04	5.53E-04	1.40E-03

[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.
[e] COY is a duplicate of LST (Lost Tank).
[f] COY 7/1 is a sample blank.

Neither ^{137}Cs nor ^{90}Sr were detected in any of the samples. Cobalt-60 was detected at location FWT at a concentration of 7.80E-01 Bq/l and at SWL at a concentration of 7.32E-01 Bq/l. These concentrations are very close to the MDCs and the MDCs fall within the total error associated with the results (Table 4.9). Comparison of these values with baseline data shows that they fell within the 99 percent confidence interval ranges of the baseline concentrations (DOE/WIPP 92-037).

Potassium-40 was detected in approximately 70 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. The two highest concentrations of ^{40}K detected in samples collected during this reporting year were slightly above the 99 percent confidence interval range of the baseline concentrations (upper 99th percentile = 7.60E-01 Bq/l). There was a significant difference in ^{40}K concentrations detected among locations (ANOVA p=0.002), but not between 2003 and 2004 (ANOVA, p = 0.703). The difference in ^{40}K concentrations is because this isotope is naturally occurring in the earth's crust and the concentration varies in different locations.

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	-4.09E-01	5.05E-01	5.29E-01	5.18E-01	4.90E-01	5.60E-01
BRA	1.64E-01	2.17E-01	2.67E-01	-2.70E-01	3.33E-01	3.37E-01
CBD	-5.87E-01	5.21E-01	5.30E-01	3.15E-01	5.03E-01	5.64E-01
COW	-5.54E-02	2.36E-01	2.72E-01	1.16E-01	3.09E-01	3.65E-01
COY	-1.57E-01	4.87E-01	5.31E-01	1.62E-01	5.10E-01	5.66E-01
FWT	-9.97E-02	2.76E-01	5.32E-01	7.80E-01	4.93E-01	5.70E-01
HIL	-8.19E-01	5.42E-01	5.31E-01	4.37E-01	4.77E-01	5.44E-01
IDN	4.23E-02	3.06E-01	3.49E-01	-8.59E-03	3.55E-01	4.17E-01
LST	6.91E-02	2.34E-01	2.68E-01	-3.34E-02	2.96E-01	3.34E-01
NOY	-8.42E-02	2.97E-01	3.24E-01	3.60E-02	2.44E-01	2.90E-01
PCN	-1.76E-01	2.98E-01	3.11E-01	1.91E-01	3.39E-01	4.02E-01
COY 7/1	-3.91E-02	2.39E-01	2.77E-01	1.75E-01	2.99E-01	3.60E-01
RED	4.58E+00	6.09E+00	7.46E+00	-7.72E+00	8.73E+00	8.69E+00
SWL	-9.01E-01	5.63E-01	5.47E-01	7.32E-01	5.20E-01	5.96E-01
TUT	1.00E-01	2.28E-01	2.75E-01	-1.34E-01	3.31E-01	3.57E-01
UPR	-4.92E-01	5.13E-01	5.30E-01	3.12E-01	4.72E-01	5.33E-01
	^{90}Sr			^{40}K		
BHT	1.92E-02	3.24E-02	1.65E-02	1.23E+01	5.36E+00	6.08E+00
BRA	-8.25E-03	2.01E-02	4.68E-03	-6.57E-01	3.08E+00	3.42E+00
CBD	2.01E-02	3.04E-02	7.77E-03	4.37E+00	5.26E+00	5.83E+00
COW	-6.47E-03	1.99E-02	4.42E-03	4.18E+00	2.91E+00	3.73E+00
COY	1.89E-02	2.29E-02	8.56E-03	9.94E+00	5.37E+00	6.06E+00
FWT	1.38E-02	1.93E-02	4.55E-03	1.08E+01	5.11E+00	5.83E+00
HIL	1.23E-02	2.08E-02	4.87E-03	5.85E+00	4.47E+00	6.94E+00
IDN	1.62E-02	2.48E-02	1.01E-02	4.77E+00	3.43E+00	4.46E+00
LST	2.49E-02	6.36E-02	3.34E-02	3.73E+00	1.59E+00	1.98E+00
NOY	2.21E-02	2.32E-02	9.44E-03	6.79E+00	3.39E+00	4.65E+00
PCN	8.90E-03	2.19E-02	8.34E-03	5.19E+00	3.45E+00	4.34E+00
COY 7/1	2.14E-03	2.10E-02	7.54E-03	1.34E+00	1.63E+00	2.61E+00
RED	1.21E-02	2.31E-02	9.26E-03	5.56E+01	4.26E+01	6.43E+01
SWL	3.01E-03	1.95E-02	4.21E-03	8.51E+01	1.50E+01	7.54E+00
TUT	1.45E-02	1.95E-02	4.63E-03	4.36E+00	1.98E+00	2.64E+00
UPR	-1.65E-02	2.22E-02	5.52E-03	8.01E+00	5.12E+00	5.80E+00

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

Duplicate samples were collected from two locations (LST and NOY) 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 NOY were less than 1.0, indicating no difference between duplicate samples and confirming the required precision for the sampling and analytical techniques. All RER values for LST were greater than 1.0 indicating poor reproducibility. The poor reproducibility of these samples was most likely due to inhomogeneity in the distribution of uranium isotopes at the collection location.

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

Location		Sample			Duplicate			
		[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
LST	^{234}U	6.81E-02	1.32E-02	1.05E-03	4.01E-02	8.43E-03	1.07E-03	1.79
	^{235}U	5.91E-03	2.29E-03	1.50E-03	2.41E-03	1.36E-03	1.53E-03	1.31
	^{238}U	8.27E-02	1.57E-02	1.31E-03	4.69E-02	9.62E-03	1.33E-03	1.94
	^{40}K	3.73E+00	1.59E+00	1.98E+00	9.94E+00	5.37E+00	6.06E+00	1.11
NOY	^{234}U	2.57E-02	5.89E-03	1.09E-03	2.57E-02	5.36E-03	8.44E-04	0.00
	^{238}U	2.79E-02	6.24E-03	1.36E-03	2.73E-02	5.63E-03	1.05E-03	0.07

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

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.

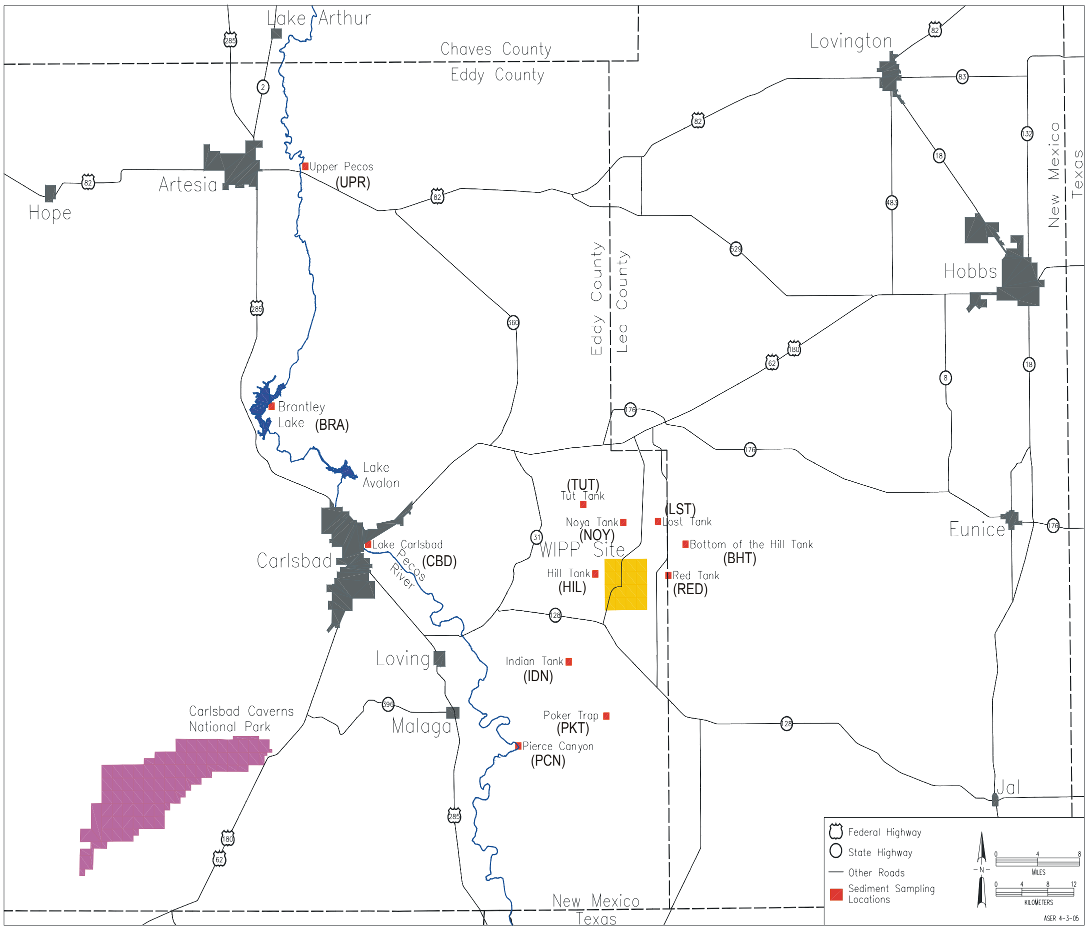

Figure 4.3 - Sediment Sampling Sites

4.5.4 Results and Discussion

Uranium-234, ^{235}U,and ^{238}U were detected in every sediment sample (Table 4.11). There was not a significant difference between detected uranium concentrations for either for locations (ANOVA ^{234}U p = 0.239, ^{235}U p = 0.0555, ^{238}U p = 0.503), or between 2003 and 2004 (ANOVA ^{234}U p = 0.723, ^{235}U p = 0.372, ^{238}U p = 0.559). Concentrations of all three uranium isotopes fell within the 99 percent confidence interval ranges of the baseline data (^{234}U: 1.10E-01 Bq/g; ^{235}U: 3.20E-03 Bq/g; ^{238}U: 5.00E-02 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	3.17E-02	5.81E-03	2.95E-04	1.57E-03	6.08E-04	4.56E-04	2.81E-02	5.20E-03	4.25E-04
BHT	2.42E-02	4.46E-03	3.66E-04	2.04E-03	6.81E-04	3.57E-04	2.85E-02	5.17E-03	3.84E-04
CBD	5.03E-02	8.93E-03	2.76E-04	2.93E-03	8.76E-04	4.26E-04	3.41E-02	6.18E-03	3.97E-04
HIL	2.49E-02	4.63E-03	2.59E-04	1.71E-03	6.09E-04	4.00E-04	2.63E-02	4.88E-03	3.73E-04
IDN	2.42E-02	4.39E-03	3.51E-04	1.95E-03	6.41E-04	3.42E-04	2.74E-02	4.91E-03	3.68E-04
LST	2.07E-02	3.88E-03	3.58E-04	1.24E-03	4.92E-04	3.49E-04	2.36E-02	4.38E-03	3.76E-04
NOY	1.17E-02	2.14E-03	2.17E-04	3.84E-04	2.77E-04	3.35E-04	1.22E-02	2.22E-03	3.12E-04
PCN	2.29E-02	4.39E-03	3.78E-04	1.10E-03	4.71E-04	3.69E-04	1.53E-02	3.04E-03	3.97E-04
PKT	3.08E-02	5.65E-03	3.65E-04	2.03E-03	6.73E-04	3.56E-04	2.89E-02	5.33E-03	3.83E-04
RED	2.34E-02	4.33E-03	3.48E-04	1.98E-03	6.48E-04	3.39E-04	2.25E-02	4.17E-03	3.65E-04
TUT	2.42E-02	4.40E-03	2.46E-04	1.67E-03	5.84E-04	3.81E-04	2.47E-02	4.47E-03	3.55E-04
UPR	1.85E-02	3.50E-03	2.36E-04	1.37E-03	5.12E-04	3.64E-04	1.84E-02	3.47E-03	3.39E-04

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

Sediment samples were analyzed for ^{241}Am, ^{238}Pu, and $^{239+240}$Pu (Table 4.12). None of these isotopes were detected; therefore, a statistical comparison between years and sampling locations was not prepared.

Table 4.12 - Americium and Plutonium Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for 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	1.22E-04	1.24E-04	2.26E-04	-4.82E-05	1.67E-04	3.29E-04	0.00E+00	N/A[d]	3.69E-04
BHT	1.95E-04	2.58E-04	2.09E-04	6.62E-05	3.51E-04	1.02E-03	4.63E-04	3.63E-04	1.01E-03
CBD	1.27E-04	1.28E-04	2.35E-04	2.48E-05	1.31E-04	1.70E-04	9.91E-05	1.00E-04	1.90E-04
HIL	1.95E-04	2.08E-04	2.41E-04	2.20E-04	3.31E-04	5.01E-04	1.46E-04	2.10E-04	5.61E-04
IDN	1.75E-04	2.12E-04	2.62E-04	1.96E-04	1.99E-04	7.59E-04	4.88E-04	3.50E-04	7.59E-04
LST	7.50E-05	3.00E-04	2.81E-04	1.18E-04	1.77E-04	2.44E-04	1.57E-04	1.59E-04	2.69E-04
NOY	-6.55E-05	1.31E-04	2.43E-04	-5.91E-05	8.41E-05	2.02E-04	0.00E+00	N/A[d]	2.26E-04
PCN	0.00E+00	N/A[d]	2.36E-04	5.10E-05	7.26E-05	1.58E-04	0.00E+00	N/A[d]	1.74E-04
PKT	1.39E-04	1.98E-04	2.60E-04	2.68E-04	2.24E-04	6.95E-04	5.80E-04	3.60E-04	6.94E-04
RED	2.20E-04	2.30E-04	2.36E-04	7.34E-05	2.55E-04	4.56E-04	2.93E-04	3.00E-04	5.02E-04
TUT	-3.74E-05	1.68E-04	2.77E-04	1.90E-04	3.02E-04	3.24E-04	9.47E-05	1.35E-04	3.63E-04
UPR	1.33E-04	1.64E-04	2.46E-04	-2.88E-05	1.29E-04	1.97E-04	0.00E+00	N/A[d]	2.20E-04

[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 (Table 4.13). There was not a significant difference in ^{137}Cs concentrations among either sampling locations (ANOVA, p =0.0609) or between sampling years 2003 and 2004 (ANOVA, p = 0.183). 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). There was no significant difference between ^{40}K concentrations detected among sampling locations (ANOVA, p = 0.161) or between 2003 and 2004 (ANOVA, p = 0.783). All detected concentrations of ^{40}K observed in these samples were within the 99 percent confidence interval range of baseline concentrations.

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	2.92E-04	1.13E-04	2.57E-04	1.94E-04	4.46E-04	5.13E-04
BHT	1.34E-02	1.96E-03	4.94E-04	-8.75E-04	8.99E-04	8.97E-04
CBD	5.97E-03	8.05E-04	3.47E-04	5.98E-05	5.29E-04	5.78E-04
HIL	1.36E-03	2.61E-04	3.70E-04	1.29E-04	5.74E-04	6.28E-04
IDN	1.28E-02	1.88E-03	4.86E-04	5.90E-04	8.44E-04	9.50E-04
LST	2.93E-03	5.94E-04	5.64E-04	-6.63E-05	6.93E-04	7.57E-04
NOY	1.92E-03	3.16E-04	3.38E-04	-2.36E-04	5.68E-04	5.98E-04
PCN	3.85E-04	1.74E-04	2.51E-04	-1.91E-04	4.31E-04	4.65E-04
PKT	1.89E-02	2.74E-03	6.27E-04	1.04E-04	1.04E-03	1.14E-03
RED	4.01E-03	6.57E-04	4.41E-04	7.95E-04	7.41E-04	8.52E-04
TUT	1.61E-03	2.81E-04	3.12E-04	-4.62E-04	5.93E-04	6.22E-04
UPR	8.55E-04	1.88E-04	2.87E-04	-2.23E-04	5.06E-04	5.46E-04
		^{90}Sr			^{40}K	
BRA	1.25E-04	4.58E-03	2.20E-03	3.17E-01	4.17E-02	3.87E-03
BHT	1.39E-03	6.30E-03	2.99E-03	6.70E-01	1.09E-01	8.43E-03
CBD	-1.02E-03	4.70E-03	2.30E-03	3.52E-01	4.59E-02	6.15E-03
HIL	2.39E-03	6.06E-03	3.65E-03	6.65E-01	8.59E-02	6.33E-03
IDN	3.40E-03	5.35E-03	1.87E-03	7.26E-01	1.18E-01	8.27E-03
LST	2.98E-03	5.72E-03	2.63E-03	4.39E-01	7.20E-02	7.85E-03
NOY	-1.57E-03	4.83E-03	2.45E-03	5.24E-01	6.78E-02	6.55E-03
PCN	1.42E-03	4.88E-03	1.93E-03	2.19E-01	2.91E-02	4.38E-03
PKT	1.90E-03	4.81E-03	1.66E-03	1.10E+00	1.79E-01	9.46E-03
RED	1.62E-03	5.37E-03	2.36E-03	5.90E-01	9.62E-02	7.67E-03
TUT	-2.89E-04	5.11E-03	2.63E-03	7.14E-01	9.26E-02	5.79E-03
UPR	2.77E-04	4.90E-03	2.55E-03	4.35E-01	5.68E-02	4.59E-03

[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 LST and NOY (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 ^{235}U, and ^{238}U at LST. 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 Sampling Analysis. Units are Bq/g. See Appendix C for sampling location codes.

Location		Sample			Duplicate			
		[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
LST	^{234}U	2.07E-02	3.88E-03	3.58E-04	1.61E-02	3.03E-03	3.28E-04	0.93
	^{235}U	1.24E-03	4.92E-04	3.49E-04	5.12E-04	2.87E-04	3.20E-04	1.28
	^{238}U	2.36E-02	4.38E-03	3.76E-04	1.63E-02	3.05E-03	3.44E-04	1.37
	^{40}K	4.39E-01	7.20E-02	7.85E-03	4.72E-01	7.73E-02	6.93E-03	0.31
	^{137}Cs	2.93E-03	5.94E-04	5.64E-04	3.02E-03	7.30E-04	8.58E-04	0.10
NOY	^{234}U	1.17E-02	2.14E-03	2.17E-04	1.25E-02	2.45E-03	2.71E-04	0.25
	^{235}U	3.84E-04	2.77E-04	3.35E-04	4.37E-04	2.86E-04	4.19E-04	0.13
	^{238}U	1.22E-02	2.22E-03	3.12E-04	1.27E-02	2.49E-03	3.91E-04	0.15
	^{40}K	5.24E-01	6.78E-02	6.55E-03	5.61E-01	7.30E-02	5.07E-03	0.37
	^{137}Cs	1.92E-03	3.16E-04	3.38E-04	1.74E-03	4.64E-04	6.07E-04	0.32

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

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.

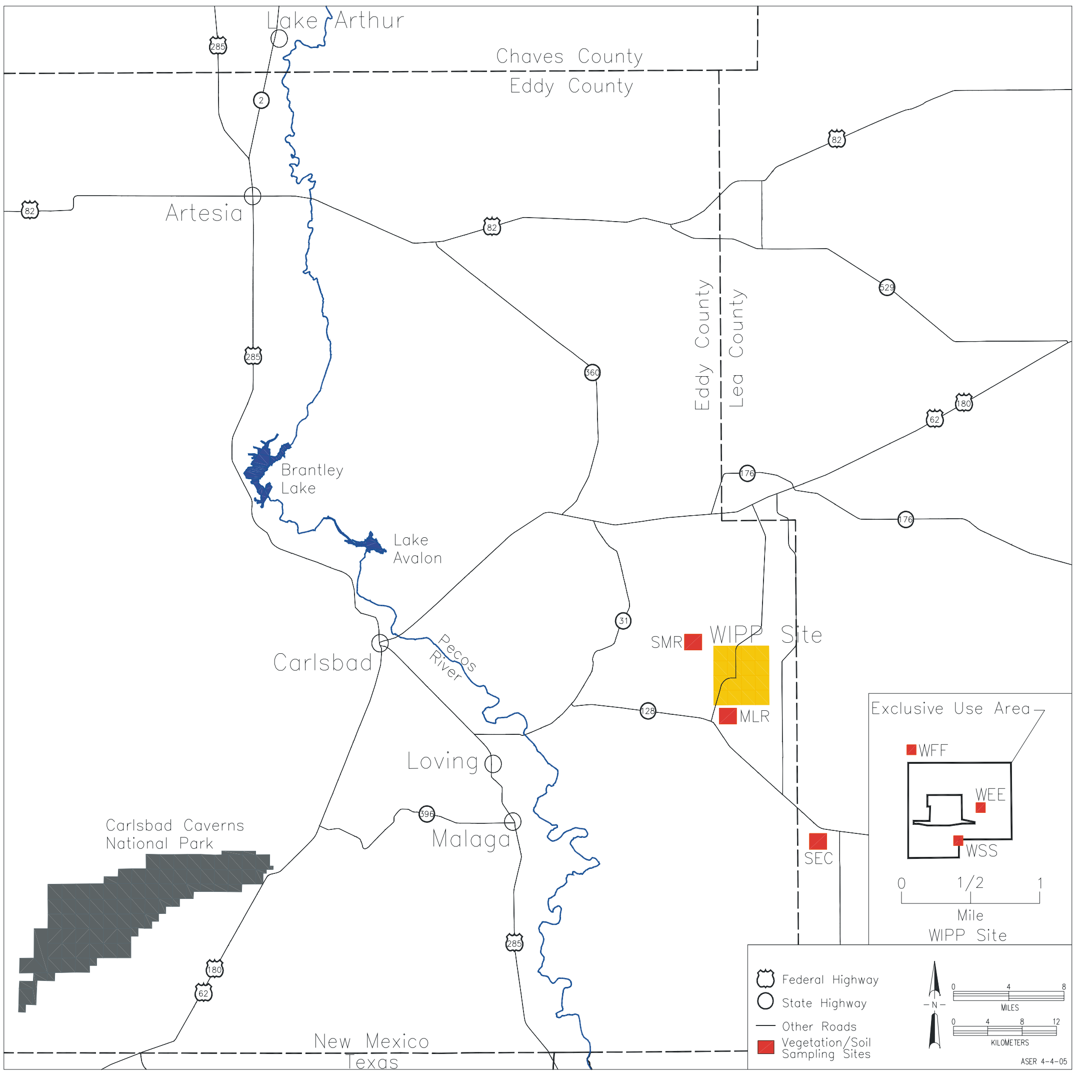

Figure 4.4 - Routine Soil and Vegetation Sampling Areas

4.6.4 Results and Discussion

Uranium-234, ^{235}U, and ^{238}U, were detected in every soil sample in 2004 (Table 4.15). There was no significant variation in uranium isotope concentration among sampling locations (ANOVA, ^{234}U $p = 0.408$; ^{235}U $p = 0.588$; ^{238}U $p = 0.401$). There was a significant difference between detected uranium isotope concentrations between 2003 and 2004 (ANOVA, ^{234}U p = 0.000325; ^{235}U p = 0.000106; ^{238}U p = 0.000515), with the higher concentrations detected in 2004. Uranium-235 (highest concentration: 2.90E-03 Bq/g) and ^{238}U (highest concentration: 3.49E-02 Bq/g) were somewhat higher than baseline concentrations (1.70E-03 Bq/g and 1.30E-02 Bq/g, respectively) (DOE/WIPP 92-037). However, these detected concentrations fell within the range of natural concentrations of uranium found in soils throughout the world. The average concentration of ^{238}U in soil (upper crust) is 3.6E-02 Bq/g (NCRP Report No. 94, 1977). The consistency of the measured uranium concentrations with natural uranium in soils throughout the world, the fact that increases in uranium concentrations from 2003 to 2004 were not observed in any other environmental media or biota, the natural variability of uranium in soils, and the fact that none of the actinides, which would be expected to be released along with uranium, were detected in concentrations in excess of baseline quantities, suggests that these soil concentrations follow 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	3.22E-02	5.69E-03	2.22E-04	2.90E-03	8.04E-04	2.74E-04	3.15E-02	5.58E-03	2.21E-04
MLR	2-5	3.29E-02	5.79E-03	2.40E-04	2.48E-03	7.41E-04	2.96E-04	3.49E-02	6.13E-03	2.39E-04
MLR	5-10	3.02E-02	5.41E-03	2.41E-04	2.75E-03	7.99E-04	2.97E-04	3.13E-02	5.59E-03	2.40E-04
SEC	0-2	2.74E-02	4.86E-03	3.25E-04	1.20E-03	4.61E-04	3.27E-04	2.48E-02	4.44E-03	2.81E-04
SEC	2-5	2.77E-02	5.07E-03	3.47E-04	1.62E-03	5.73E-04	3.49E-04	2.74E-02	5.03E-03	2.99E-04
SEC	5-10	3.38E-02	6.60E-03	4.33E-04	2.66E-03	8.65E-04	4.36E-04	3.26E-02	6.36E-03	3.74E-04
SMR	0-2	2.12E-02	3.87E-03	2.26E-04	1.53E-03	5.36E-04	2.79E-04	2.41E-02	4.35E-03	2.25E-04
SMR	2-5	2.98E-02	6.29E-03	3.51E-04	1.86E-03	7.62E-04	4.33E-04	2.70E-02	5.75E-03	3.49E-04
SMR	5-10	2.35E-02	4.70E-03	3.25E-04	2.15E-03	7.76E-04	4.01E-04	2.20E-02	4.43E-03	3.24E-04
WEE	0-2	1.57E-02	3.18E-03	4.25E-04	1.71E-03	6.43E-04	4.28E-04	1.60E-02	3.22E-03	3.67E-04
WEE	2-5	1.95E-02	3.93E-03	4.29E-04	9.08E-04	4.68E-04	4.32E-04	1.91E-02	3.86E-03	3.70E-04
WEE	5-10	2.12E-02	4.11E-03	3.86E-04	9.02E-04	4.25E-04	3.88E-04	2.14E-02	4.14E-03	3.33E-04
WFF	0-2	1.58E-02	2.88E-03	2.11E-04	1.53E-03	5.20E-04	2.61E-04	1.68E-02	3.05E-03	2.11E-04
WFF	2-5	1.49E-02	2.72E-03	2.10E-04	1.42E-03	4.94E-04	2.59E-04	1.57E-02	2.86E-03	2.09E-04
WFF	5-10	1.32E-02	2.52E-03	2.31E-04	1.64E-03	5.63E-04	2.85E-04	1.39E-02	2.64E-03	2.30E-04
WSS	0-2	2.08E-02	3.79E-03	3.31E-04	1.14E-03	4.53E-04	3.33E-04	2.10E-02	3.84E-03	2.86E-04
WSS	2-5	2.81E-02	5.50E-03	2.94E-04	2.32E-03	7.84E-04	3.62E-04	2.98E-02	5.79E-03	2.92E-04
WSS	5-10	2.22E-02	4.09E-03	3.45E-04	1.65E-03	5.76E-04	3.48E-04	2.25E-02	4.15E-03	2.98E-04

[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 detected in one sample. Plutonium-239+240 was detected in two samples and ^{241}Am was detected in one sample. 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). 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. 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	9.93E-05	1.99E-04	2.67E-04	3.01E-05	1.59E-04	2.03E-04	5.72E-04	3.03E-04	2.06E-04
MLR	2-5	1.64E-04	1.66E-04	3.30E-04	-7.66E-05	1.88E-04	2.58E-04	4.59E-04	2.77E-04	2.62E-04
MLR	5-10	1.38E-04	1.66E-04	2.22E-04	1.97E-04	1.80E-04	2.92E-04	3.95E-05	1.37E-04	3.02E-04
SEC	0-2	2.50E-04	1.93E-04	2.73E-04	7.44E-05	3.94E-04	8.23E-04	2.97E-04	3.04E-04	7.13E-04
SEC	2-5	1.04E-04	1.56E-04	2.65E-04	1.14E-04	5.12E-04	1.27E-03	3.43E-04	5.17E-04	1.10E-03
SEC	5-10	-6.67E-05	1.34E-04	2.55E-04	6.11E-04	5.18E-04	1.13E-03	1.02E-04	3.53E-04	9.76E-04
SMR	0-2	2.92E-05	1.54E-04	2.36E-04	-7.73E-05	2.68E-04	5.72E-04	0.00E+00	N/A[d]	5.92E-04
SMR	2-5	8.38E-05	1.19E-04	3.38E-04	2.10E-04	2.14E-04	3.88E-04	5.24E-05	1.05E-04	4.02E-04
SMR	5-10	6.03E-05	8.59E-05	2.44E-04	3.93E-04	3.61E-04	5.81E-04	0.00E+00	N/A[d]	6.01E-04
WEE	0-2	3.96E-05	1.37E-04	3.03E-04	0.00E+00	N/A[d]	9.72E-04	-8.77E-05	1.77E-04	8.42E-04
WEE	2-5	5.92E-05	1.68E-04	2.27E-04	1.26E-04	2.53E-04	6.97E-04	1.26E-04	1.80E-04	6.03E-04
WEE	5-10	-2.96E-05	2.29E-04	2.27E-04	1.82E-04	2.61E-04	1.01E-03	-9.08E-05	1.83E-04	8.71E-04
WFF	0-2	1.43E-04	1.73E-04	2.31E-04	3.46E-05	1.55E-04	2.56E-04	6.91E-05	3.31E-04	2.65E-04
WFF	2-5	1.64E-04	1.67E-04	3.31E-04	-3.02E-05	1.05E-04	2.23E-04	1.21E-04	1.22E-04	2.31E-04
WFF	5-10	7.83E-05	1.57E-04	3.16E-04	3.05E-05	1.36E-04	2.25E-04	-3.04E-05	1.36E-04	2.33E-04
WSS	0-2	1.07E-04	1.09E-04	2.05E-04	1.43E-04	2.04E-04	7.89E-04	7.12E-05	1.43E-04	6.83E-04
WSS	2-5	3.49E-04	2.09E-04	2.45E-04	5.05E-04	3.33E-04	3.87E-04	2.02E-04	2.05E-04	4.84E-04
WSS	5-10	1.48E-04	1.80E-04	2.27E-04	-7.41E-05	1.49E-04	8.20E-04	0.00E+00	N/A[d]	7.10E-04

[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 significantly different among sampling locations (ANOVA, p = 8.79E-09), but not different between 2003 and 2004 (ANOVA, p = 0.722). Potassium-40 concentrations at some locations (highest concentration: 5.24E-01 Bq/g) were higher than baseline levels (3.40E-01 Bq/g) (DOE/WIPP 92-037). However, the range of concentrations observed is consistent with the average natural ^{40}K concentration in soils around the world (4.00E-01 Bq/g [1.08E+1 pCi/g]; NCRP, 1987a).

Cesium-137 was detected in all soil samples with the exception of two samples taken at SMR (Table 4.17). Although concentrations varied among sampling locations (ANOVA, p = 0.00271), there was no statistically significant difference in concentrations between 2003 and 2004 (ANOVA, p = 0.190). In addition, all ^{137}Cs concentrations fell within the

99 percent confidence interval range of baseline values. 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 sampling location codes.

Location	Depth (cm)	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
		^{137}Cs			^{60}Co		
MLR	0-2	7.18E-03	9.48E-04	2.84E-04	-4.03E-05	4.92E-04	5.49E-04
MLR	2-5	4.51E-03	6.81E-04	4.72E-04	5.17E-04	5.58E-04	6.22E-04
MLR	5-10	2.30E-03	3.54E-04	2.91E-04	4.75E-05	4.67E-04	5.28E-04
SEC	0-2	2.50E-03	5.12E-04	5.75E-04	3.27E-04	4.84E-04	5.40E-04
SEC	2-5	3.03E-03	4.77E-04	3.44E-04	-2.13E-05	4.06E-04	4.56E-04
SEC	5-10	1.08E-03	2.22E-04	3.45E-04	1.15E-04	4.81E-04	5.29E-04
SMR	0-2	1.11E-03	2.27E-04	3.46E-04	3.08E-04	5.62E-04	6.20E-04
SMR	2-5	-6.30E-04	4.04E-04	6.03E-04	3.55E-04	5.75E-04	6.35E-04
SMR	5-10	-3.12E-05	2.71E-04	4.73E-04	3.54E-04	5.12E-04	5.90E-04
WEE	0-2	2.05E-03	3.63E-04	4.24E-04	1.05E-04	3.92E-04	4.49E-04
WEE	2-5	1.84E-03	3.83E-04	4.22E-04	-3.90E-05	4.70E-04	5.09E-04
WEE	5-10	1.69E-03	2.71E-04	2.15E-04	1.68E-04	3.88E-04	4.50E-04
WFF	0-2	1.31E-03	2.24E-04	2.06E-04	3.25E-04	3.48E-04	4.18E-04
WFF	2-5	1.06E-03	2.17E-04	2.95E-04	3.25E-04	4.72E-04	5.28E-04
WFF	5-10	9.91E-04	2.33E-04	2.64E-04	9.72E-05	3.52E-04	4.06E-04
WSS	0-2	2.12E-03	3.37E-04	3.16E-04	1.53E-04	4.88E-04	5.38E-04
WSS	2-5	1.69E-03	3.51E-04	3.80E-04	4.52E-04	4.88E-04	5.48E-04
WSS	5-10	1.50E-03	2.82E-04	2.60E-04	1.09E-04	3.99E-04	4.57E-04
		^{90}Sr			^{40}K		
MLR	0-2	7.37E-03	8.24E-03	2.83E-03	4.16E-01	5.44E-02	4.90E-03
MLR	2-5	4.23E-03	8.19E-03	2.84E-03	4.05E-01	5.26E-02	6.39E-03
MLR	5-10	-1.95E-03	8.34E-03	3.06E-03	3.76E-01	4.93E-02	4.52E-03
SEC	0-2	-2.87E-03	7.43E-03	3.17E-03	2.13E-01	2.82E-02	5.86E-03
SEC	2-5	7.22E-03	7.53E-03	3.18E-03	2.31E-01	3.07E-02	4.65E-03
SEC	5-10	5.84E-03	7.44E-03	3.13E-03	2.46E-01	3.25E-02	6.11E-03
SMR	0-2	6.90E-04	8.44E-03	3.03E-03	4.87E-01	6.31E-02	6.37E-03
SMR	2-5	-8.22E-04	7.93E-03	2.90E-03	5.24E-01	6.78E-02	6.50E-03
SMR	5-10	2.93E-03	8.13E-03	2.89E-03	5.13E-01	6.68E-02	5.48E-03
WEE	0-2	2.17E-03	7.15E-03	2.98E-03	2.21E-01	2.92E-02	3.98E-03
WEE	2-5	7.52E-04	7.22E-03	2.92E-03	2.28E-01	3.00E-02	6.04E-03
WEE	5-10	2.43E-03	7.22E-03	3.00E-03	2.34E-01	3.10E-02	3.44E-03
WFF	0-2	2.93E-03	8.47E-03	3.05E-03	1.94E-01	2.59E-02	3.00E-02
WFF	2-5	6.81E-04	8.17E-03	2.82E-03	1.83E-01	2.44E-02	5.85E-03
WFF	5-10	2.00E-03	8.33E-03	2.88E-03	1.94E-01	2.59E-02	4.05E-03

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

Location	Depth (cm)	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
WSS	0-2	5.82E-03	7.41E-03	3.06E-03	2.55E-01	3.36E-02	5.99E-03
WSS	2-5	1.30E-03	5.23E-03	2.24E-03	2.43E-01	3.20E-02	6.06E-03
WSS	5-10	4.62E-03	7.26E-03	3.02E-03	2.43E-01	3.22E-02	4.33E-03

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

Soil samples collected from one location (SEC) were divided into two parts and analyzed separately (Table 4.18). Detected concentrations of ^{234}U, ^{235}U, ^{238}U, ^{40}K, and ^{137}Cs were compared between the samples and 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.

Table 4.18 - Results of Duplicate Soil Sampling Analysis in Soil Near the WIPP Site. Units are Bq/g. See Appendix C for sampling location codes.

Location	Depth (cm)		Sample			Duplicate			
			[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
SEC	0-2	^{234}U	2.74E-02	4.86E-03	3.25E-04	2.32E-02	4.08E-03	3.23E-04	0.66
SEC	2-5		2.77E-02	5.07E-03	3.47E-04	2.99E-02	5.28E-03	2.22E-04	0.30
SEC	5-10		3.38E-02	6.60E-03	4.33E-04	2.89E-02	5.20E-03	2.32E-04	0.58
SEC	0-2	^{235}U	1.20E-03	4.61E-04	3.27E-04	1.29E-03	4.79E-04	3.25E-04	0.14
SEC	2-5		1.62E-03	5.73E-04	3.49E-04	1.68E-03	5.62E-04	2.73E-04	0.07
SEC	5-10		2.66E-03	8.65E-04	4.36E-04	2.17E-03	6.77E-04	2.87E-04	0.45
SEC	0-2	^{238}U	2.48E-02	4.44E-03	2.81E-04	2.06E-02	3.65E-03	2.78E-04	0.73
SEC	2-5		2.74E-02	5.03E-03	2.99E-04	2.74E-02	4.87E-03	2.21E-04	0.00
SEC	5-10		3.26E-02	6.36E-03	3.74E-04	2.83E-02	5.12E-03	2.31E-04	0.53
SEC	0-2	^{40}K	2.13E-01	2.82E-02	5.86E-03	2.01E-01	2.68E-02	4.35E-03	0.31
SEC	2-5		2.31E-01	3.07E-02	4.65E-03	2.28E-01	3.04E-02	4.52E-03	0.07
SEC	5-10		2.46E-01	3.25E-02	6.11E-03	2.42E-01	3.19E-02	6.03E-03	0.09
SEC	0-2	^{137}Cs	2.50E-03	5.12E-04	5.75E-04	2.44E-03	3.62E-04	2.23E-04	0.10
SEC	2-5		3.03E-03	4.77E-04	3.44E-04	3.05E-03	4.82E-04	3.54E-04	0.03
SEC	5-10		1.08E-03	2.22E-04	3.45E-04	1.15E-03	2.34E-04	3.58E-04	0.22

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

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). Also collected were muscle tissues from one deer and one quail, both species commonly consumed by humans. In 2004, according to the U.S. Fish and Wildlife Service (personal communication), a golden algae bloom killed up to 85 percent of area river fish; therefore a sample of fish was not acquired in 2004. All biota samples, when available, were analyzed for concentrations of the radionuclides of interest.

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 furnace at 350-375°C for 8-12 hours. If gamma analysis was required, 0.5 M 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-238 was detected in three of six vegetation samples. Neither ^{234}U or ^{235}U were detected in any of the samples (Table 4.19). Statistical comparison of detected concentrations of ^{238}U indicated that there was no significant difference between among sampling locations (ANOVA, p = 0.659) or between 2003 and 2004 (ANOVA, p = 0.109). In addition, comparison of detected uranium concentrations with baseline values suggest higher concentrations of ^{238}U in 2004 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 2004 data having to be made to the mean 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.

Americium-241, ^{238}Pu, and $^{239+240}$Pu were not detected in any of the vegetation samples (Table 4.19).

Potassium-40 was detected in every vegetation sample (Table 4.19). The detected concentrations of ^{40}K in vegetation did not show a statistically significant difference among locations (ANOVA, p = 0.988), but were statistically different between 2003 and 2004, with 2004 having the higher concentrations (ANOVA, p = 0.0000111). 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. The apparent increase in ^{40}K in vegetation samples from 2003 to 2004 is unlikely to be related to WIPP operations, because of the following factors:

- Natural variability in ^{40}K distribution and plant uptake
- ^{40}K is not a component of WIPP waste streams
- 2004 ^{40}K values in vegetation are within the preoperational baseline levels.

Cesium-137 and ^{60}Co were not detected in vegetation samples. Strontium-90 was detected at all sampling locations with the exception of MLR (Table 4.19). There were insufficient detections of these fission products to allow statistical comparisons between years (^{90}Sr was detected in only one sample in 2003). No comparison with baseline data was available for the ^{90}Sr concentrations, as it was not reported for vegetation samples analyzed for the baseline report (DOE/WIPP 92-037). The average ^{90}Sr concentration in surface soil is about 3.7E-03 Bq/g (Human Health Fact Sheet, Strontium, Argonne National Laboratory, 2005).

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

Location	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
	^{241}Am			^{238}Pu			^{239}Pu		
MLR	8.88E-06	3.76E-05	2.04E-04	3.52E-05	9.63E-05	1.15E-04	-7.03E-06	2.31E-05	1.89E-04
SEC	-2.10E-05	3.93E-05	2.12E-04	3.76E-05	1.22E-04	1.60E-04	1.67E-05	8.80E-05	2.34E-04
SMR	8.83E-05	1.04E-04	2.19E-04	3.62E-06	8.47E-05	1.47E-04	-1.21E-05	3.83E-05	2.21E-04
WEE	6.87E-06	6.08E-05	1.97E-04	-6.66E-06	5.95E-05	1.01E-04	-6.66E-06	1.92E-05	1.75E-04
WFF	1.01E-05	8.10E-05	2.09E-04	-1.92E-06	7.40E-05	1.12E-04	-8.35E-06	2.45E-05	1.87E-04
WSS	1.65E-05	4.07E-05	1.95E-04	-4.75E-06	5.26E-05	9.66E-05	3.42E-05	4.59E-05	1.71E-04
	^{234}U			^{235}U			^{238}U		
MLR	1.51E-04	1.03E-04	1.09E-03	1.72E-05	4.56E-05	2.93E-04	2.47E-04	1.33E-04	5.42E-04
SEC	6.58E-04	1.88E-04	1.08E-03	3.09E-05	4.91E-05	2.81E-04	8.73E-04	2.17E-04	5.32E-04
SMR	6.72E-04	2.32E-04	1.09E-03	-6.82E-06	2.54E-05	3.02E-04	6.74E-04	2.30E-04	5.49E-04
WEE	9.74E-05	6.39E-05	1.07E-03	1.02E-05	2.66E-05	2.69E-04	1.37E-04	7.51E-05	5.22E-04
WFF	2.54E-04	1.43E-04	1.09E-03	-3.65E-06	1.86E-05	3.02E-04	2.52E-04	1.43E-04	5.49E-04
WSS	3.86E-04	1.34E-04	1.07E-03	7.17E-05	6.44E-05	2.75E-04	5.62E-04	1.61E-04	5.27E-04
	^{137}Cs			^{60}Co			^{90}Sr		
MLR	5.00E-04	1.16E-03	1.39E-03	-4.60E-04	1.68E-03	1.85E-03	3.24E-03	3.40E-03	1.80E-03
SEC	2.05E-04	1.17E-03	1.38E-03	-1.49E-04	1.32E-03	1.91E-03	6.43E-03	3.15E-03	1.43E-03
SMR	-1.52E-03	2.18E-03	2.31E-03	-2.53E-03	2.52E-03	2.51E-03	2.55E-03	2.40E-03	1.19E-03
WEE	-1.34E-03	2.19E-03	2.33E-03	-2.04E-03	2.44E-03	2.46E-03	5.22E-03	3.70E-03	2.02E-03
WFF	-1.20E-03	1.27E-03	1.36E-03	3.07E-04	1.63E-03	1.87E-03	9.36E-03	2.89E-03	1.18E-03
WSS	-1.61E-04	1.07E-03	1.24E-03	-1.27E-03	1.60E-03	1.64E-03	3.80E-03	2.95E-03	1.42E-03
	^{40}K								
MLR	8.08E-01	1.09E-01	1.79E-02						
SEC	6.49E-01	8.86E-02	1.89E-02						
SMR	8.92E-01	1.19E-01	2.79E-02						
WEE	6.94E-01	9.41E-02	2.81E-02						
WFF	7.27E-01	9.84E-02	1.87E-02						
WSS	3.74E-01	5.37E-02	1.89E-02						

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

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

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

Location		Sample			Duplicate			
		[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	RER[d]
MLR	^{40}K	8.08E-01	1.09E-01	1.79E-02	9.51E-01	1.26E-01	2.88E-02	0.86

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

Animals

Of the radionuclides of interest, ^{40}K was detected in the both the deer and quail sample and ^{60}Co was detected in the deer sample (Table 4.21). The remaining isotopes of interest were not detected in any of the 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 and Quail Near the WIPP Site

	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC	[RN]	2 × TPU	MDC
		^{241}Am			^{238}Pu			^{239}Pu	
Deer	3.07E-06	5.80E-06	1.63E-06	1.35E-06	7.67E-06	7.89E-05	-7.34E-07	2.20E-06	1.53E-04
Quail	-4.76E-07	1.13E-06	1.88E-04	1.30E-06	2.50E-06	1.01E-04	4.26E-06	1.45E-06	1.01E-04
		^{234}U			^{235}U			^{238}U	
Deer	7.94E-06	5.10E-06	1.03E-03	-2.07E-07	8.79E-07	2.38E-04	7.02E-06	4.85E-06	5.10E-04
Quail	6.85E-06	4.49E-06	7.69E-04	2.54E-06	3.03E-06	1.01E-04	5.38E-06	4.03E-06	3.48E-04
		^{137}Cs			^{60}Co			^{90}Sr	
Deer	-3.85E-04	9.30E-04	1.01E-03	1.06E-03	9.27E-04	1.05E-03	6.51E-05	1.13E-04	4.43E-05
Quail	-8.27E-05	4.25E-04	4.91E-04	9.42E-05	5.84E-04	6.75E-04	8.05E-05	1.82E-04	7.80E-05
		^{40}K							
Deer	2.47E-01	4.14E-02	1.25E-02						
Quail	1.75E-02	1.57E-02	6.48E-03						

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

4.8 Potential Dose from WIPP Operations

4.8.1 Dose Limits

Compliance with the regulatory standards is determined by comparing annual radiation doses to the regulatory limits. The regulatory basis for the WIPP Effluent Monitoring Program can be found in 40 CFR (the EPA) Part 191, Subpart A, "Environmental

Standards for Management and Storage." The referenced standard specifies that the combined annual dose equivalent to any member of the public in the general environment resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed 25 mrem to the whole body and 75 mrem to any critical organ. In addition, in a 1995 Memorandum of Understanding between the EPA and the DOE, the DOE agreed that WIPP would comply with NESHAP. The NESHAP standard states that the emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an EDE of 10 mrem per year.

The SDWA (40 CFR §141.66) states that average annual concentrations fo 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 medicinal procedures.

Compliance with the above regulatory requirements 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.

4.8.2 Background Radiation

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 in the southeastern New Mexico environment may be due to the deposition of tailings from local potash mining. Radon gas, a decay product of uranium, is a widely known naturally occurring terrestrial radionuclide. In addition to natural radioactivity, small amounts of radioactivity from aboveground 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 radioactive particulates such as the decay products of radon. 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)

	Average Annual EDE	
Source	**(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 Subpart A standard limits radiation doses to members of the public in the general environment. For the WIPP facility, the EPA emphasizes doses from releases via the air pathway, because WIPP has identified air emissions as the major pathway of concern. Based on this position the EPA has concluded that the only plausible pathway for radionuclide transport during receipt and emplacement of waste at the WIPP is by air emissions through the underground exhaust shaft or the ventilation system of the Waste Handling Building.

Compliance with Subpart A (40 CFR §191.03[b]) and the NESHAP (40 CFR §61.92) standards is determined by comparing annual radiation doses to the MEI. As recommended by the EPA, the DOE utilizes computer modeling to calculate radiation doses for compliance with the Subpart A and NESHAP standards. 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 Stations A, B, and C. Air filter samples were analyzed for

^{241}Am, $^{239+240}$Pu, ^{238}Pu, and ^{90}Sr because these radionuclides 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.

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 2004.

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 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, *Title 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 total dissolved solids (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 2004 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 2004 were mule deer and quail. 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 2004.

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. The hypothetical MEI who resides year-round at the WIPP fence line is less than 1.27E-06 mSv (1.27E-04 mrem) per year for the whole body, and is less than 2.11E-05 mSv (2.11E-03 mrem) per year for the critical organ. These values are in compliance with the Subpart A requirements specified in 40 CFR §191.03(b). For NESHAP (40 CFR §61.92) standards, the EDE potentially received by the MEI assumed to be residing 7.5 km (4.66 miles) west-northwest of WIPP was calculated to be 5.69E-08 mSv (5.69E-06 mrem) per year whole body. This value is in compliance with 40 CFR §61.92 requirements. The total radiological dose and atmospheric release at WIPP in 2004 is summarized in Table 4.23 for both regulations.

Table 4.23 - WIPP Radiological Dose and Release Summary

WIPP Radiological Atmospheric Releases [a] During 2004			
^{238}Pu	$^{239+240}Pu$	^{241}Am	^{90}Sr
7.5E-08 Ci[b] 2.76E-03 Bq[c]	7.1E-08 Ci 2.63E-03 Bq	8.3E-08 Ci 3.06E-03 Bq	2.1E-06 Ci 7.69E-04 Bq

WIPP Radiological Dose Reporting Table in 2004 per 40 CFR §61.92							
Pathway	EDE to the Maximally Exposed Individual at 7,500 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
	(mrem/year)	*(mSv/year)*		*(person-rem/year)*	*(person-Sv/ year)*		*(person-rem)*
Air	5.69E-06	5.69E-08	5.69E-05	1.07E-05	1.07E-07	100,944	30,288
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 2004 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	1.27E-04	1.27E-06	5.08E-04	2.11E-03	2.11E-05	2.81E-03
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 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 1.27E-06 mSv (1.27E-04 mrem) per year whole body and 2.11E-05 mSv (2.11E-03 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.

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 2004 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 2004.

Medium	Radionuclide	Maximum Observed Concentration	BCG[a]	Concentration/BCG
Aquatic System Evaluation				
Sediment[b] (Bq/g)	^{60}Co	ND[c]	5.00E+01	NA[d]
	^{90}Sr	ND	2.00E+01	NA
	^{137}Cs	1.89E-02	1.00E+02	1.89E-04
	^{234}U	5.03E-02	2.00E+02	2.52E-04
	^{235}U	2.93E-03	1.00E+02	2.93E-05
	^{238}U	3.41E-02	9.00E+01	3.79E-04
	^{238}Pu	ND	2.00E+02	NA
	^{239}Pu	ND	2.00E+02	NA
	^{241}Am	ND	2.00E+02	NA
Water[b] (Bq/l)	^{60}Co	7.80E-01	1.00E+02	7.80E-03
	^{90}Sr	ND	1.00E+01	NA
	^{137}Cs	ND	2.00E+00	NA
	^{234}U	4.33E-01	7.00E+00	6.19E-02
	^{235}U	9.00E-03	8.00E+00	1.13E-03
	^{238}U	1.19E-01	8.00E+00	1.49E-02
	^{238}Pu	ND	7.00E+00	NA
	^{239}Pu	ND	7.00E+00	NA
	^{241}Am	ND	2.00E+01	NA
			Sum of Fractions	8.65E-02
Terrestrial System Evaluation				
Soil (Bq/g)	^{60}Co	ND	3.00E+01	NA
	^{90}Sr	ND	8.00E-01	NA
	^{137}Cs	7.18E-03	8.00E-01	8.98E-03
	^{234}U	3.38E-02	2.00E+02	1.69E-04
	^{235}U	2.90E-03	1.00E+02	2.90E-05
	^{238}U	3.49E-02	6.00E+01	5.82E-04
	^{238}Pu	5.05E-04	2.00E+02	2.53E-06
	^{239}Pu	5.72E-04	2.00E+02	2.86E-06
	^{241}Am	3.49E-04	1.00E+02	3.49E-06
Water (Bq/l)	^{60}Co	7.80E-01	4.00E+04	1.95E-05
	^{90}Sr	ND	2.00E+04	NA
	^{137}Cs	ND	2.00E+04	NA
	^{234}U	4.33E-01	1.00E+04	4.33E-05
	^{235}U	9.00E-03	2.00E+04	4.50E-07
	^{238}U	1.19E-01	2.00E+04	5.95E-06

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 2004.

	^{238}Pu	ND	7.00E+03	NA
	^{239}Pu	ND	7.00E+03	NA
	^{241}Am	ND	7.00E+03	NA
			Sum of Fractions	9.83E-03

[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.
[c] Not detected in all sampling locations for a given medium.
[d] Not available for calculation

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 2004. 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 2004, the EDE to the receptor (hypothetical MEI) who resides year-round at the WIPP fence line is less than 1.27E-06 mSv (1.27E-04 mrem) per year for the whole body, and is less than 2.11E-05 mSv (2.11E-03 mrem) per year for the critical organ. For the WIPP Effluent Monitoring Program, Figure 4.5 and Table 4.25 shows the dose to the whole body for the hypothetical MEI for calendar years 1999 to 2004. In addition, Figure 4.6 and Table 4.26 show the dose to the critical organ for the hypothetical MEI for calendar years 1999 to 2004. These dose equivalent values are below the 25 mrem to the whole body and 75 mrem to any critical organ in accordance with the provisions of 40 CFR §191.03(b).

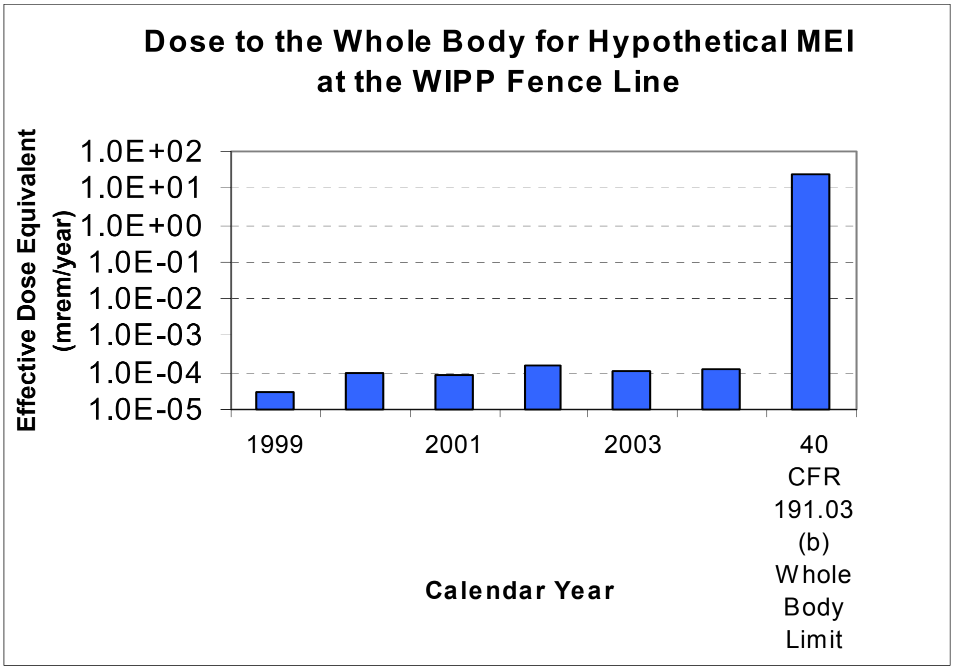

Figure 4.5 - Dose to the Whole Body for Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.25 - Dose to the Whole Body: 40 CFR §191.03(b)

Year	Annual Dose (mrem/yr)	Percent of EPA Limit
1999	3.10E-05	124 millionth
2000	9.35E-05	374 millionth
2001	8.99E-05	360 millionth
2002	1.51E-04	604 millionth
2003	1.15E-04	460 millionth
2004	1.27E-04	508 millionth
40 CFR §191.03(b) Whole Body Limit	25	

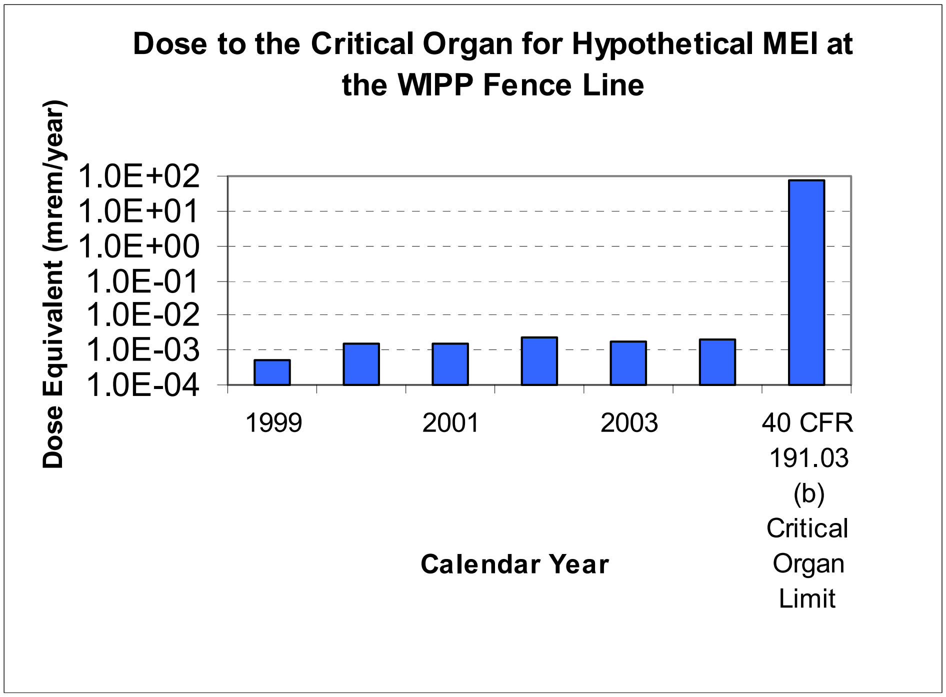

Figure 4.6 - Dose to the Critical Organ for Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.26 - Dose to the Critical Organ: 40 CFR §191.03(b)

Year	Annual Dose (mrem/yr)	Percent of EPA Limit
1999	5.30E-04	707 millionth
2000	1.63E-03	2170 millionth
2001	1.56E-03	2080 millionth
2002	2.46E-03	3280 millionth
2003	1.85E-03	2470 millionth
2004	2.11E-03	2810 millionth
40 CFR §191.03(b) Critical Organ Limit	75	

In addition, for calendar year 2004, the EDE to the MEI individual from normal operations conducted at the WIPP is less than 5.69E-08 mSv (5.69E-06 mrem) per year. For the WIPP Effluent Monitoring Program, Figure 4.7 and Table 4.27 show the EDE to the MEI for calendar years 1999 to 2004. Note that these EDE values are more than six orders of magnitude below the EPA NESHAP standard of 10 mrem per year as specified in 40 CFR §61.92.

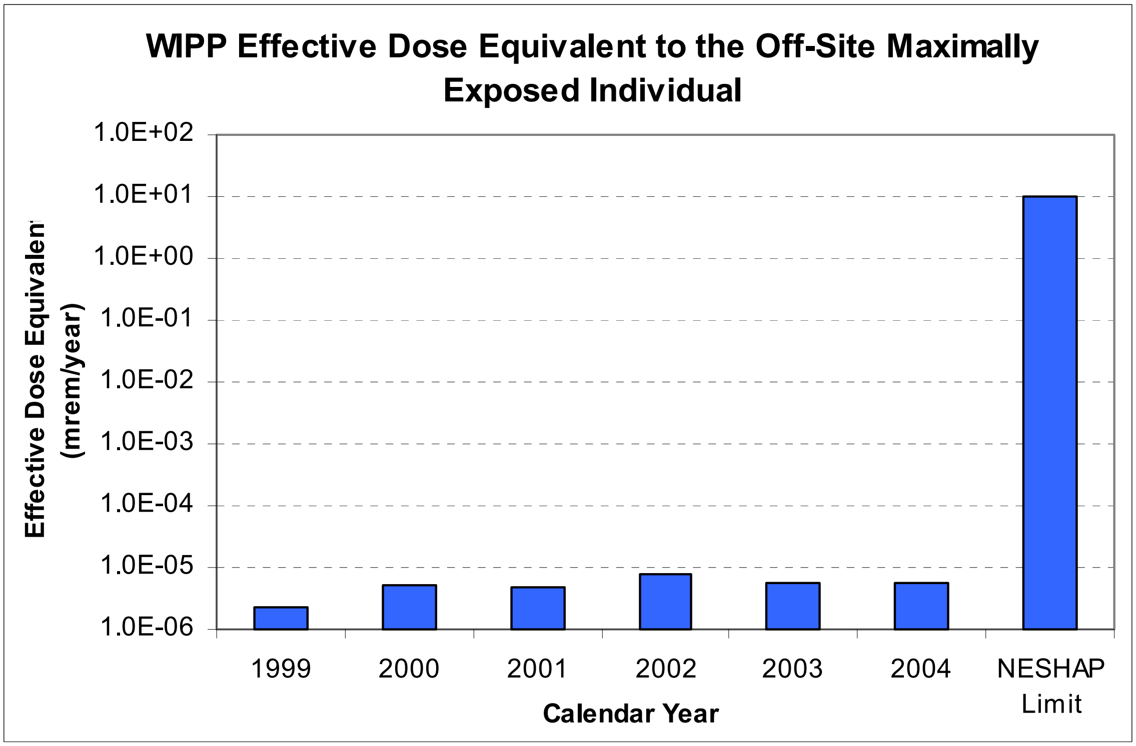

Figure 4.7 - WIPP Effective Dose Equivalent to the Off-Site Maximally Exposed Individual

Table 4.27 - 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
2004	5.69E-06	56.9 millionth

<u>Environmental Monitoring</u>

Radionuclide concentrations observed in environmental monitoring were extremely small and mostly comparable to radiological baseline levels. Appendix H contains graphs comparing all detected concentrations of radionuclides to their respective baseline values. In cases where the radionuclide concentrations slightly exceeded baseline levels (uranium isotopes 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.

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 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.

5.2.1 Climatic Data

The precipitation at the WIPP site for 2004 was 528 mm (20.8 in.) which was 322 mm (12.7 in.) greater than the previous year's rainfall. Figure 5.1 displays the monthly precipitation at WIPP.

The mean temperature at the WIPP site in 2004 was 16.8°C (62.2°F). The mean monthly temperatures for the WIPP area ranged from 26.6°C (79.9°F) during July to 6.9°C (44.4°F) in December. Generally, maximum temperatures occurred from May through September, while minimum temperatures occurred in January, February, November, and December. The lowest recorded temperature was -12.0°C (10.4°F) in February. The maximum recorded temperature was 38.6°C (101.5°F) in June. Monthly temperatures are illustrated in Figures 5.2, 5.3, and 5.4.

5.2.2 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 2004, wind speed measured at the 10-m (33-ft) level was 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 to 6.30 m/s (1.12 to 3.15 mph) were the most prevalent over 2004, occurring 35.8 percent of the time. Figure 5.5 displays the annual wind data at WIPP for 2004.

Precipitation Report
January 1, 2004 to December 31, 2004

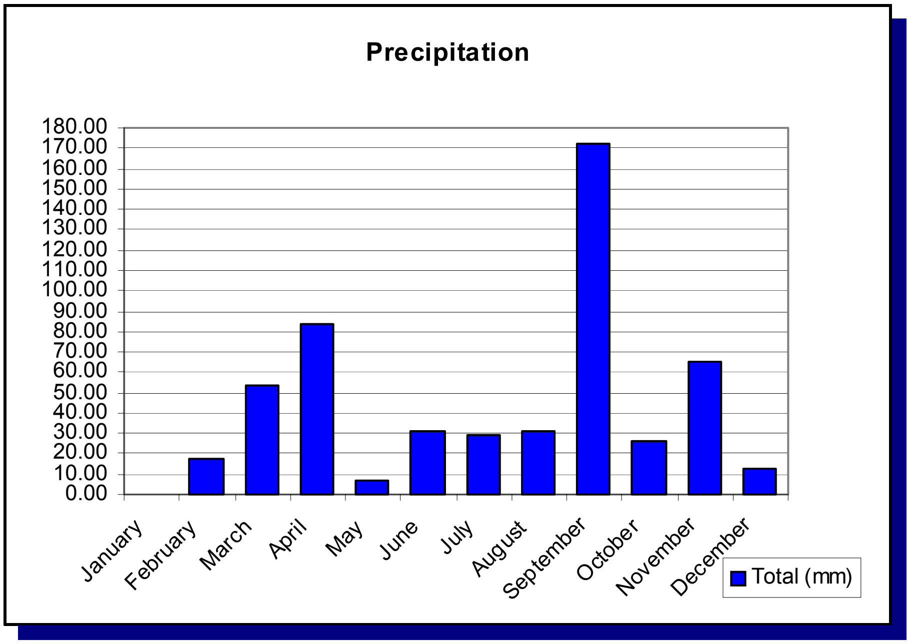

Figure 5.1 - 2004 Precipitation at WIPP

Month	Total (mm)
January	0.00
February	17.78
March	53.09
April	83.31
May	6.35
June	30.73
July	29.21
August	31.50
September	172.46
October	26.42
November	64.77
December	12.70

Temperature Report - Highs
January 1, 2004, to December 31, 2004, Elevation 10.0 Meters

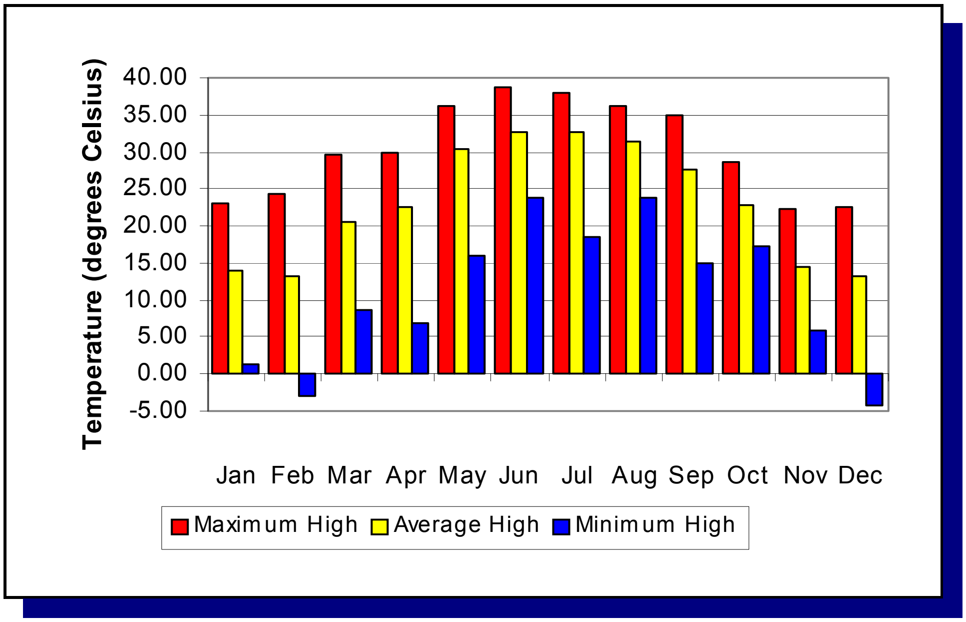

Figure 5.2 - 2004 High Temperatures at WIPP

Month	Maximum High	Average High	Minimum High
January	22.96°C	13.85°C	1.26°C
February	24.35°C	13.09°C	-2.99°C
March	29.63°C	20.55°C	8.62°C
April	29.81°C	22.45°C	6.82°C
May	36.10°C	30.40°C	15.91°C
June	38.63°C	32.74°C	23.74°C
July	38.03°C	32.69°C	18.52°C
August	36.32°C	31.33°C	23.72°C
September	34.86°C	27.57°C	14.93°C
October	28.58°C	22.79°C	17.26°C
November	22.19°C	14.46°C	5.96°C
December	22.52°C	13.11°C	-4.17°C

Temperature Report - Averages
January 1, 2004, to December 31, 2004, Elevation 10.0 Meters

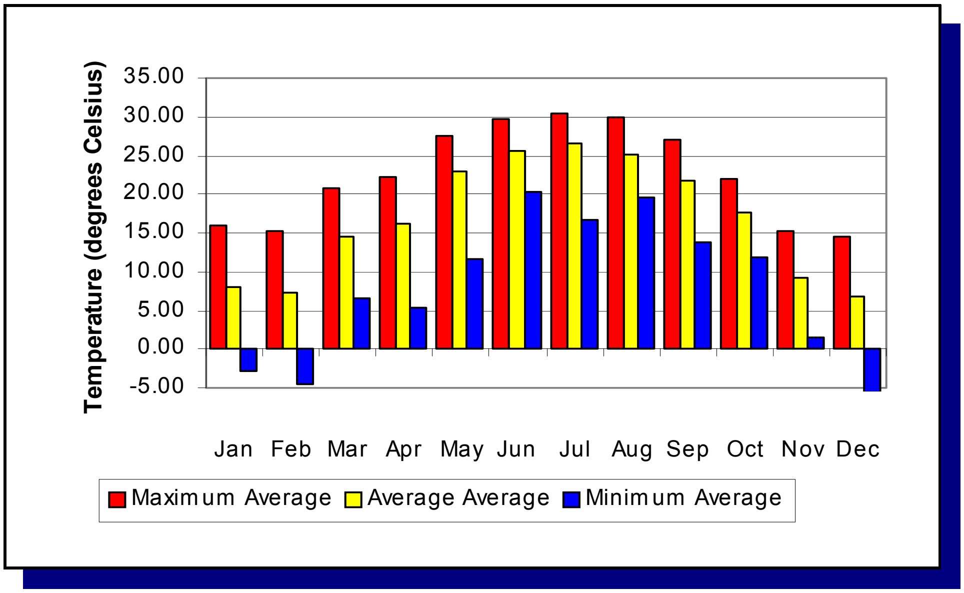

Figure 5.3 - 2004 Average Temperatures at WIPP

Month	Maximum Average	Average Average	Minimum Average
January	15.92°C	8.05°C	-2.92°C
February	15.19°C	7.27°C	-4.43°C
March	20.87°C	14.44°C	6.54°C
April	22.15°C	16.12°C	5.39°C
May	27.62°C	23.04°C	11.60°C
June	29.61°C	25.63°C	20.34°C
July	30.53°C	26.62°C	16.80°C
August	29.99°C	25.14°C	19.50°C
September	27.02°C	21.86°C	13.87°C
October	21.98°C	17.58°C	11.88°C
November	15.18°C	9.28°C	1.60°C
December	14.44°C	6.92°C	-7.71°C

Temperature Report - Lows
January 1, 2004, to December 31, 2004, Elevation 10.0 meters

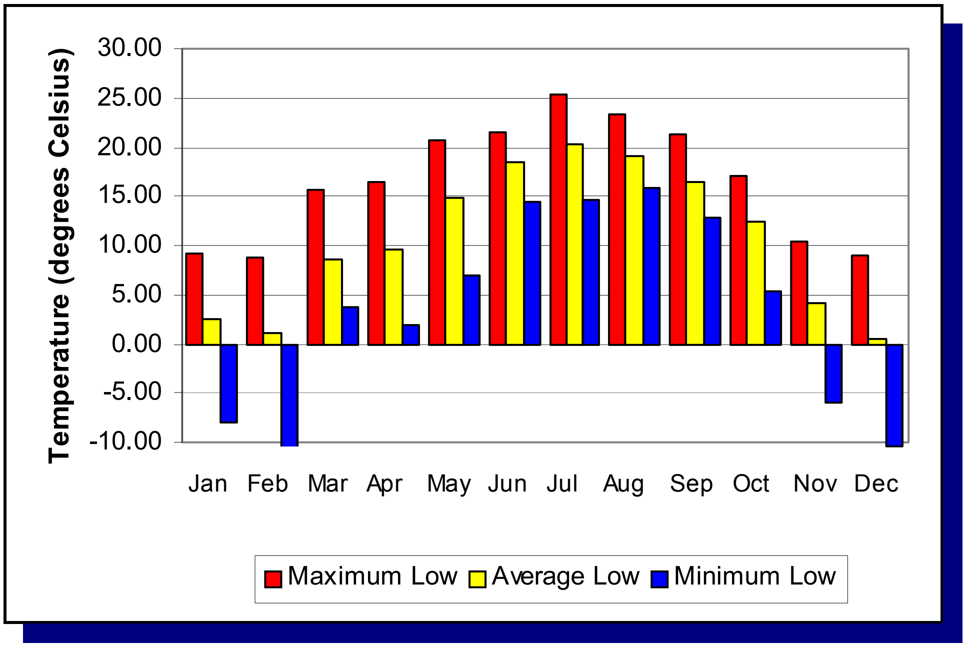

Figure 5.4 - 2004 Low Temperatures at WIPP

Month	Maximum Low	Average Low	Minimum Low
January	9.17°C	2.55°C	-8.00°C
February	8.79°C	1.17°C	-11.96°C
March	15.75°C	8.67°C	3.79°C
April	16.54°C	9.69°C	1.89°C
May	20.65°C	14.87°C	6.90°C
June	21.49°C	18.51°C	14.52°C
July	25.36°C	20.27°C	14.67°C
August	23.32°C	19.14°C	15.77°C
September	21.25°C	16.50°C	12.80°C
October	17.07°C	12.49°C	5.36°C
November	10.37°C	4.18°C	-6.00°C
December	9.00°C	0.58°C	-10.35°C

Wind Speed Report (Meters/Second)
January 1, 2004, to December 31, 2004, Elevation 10.0 Meters

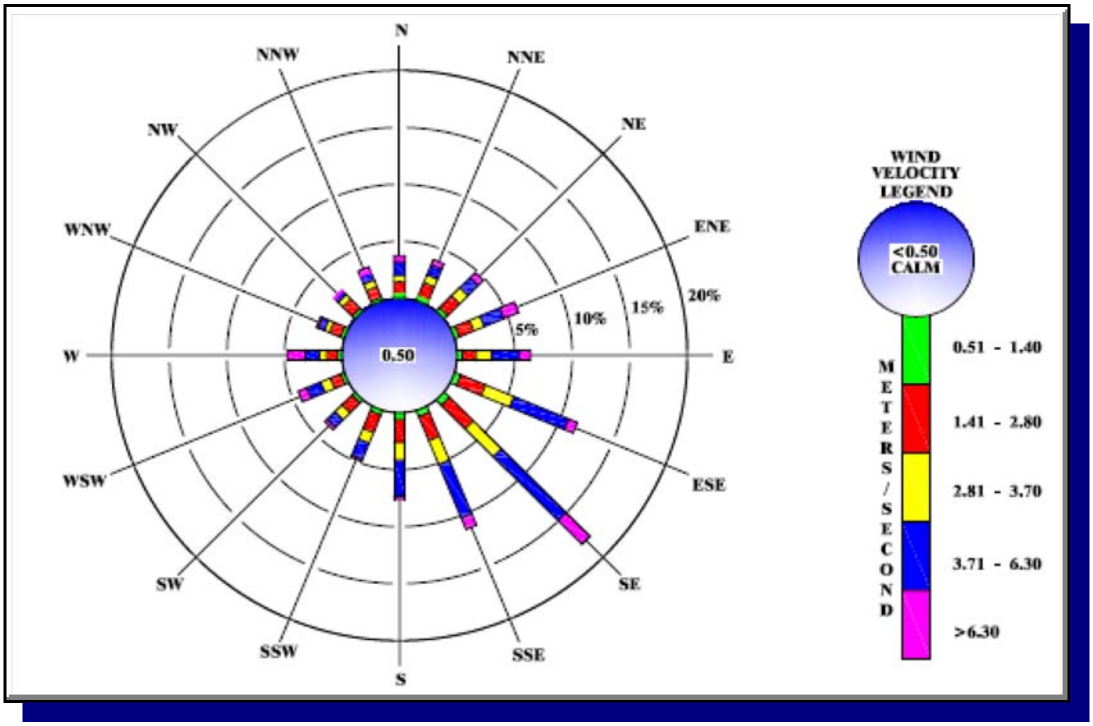

Figure 5.5 - 2004 Wind Speed Direction at WIPP

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	0.04	0.46	1.22	1.30	2.41	0.98	6.41
ENE	0.05	0.43	1.35	0.98	1.86	1.38	6.05
NE	0.06	0.41	1.48	0.99	1.28	0.63	4.85
NNE	0.05	0.39	1.32	0.73	0.96	0.49	3.93
N	0.04	0.38	1.06	0.59	1.18	0.53	3.79
NNW	0.03	0.29	1.04	0.63	0.76	0.48	3.22
NW	0.05	0.33	1.16	0.56	0.43	0.10	2.63
WNW	0.03	0.36	1.04	0.46	0.56	0.21	2.67
W	0.03	0.37	0.97	0.60	1.22	1.60	4.78
WSW	0.07	0.33	0.98	0.90	1.31	0.81	4.40
SW	0.04	0.35	1.23	0.87	0.94	0.30	3.73
SSW	0.08	0.44	1.66	1.00	1.53	0.20	4.91
S	0.06	0.55	2.05	1.53	3.19	0.27	7.66
SSE	0.09	0.57	2.29	2.26	5.08	1.09	11.37
SE	0.10	0.65	2.93	3.44	7.95	2.93	17.99
ESE	0.09	0.57	2.32	2.66	5.14	0.84	11.62
	0.91%	6.87%	24.09%	19.49%	35.80%	12.83%	100.00%

5.3 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 in the annual averages 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 limits (MRLs) are shown in Table 5.2. 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. 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 2004 VOC monitoring indicated an increase in the number of samples containing carbon tetrachloride, toluene, 1,1,1-trichloroethane, methylene chloride, and chloroform in air downstream of Panel 1. These increased detections were at very low levels and all were estimated values. During 2004, all VOC sample results were all below the MRLs and well below the concentrations of concern listed in Table 5.1.

Table 5.2 - Volatile Organic Compound MRLs

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

5.4 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 which 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 instrument 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 Seven Rivers Hills and brought on line during this reporting period, to closely monitor events possibly induced by hydrocarbon extraction activities. The station at Hat Mesa was temporarily taken offline to accommodate the Seven Rivers Hills installation. 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 2004 was approximately 94.8 percent. From January 1 through December 31, locations for 240 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 3.6) occurred on May 23 and was located approximately 86 km (53 mi) west-northwest of the site. The closest events to the site were located approximately 51 km (32 mi) west-northwest. A magnitude 1.2 event occurred on

February 28 and a magnitude 0.5 event occurred on December 3. These events had no effect on WIPP structures.

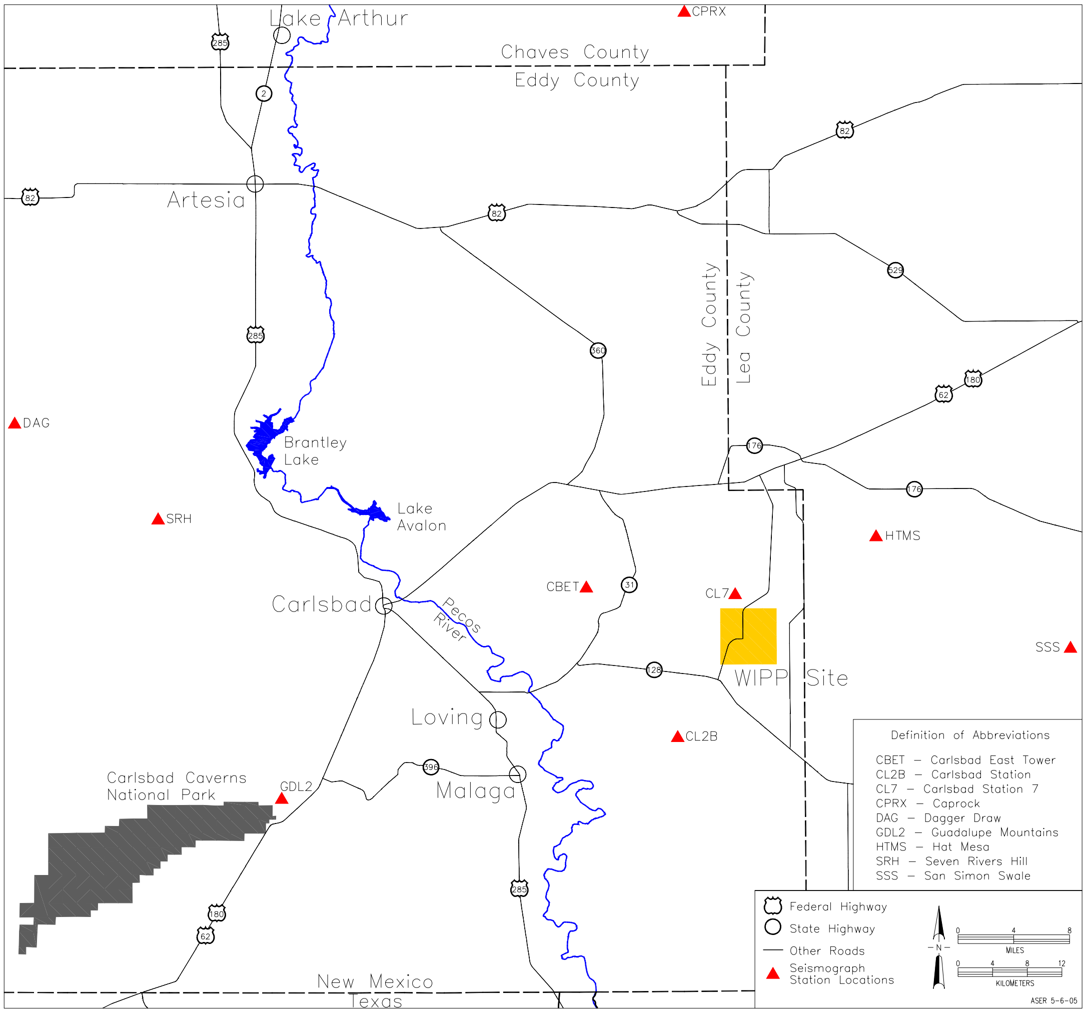

Figure 5.6 - WIPP Seismograph Station Locations

5.5 Liquid Effluent Monitoring

The NMED Ground and Surface Water Protection regulations set forth in 20.6.2 NMAC regulate discharges that could impact surface water or groundwater. WIPP compliance with the Ground and Surface Water Protection Regulations is discussed in Chapter 3, Section 3.2.7. The WIPP site has no discharges that could impact surface water. WIPP does have a discharge permit, DP-831, for potential discharges from the sewage treatment facility, the H-19 Evaporation Pond and for the control of subsurface discharges from active and inactive salt piles.

The WIPP sewage treatment system is a zero-discharge facility consisting of two primary settling ponds and two polishing ponds lined with 36-mil synthetic liners which discharge into three evaporation ponds lined with 30-mil synthetic liners. The facility is permitted for the disposal of up to 87,064 liters (23,000 gallons) per day of sewage effluent and up to 7,570 liters (2,000 gallons) of nonhazardous brine water to the north evaporation pond.

The H-19 Evaporation Pond is lined with a 36-mil synthetic liner and is permitted for the treatment of up to 30,283 liters (8,000 gallons) per day of nonhazardous brine waters from groundwater monitoring and observation wells, mine dewatering and condensate collected from the mine ventilation system. The permit also authorizes the discharge of up to 378 liters (100 gallons) of neutralized acid waste; however, the neutralized acid waste is no longer generated at WIPP.

A discharge permit modification approved on December 23, 2003, addressed discharges of storm water containing high TDS to the subsurface from a 16-acre salt pile accumulated from the construction of the underground repository and associated underground drifts. In accordance with the discharge permit modification, a new salt storage area with a 60-mil synthetic liner and an associated double-lined evaporation pond with leak detection was constructed to contain and evaporate salt contact storm water runoff. Additionally, the salt pile evaporation pond and three storm water evaporation ponds were lined with 60-mil high-density polyethylene liners to collect storm water runoff for evaporation and minimize the infiltration of storm water where collected.

Discharge monitoring reports are submitted semiannually to the NMED to demonstrate compliance with the inspection monitoring and reporting requirements identified in the discharge permit. The discharge permit requires semiannual sampling of the sewage lagoons and the H-19 Evaporation Pond and annual sampling of the storm water infiltration control ponds. Data from the discharge monitoring reports are summarized in the tables below. Subsurface shallow water monitoring results are outlined in Chapter 6, Section 6.1.2.

Table 5.3 - Sewage Lagoon and H-19 Semiannual Analytical Results - January 1 - June 30, 2004

Analyte	Influent to Facultative Lagoon System		Evaporation Pond B		Evaporation Pond C		H-19 Evaporation Pond	
Nitrate (mg/l)	<0.10		NA		NA		NA	
TKN (mg/l)	19		NA		NA		NA	
TDS (mg/l)	500		12,080		13,860		114,000	
	Activity	TPU 2 σ	Activity	TPU 2 σ	Activity	TPU 2 σ	Activity	TPU 2 σ
$^{233/234}$U Bq/l)	1.48E-02	3.85E-03	4.65E-02	9.92E-03	4.00E-02	8.57E-03	2.61E-01	5.44E-02
^{235}U (Bq/l)	6.89E-04	6.99E-04	2.34E-03	1.42E-03	2.18E-03	1.37E-03	1.57E-02	5.27E-03
^{238}U (Bq/l)	4.45E-03	1.79E-03	1.84E-03	1.42E-03	1.63E-02	4.29E-03	8.20E-02	1.86E-02
^{238}Pu (Bq/l)	1.10E-04	2.21E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E-04	4.84E-04
$^{239/240}$Pu (Bq/l)	1.10E-04	3.82E-04	-2.15E-04	3.05E-04	1.06E-04	2.14E-04	3.39E-04	4.83E-04
^{241}Am (Bq/l)	0.00E+00	0.00E+00	1.07E-04	4.81E-04	3.47E-04	6.14E-04	0.00E+00	0.00E+00
^{90}Sr (Bq/l)	1.77E-02	3.84-02	-1.06E-02	4.62E-02	2.91E-02	3.77E-02	5.01E-02	4.76E-02

TPU 2 σ = total propagated uncertainty at 2-sigma (95% confidence interval)
NA = The analytical parameter is not required.

Table 5.4 - Sewage Lagoon and H-19 Semiannual Analytical Results - July 1 - December 31, 2004

Analyte	Influent to Facultative Lagoon System		Evaporation Pond B		Evaporation Pond C		H-19 Evaporation Pond	
Nitrate (mg/l)	<0.10		NA		NA		NA	
TKN (mg/l)	19		NA		NA		NA	
TDS (mg/l)	500		12,080		13,860		114,000	
	Activity	TPU 2 σ	Activity	TPU 2 σ	Activity	TPU 2 σ	Activity	TPU 2 σ
$^{233/234}$U Bq/l)	1.48E-02	3.85E-03	4.65E-02	9.92E-03	4.00E-02	8.57E-03	2.61E-01	5.44E-02
^{235}U (Bq/l)	6.89E-04	6.99E-04	2.34E-03	1.42E-03	2.18E-03	1.37E-03	1.57E-02	5.27E-03
^{238}U (Bq/l)	4.45E-03	1.79E-03	1.84E-03	1.42E-03	1.63E-02	4.29E-03	8.20E-02	1.86E-02
^{238} Pu (Bq/l)	1.10E-04	2.21E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.40E-04	4.84E-04
$^{239/240}$Pu (Bq/l)	1.10E-04	3.82E-04	-2.15E-04	3.05E-04	1.06E-04	2.14E-04	3.39E-04	4.83E-04
^{241}Am (Bq/l)	0.00E+00	0.00E+00	1.07E-04	4.81E-04	3.47E-04	6.14E-04	0.00E+00	0.00E+00
^{90}Sr (Bq/l)	1.77E-02	3.84-02	-1.06E-02	4.62E-02	2.91E-02	3.77E-02	5.01E-02	4.76E-02

TPU 2 σ = total propagated uncertainty at 2-sigma (95% confidence interval)
NA = The analytical parameter is not required.

Table 5.5 - Infiltration Control Evaporation Ponds Analytical Results

Evaporation Pond	Chloride (mg/l)	Nitrate-N (mg/l)	Sulfate (mg/l)	TDS (mg/l)	Selenium (mg/l)	Chromium (mg/l)	Water Depth(ft)/ Volume (ft^3)
SPEP	10,000	<20.0	220	18,00	<0.0500	<0.250	NM
Salt Storage Extension	92,100	1.26	10,400	128,000	<0.0500	<0.250	NM
Pond 1	8.70	1.09	8.86	218.0	<0.0100	<0.0500	1.8/24,190
Pond 2	75.0	1.11	10.3	244.0	<0.0100	<0.0500	5.2/194,671
Pond A	120	<1.00	12.1	312	<0.0500	<0.250	2.9/550,000

NM = Not Measured

SPEP = Salt Pile Evaporation Pond

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 studied extensively 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 at and near the WIPP site. 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 at and in the vicinity of the site. Another very low transmissivity, saline water-bearing zone 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 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 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 2.8E-06 to 7.43E-01 m^2/day (3.0E-05 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 most significant potential hydrologic pathway for a radiologic release to the accessible environment.

Tests show that the Culebra is a fractured, heterogeneous system with varying local anisotropic characteristics (Mercer and Orr, 1977; Mercer, 1983; Beauheim, 1986, 1987; Beauheim and Ruskauff, 1998). Calculated transmissivities for the Culebra within the WIPP site boundary have a wide range with values between 2.7E-03 to approximately 21 $meters^2$/day (9.0E-02 to approximately 69 ft^2/day); the majority of the values are less than 0.3 $meters^2$/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 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 3.72E-04 to 2.79E-02 m^2/day (4.0E-03 to 3.0E-01 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 152 m (500 ft) thick and consists of alternating thin beds of siltstone and fine-grained sandstone. The upper Dewey Lake consists of a thick, generally unsaturated section. The middle Dewey Lake is the interval immediately above a cementation change, from carbonate (above) to sulfate (below), where saturated conditions and a natural water table have been identified in limited areas. The average saturated thickness is 5.1 m (16.6 ft). An anthropogenic saturated zone has been observed in the overlying Santa Rosa Formation and in the upper part of the Dewey Lake Redbeds since 1995. This is described in Sections 6.1.2.7 and 6.5. The lower Dewey Lake is below the sulfate cementation change, with much lower permeabilities. See Sections 6.5 and 6.6, as appropriate, for additional information.

WIPP monitoring well WQSP-6A intersects water in the Dewey Lake. At this location, the saturated horizon is within the middle portion of the formation. 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 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 (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 approximately 6 to 9 m (19 to 31 ft) at the WIPP site and consists of silt, sand, and clay, with deposits in localized depressions.

The Gatuña is water-bearing in some areas, with saturation occurring in discontinuous perched zones. However, because of its erratic distribution, the Gatuña 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 (Daniel B. Stephens & Associates, Inc., 2003).

Water in the Santa Rosa 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 2004 Activities

Groundwater monitoring support activities during 2004 included drilling of two 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 classified 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 2004 from the groundwater monitoring program are summarized in Chapter 4. The remainder of the results from the groundwater monitoring program are contained in this chapter.

Table 6.1 - Summary of 2004 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	86	N/A
Number of Samples Taken	N/A	N/A	14	N/A
Number of Water Level Measurements	N/A	N/A	788	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 (WQSP-1 through WQSP-6) and one well completed in the Dewey Lake (WQSP-6A; Figure 6.1).

The total amount of water removed from the Culebra as a result of Water Quality Sampling was 15,789 gallons. A total of 2,538 gallons were removed from the Dewey Lake for the same purpose.

Two new wells were constructed in 2004: SNL-1 (Culebra), and SNL-5 (Culebra). These wells were drilled to provide new hydraulic testing locations to help determine the cause of rising water levels in the Culebra.

Well development took place at two wells in 2004: SNL-1 and SNL-5. The total number of gallons removed from the Culebra as a result of well development was 28,989. 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 nine wells in 2004 in the Culebra. The wells tested were SNL-2, C-2737, SNL-3, SNL-1, SNL-5, SNL-12, SNL-9, WIPP-25, and WIPP-11. There were a total of 1,037,430 gallons of water removed from the Culebra during testing activities.

Groundwater surface elevation data were gathered from 86 well bores located across the WIPP region (Figure 6.2), six of which were equipped with production-injection-packers (PIPs) to allow groundwater level surveillance of more than one producing zone through the same well.

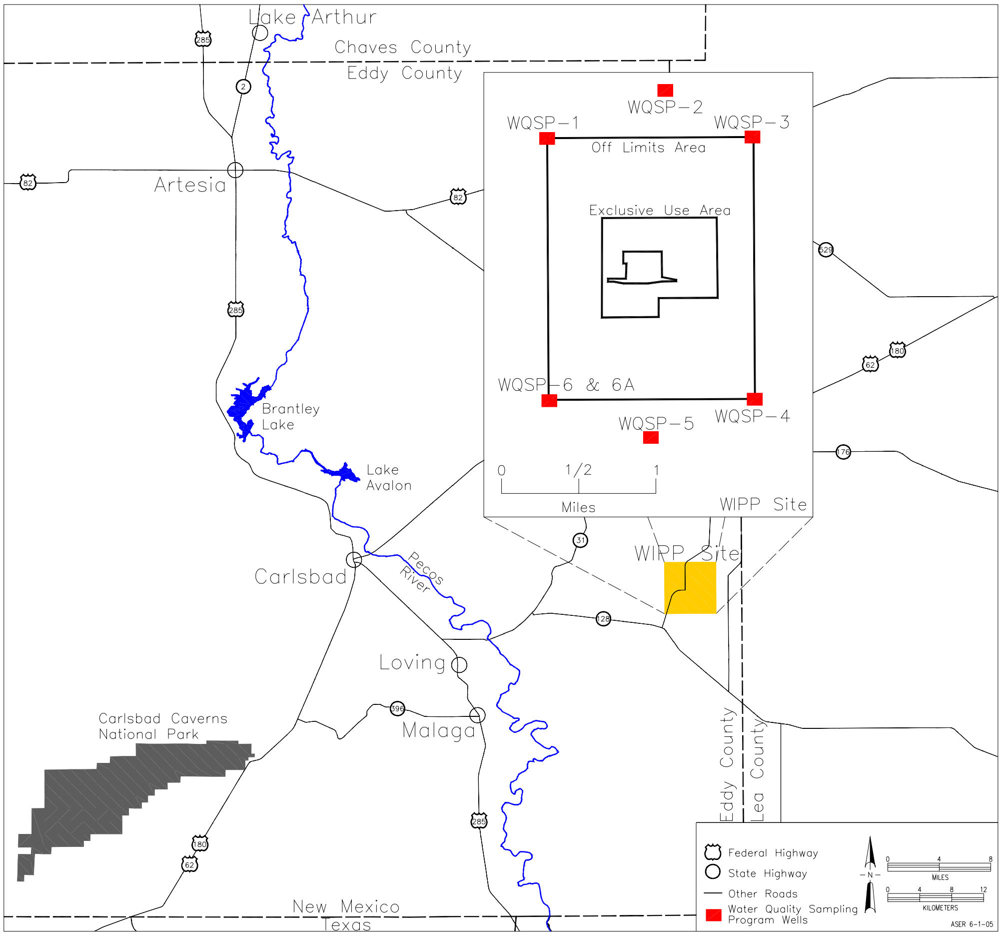

Figure 6.1 - Water Quality Sampling Program Wells (Inset shows the locations of the DMP wells within the 16-square-mile area of the WIPP site [Land Withdrawal Area.)

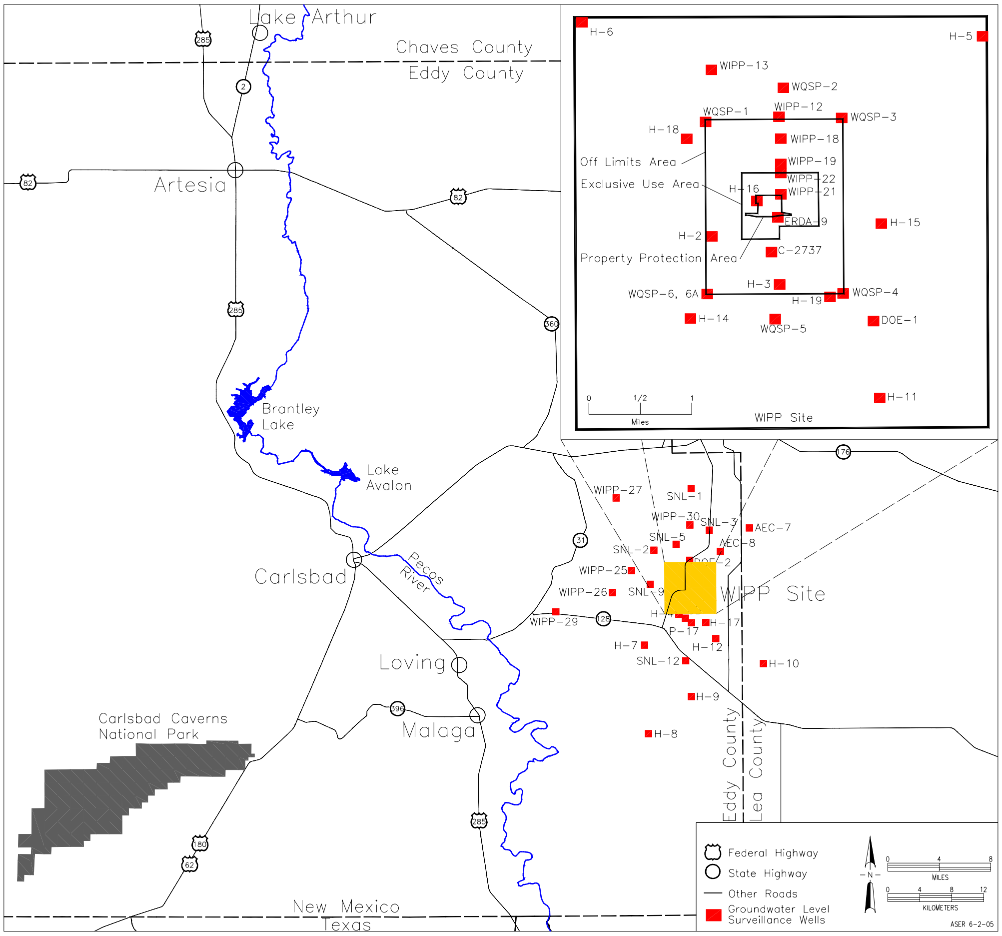

Figure 6.2 - Groundwater Level Surveillance Wells (Insert represents the groundwater surveillance wells in the 16-square-mile area of the WIPP site [Land Withdrawal Area].)

6.2.3 Groundwater Quality Sampling

The HWFP Module V requires groundwater quality sampling twice a year, from March through May (Round 18 for 2004) and, again, from September through November (Round 19 for 2004). Sampling for groundwater quality was performed at seven well sites during 2004 (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 area based on the greatest velocity magnitude of groundwater flow leaving the 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 at the WQSP-6 well pad to assess shallower 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 through 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.

The difference between the depth of the WIPP repository and the depth of the DMP wells varies from 387 m to 587 m (1,271 ft to 1,925 ft). The 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 2004 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
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

Table 6.2 - Analytical Parameters for Which Groundwater Was Analyzed

CAS No.[a]	Parameter	EPA Method Number	CAS No.	Parameter	EPA Method Number
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 2004, TDS concentrations in the Culebra varied from a low of 13,650 mg/l to a high of 234,000 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 indicate the waters are considerably better quality than that from the Culebra. In 2004, the TDS values in this formation (WQSP-6A) were less than 4,000 mg/l. This water is suitable for livestock consumption, and is classified as Class II water by EPA guidelines. Saturation of the Dewey Lake in the area of WIPP is discontinuous. In addition to this naturally occurring groundwater, anthropogenic shallow subsurface water has been encountered in the upper Dewey Lake at the Santa Rosa 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 2004 (Rounds 18 and 19) are summarized in Appendix F, Tables F.1 through F.7.

In these tables, either the 95th upper tolerance limit value (UTLV) or the 95th percentile value (as calculated for the background sampling rounds) is presented for each parameter 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 95th 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 contract required reporting limit for the contract laboratory. These values have been recomputed after baseline sampling was completed in 2000, and were used for sampling Rounds 18 and 19 to evaluate potential contamination of the local groundwater.

In a few isolated cases during 2004, reported concentrations of some parameters, such as sulfate and total organic halogens (TOX) slightly exceeded the calculated 95th percentile or the 95th UTLV. Such exceedences do not indicate the presence of contamination. The 95th 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 has very high concentrations of dissolved solids and major cations and anions. The laboratory reported concentrations for parameters such as sulfate and chloride are variable from sampling round to round. A previous contract analytical laboratory did exhibit some difficulty performing the analyses for TOX, due to very high chloride concentrations, and some of the cations found in the highly concentrated brines. For Round 19 in 2004, a new contract laboratory performed the TOX analysis. This new laboratory reported much more consistent results for TOX, during Round 19.

6.2.5 Groundwater Level Surveillance

Groundwater surface elevations in the vicinity of WIPP have been and may still be affected 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.

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 (see Figure 1.1). Throughout the year, 52 Culebra wells were measured each month and 14 wells in the

Magenta. Two well measurements were taken in the Dewey Lake Redbeds Formation monthly and three measurements were taken in the Bell Canyon. One measurement was taken each month in the Rustler/Salado contact. Fifteen measurements were taken in the shallow zone of the Santa Rosa/Dewey Lake interface. In 2004, 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).

Six existing well bores (WIPP-30-Culebra/Magenta, C-2737-Culebra/Magenta, WIPP-25-Culebra/Magenta, WIPP-27-Culebra/Magenta, H-9c-Culebra/Magenta, and H-15-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 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 39 of 52 wells completed in the Culebra. Rising water level trends were noted in 33 wells while 6 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 2004 (as opposed to a number of surveillance wells).

Groundwater level data were transmitted on a monthly basis to the NMED, SNL, and 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 steady-state numerical modeling techniques calibrated to current groundwater head elevations.

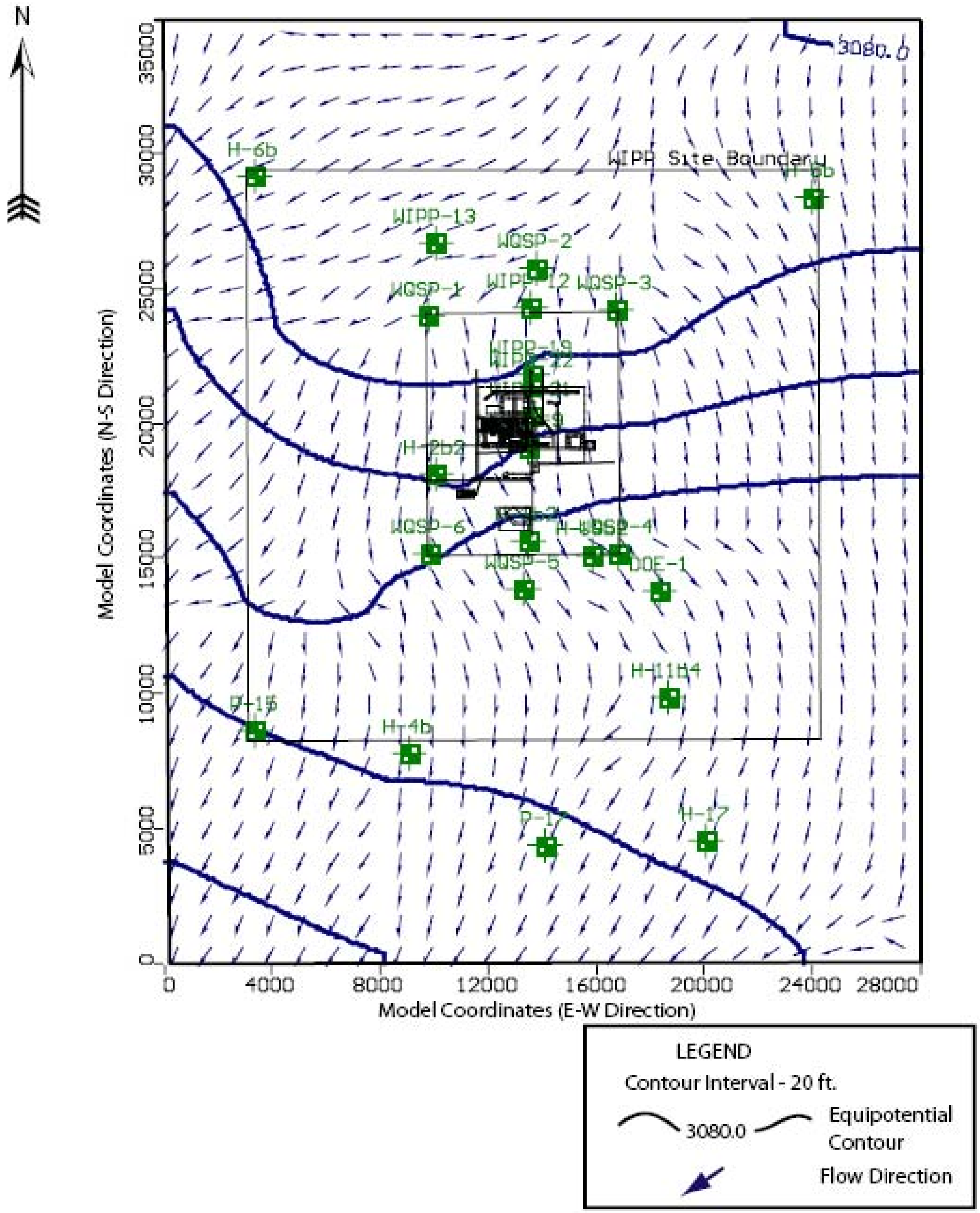

Figure 6.3 - Flow Direction of Groundwater Across the WIPP Site in the Culebra Based on 2004 Data

Flow rates over the entire model area (Figure 6.3) ranged from a high of 2.71E-04 m/d (8.88E-04 ft/d) to a low of 1.03E-04 m/d (3.38E-04 ft/d). The average flow rate across the domain was 1.76E-04 m/d (5.76E-04 ft/d). The west half of the area ranged from 1.88E-04 m/d to 1.41E-04 m/d (6.18E-04 ft/d to 4.63E-04 ft/d). The eastern half of the area ranged from 2.71E-04 m/d to 1.03E-04 m/d (8.88E-04 ft/day to 3.38E-04 ft/d).

Groundwater data collected in 2004 are similar to previous years. Figures 6.4 through 6.10 provide hydrographs of the DMP wells for 2004.

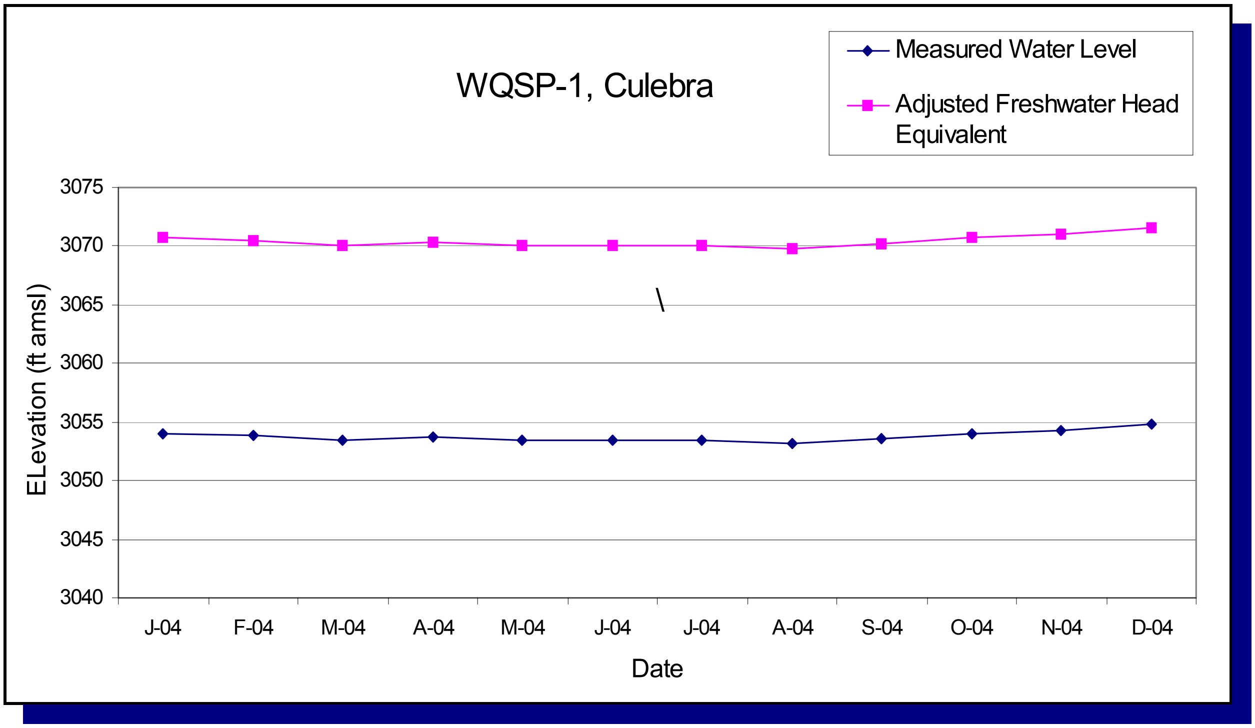

Figure 6.4 - Hydrograph of WQSP-1

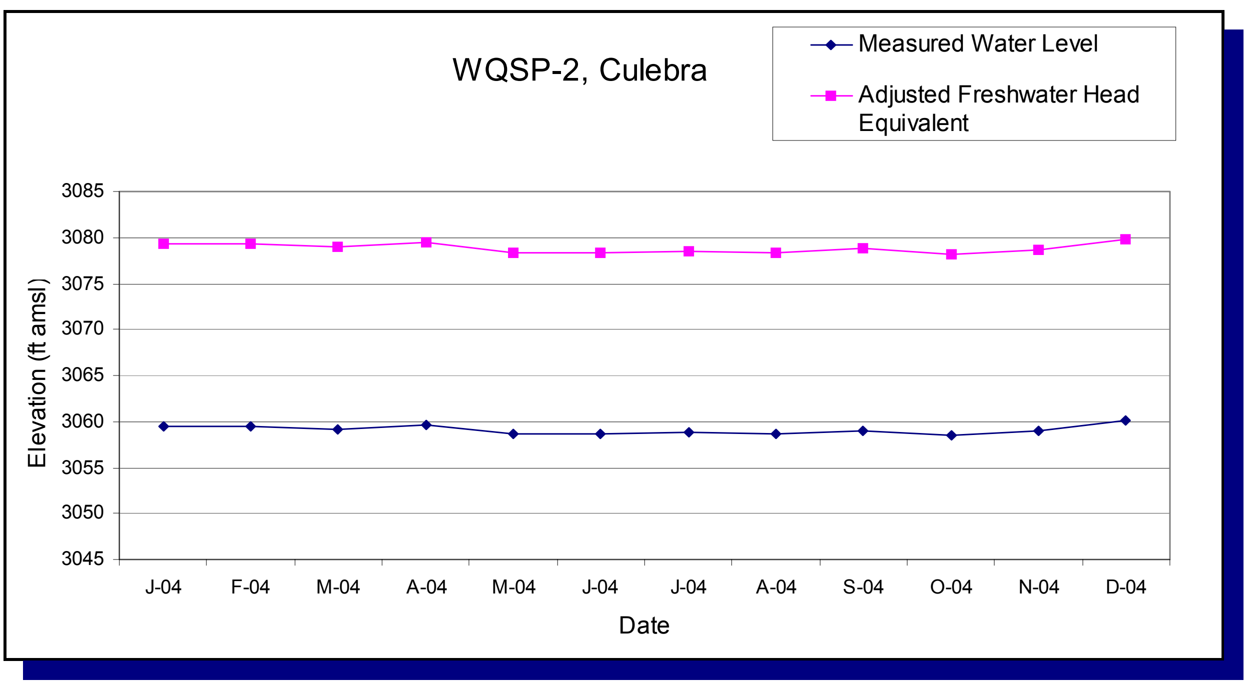

Figure 6.5 - Hydrograph of WQSP-2

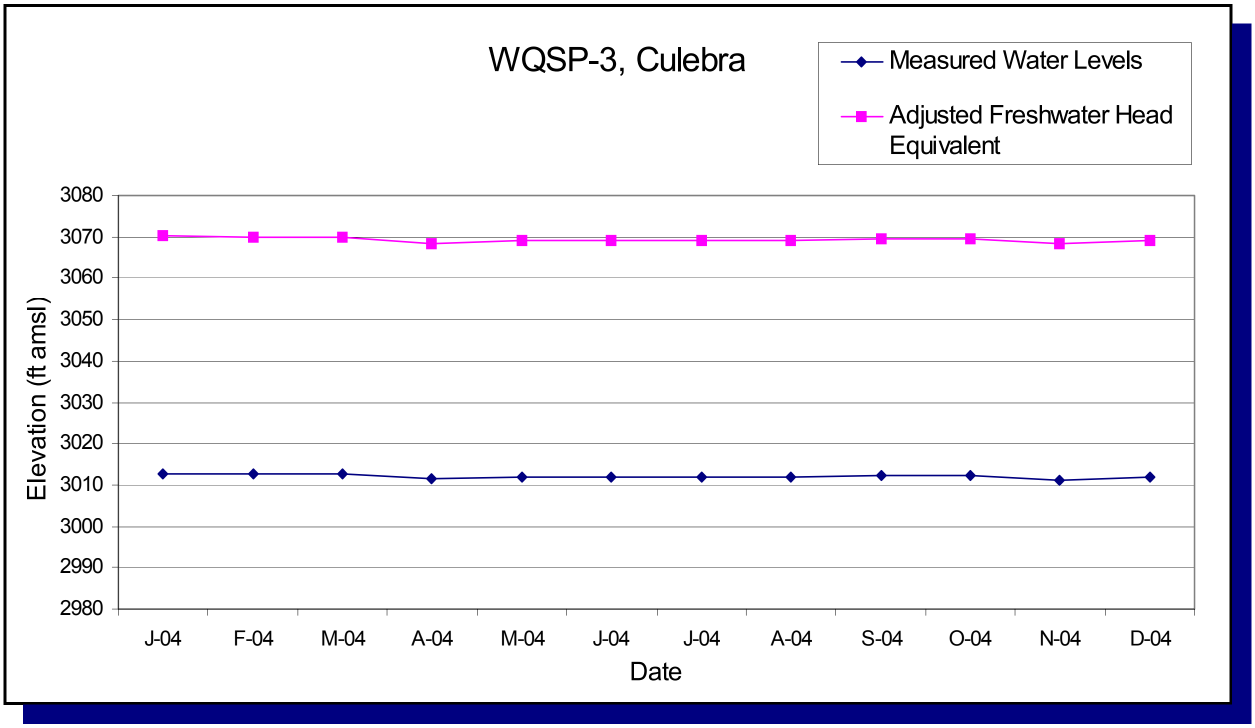

Figure 6.6 - Hydrograph at WQSP-3

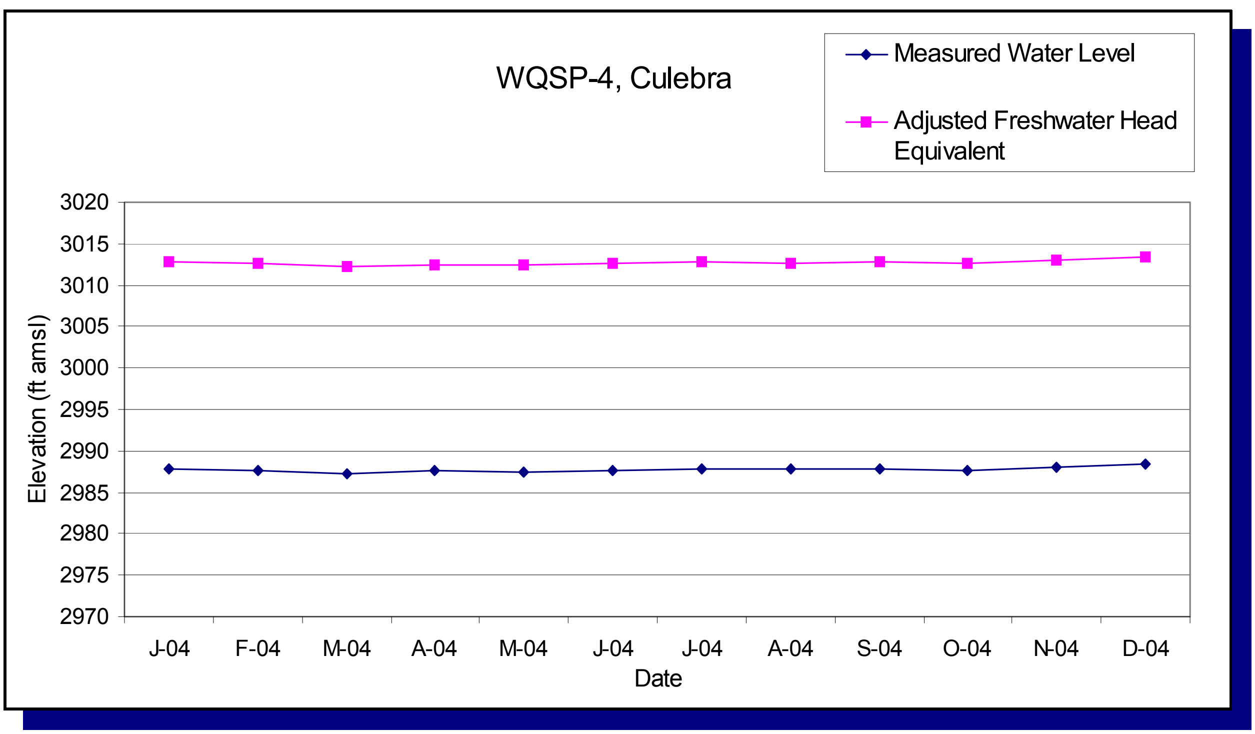

Figure 6.7 - Hydrograph of WQSP-4

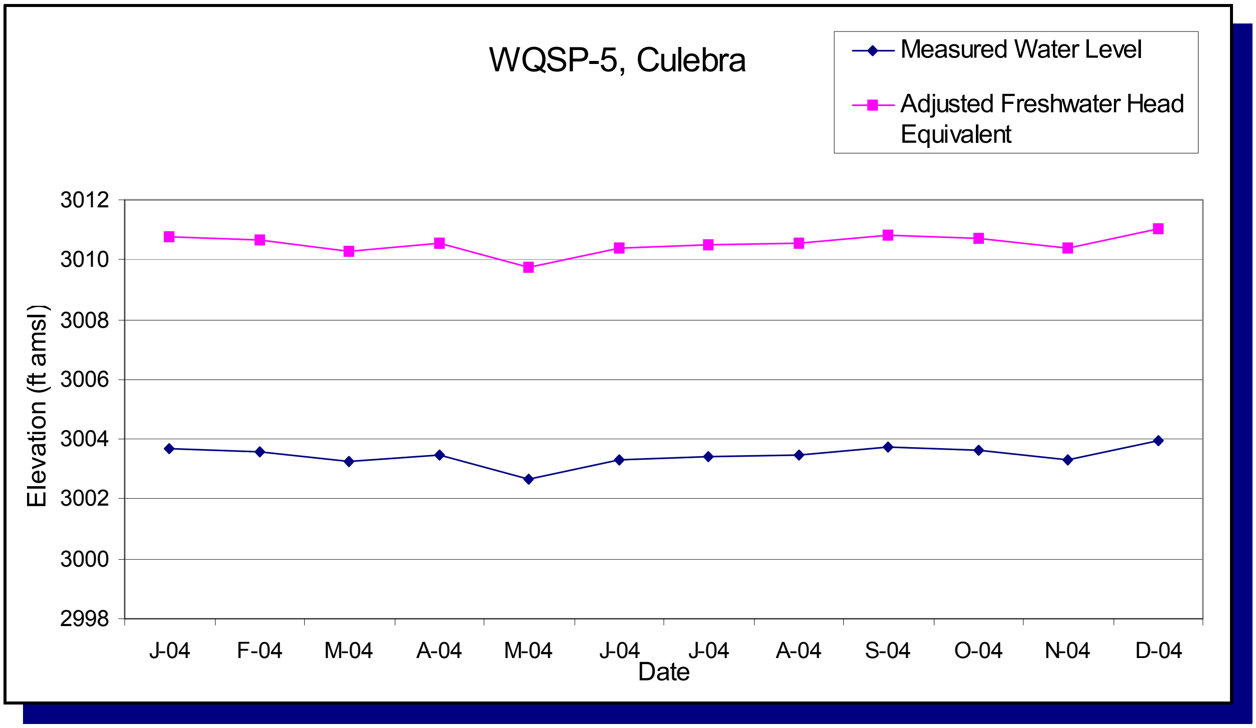

Figure 6.8 - Hydrograph of WQSP-5

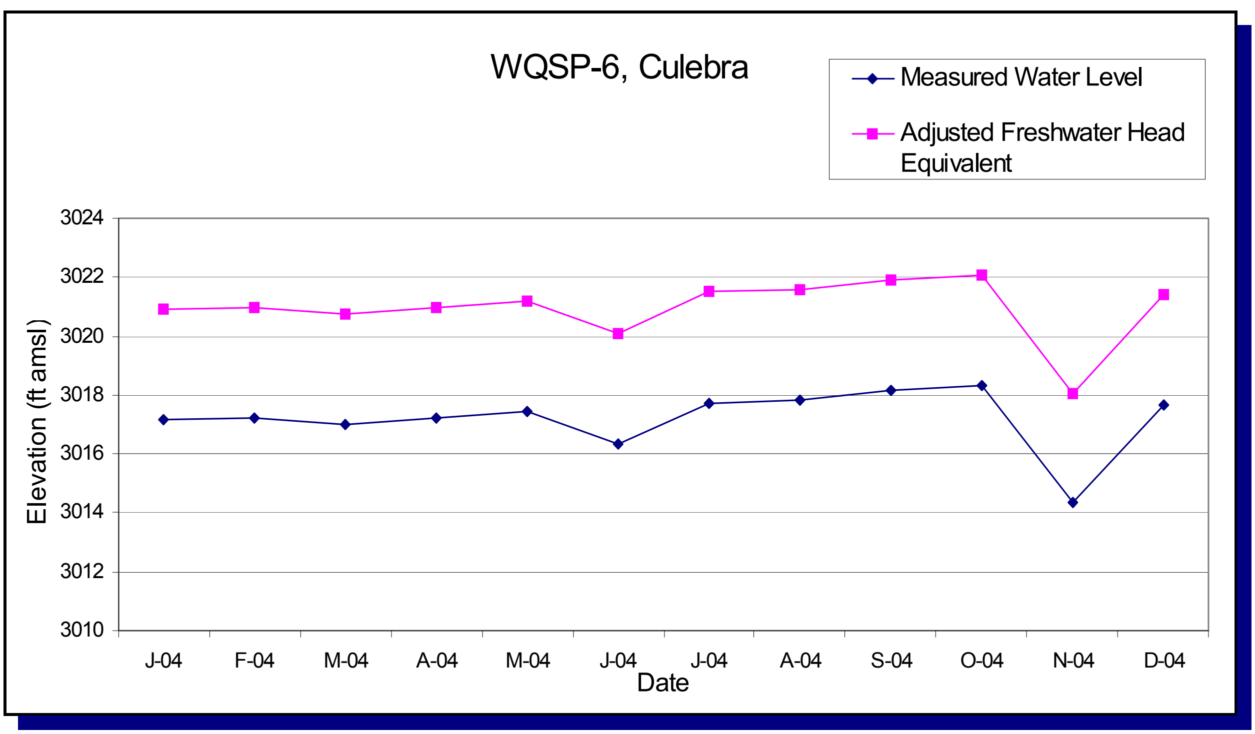

Figure 6.9 - Hydrograph of WQSP-6

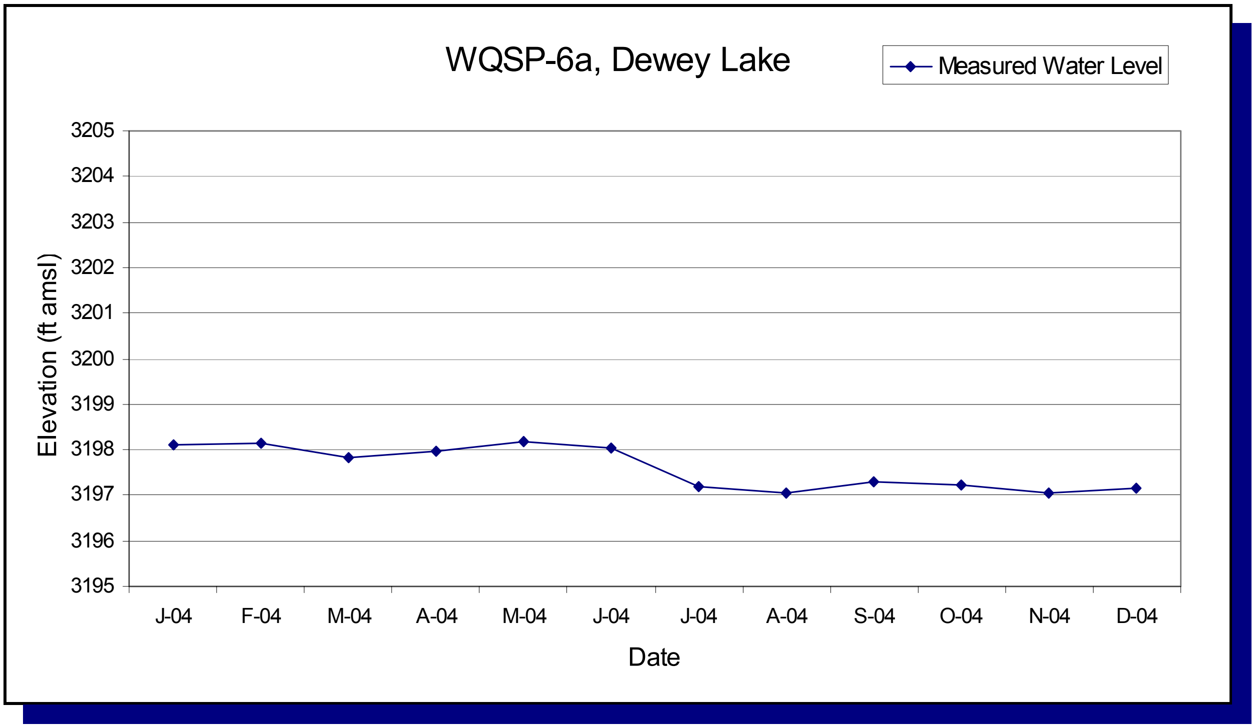

Figure 6.10 - Hydrograph of WQSP-6A

6.2.6 Pressure Density Surveys

At WIPP, variable TDS concentrations are reflected in a commensurate variability in groundwater density. WIPP measures the density of well-bore fluids in water level monitoring wells to adjust water levels to their equivalent fresh-water head values. This allows more accurate determination fo relative water levels between wells.

In 2004, pressure-density measurements were taken in 33 wells, as shown in Table 6.3.

Table 6.3 - Pressure Density Survey for 2004

Well Name	Date	Hydraulic Unit	Density
DOE-1	8/2/04	Culebra	1.099 g/cc
H-02b1	10/25/04	Magenta	1.012 g/cc
H-02b2	10/25/04	Culebra	1.013 g/cc
H-03b2	8/20/04	Culebra	1.001 g/cc
H-03b1	8/20/04	Magenta	1.012 g/cc
H-04b	8/20/04	Culebra	1.011 g/cc
H-04c	8/20/04	Magenta	1.023 g/cc
H-05b	8/18/04	Culebra	1.099 g/cc
H-05c	8/18/04	Magenta	1.009 g/cc
H-06b	8/6/04	Culebra	1.041 g/cc

Table 6.3 - Pressure Density Survey for 2004

Well Name	Date	Hydraulic Unit	Density
H-06c	8/6/04	Magenta	1.005 g/cc
H-07b1	8/16/04	Culebra	1.024 g/cc
H-08a	10/26/04	Magenta	1.043 g/cc
H-10a	11/9/04	Magenta	1.006 g/cc
H-10c	11/8/04	Culebra	1.009 g/cc
H-11b2	8/4/04	Magenta	1.054 g/cc
H-11b4	8/4/04	Culebra	1.043 g/cc
H-14	8/18/04	Magenta	1.028 g/cc
H-17	8/4/04	Culebra	1.136 g/cc
H-18	8/6/04	Magenta	1.008 g/cc
H-19b2	8/2/04	Culebra	1.066 g/cc
SNL-2	8/16/04	Culebra	1.013 g/cc
SNL-3	8/16/04	Culebra	1.027 g/cc
SNL-9	8/16/04	Culebra	1.012 g/cc
SNL-12	10/26/04	Culebra	1.015 g/cc
P-17	11/9/04	Culebra	1.069 g/cc
WIPP-12	12/1/04	Culebra	1.107 g/cc
WIPP-13	11/8/04	Culebra	1.050 g/cc
WIPP-18	12/1/04	Magenta	1.017 g/cc
WIPP-19	12/1/04	Culebra	1.060 g/cc
WIPP-21	12/15/04	Culebra	1.081 g/cc
WIPP-29	10/26/04	Culebra	1.206 g/cc

6.3 Drilling Activities

The overall objective of drilling activities was to provide data needed for additional modeling of WIPP hydrology. Two new wells were drilled and completed in the Culebra during 2004: SNL-1 and SNL-5. These wells were drilled to provide new monitoring and testing locations to support continued area-wide modeling of groundwater flow in the Culebra. 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, fracturing and transmissivity of the Culebra, and hydrologic information such as groundwater flow directions and potential connection to the flow system in Nash Draw.

SNL-1 (permitted by the New Mexico State Engineer as C-2953) was drilled to provide geological data and hydrological testing of the Culebra in the northeast arm of Nash Draw. SNL-1 is located in the northwest quarter of section 16, T21S, R31E, it is located 3842 ft from the south line (fsl) and 535 ft from the west line (fwl) of the section in eastern Eddy County, New Mexico, and is adjacent to the tailings pile of Mississippi Potash Incorporated (now Intrepid) East mine. One objective of SNL-1 is to test for the presence of shallow saturated zones. SNL-1 was drilled to a total depth of 644 ft below ground level (bgl) and geophysical logs were obtained. SNL-1 was cleaned on April 15, 2004, by jetting at 200 psi with approximately 112 barrels of water. On April 16, 2004, the well was pumped for 6.67 hours at a rate of approximately 15 gallons per minute (gpm). On April 20, 2004, SNL-1 was pumped for three hours at 13 gpm, and the final fluid density was 1.025 g/cc. Specific Details of drilling, geophysical description, and well completion can be found in the *Basic Data Report for Drillhole SNL-1 (C-2953)*, DOE/WIPP 04-3301.

SNL-5 (permitted by the New Mexico State Engineer as C-3002) was drilled and completed in April and May 2004 to provide geological data and hydrological testing of the Culebra in an area north of the WIPP site where data are sparse and where a pumping or monitoring well for a northern pumping test is needed. SNL-5 is located in the southeast quarter of section 6, T22S, R31E, located 2011 ft from the south line (fsl) and 369 ft from the west line (fwl) of the section in eastern Eddy County, New Mexico. SNL-5 was drilled to a total depth of 687 ft bgl, based on driller's measurements, and geophysical logs that were obtained. SNL-5 was cleaned on May 11, 2004, by jetting at 200–250 psi with about 180 barrels of fresh water. On May 19, 2004, the well was pumped at variable rates from 5 to12 gpm and backwashed over a period of seven hours. On May 20, 2004, SNL-5 was pumped for 5.75 hours at a beginning rate of 12 gpm, decreasing to 5 gpm. The final fluid density was 1.006 grams per cubic centimeter at 25.2°C. Specific details of drilling, geophysical descriptions, and well completion can be found in the *Basic Data Report for Drillhole SNL-5 (C-3002)*, DOE/WIPP 04-3305.

6.4 Well Maintenance Activities

Well maintenance activities for 2004 consisted of reconfiguration of three monitoring network wells to single completion intervals. All three wells were dual completion wells where the monitored intervals were separated by tubing and production-injection packers (PIP) and/or bridge plugs. These wells were initially drilled greater than 4,000 ft bgl and completed in various intervals. Below are summary descriptions of each well reconfiguration.

Well Cabin Baby 1 (CB-1) was reconfigured during late January and early February 2004. This well was first installed in 1974 and eventually configured to monitor hydrostatic head in the Bell Canyon and the Culebra through tubing and two PIPs. Well CB-1 was reconfigured by removing the old tubing and PIPs and installing new tubing and a single PIP to monitor only the water elevation of the Bell Canyon (DOE/WIPP-04-3306).

Well DOE-2 was reconfigured in late February and early March 2004. This well was initially drilled in 1985 and configured to monitor hydrostatic head in the Bell Canyon and the Culebra. It was later reconfigured to monitor only the Culebra Member by separating it from the Bell Canyon with a bridge plug. In 2004 DOE-2 was reconfigured again to monitor only the Bell Canyon via tubing and PIP, which was set at 4,015 ft bgl (DOE/WIPP-04-3307).

Well AEC-7 was reconfigured during late March and early April. This well was initially drilled in 1974 to a depth of 3,906 ft bgl and cased to 1,006 ft below ground surface, leaving the remainder of the hole open to the formation. In 1979 the hole was deepened to 4,720 ft bgl to investigate the Bell Canyon. Well AEC-7 was subsequently plugged from 4,483 to 4,452 ft bgl to seal off pressure from the Bell Canyon. The well was then perforated and configured with a bridge plug and PIP to monitor only the Culebra. The reconfiguration in 2004 consisted of removing all well appurtenances and plugging the borehole with cement to just below the Culebra Member perforations, thus converting the well to monitor only this interval and sealing off all lower formations (DOE/WIPP 04-3308, *Basic Data Report for Monitor Well AEC-7 Reconfiguration*).

Six wells were surveyed for elevation reference in 2004 because they were new completions or the well was reconfigured to optimize data collection. These wells were SNL-1, SNL-5, I-461, CB-1, AEC-7 and DOE-2. The results are tabulated below.

Table 6.4 - Elevation Survey Results

Well #	**Casing Elevation** (ft amsl)	**Benchmark Elevation** (ft amsl)	**Ground Level Elevation** (ft amsl)
I-461	3289.48	3287.30	N/A
SNL-5	3381.88	3379.45	N/A
SNL-1	3512.84	3510.62	N/A
CB-1 (Cabin Baby)	3328.87	3327.27	3326.74
AEC-7	3657.29	N/A	3656.85
DOE-2	3418.96	3418.28	3417.63

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 TDS 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 2004 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, TDS, selenium, and chromium. Field parameters (pH, conductivity, and temperature) are also to be measured during serial sampling.

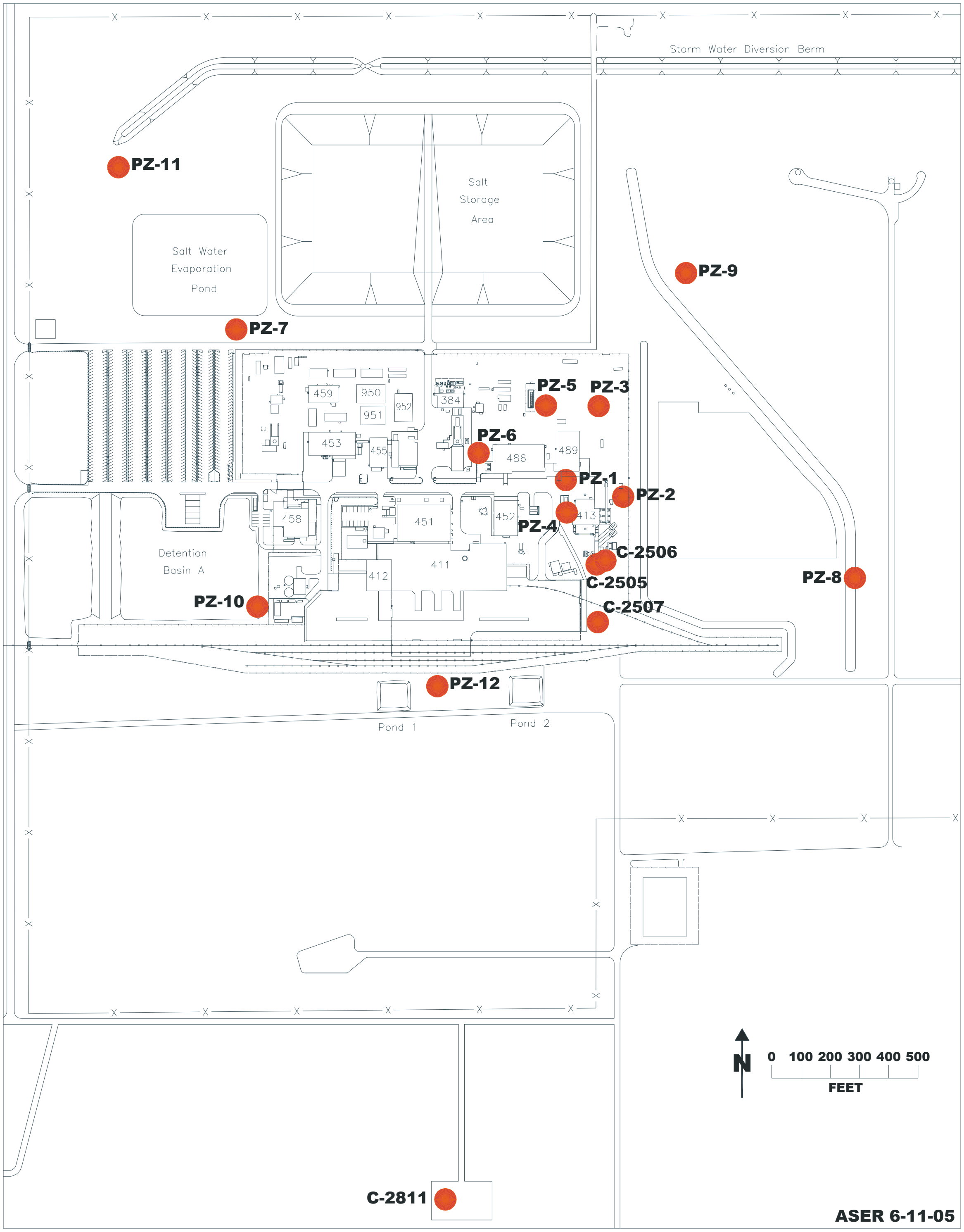

Figure 6.11 - Locations of SSW Wells (Piezometers PZ-1 through 12; Wells C2811, C2505, C2506, and C2507)

6.5.1 Shallow Subsurface Water Quality Sampling

DP-831, as modified, requires ten SSW wells to be sampled on a quarterly basis. Wells PZ-1, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, C-2811, and C-2507 are sampled for this program. All wells were sampled in June and November 2004 and laboratory analyzed for the parameters presented in the previous section. Results are indicated in Table 6.5.

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 quarterly for all locations presented in Figure 6.11 (Appendix F, Table F.8). Well PZ-8 remained dry during 2004 as it historically has been.

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 both PZ-12 and PZ-8.

Table 6.5 - 2004 Shallow Subsurface Water Quality Sampling Results

	General Chemistry Parameters					Trace Metals	
Monitoring Site	Sample Date	Nitrate (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	TDS (mg/l)	Selenium (mg/l)	Chromium (mg/l)
PZ-1	6/21/04	<10	1530	36300	79600	0.0440	<0.00500
PZ-1	11/09/04	1.30	6530	45700	85800	0.106	<0.0100
PZ-2	NS	NS	NS	NS	NS	NS	NS
PZ-3	NS	NS	NS	NS	NS	NS	NS
PZ-4	NS	NS	NS	NS	NS	NS	NS
PZ-5	6/21/04	20.7	1340	28800	55200	0.0670	<0.00500
PZ-5 Dup.	6/21/04	20.7	1370	32300	66000	0.0630	<0.00500
PZ-5	11/09/04	<2.50	1820	47800	86000	0.0940	<0.0100
PZ-5 Dup.	11/09/04	3.59	12000	58600	77800	0.0890	<0.0100
PZ-6	6/21/04	21.2	2860	70500	134000	0.0170	<0.00500
PZ-6	11/09/04	4.89	13000	75400	113000	0.0600	<0.0100
PZ-7	6/21/04	20.7	2620	53000	109000	0.041	<0.00500
PZ-7	11/08/04	2.89	7460	43600	80400	0.0880	<0.0100
PZ-8	NS	NS	NS	NS	NS	NS	NS
PZ-9	6/21/04	<20.0	3740	80200	140000	<0.0100	<0.00500
PZ-9	11/09/04	1.40	14500	92400	144000	0.0660	<0.0100
PZ-10	6/14/04	3.81	469	368	1714	0.0200	<0.00500
PZ-10	11/08/04	3.69	431	353	1576	<0.0500	<0.0100
PZ-11	6/21/04	20.8	2220	58100	123000	<0.0100	<0.00500
PZ-11	11/08/04	3.15	13000	84100	119000	<0.0500	<0.0100
PZ-12	6/14/04	11.2	773	5320	9700	0.0770	<0.00500

Table 6.5 - 2004 Shallow Subsurface Water Quality Sampling Results

	General Chemistry Parameters					Trace Metals	
Monitoring Site	Sample Date	Nitrate (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	TDS (mg/l)	Selenium (mg/l)	Chromium (mg/l)
PZ-12	11/08/04	19.8	879	7170	9540	0.0660	<0.0100
C-2811	6/14/04	6.06	299	769	2022	0.0470	<0.00500
C-2811	11/08/04	7.63	305	1030	1996	0.0540	<0.0100
C-2505	NS	NS	NS	NS	NS	NS	NS
C-2506	NS	NS	NS	NS	NS	NS	NS
C-2507	6/21/04	7.55	717	1300	3830	0.029	0.028
C-2507	11/09/04	7.58	824	1380	3350	0.0800	0.0140

NS = Not Sampled as per permit conditions

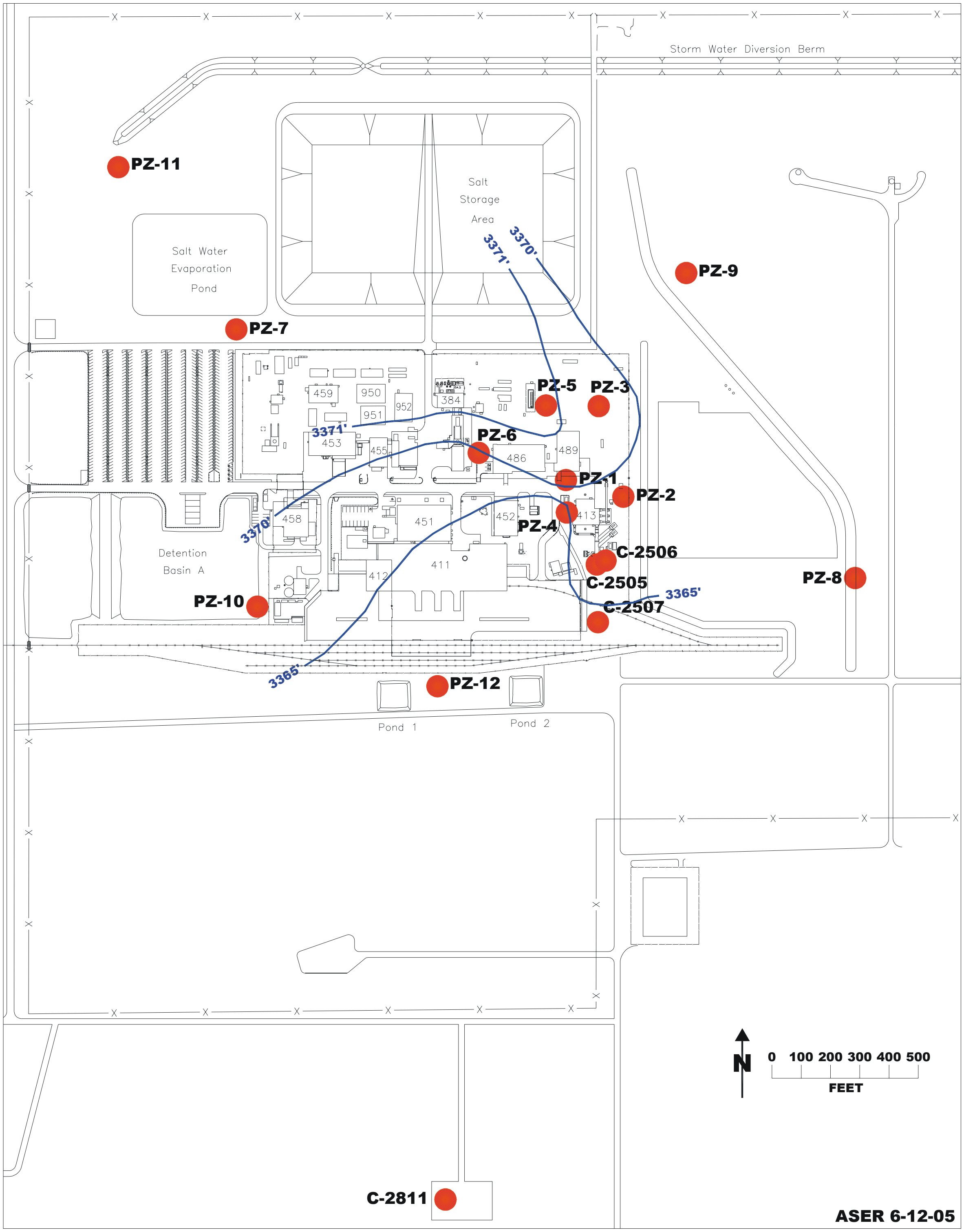

Figure 6.12 - Contour Plot of SSW Piezometric Surface in the Santa Rosa Formation

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 ft. 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).

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CHAPTER 7 - QUALITY ASSURANCE

The fundamental objective of a QA program, as applied to environmental work, is to ensure that 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 2004, WIPP Laboratories performed the radiological analyses of WIPP environmental samples, while contract laboratories, Air Toxics, Ltd., in Folsom, California; CEMRC, in Carlsbad, New Mexico; and Trace Analysis, in Lubbock, Texas, performed the nonradiological analyses. All laboratories, with the exception of CEMRC, 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. CEMRC was required by contract to comply with all the above requirements with the exception of the participation in intercomparison programs. Internal evaluation of comparison samples was performed as part of the laboratory qualification. CEMRC was subjected to comparison samples that were also analyzed by Air Toxics. Results of this comparison are discussed in Section 7.2.4.

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*
- ISO/IEC DIS 17025, *General Requirements for the Competence of Testing and Calibration Laboratories,* International Organization for Standardization.
- National Environmental Laboratory Accreditation Program (NELAP)

The WIPP Environmental Monitoring Section performed assessments and audits to ensure that 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. 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.

In 2004, four laboratories provided services to WIPP. Sections 7.1, 7.2, and 7.3 discuss the quality control results for the WIPP Laboratories, Air Toxics and CEMRC, and Trace Analysis respectively, 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 all environmental media (air particulate composites, groundwater, surface water, soil, sediment, and animal and plant tissues) were 100 percent complete for 2004.

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 2004. 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:

$(\text{Mean Activity})_{ori}$	=	Mean Activity of Original Sample
$(\text{Mean Activity})_{dup}$	=	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 for multiple constituents, indicating good reproducibility of sampling techniques and methods. One or more duplicate pairs for air particulates, groundwater, surface water, and sediments showed RERs greater than one for only one or two constituents, the others being less than one. (Tables 4.3, 4.6, 4.10, and 4.14). The cause is unclear but may be due to inhomogeneities in the sampled media. More detailed explanations for each of these duplicates can be found in Sections 4.2, 4.3, 4.4, and 4.5.

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 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 fell within the acceptable ranges, indicating good accuracy.

Accuracy is also ensured through participation by the laboratory in the DOE EML QAP, the DOE MAPEP, 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, MAPEP, 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 2004, the WIPP Laboratories participated in the DOE EML QAP, the DOE MAPEP, and the NRIP programs. The DOE EML QAP was discontinued after June 2004. The EML, MAPEP, and NRIP prepare QC samples containing various alpha-, beta-, and gamma-emitting nuclides in water, soil, air filter, vegetation, synthetic urine, synthetic feces, 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, MAPEP, 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 2004. Results are presented for one round of comparison: June 2004 (QAP 60). All bias results were acceptable (-25 percent/ +50 percent) for all radionuclides and media of interest at the WIPP site with the exception of ^{238}Pu in air filter.

Results of the NRIP comparisons for 2004 are presented in Table 7.5. WIPP results were rated as "P" (for pass) for all applicable radionuclides in synthetic urine and synthetic feces.

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, 2004 MATRIX: Air Filter (Bq/Filter)

	QAP[a] 60 June 2004					
	Reported		EML[b]			
[RN][c]	Value	Error	Value	Error	E.[d]	% Bias
^{241}Am	0.10	0.02	0.10	0.00	A	-1.44
^{60}Co	36.00	4.44	35.40	0.85	A	1.69
^{137}Cs	25.80	3.37	26.40	0.86	A	-2.27
^{238}Pu	0.03	0.01	0.04	0.00	W	-23.46
^{239}Pu	0.15	0.04	0.16	0.01	A	-8.76
^{90}Sr	1.69	0.16	1.76	0.19	A	-3.86
BqU	0.19	0.02	0.17	0.00	A	6.84

[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, 2004 MATRIX: Soil (Bq/kg)

	QAP[a] 60 June 2004					
	Reported		EML[b]			
[RN][c]	Value	Error	Value	Error	E.[d]	% Bias
^{241}Am	12.43	2.48	13.00	0.43	A	-4.38
^{137}Cs	1233.00	192.00	1323.00	66.17	A	-6.80
^{40}K	597.30	101.10	539.00	29.11	A	10.82
^{239}Pu	22.64	7.41	22.82	0.56	A	-0.79
^{90}Sr	53.25	13.51	51.00	5.90	A	4.41
BqU	173.30	13.80	180.22	6.21	A	-3.84

[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, 2004 MATRIX: Vegetation (Bq/kg)

	QAP[a] 60 June 2004					
	Reported		EML[b]			
[RN][c]	Value	Error	Value	Error	E.[d]	% Bias
^{241}Am	4.54	0.87	4.93	0.29	A	-8.01
^{60}Co	15.00	3.20	14.47	0.64	A	3.66
^{137}Cs	562.50	100.80	584.67	29.23	A	-3.79
^{40}K	820.50	157.00	720.00	37.92	A	13.96
^{238}Pu	0.44	0.17	0.46	0.05	A	-3.08
^{239}Pu	6.95	1.22	6.81	0.28	A	1.98
^{90}Sr	720.30	64.80	734.00	82.00	A	-1.87

[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, 2004 MATRIX: Vegetation (Bq/l)

	QAP[a] 60 June 2004					
	Reported		EML[b]			
[RN][c]	Value	Error	Value	Error	E.[d]	% Bias
^{241}Am	1.25	0.23	1.31	0.04	A	-4.58
^{60}Co	173.80	25.10	163.20	5.90	A	6.50
^{137}Cs	52.10	8.10	51.95	2.70	A	0.29
^{238}Pu	1.04	0.24	1.10	0.03	A	-5.73
^{239}Pu	2.90	0.58	3.08	0.10	A	-5.71
^{90}Sr	4.82	0.49	4.76	0.50	A	1.20
BqU	4.61	0.48	4.62	0.06	A	-0.17

[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, 2004

	Synthetic Urine (Bq/g-)						Synthetic Feces (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	E	% Bias
^{241}Am	0.785	10.8	0.897	0.64	P	-12.5	0.582	13.9	0.591	0.64	P	-1.6
^{238}Pu	0.949	7.5	0.997	0.68	P	-4.9	0.520	14.8	0.520	0.68	P	0.1
^{90}Sr	2.497	15.1	2.256	0.74	P	10.7	2.230	12.9	2.240	0.74	P	-0.5
^{234}U	2.168	6.0	2.224	0.98	P	-2.5	2.460	12.8	2.234	0.98	P	10.1
^{238}U	2.263	6.0	2.309	0.60	P	-2.0	2.550	12.7	2.319	0.60	P	10.0

[a] National Institute of Standards and Technology
[b] Radionuclide
[c] Evaluation Rating (P = pass, F = fail)

Table 7.6 - Mixed Analyte Performance Evaluation Review for WIPP Laboratories, 2004

	MATRIX: Air Filter (Bq/Sample) MAPEP-04RDF12				MATRIX: Water Standard (Bq/l) MAPEP-04 MaW12			
[RN][a]	Reported Value	MAPEP[b] Value	E[c]	% Bias	Reported Value	MAPEP Value	E	% Bias
^{241}Am	0.1016	0.1	A	1.6	0.5412	0.59	A	-8.3
^{60}Co	2.45	2.35	A	4.3	174	163	A	6.7
^{134}Cs	2.65	2.9	A	-8.6	193	208	A	-7.2
^{137}Cs	1.85	1.96	A	-5.6	237	250	A	-5.2
^{238}Pu	0.1310	0.13	A	0.8	1.152	1.24	A	-7.1
$^{239+240}$Pu	0.08713	0.09	A	-3.2	0.01242	NR[d]	NR	NR
^{90}Sr	0.8543	0.83	A	2.9	7.305	7.4	A	-1.3
$^{234/233}$U	0.2165	0.21	A	3.1	0.1510	0.144	A	4.9
^{238}U	4.53	4.11	A	-1.5	0.9359	0.94	A	-0.4

	MATRIX: Soil Standard (Bq/kg) MAPEP-04-MaS12			
[RN]	Reported Value	MAPEP Value	E	% Bias
^{241}Am	63.07	67	A	-5.9
^{60}Co	523	518	A	1.0
^{134}Cs	337	414	A	-18.6
^{137}Cs	734	836	A	-12.2
^{238}Pu	35.33	35.4	A	-0.2
$^{239+240}$Pu	40.77	41.8	A	-2.5
^{90}Sr	1.093	NR	NR	NR
$^{234/233}$U	31.05	37	A	-16.1
^{238}U	32.61	38.9	A	-16.2

[a] Mixed Analyte Performance Evaluation Program
[b] Radionuclide
[c] Evaluation Rating (A = acceptable, W = Acceptable with warning, N = Not acceptable)
[d] Not Reported

7.2 Air Toxics and CEMRC

The company Air Toxics, Ltd., and the Carlsbad Environmental Monitoring and Research Center (CEMRC) performed the analyses of VOC samples collected in the WIPP underground during 2004.

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. For 2004, 218 samples were collected, of which 216 produced valid data. This results in a program completion percentage of 99 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 2004, 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.

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 for the instrument tune; that is, a mass calibration check performed prior to analyses of calibration curves and samples.

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 2004, 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 2004, 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 2004, 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 2004, 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 2004, all ion abundance criteria were within tolerance.

7.2.4 Comparability

Air Toxics, Ltd., participates in a biennial independent assessment. In 2004, Air Toxics participated in the ERA, for 49 VOCs in nonpotable water. Results were 100 percent satisfactory. The CEMRC analyzed audit canisters prepared by Shaw Environmental. These canisters contained a mixture of known VOCs at estimated concentrations. This sample type was also submitted to Air Toxics for analytical comparison. The CEMRC successfully identified all of the compounds within the 25 percent acceptance criteria for each compound.

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.

Table 7.7 - 2004 VOC Sample Comparison for CEMRC

Compound	Air Toxics (ppbv)	CEMRC (ppbv)	RPD %	Passing Criteria	Results
1,1,1-Trichloroethane	18.3	17.09	6.8	± 25%	Pass
1,1,2,2-Tetrachloroethane	14.6	12.74	13.6	± 25%	Pass
1,1-Dichloroethene	16.6	17.92	7.6	± 25%	Pass
1,2-Dichloroethane	19.0	16.66	13.1	± 25%	Pass
Carbon Tetrachloride	17.3	17.59	1.7	± 25%	Pass
Chlorobenzene	14.6	14.49	0.8	± 25%	Pass
Chloroform	17.6	16.84	4.4	± 25%	Pass
Methylene Chloride	15.3	17.02	10.6	± 25%	Pass
Toluene	15.3	15.4	0.7	± 25%	Pass

Reported concentrations are three sample averages
ppbv = parts per billion by volume

Table 7.8 - Environmental Resource Associates® Assessment of Air Toxics, Ltd., WP-111, June 10, 2004, for Volatile Organic Compounds

Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Acetone	µg/l	67.1	134	26.7 - 221	Acceptable
Acetonitrile	µg/l	<10.0	0	N/A	Acceptable
Acrylonitrile	µg/l	<2.0	0	N/A	Acceptable
Acrolein	µg/l	<10.0	0	N/A	Acceptable
Benzene	µg/l	44.9	50.9	36.7 - 65.5	Acceptable
Bromodichloromethane	µg/l	33.4	36.1	25.5 - 47.1	Acceptable
Bromoform	µg/l	55.2	58.9	38.5 - 80.6	Acceptable
Bromomethane	µg/l	<2.0	0	N/A	Acceptable
2-Butanone (MEK)	µg/l	77.6	97	24.5 - 158	Acceptable
Carbon disulfide	µg/l	<2.0	0	N/A	Acceptable
Carbon tetrachloride	µg/l	34.2	41.2	25.5 - 58.1	Acceptable
Chlorobenzene	µg/l	18.3	20.8	15.1 - 26.3	Acceptable
Chlorodibromomethane	µg/l	46.4	51.2	33.8 - 68.0	Acceptable
Chloroethane	µg/l	17.9	19	11.7 - 36.5	Acceptable
2-Chloroethylvinylether	µg/l	<10.0	0	N/A	Acceptable
Chloroform	µg/l	38.8	43.9	30.5 - 56.4	Acceptable
Chloromethane	µg/l	<2.0	0	N/A	Acceptable
DBCP	µg/l	<10.0	0	N/A	Acceptable
1,2-Dibromoethane (EDB)	µg/l	<2.0	0	N/A	Acceptable
Dibromomethane	µg/l	<2.0	0	N/A	Acceptable
1,2-Dichlorobenzene	µg/l	47	49.8	35.2 - 62.9	Acceptable
1,3-Dichlorobenzene	µg/l	40	43.3	30.6 - 54.0	Acceptable
1,4-Dichlorobenzene	µg/l	29.1	31.5	21.6 - 40.8	Acceptable
Dichlorodifluoromethane	µg/l	<2.0	0	N/A	Acceptable
1,1-Dichloroethane	µg/l	<2.0	0	N/A	Acceptable
1,2-Dichloroethane	µg/l	53.5	58	40.0 - 77.1	Acceptable
1,1-Dichloroethylene	µg/l	30.3	36.3	18.9 - 56.9	Acceptable
cis-1,2-Dichloroethylene	µg/l	<2.0	0	N/A	Acceptable
trans-1,2-Dichloroethylene	µg/l	<2.0	0	N/A	Acceptable
1,2-Dichloropropane	µg/l	<2.0	0	N/A	Acceptable
cis-1,3-Dichloropropylene	µg/l	<2.0	0	N/A	Acceptable
trans-1,3-Dichloropropylene	µg/l	<2.0	0	N/A	Acceptable
Ethylbenzene	µg/l	40.4	42.6	28.5 - 55.6	Acceptable
2-Hexanone	µg/l	<10.0	0	N/A	Acceptable
Methylene chloride	µg/l	35.3	40.3	25.5 - 55.7	Acceptable
4-Methyl-2-pentanone (MIBK)	µg/l	<10.0	0	N/A	Acceptable
Styrene	µg/l	66.2	67.1	44.9 - 89.2	Acceptable
1,1,1,2-Tetrachloroethane	µg/l	<2.0	0	N/A	Acceptable
1,1,2,2-Tetrachloroethane	µg/l	<2.0	0	N/A	Acceptable
Tetrachloroethylene	µg/l	53.5	61.5	40.7 - 78.7	Acceptable
Toluene	µg/l	39	42.4	30.4 - 53.0	Acceptable
1,1,1-Trichloroethane	µg/l	28.1	34	22.1 - 44.8	Acceptable

Table 7.8 - Environmental Resource Associates® Assessment of Air Toxics, Ltd., WP-111, June 10, 2004, for Volatile Organic Compounds

Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
1,1,2-Trichloroethane	μg/l	<2.0	0	N/A	Acceptable
Trichloroethylene	μg/l	29.8	34.5	22.5 - 44.7	Acceptable
Trichlorofluoromethane	μg/l	20.7	26	9.63 - 43.2	Acceptable
1,2,3-Trichloropropane	μg/l	<2.0	0	N/A	Acceptable
Vinyl acetate	μg/l	<10.0	0	N/A	Acceptable
Vinyl chloride	μg/l	<2.0	0	N/A	Acceptable
Xylenes, total	μg/l	256	280	161-373	Acceptable

N/A - Not Applicable

7.3 TRACE Analysis

TRACE Analysis of Lubbock, Texas, was subcontracted for 2004 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 2004, 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 2004, 14 sets of water samples were collected of which the vast majority produced complete and valid data. In a few isolated cases, some reported values were classified as unusable due to recoveries in matrix spike/spike duplicate samples or recoveries in other quality control samples. For 2004, the completeness percentage was 99 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 2004, precision was very good for both sampling Rounds 18 and 19. The precision for the general chemistry analyses averaged 2.40 percent RPD. Precision for metals averaged 2.30 percent RPD. Precision for VOCs and SVOCs were both less than one 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 2004, all recoveries from LCSs and LCSDs were within the acceptable range for general chemistry, metals and VOCs. The majority of SVOC recovery results were also within the acceptable range except for a few isolated instances. Four SVOC LCS and LCSD results were recovered above the prescribed recovery percentage range (Round 18) and three SVOC results were recovered below the percentage range (Round 19).

7.3.4 Comparability

TRACE Analysis, Inc., participated in an Absolute Grade PT Program interlaboratory assessment. For the assessment program, runs from October to November 2004 analyzing blind performance standards (Tables 7.9, 7.10, and 7.11), 183 of 189 (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 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
pH	SU[a]	7.08	7.10	6.91-7.29	ACCEPT
Cyanide	mg/l	0.708	0.702	0.487-0.902	ACCEPT
Phenolics, total	mg/l	0.63	0.49	0.26-0.72	ACCEPT
Grease & Oil (Gravimeteric)	mg/l	19.1	22.6	13.4-27.5	ACCEPT
Total Residual Chlorine	mg/l	0.26	0.32	0.198-0.442	ACCEPT
Mercury	µg/l	1.92	1.60	1.09-2.12	ACCEPT
Hexavalent Chromium	µg/l	638	620	504-713	ACCEPT
Minerals					
Total solids at 105°C	mg/l	N/A	N/A	N/A	NOT REPORTED
Total Dissolved Solids	mg/l	377	470	360-580	CK FOR ERROR
Conductivity at 25°C	µmhos	458	471	434-508	ACCEPT
Alkalinity as CaCO3	mg/l	32	31.4	26.9-36.7	ACCEPT
Chloride	mg/l	183	162	148-177	NOT ACCEPT
Fluoride	mg/l	1.74	1.29	1.11-1.46	NOT ACCEPT
Potassium	mg/l	43.5	39.6	34.3-45.1	CK FOR ERROR
Sodium	mg/l	17.6	16.0	14.2-18.4	ACCEPT
Sulfate	mg/l	46.5	48.6	39.7-56.2	ACCEPT
Hardness					
Total suspended solids	mg/l	50.9	52.7	39.9-56.6	ACCEPT

Table 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
Calcium	mg/l	67.9	66.5	59.4-75.3	ACCEPT
Magnesium	mg/l	17.1	15.6	13.6-17.5	CK FOR ERROR
Calcium hardness as $CaCO_3$	mg/l	N/A	N/A	N/A	NOT REPORTED
Total hardness as $CaCO_3$	mg/l	240	230	210-251	ACCEPT
Demand					
BOD	mg/l	171	153	77.7-229	ACCEPT
CBOD	mg/l	159	132	59.1-205	ACCEPT
COD	mg/l	199	250	196-282	CK FOR ERROR
TOC	mg/l	99.2	99.1	82.8-114	ACCEPT
Nutrients					
Ammonia as N	mg/l	12.7	10.3	7.99-12.5	NOT ACCEPT
Nitrate as N	mg/l	10.3	10.8	8.51-12.8	ACCEPT
Ortho-phosphate as P	mg/l	3.79	3.79	3.23-4.38	ACCEPT
Total phosphorus as P	mg/l	1.64	2.12	1.61-2.51	CK FOR ERROR
Total kjeldahl nitrogen as N	mg/l	17.1	12.8	9.23-16.0	NOT ACCEPT
Trace Metals					
Aluminum	µg/l	1300	1400	1198-1594	ACCEPT
Antimony	µg/l	793	861	611-1033	ACCEPT
Arsenic	µg/l	422	417	348-489	ACCEPT
Barium	µg/l	N/A	N/A	N/A	NOT REPORTED
Beryllium	µg/l	471	480	408-542	ACCEPT
Boron	µg/l	N/A	N/A	N/A	NOT REPORTED
Cadmium	µg/l	703	690	589-783	ACCEPT
Chromium	µg/l	308	310	269-352	ACCEPT
Cobalt	µg/l	70	70	60-79.5	ACCEPT
Copper	µg/l	585	580	527-637	ACCEPT
Iron	µg/l	809	810	715-917	ACCEPT
Lead	µg/l	1010	960	842-1074	ACCEPT
Manganese	µg/l	1420	1430	1286-1589	ACCEPT
Molybdenum	µg/l	239	240	205-275	ACCEPT
Nickel	µg/l	680	670	604-750	ACCEPT
Selenium	µg/l	391	380	299-441	ACCEPT
Silver	µg/l	537	520	446-596	ACCEPT
Strontium	µg/l	266	260	221-298	ACCEPT
Thallium	µg/l	266	720	581-835	NOT ACCEPT
Vanadium	µg/l	1490	1490	1344-1637	ACCEPT
Zinc	µg/l	421	410	361-464	ACCEPT
PCBs in H_2O (Standard #1)					
Aroclor 1242	µg/l	7.6	12.0	3.1-17.1	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	<0.50	0	0	ACCEPT

Table 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
PCBs in H_2O (Standard #2)					
Aroclor 1242	µg/l	1.3	0	0	NOT ACCEPT
Aroclor 1221	µg/l	N/A	N/A	N/A	NOT REPORTED
Aroclor 1232	µg/l	<0.50	3.4	0.51-5.77	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 Oil (Standard #1)					
Aroclor 1016/1242	mg/kg	<0.50	0	0	ACCEPT
Aroclor 1254	mg/kg	<0.50	0	0	ACCEPT
Aroclor 1260	mg/kg	24.1	26.0	4.83-37.0	ACCEPT
PCBs in Oil (Standard #2)					
Aroclor 1016/1242	mg/kg	<0.50	0	0	ACCEPT
Aroclor 1254	mg/kg	33.9	38.0	5.83-55.6	ACCEPT
Aroclor 1260	mg/kg	<0.50	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	36.7	36.0	25.8-46.5	ACCEPT
Bromodichloromethane	µg/l	55.9	48.0	34.0-62.5	ACCEPT
Bromoform	µg/l	36.4	32.0	20.4-43.9	ACCEPT
Bromomethane	µg/l	<5.0	0	0	ACCEPT
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	35.6	32.0	19.9-45.2	ACCEPT
Chlorobenzene	µg/l	47.8	44.0	31.2-56.0	ACCEPT
Chlorodibromomethane	µg/l	56.4	48.0	31.7-63.8	ACCEPT
Chloroethane	µg/l	<1.0	0	0	ACCEPT
2-Chloroethylvinylether	µg/l	N/A	N/A	N/A	NOT REPORTED
Chloroform	µg/l	32.4	32.0	22.4-41.2	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	27.5	24.8	9.92-39.7	ACCEPT
Dibromomethane	µg/l	36.1	32.0	12.8-51.2	ACCEPT
1,2-Dichlorobenzene	µg/l	48.4	44.0	31.0-55.7	ACCEPT
1,3-Dichlorobenzene	µg/l	47.4	44.0	31.1-54.9	ACCEPT
1,4-Dichlorobenzene	µg/l	50.3	44.0	30.0-56.8	ACCEPT
Dichlorodifluoromethane	µg/l	<1.0	0	0	ACCEPT
1,1-Dichloroethane	µg/l	34.2	32.0	12.8-51.2	ACCEPT
1,2-Dichloroethane	µg/l	28.1	24.8	17.3-33.4	ACCEPT
1,1-Dichloroethylene	µg/l	45.7	48.0	25.7-74.2	ACCEPT
cis-1,2-Dichloroethylene	µg/l	53.2	48.0	19.2-76.8	ACCEPT

Table 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
trans-1,2-Dichloroethylene	µg/l	50.0	48.0	29.3-66.8	ACCEPT
1,2-Dichloropropane	µg/l	27.4	24.8	17.7-31.1	ACCEPT
cis-1,3-Dichloropropylene	µg/l	26.2	25.1	21.4-28.8	ACCEPT
trans-1,3-Dichloropropylene	µg/l	26.4	24.8	10.1-35.6	ACCEPT
Ethylbenzene	µg/l	42.1	36.0	24.1-47.0	ACCEPT
2-Hexanone	µg/l	N/A	N/A	N/A	NOT REPORTED
Methylene chloride	µg/l	50.0	48.0	30.3-66.2	ACCEPT
4-Methyl-2-pentanone (MIBK)	µg/l	N/A	N/A	N/A	NOT REPORTED
Styrene	µg/l	42.2	36.0	14.4-57.6	ACCEPT
1,1,1,2-Tetrachloroethane	µg/l	28.0	24.8	9.92-39.7	ACCEPT
1,1,2,2-Tetrachloroethane	µg/l	24.8	24.8	14.0-34.9	ACCEPT
Tetrachloroethylene	µg/l	23.2	32.0	21.1-41.2	CK FOR ERROR
Toluene	µg/l	40.0	36.0	25.8-45.2	ACCEPT
1,1,1-Trichloroethane	µg/l	34.8	32.0	20.8-42.2	ACCEPT
1,1,2-Trichloroethane	µg/l	27.4	24.8	17.5-32.0	ACCEPT
Trichloroethylene	µg/l	28.5	24.8	16.2-32.2	ACCEPT
Trichlorofluoromethane	µg/l	<1.0	0	0	ACCEPT
1,2,3-Trichloropropane	µg/l	21.3	24.8	9.92-39.7	ACCEPT
Vinyl acetate	µg/l	N/A	N/A	N/A	NOT REPORTED
Vinyl chloride	µg/l	93.8	100.0	45.1-181.0	ACCEPT
Xylenes, total	µg/l	141.0	124.0	70.9-167.0	ACCEPT
SVOCs-Acids					
Benzoic acid	µg/l	N/A	N/A	N/A	NOT REPORTED
4-Chloro-3-methylphenol	µg/l	136.0	184	72.9-236	ACCEPT
2-Chlorophenol.	µg/l	73.8	132	37.7-166	ACCEPT
2,4-Dichlorophenol	µg/l	66.8	101.0	36.3-122.0	ACCEPT
2,6-Dichlorophenol	µg/l	N/A	N/A	N/A	NOT REPORTED
2,4-Dimethylphenol	µg/l	52.9	91.1	18.7-120.0	ACCEPT
4,6-Dinitro-2-methylphenol	µg/l	N/A	N/A	N/A	NOT REPORTED
2,4-Dinitrophenol	µg/l	79.0	109.0	0.0-146.0	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	28.6	42.9	13.6-55.6	ACCEPT
3-Nitrophenol	µg/l	N/A	N/A	N/A	NOT REPORTED
4-Nitrophenol	µg/l	20.6	131.0	0.0-177.0	ACCEPT
Pentachlorophenol	µg/l	124.0	149.0	40.6-205.0	ACCEPT
Phenol	µg/l	128.0	130.0	0.0-175.0	ACCEPT
2,4,5-Trichlorophenol	µg/l	99.5	114.0	81.0-148.0	ACCEPT
2,4,6-Trichlorophenol	µg/l	<5.0	0	0	ACCEPT
SVOCs Base Neturals					
Acenaphthene	µg/l	41.4	55.8	21.6-71.3	ACCEPT
Acenaphthylene	µg/l	74.9	81.7	32.3-99.7	ACCEPT
Aniline	µg/l	N/A	N/A	N/A	NOT REPORTED

Table 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
Anthracene	µg/l	33.8	42.1	18.9-54.5	ACCEPT
Benzidine	µg/l	N/A	N/A	N/A	NOT REPORTED
Benzo(a)anthracene	µg/l	31.7	32.7	19.1-37.6	ACCEPT
Benzo(b)fluoranthene	µg/l	34.8	45.3	14.7-62.7	ACCEPT
Benzo(k)fluoranthene	µg/l	112.0	120.0	30.2-171.0	ACCEPT
Benzo(g,h,i)perylene	µg/l	55.0	64.0	14.6-95.7	ACCEPT
Benzo(a)pyrene	µg/l	41.1	46.5	18.0-74.9	ACCEPT
Benzyl alcohol	µg/l	N/A	N/A	N/A	NOT REPORTED
4-Bromophenyl-phenylether	µg/l	138.0	168.0	70.3-215.0	ACCEPT
Butylbenzylphthalate	µg/l	138.0	146.0	0.0-231.0	ACCEPT
Carbazole	µg/l	N/A	N/A	N/A	NOT REPORTED
4-Chloroaniline	µg/l	<0.5	0.0	0.0	ACCEPT
bis(2-Chloroethoxy)methane	µg/l	47.2	74.7	29.4-89.4	ACCEPT
bis(2-Chloroethyl)ether	µg/l	59.8	161.0	42.6-194.0	CK FOR ERROR
bis(2-Chloroisopropyl)ether	µg/l	115.0	186.0	45.6-287.0	ACCEPT
1-Chloronaphthalene	µg/l	N/A	N/A	N/A	NOT REPORTED
2-Chloronaphthalene	µg/l	30.7	49.0	19.1-59.2	ACCEPT
4-Chlorophenyl-phenylether	µg/l	62.6	82.8	32.5-105.0	ACCEPT
Chrysene	µg/l	96.3	97.4	36.8-128.0	ACCEPT
Dibenz(a,h)anthracene	µg/l	71.1	70.4	53.3-87.5	ACCEPT
Dibenzofuran	µg/l	60.9	72.6	48.3-96.9	ACCEPT
Di-n-butylphthalate	µg/l	67.7	79.2	14.8-112.0	ACCEPT
1,2-Dichlorobenzene	µg/l	47.0	61.4	30.5-92.2	ACCEPT
1,3-Dichlorobenzene	µg/l	37.5	49.8	25.4-74.2	ACCEPT
1,4-Dichlorobenzene	µg/l	18.2	25.3	12.1-38.5	ACCEPT
3,3'-Dichlorobenzidine	µg/l	N/A	N/A	N/A	NOT REPORTED
Diethylphthalate	µg/l	52.8	64.1	5.3-97.5	ACCEPT
Dimethlyphthalate	µg/l	81.7	101.0	0.0-155.0	ACCEPT
2,4-Dinitrotoluene	µg/l	121.0	144.0	61.3-193.0	ACCEPT
2,6-Dinitrotoulene	µg/l	55.3	69.7	26.6-90.2	ACCEPT
Di-n-octylphthalate	µg/l	77.5	94.0	14.7-137.0	ACCEPT
bis(2-ethylhexyl)phthalate	µg/l	286.0	51.2	16.6-73.9	NOT ACCEPT
Fluoranthene	µg/l	76.6	89.8	39.2-116.0	ACCEPT
Fluorene	µg/l	30.0	39.2	16.6-51.1	ACCEPT
Hexachlorobenzene	µg/l	37.2	47.2	20.6-61.2	ACCEPT
Hexachlorobutadiene	µg/l	23.1	43.1	5.87-53.5	ACCEPT
Hexachlorocyclopentadiene	µg/l	108.0	145.0	0.0-184.0	ACCEPT
Hexachloroethane	µg/l	76.7	144.0	11.7-184.0	ACCEPT
Indeno(1,2,3-cd)pyrene	µg/l	145.0	158.0	123.0-192.0	ACCEPT
Isophorone	µg/l	<5.0	0.0	0.0	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	86.0	135.0	32.9-176.0	ACCEPT
2-Nitroaniline	µg/l	60.2	73.4	54.8-92.0	CK FOR ERROR

Table 7.9 - Absolute Grade PT Program Assessment of Trace Analysis, Inc. October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation[b]
3-Nitroaniline	µg/l	31.5	33.1	2.31-63.8	ACCEPT
4-Nitroaniline	µg/l	67.9	73.9	54.6-93.1	ACCEPT
Nitrobenzene	µg/l	<5.0	0.0	0.0	ACCEPT
N-Nitrosodiethylamine	µg/l	N/A	N/A	N/A	NOT REPORTED
N-Nitrosodimethylamine	µg/l	41.4	118.0	0.0-139.0	ACCEPT
N-Nitrosodiphenylamine	µg/l	N/A	N/A	N/A	NOT REPORTED
N-Nitroso-di-n-propylamine	µg/l	121.0	163.0	51.1-211.0	ACCEPT
Phenanthrene	µg/l	38.5	49.4	24.5-62.2	ACCEPT
Pyrene	µg/l	105.0	114.0	37.8-154.0	ACCEPT
Pyridine	µg/l	N/A	N/A	N/A	NOT REPORTED
1,2,4-Trichlorobenzene	µg/l	28.4	48.3	13.8-59.9	ACCEPT

[a] Standard Unit
[b] Check for Error indicates result is above the warning limit, but within the acceptance limit.
N/A - Not Applicable
Not Reported - Parameter not analyzed

Table 7.10 - Absolute Grade PT Program Assessment of Trace Analysis, Inc., Petroleum October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Gasoline in Water					
Unleaded Gasoline	µg/l	3610	3450	2070-4830	ACCEPT
Benzene	µg/l	70.8	72.0	43.2-101.0	ACCEPT
Ethylbenzene	µg/l	57.0	60.0	36.0-84.0	ACCEPT
Toluene	µg/l	35.1	38.0	22.8-53.2	ACCEPT
Xylenes, M/P	µg/l	48.9	55.6	33.4-77.9	ACCEPT
Diesel in Water					
No. 2 Diesel	µg/l	2540	4222	1688-6755	ACCEPT
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

Not Reported - Parameter not analyzed

Table 7.11 - Absolute Grade PT Program Assessment of Trace Analysis, Inc., Pesticides - October - November, 2004

Parameter	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Aldrin	µg/l	2.0	2.51	0.64-3.34	ACCEPT
alpha-BHC	µg/l	5.4	6.11	2.28-8.45	ACCEPT
beta-BHC	µg/l	8.7	11.0	4.13-15.8	ACCEPT
delta-BHC	µg/l	39.1	60.1	12.4-88.7	ACCEPT
gamma-BHC (Lindane)	µg/l	15.1	18.0	5.68-26.2	ACCEPT
alpha-Chlordane	µg/l	13.4	17.0	6.8-27.2	ACCEPT
gamma-Chlordane	µg/l	8.10	8.91	3.56-14.3	ACCEPT
Chlordane, total	µg/l	7.60	6.61	2.89-9.41	ACCEPT
4,4'-DDD	µg/l	2.2	3.91	1.92-5.45	CK FOR ERROR
4,4'-DDE	µg/l	2.4	3.41	1.61-4.65	ACCEPT
4,4'-DDT	µg/l	3.9	5.01	2.29-6.77	ACCEPT
Dieldrin	µg/l	3.6	4.5	2.33-6.21	ACCEPT
Endrin	µg/l	33.3	50.1	16.8-76.8	ACCEPT
Endrin aldehyde	µg/l	4.7	5.71	1.88-8.39	ACCEPT
Endrin ketone	µg/l	7.50	9.50	3.8-15.2	ACCEPT
Endosulfan I	µg/l	16.2	16.0	6.62-23.4	ACCEPT
Endosulfan II	µg/l	28.6	30.0	5.77-48.4	ACCEPT
Endosulfan sulfate	µg/l	14.6	19.0	3.22-31.2	ACCEPT
Heptachlor	µg/l	2.2	3.2	0.84-4.46	ACCEPT
Heptachlor epoxide	µg/l	2.1	2.5	1.27-3.22	ACCEPT
Methoxychlor	µg/l	9.4	14.0	5.83-19.9	ACCEPT
Toxaphene	µg/l	430.0	346.0	141.0-551.0	ACCEPT

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, 2004 (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
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

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	Granting Agency	**Type of Permit**	**Permit Number**	**Granted/ Submitted**	**Expiration**
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 SNL-3	RW-28537	7/31/03	7/31/38
29	New Mexico Commissioner of Public Lands	Monitoring Well SNL-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	7/1/04	6/30/05
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
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 DOE-1	C-2757	11/6/00	None
49	New Mexico State Engineer Office	Monitoring Well DOE-2	C-2682	4/17/00	None
50	New Mexico State Engineer Office	Monitoring Well ERDA-9	C-2752	11/6/00	None
51	New Mexico State Engineer Office	Monitoring Well H-1	C-2765	11/6/00	None
52	New Mexico State Engineer Office	Monitoring Well H-2A	C-2762	11/6/00	None
53	New Mexico State Engineer Office	Monitoring Well H-2B1	C-2758	11/6/00	None
54	New Mexico State Engineer Office	Monitoring Well H-2B2	C-2763	11/6/00	None
55	New Mexico State Engineer Office	Monitoring Well H-2C	C-2759	11/6/00	None

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2004 (Does Not Include Hazardous Waste Facility Permit)					
	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
56	New Mexico State Engineer Office	Monitoring Well H-3B1	C-2764	11/6/00	None
57	New Mexico State Engineer Office	Monitoring Well H-3B2	C-2760	11/6/00	None
58	New Mexico State Engineer Office	Monitoring Well H-3B3	C-2761	11/6/00	None
59	New Mexico State Engineer Office	Monitoring Well H-3D	pending	11/6/00	None
60	New Mexico State Engineer Office	Monitoring Well H-4A	C-2725	11/6/00	None
61	New Mexico State Engineer Office	Monitoring Well H-4B	C-2775	11/6/00	None
62	New Mexico State Engineer Office	Monitoring Well H-4C	C-2776	11/6/00	None
63	New Mexico State Engineer Office	Monitoring Well H-5A	C-2746	11/6/00	None
64	New Mexico State Engineer Office	Monitoring Well H-5B	C-2745	11/6/00	None
65	New Mexico State Engineer Office	Monitoring Well H-5C	C-2747	11/6/00	None
66	New Mexico State Engineer Office	Monitoring Well H-6A	C-2751	11/6/00	None
67	New Mexico State Engineer Office	Monitoring Well H-6B	C-2749	11/6/00	None
68	New Mexico State Engineer Office	Monitoring Well H-6C	C-2750	11/6/00	None
69	New Mexico State Engineer Office	Monitoring Well H-7A	C-2694	4/17/00	None
70	New Mexico State Engineer Office	Monitoring Well H-7B1	C-2770	11/6/00	None
71	New Mexico State Engineer Office	Monitoring Well H-7B2	C-2771	11/6/00	None
72	New Mexico State Engineer Office	Monitoring Well H-7C	C-2772	11/6/00	None
73	New Mexico State Engineer Office	Monitoring Well H-8A	C-2780	11/6/00	None
74	New Mexico State Engineer Office	Monitoring Well H-8B	C-2781	11/6/00	None
75	New Mexico State Engineer Office	Monitoring Well H-8C	C-2782	11/6/00	None
76	New Mexico State Engineer Office	Monitoring Well H-9A	C-2785	11/6/00	None
77	New Mexico State Engineer Office	Monitoring Well H-9B	C-2783	11/6/00	None
78	New Mexico State Engineer Office	Monitoring Well H-9C	C-2784	11/6/00	None
79	New Mexico State Engineer Office	Monitoring Well H-10A	C-2779	11/6/00	None
80	New Mexico State Engineer Office	Monitoring Well H-10B	C-2778	11/6/00	None
81	New Mexico State Engineer Office	Monitoring Well H-10C	C-2695	4/17/00	None
82	New Mexico State Engineer Office	Monitoring Well H-11B1	C-2767	11/6/00	None
83	New Mexico State Engineer Office	Monitoring Well H-11B2	C-2687	4/17/00	None
84	New Mexico State Engineer Office	Monitoring Well H-11B3	C-2768	11/6/00	None
85	New Mexico State Engineer Office	Monitoring Well H-11B4	C-2769	11/6/00	None
86	New Mexico State Engineer Office	Monitoring Well H-12	C-2777	11/6/00	None
87	New Mexico State Engineer Office	Monitoring Well H-14	C-2766	11/6/00	None
88	New Mexico State Engineer Office	Monitoring Well H-15	C-2685	4/17/00	None
89	New Mexico State Engineer Office	Monitoring Well H-16	C-2753	11/6/00	None
90	New Mexico State Engineer Office	Monitoring Well H-17	C-2773	11/6/00	None
91	New Mexico State Engineer Office	Monitoring Well H-18	C-2683	4/17/00	None
92	New Mexico State Engineer Office	Monitoring Well P-17	C-2774	11/6/00	None
93	New Mexico State Engineer Office	Monitoring Well WIPP-12	C-2639	1/12/99	None
94	New Mexico State Engineer Office	Monitoring Well WIPP-13	C-2748	11/6/00	None
95	New Mexico State Engineer Office	Monitoring Well WIPP-18	C-2684	4/17/00	None
96	New Mexico State Engineer Office	Monitoring Well WIPP-19	C-2755	11/6/00	None
97	New Mexico State Engineer Office	Monitoring Well WIPP-21	C-2754	11/6/00	None
98	New Mexico State Engineer Office	Monitoring Well WIPP-25	C-2723	7/26/00	None
99	New Mexico State Engineer Office	Monitoring Well WIPP-26	C-2724	11/6/00	None

Table B.1 - Active Environmental Permits for the Waste Isolation Pilot Plant - December 31, 2004 (Does Not Include Hazardous Waste Facility Permit)					
	Granting Agency	Type of Permit	Permit Number	Granted/ Submitted	Expiration
100	New Mexico State Engineer Office	Monitoring Well WIPP-27	C-2722	11/6/00	None
101	New Mexico State Engineer Office	Monitoring Well WIPP-28	C-2636	1/12/99	None
102	New Mexico State Engineer Office	Monitoring Well WIPP-29	C-2743	11/6/00	None
103	New Mexico State Engineer Office	Monitoring Well WIPP-30	C-2727	8/4/00	None
104	New Mexico State Engineer Office	Monitoring Well SNL-2	C-2948	2/14/03	None
105	New Mexico State Engineer Office	Monitoring Well SNL-9	C-2950	2/14/03	None
106	New Mexico State Engineer Office	Monitoring Well SNL-12	C-2954	2/25/03	None
107	New Mexico State Engineer Office	Monitoring Well SNL-1	C-2953	2/25/03	None
108	New Mexico State Engineer Office	Monitoring Well SNL-3	C-2949	2/14/03	None
109	New Mexico State Engineer Office	Monitoring Well WTS-4	C-2960	3/18/03	None
110	New Mexico State Engineer Office	Monitoring Well SNL-5	C-3002	10/1/03	None
111	New Mexico State Engineer Office	Monitoring Well IMC-461	C-3015	11/25/03	None
112	New Mexico State Engineer Office	Monitoring Well SNL-11	C-3003	10/1/03	None

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

Detection

All radionuclides with the exception of ^{137}Cs, ^{60}Co, and ^{40}K are considered "detected" if the radionuclide concentration is greater than the minimum detectable concentration and the total propagated uncertainty at the two sigma level. For the exceptions noted, these radionuclides are considered detected if they meet the criteria listed above and the confidence level from which the peak or peaks associated with them can be identified by the gamma spectroscopy software at a confidence level of 90 percent or greater.

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 where the background and sample counting time are identical

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:

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

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]
Δt	=	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)

The percent bias is 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

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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 18 occurred March through May 2004 and sampling Round 19 occurred September through November 2004. See Appendix F for specific concentration information on the groundwater wells. Total suspended solids (TSS) concentrations shown in the time-trend graphs in this appendix appear to exhibit a major change from the early sampling rounds to latter rounds. Early round analyses were performed by different subcontract laboratories than those since Round 7. In many cases, the laboratories that performed TSS analyses prior to Round 7 had higher minimum detection levels than the current laboratory. Those higher detection levels appear as higher concentrations for TSS during early sampling rounds. Also, some of the higher reported concentrations for early sampling rounds were the result of the wells being newly drilled and the formation and gravel pack having some fine grained material that was eventually removed by pumping and sampling.

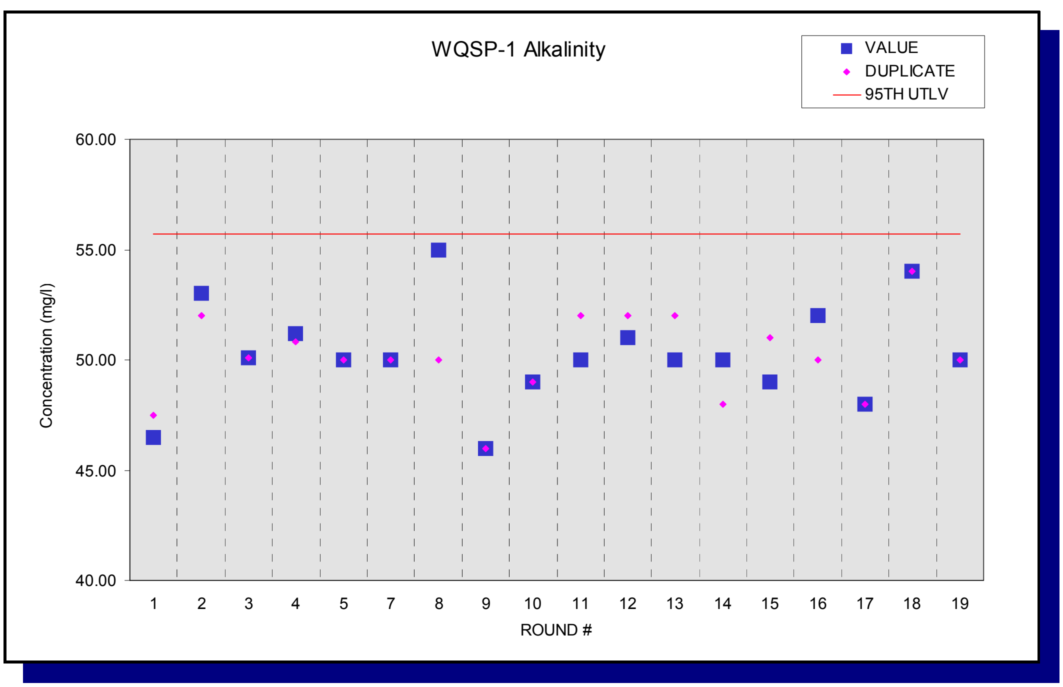

Figure E.1 - Time Trend Plot for Alkalinity at WQSP-1

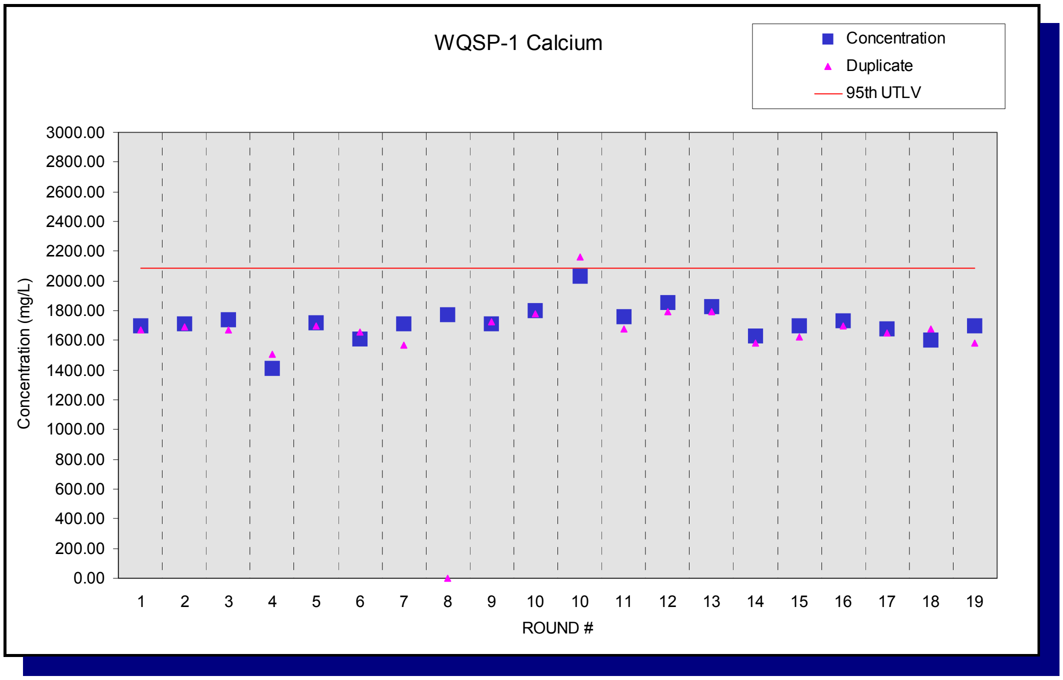

Figure E.2 - Time Trend Plot for Calcium at WQSP-1

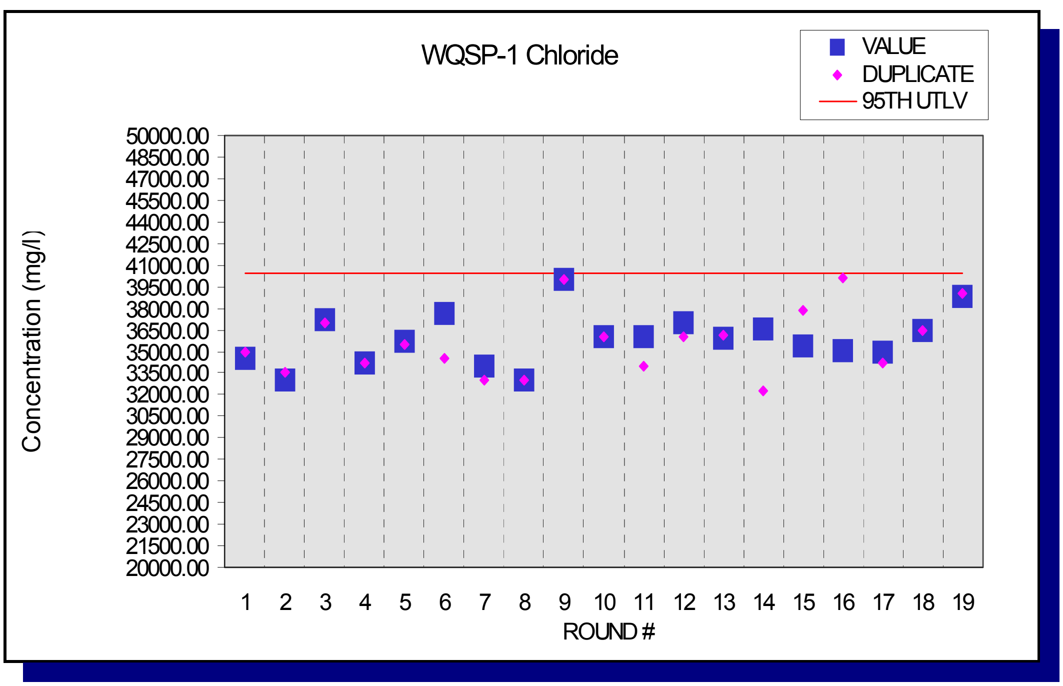

Figure E.3 - Time Trend Plot for Chloride at WQSP-1

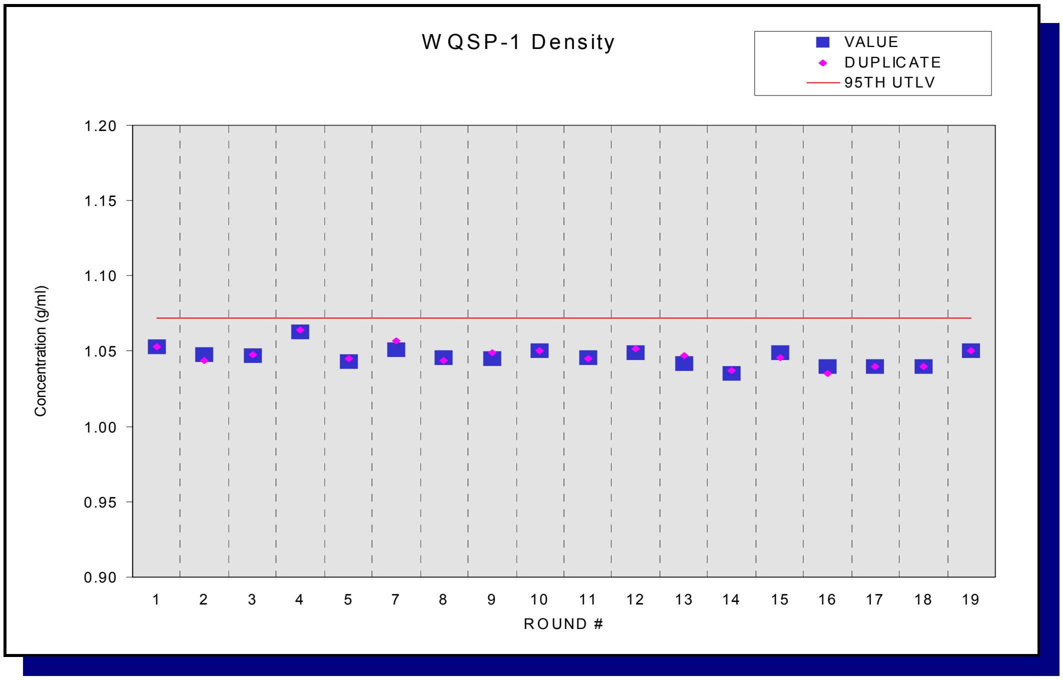

Figure E.4 - Time Trend Plot for Density at WQSP-1

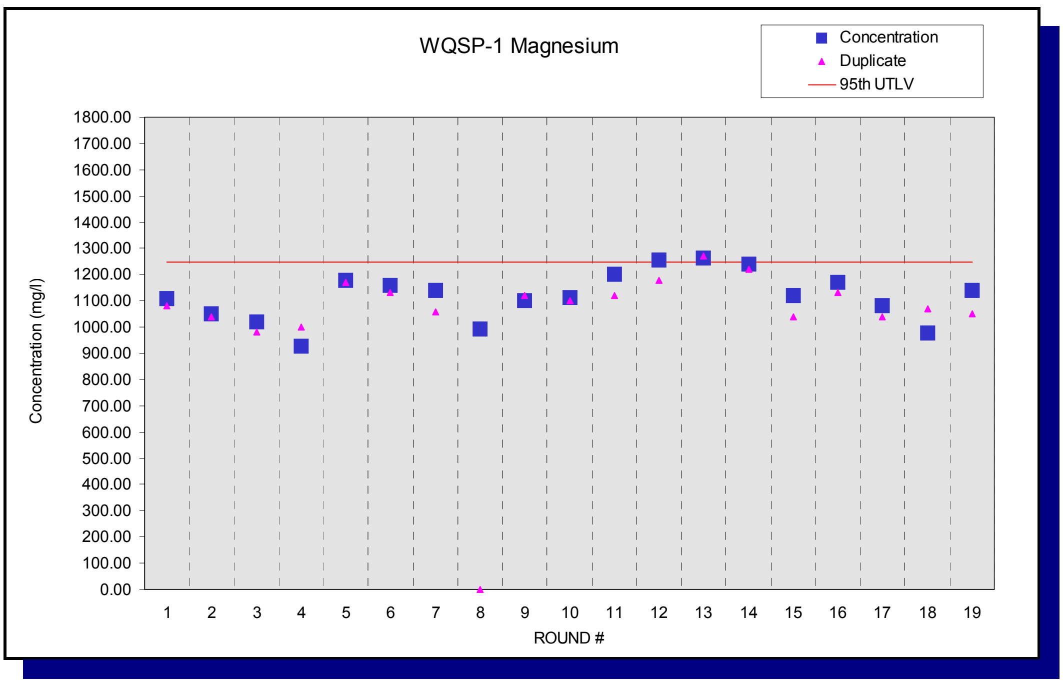

Figure E.5 - Time Trend Plot for Magnesium at WQSP-1

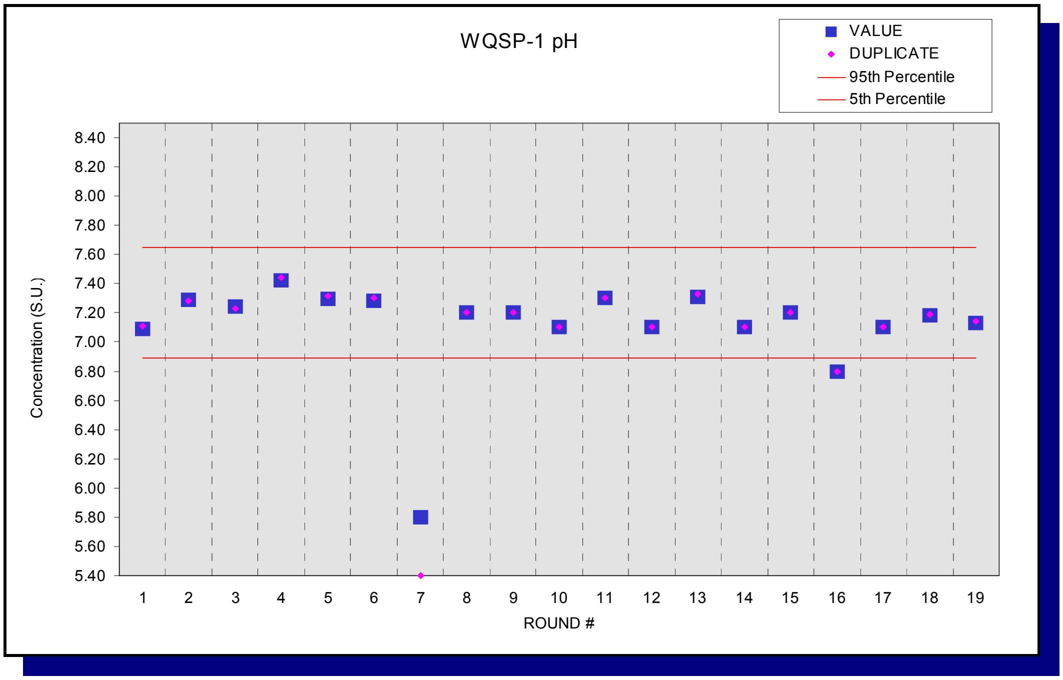

Figure E.6 - Time Trend Plot for pH at WQSP-1

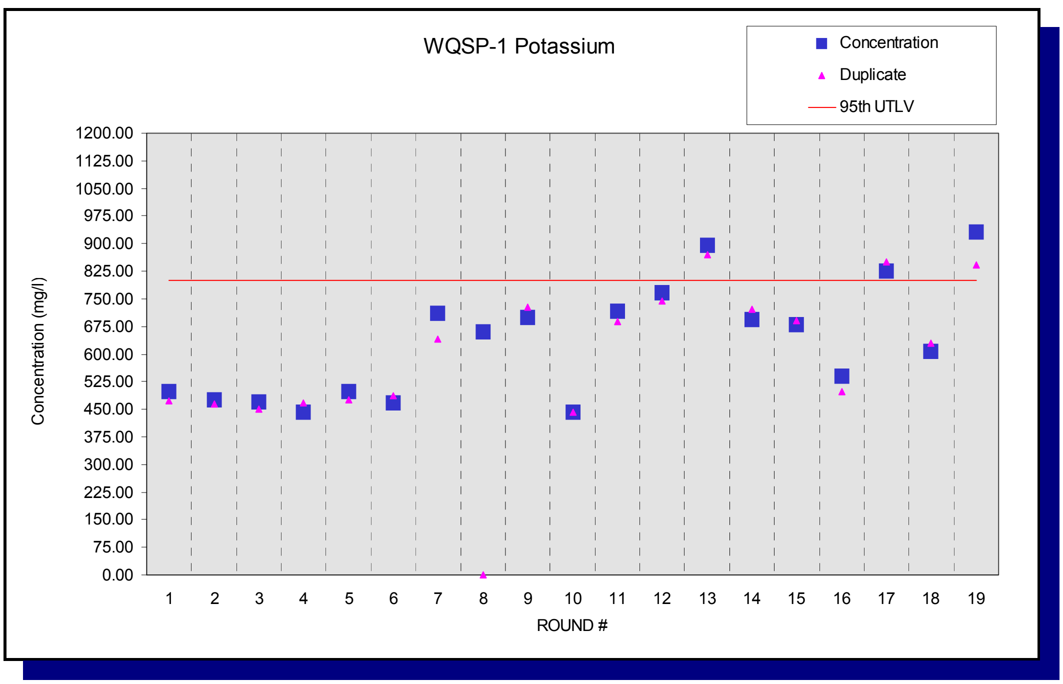

Figure E.7 - Time Trend Plot for Potassium at WQSP-1

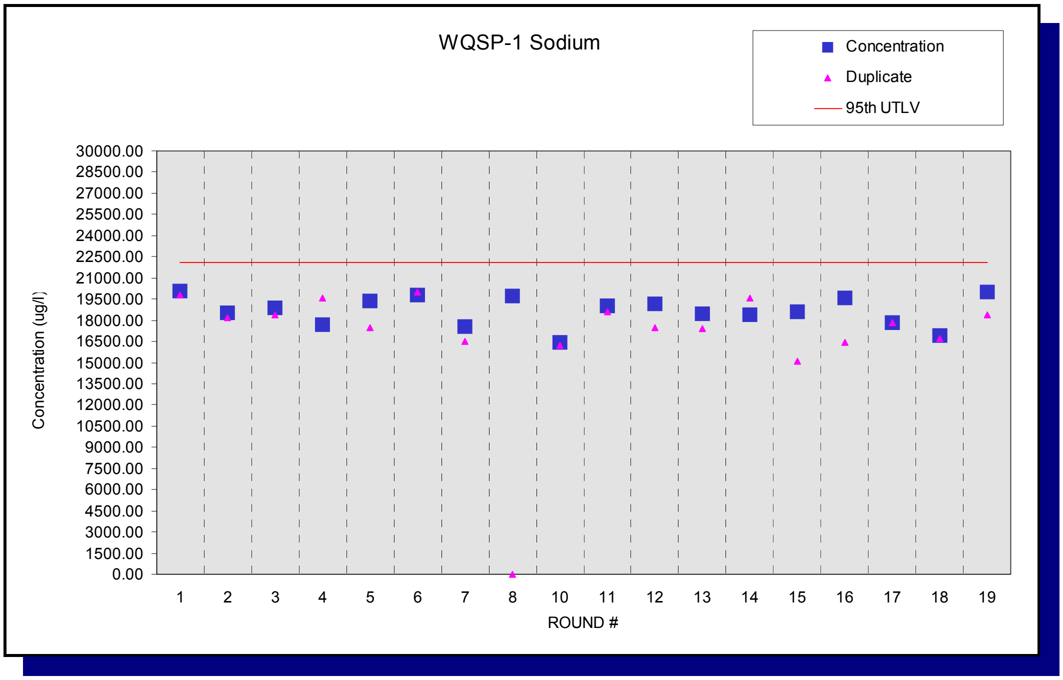

Figure E.8 - Time Trend Plot for Sodium at WQSP-1

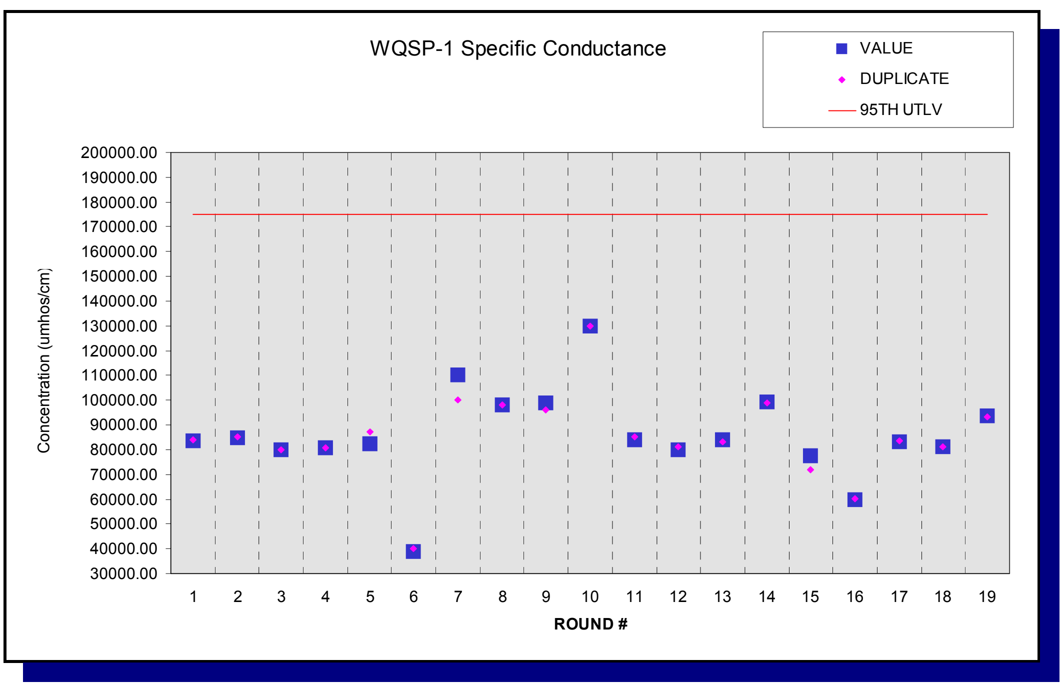

Figure E.9 - Time Trend Plot for Specific Conductance at WQSP-1

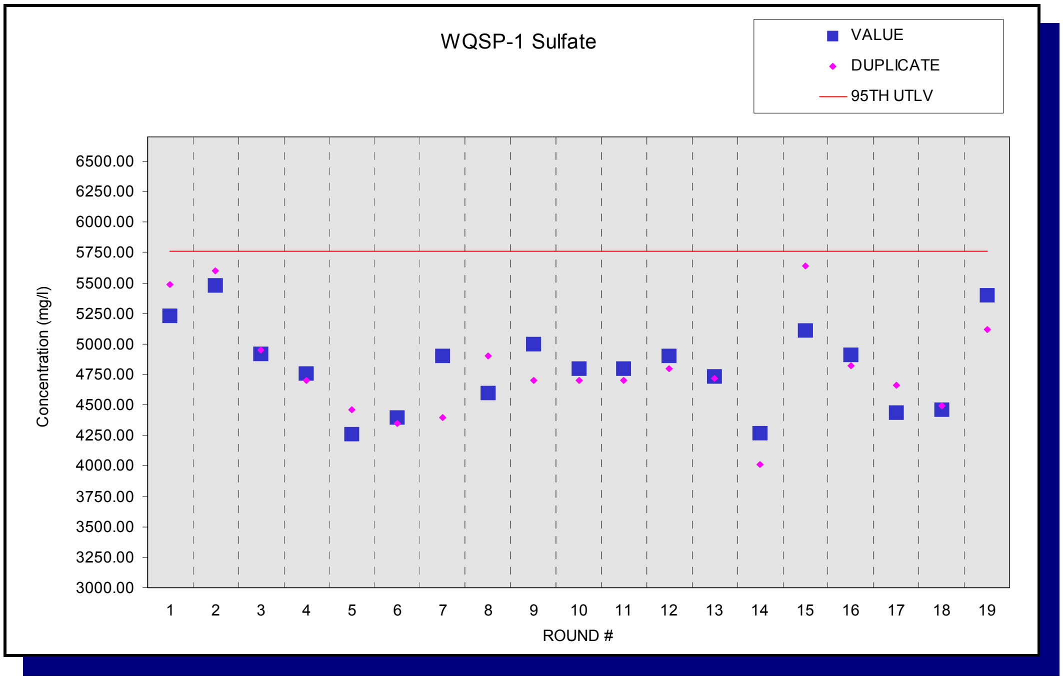

Figure E.10 - Time Trend Plot for Sulfate at WQSP-1

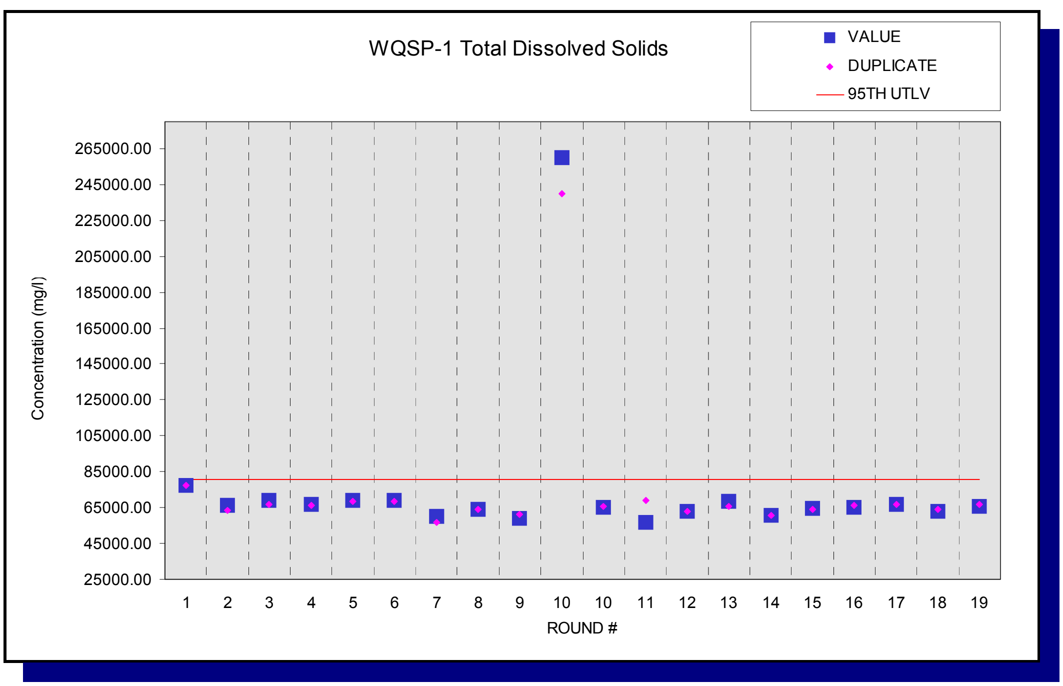

Figure E.11 - Time Trend Plot for Total Dissolved Solids at WQSP-1

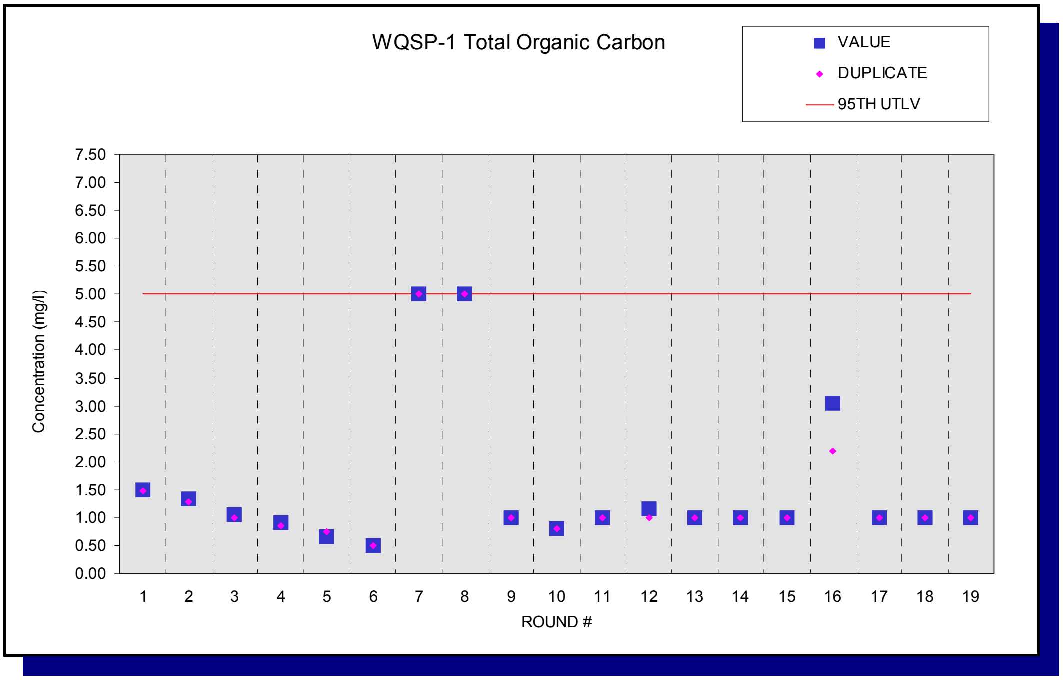

Figure E.12 - Time Trend Plot for Total Organic Carbon at WQSP-1

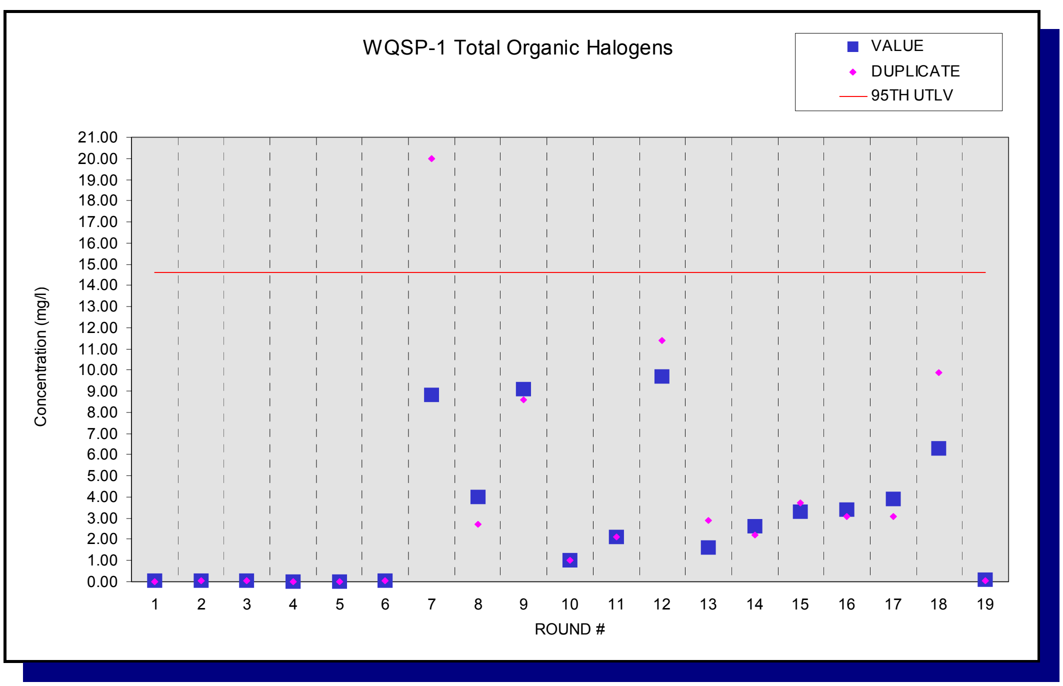

Figure E.13 - Time Trend Plot for Total Organic Halogens at WQSP-1

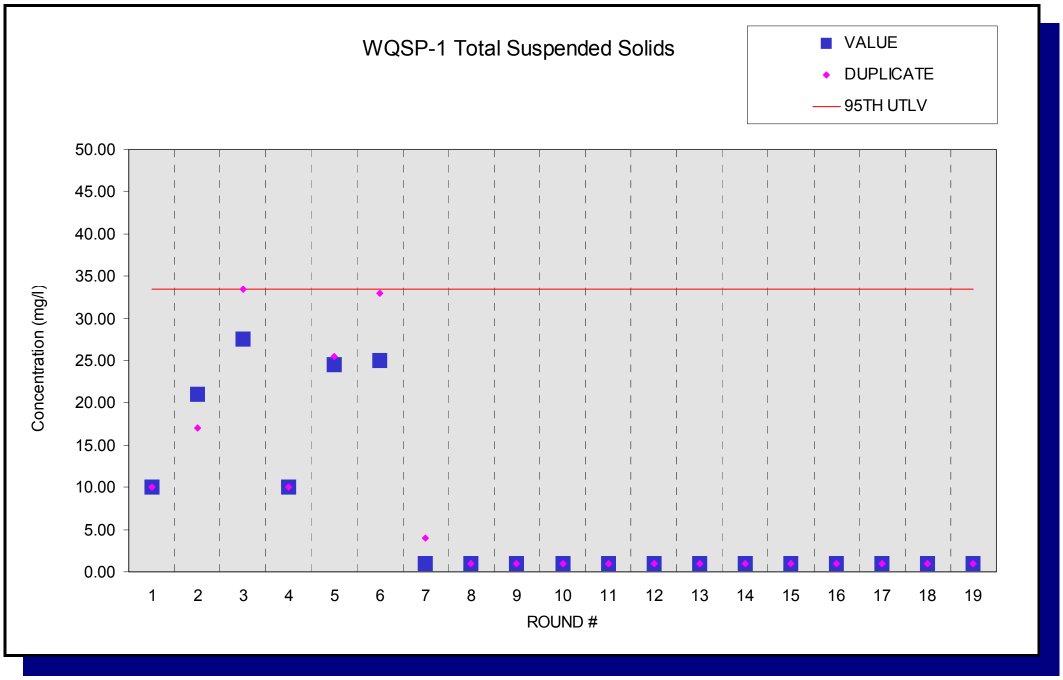

Figure E.14 - Time Trend Plot for Total Suspended Solids at WQSP-1

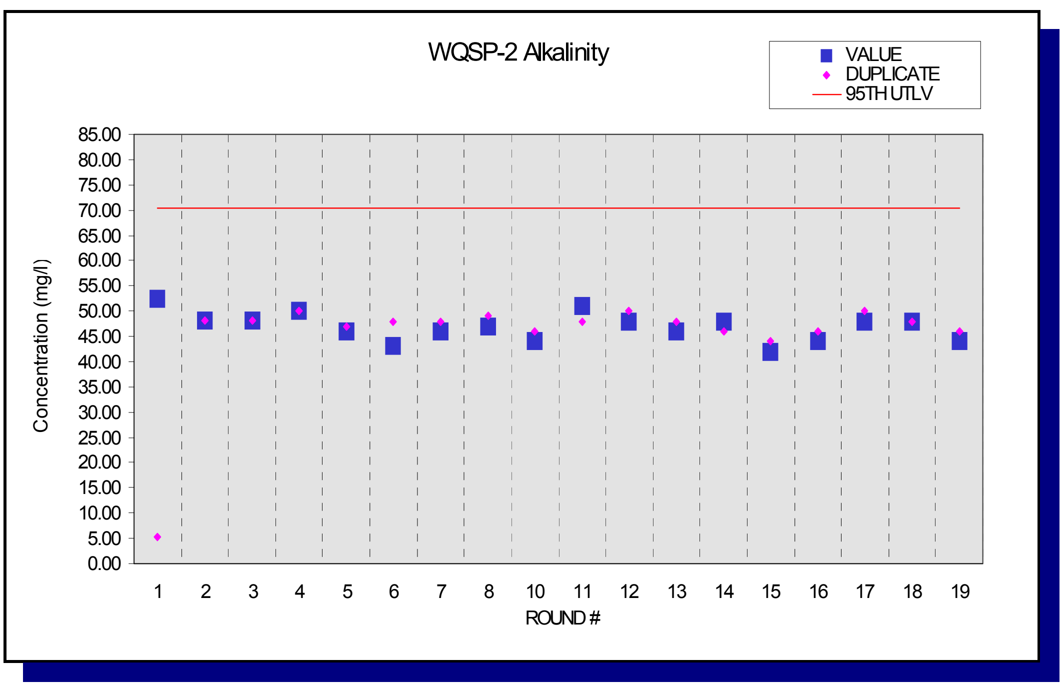

Figure E.15 - Time Trend Plot for Alkalinity at WQSP-2

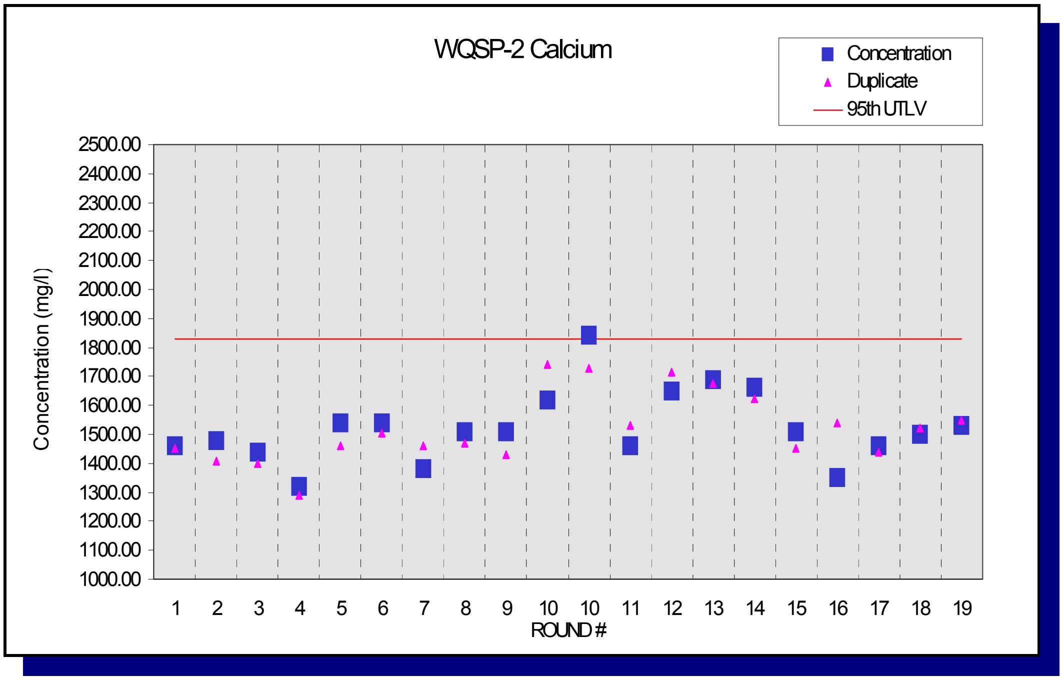

Figure E.16 - Time Trend Plot for Calcium at WQSP-2

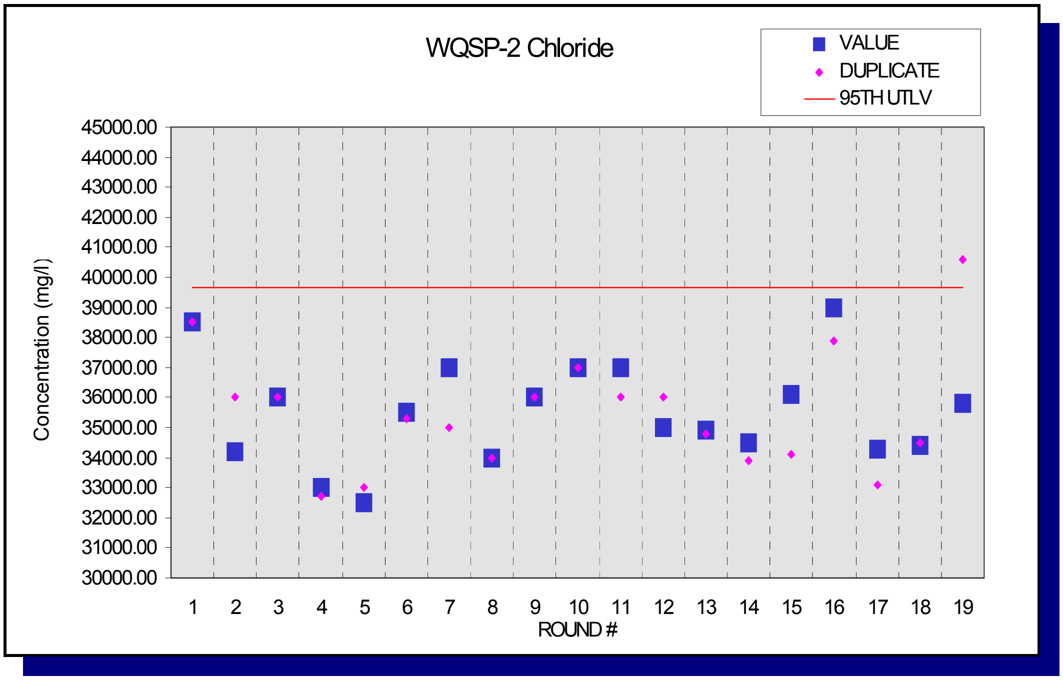

Figure E.17 - Time Trend Plot for Chloride at WQSP-2

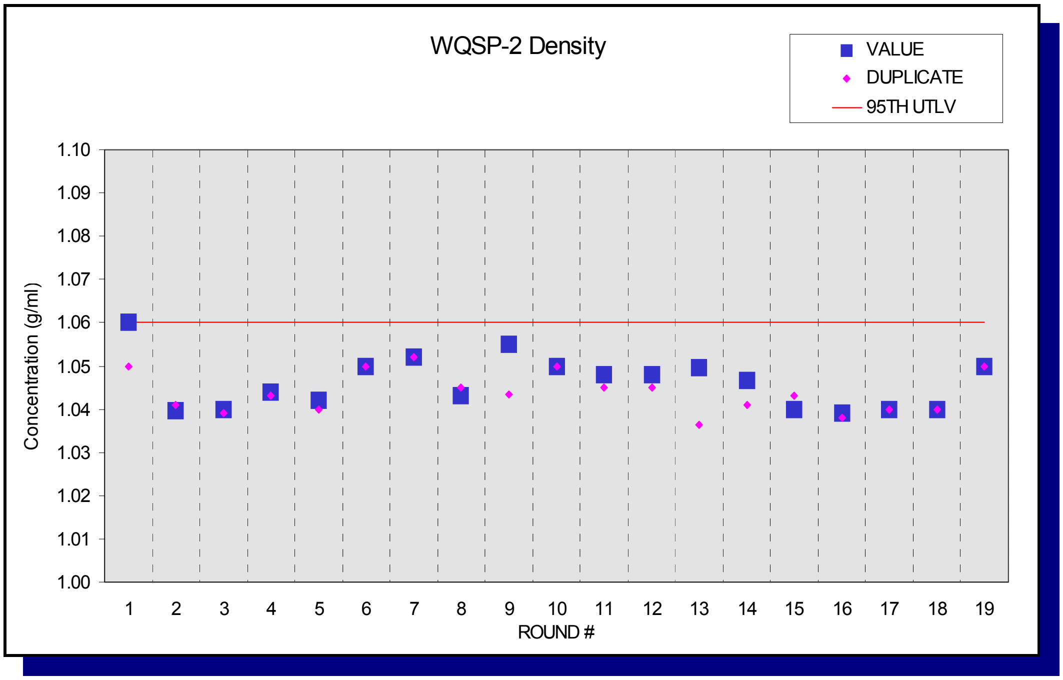

Figure E.18 - Time Trend Plot for Density at WQSP-2

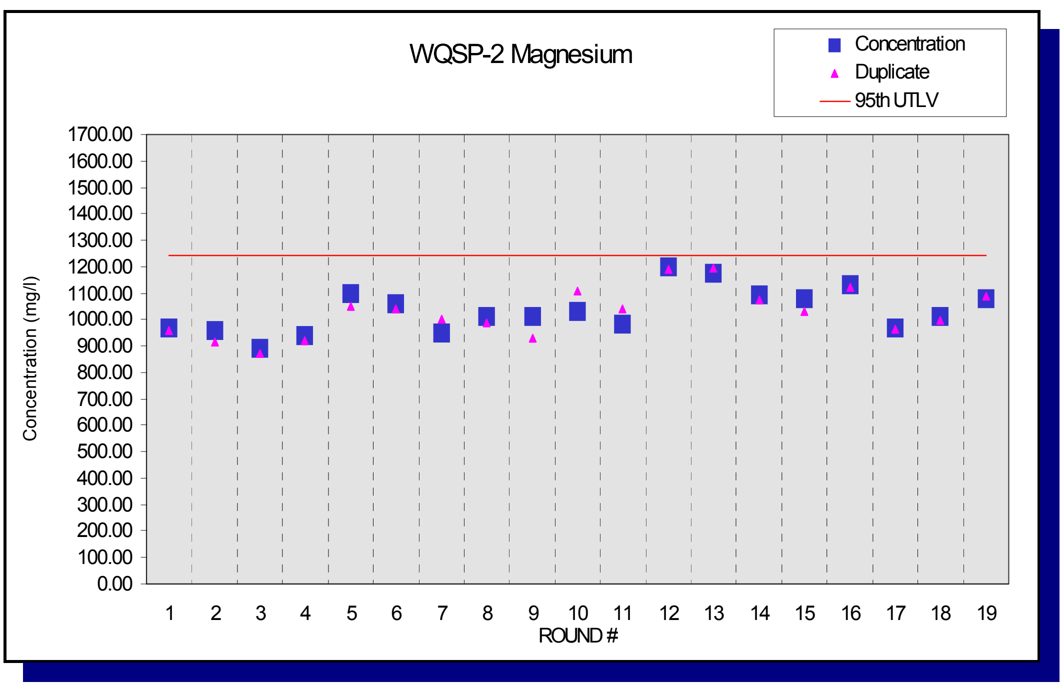

Figure E.19 - Time Trend Plot for Magnesium at WQSP-2

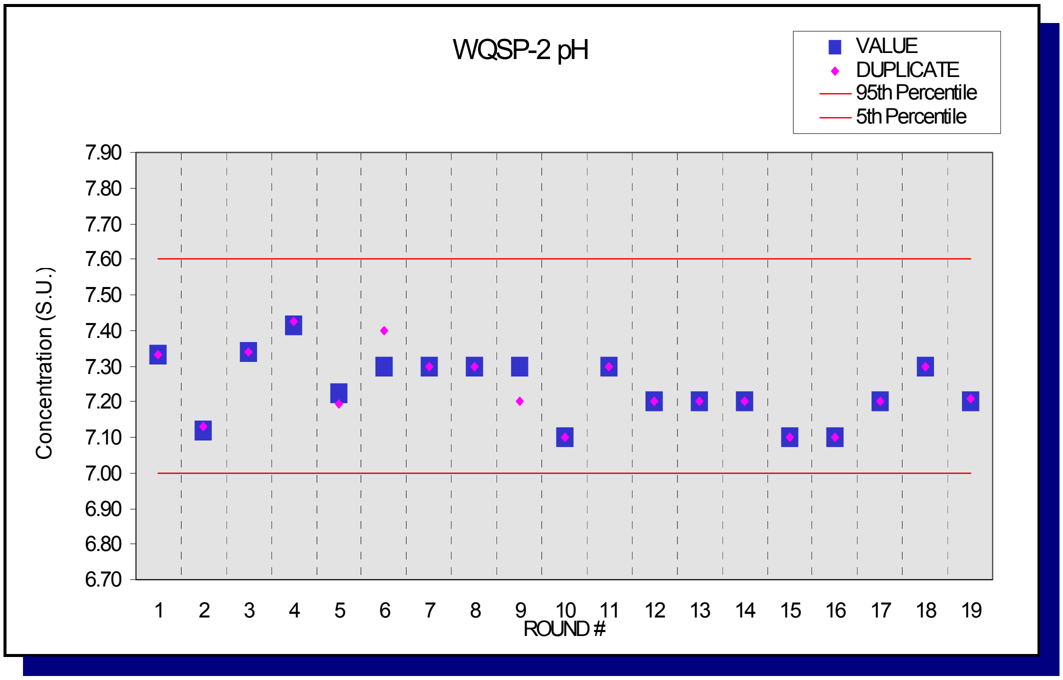

Figure E.20 - Time Trend Plot for pH at WQSP-2

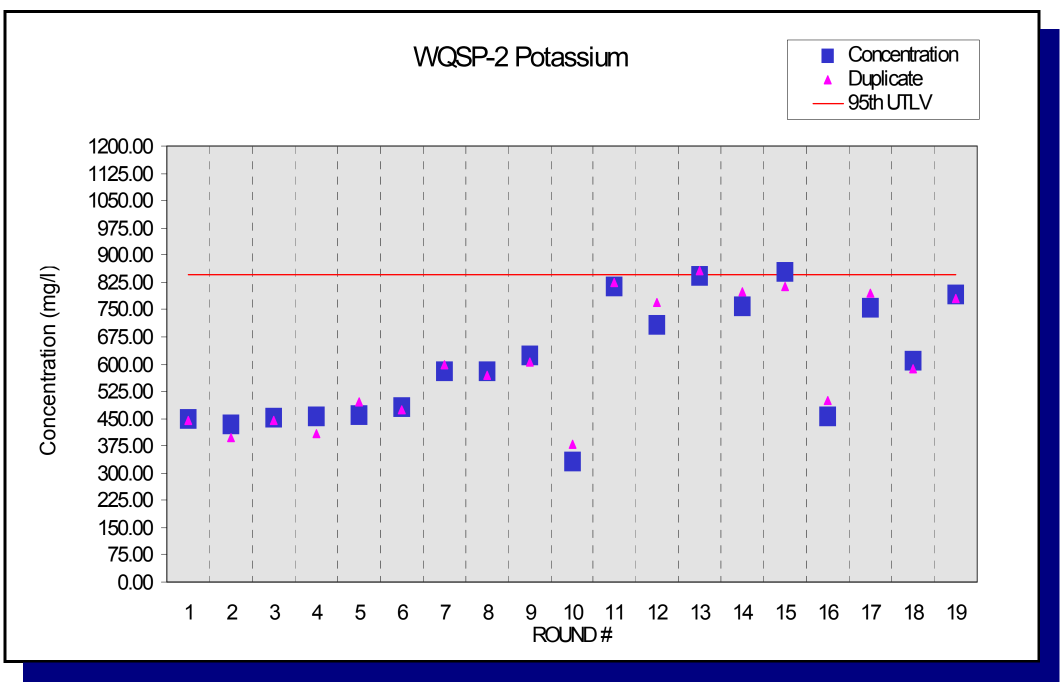

Figure E.21 - Time Trend Plot for Potassium at WQSP-2

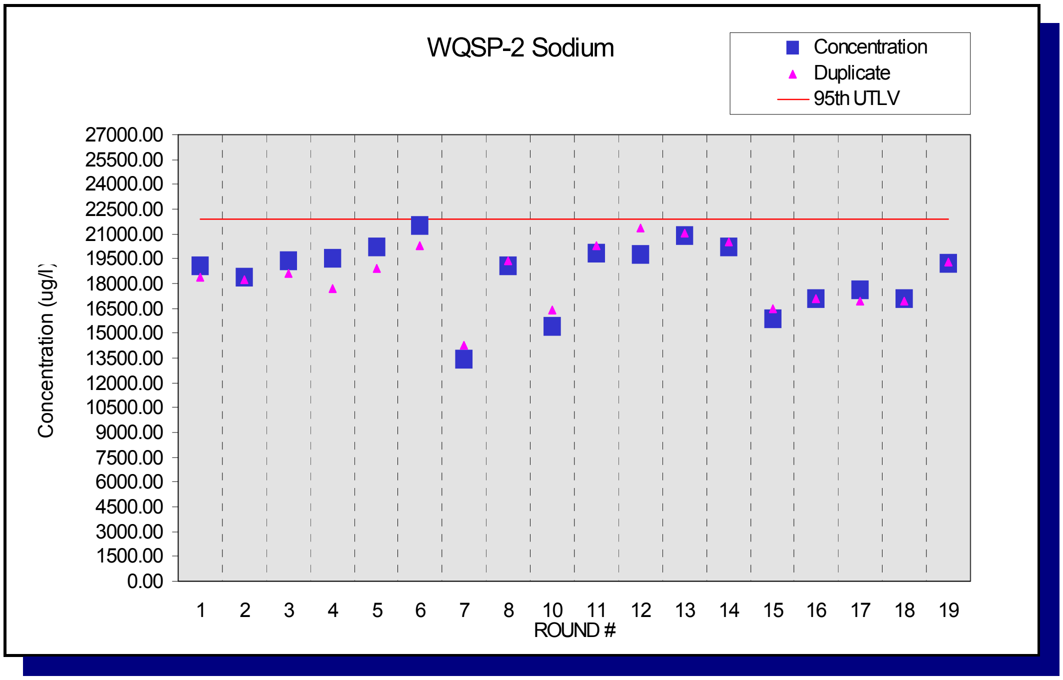

Figure E.22 - Time Trend Plot for Sodium at WQSP-2

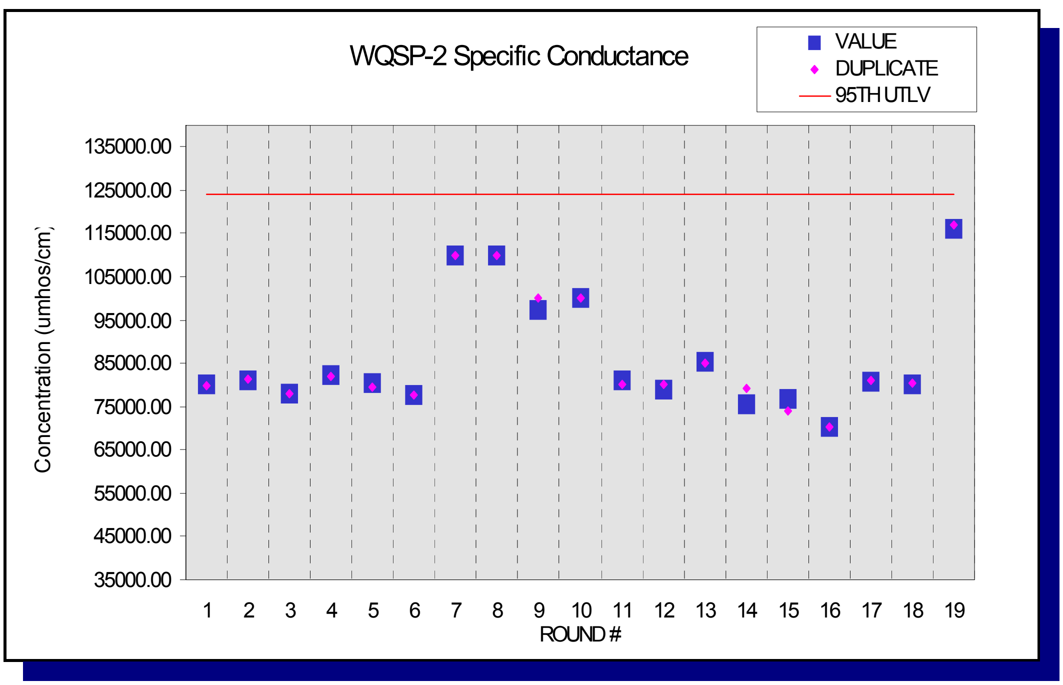

Figure E.23 - Time Trend Plot for Specific Conductance at WQSP-2

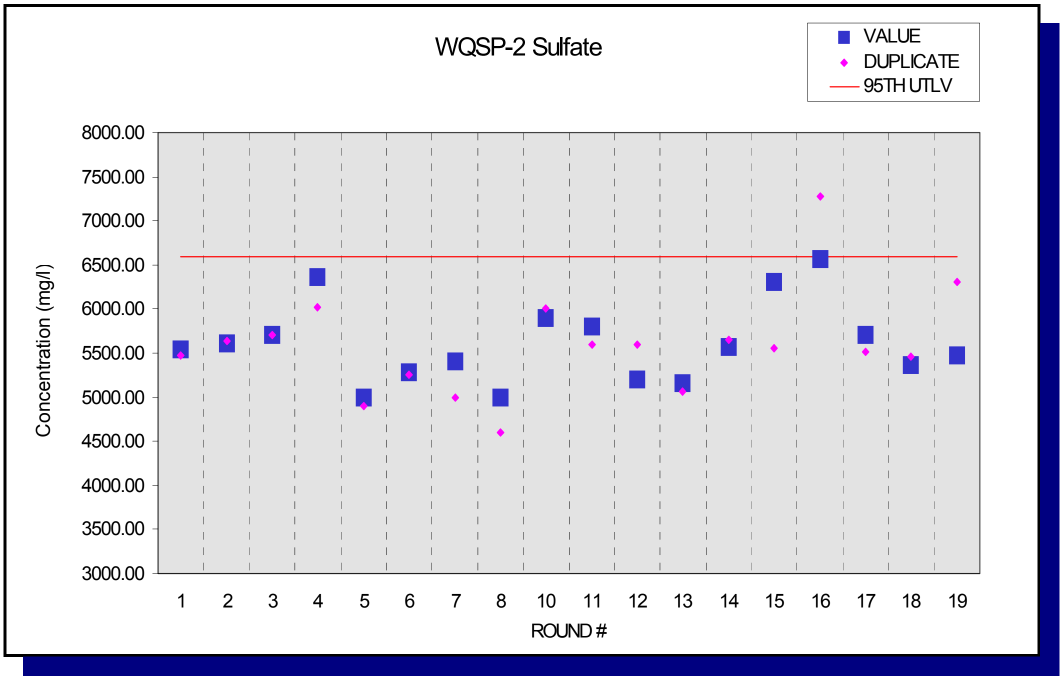

Figure E.24 - Time Trend Plot for Sulfate at WQSP-2

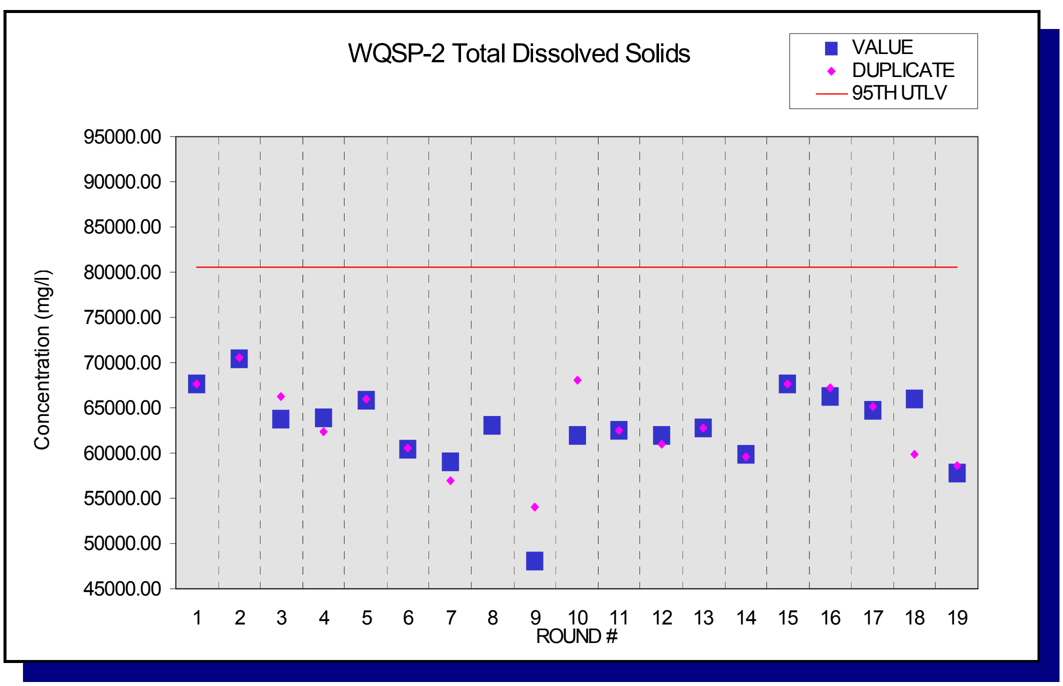

Figure E.25 - Time Trend Plot for Total Dissolved Solids at WQSP-2

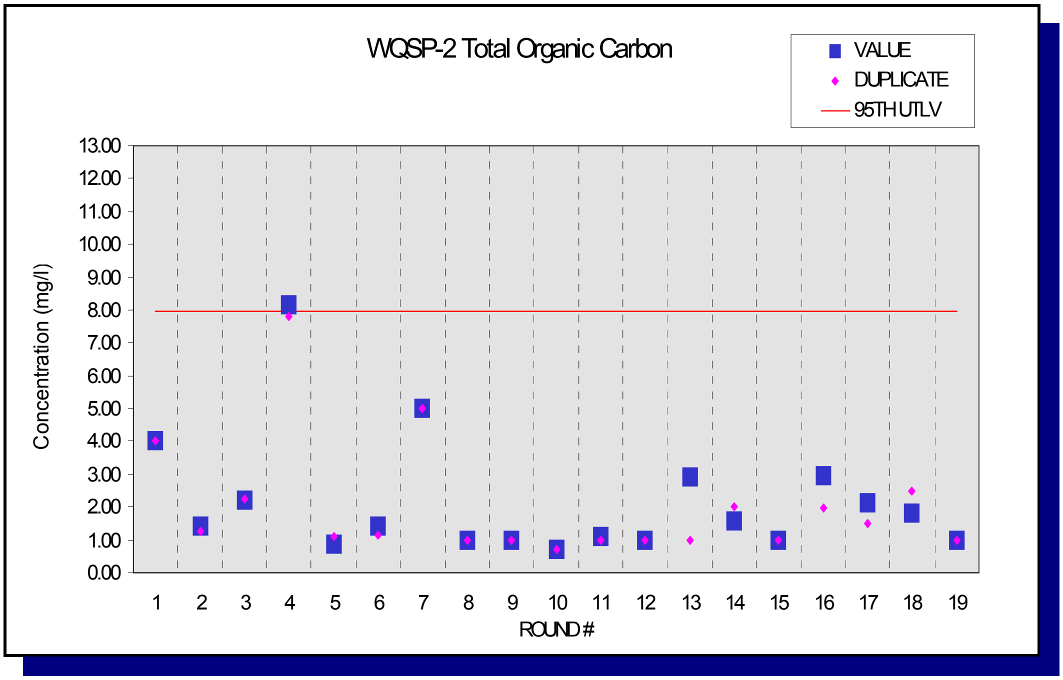

Figure E.26 - Time Trend Plot for Total Organic Carbon at WQSP-2

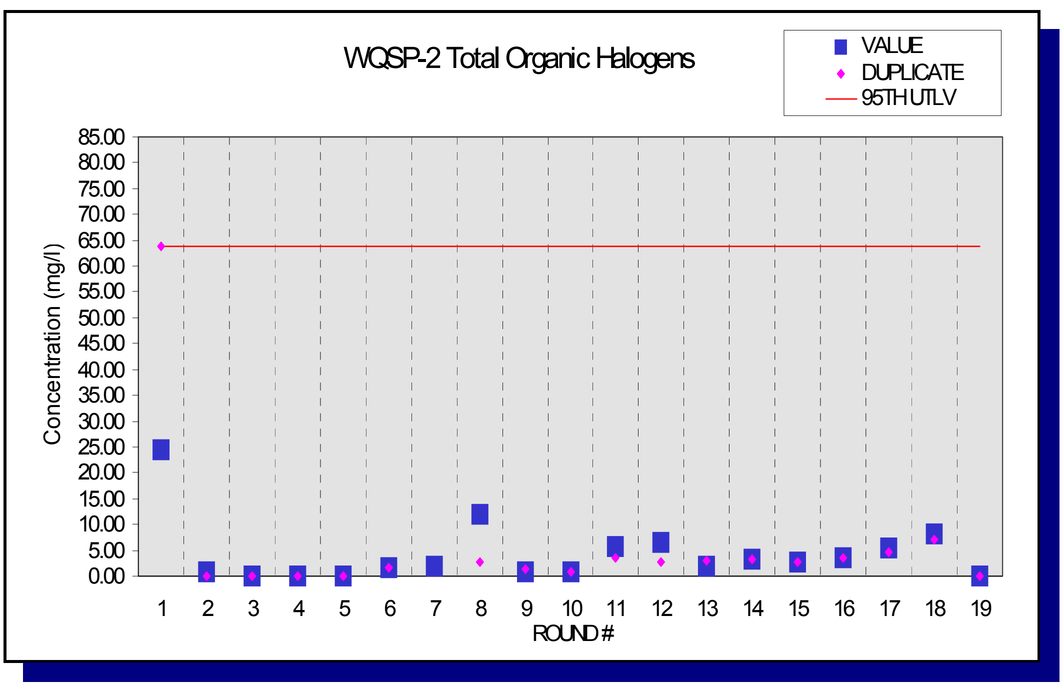

Figure E.27 - Time Trend Plot for Total Organic Halogens at WQSP-2

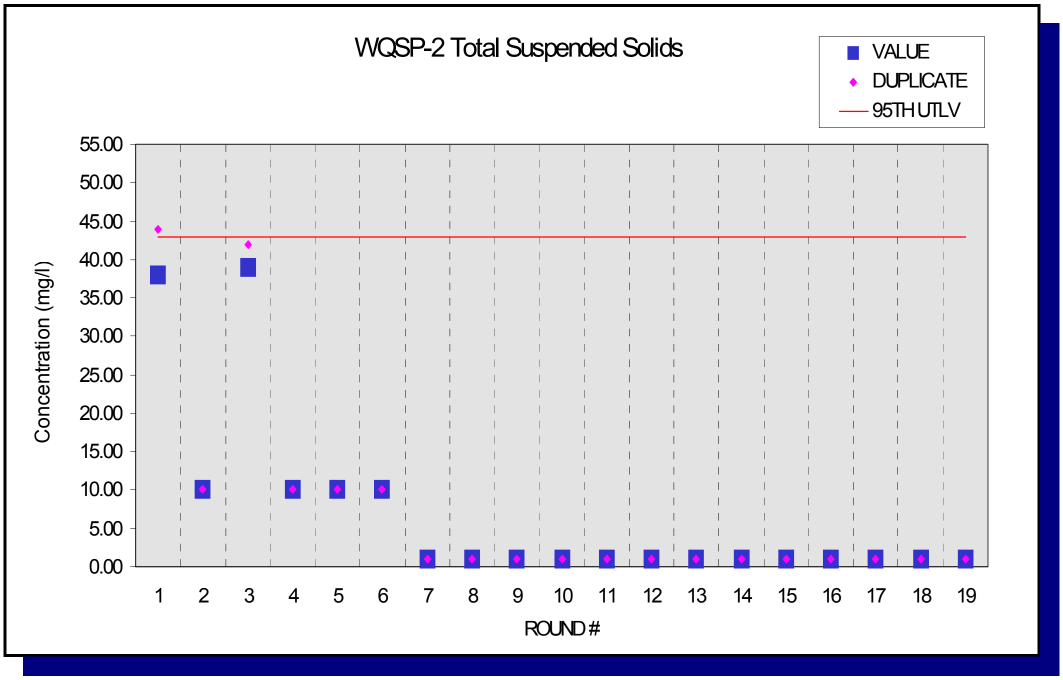

Figure E.28 - Time Trend Plot for Total Suspended Solids at WQSP-2

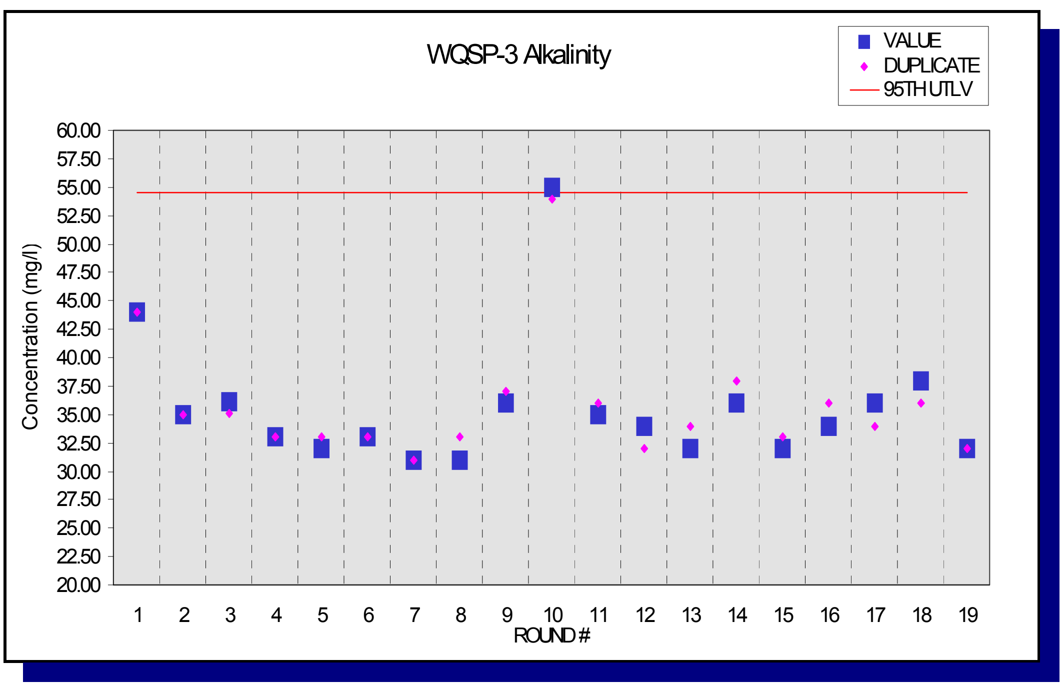

Figure E.29 - Time Trend Plot for Alkalinity at WQSP-3

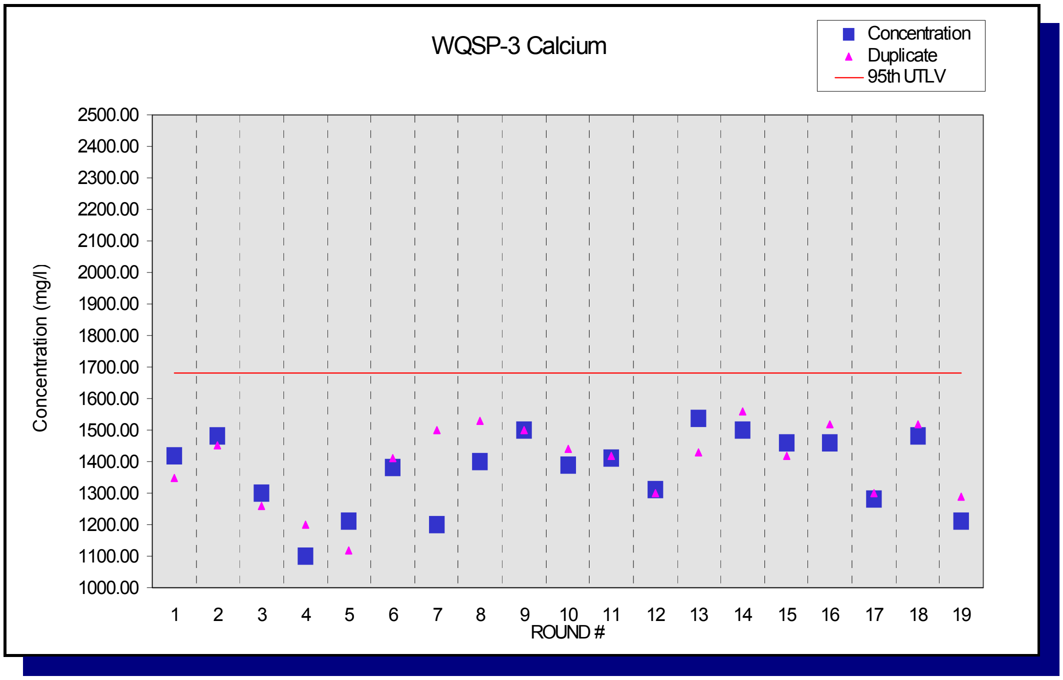

Figure E.30 - Time Trend Plot for Calcium at WQSP-3

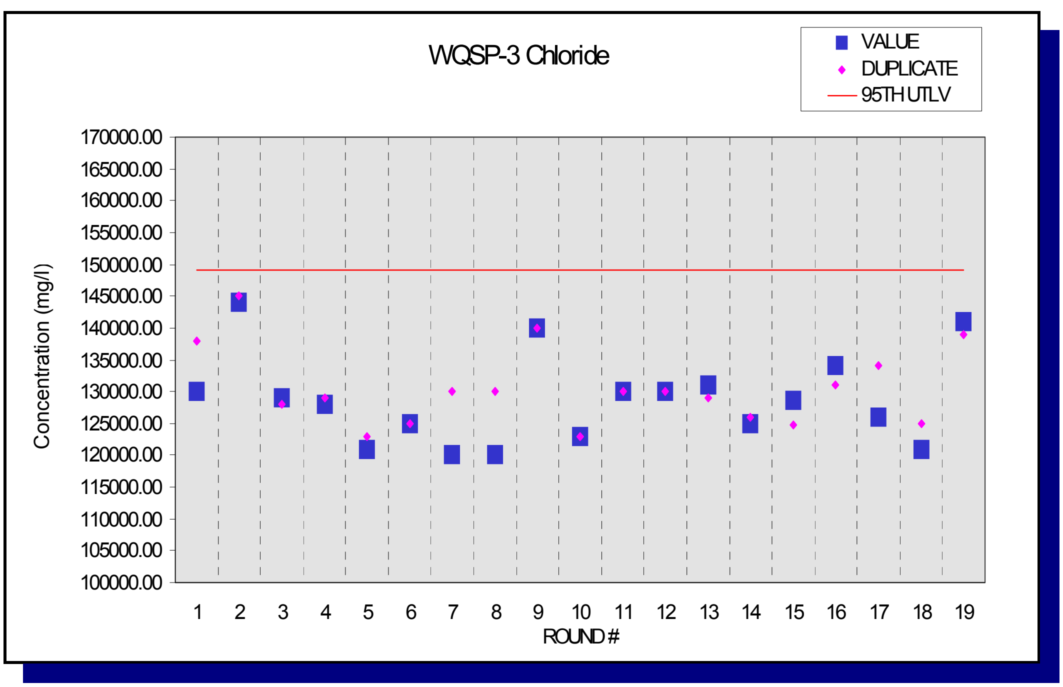

Figure E.31 - Time Trend Plot for Chloride at WQSP-3

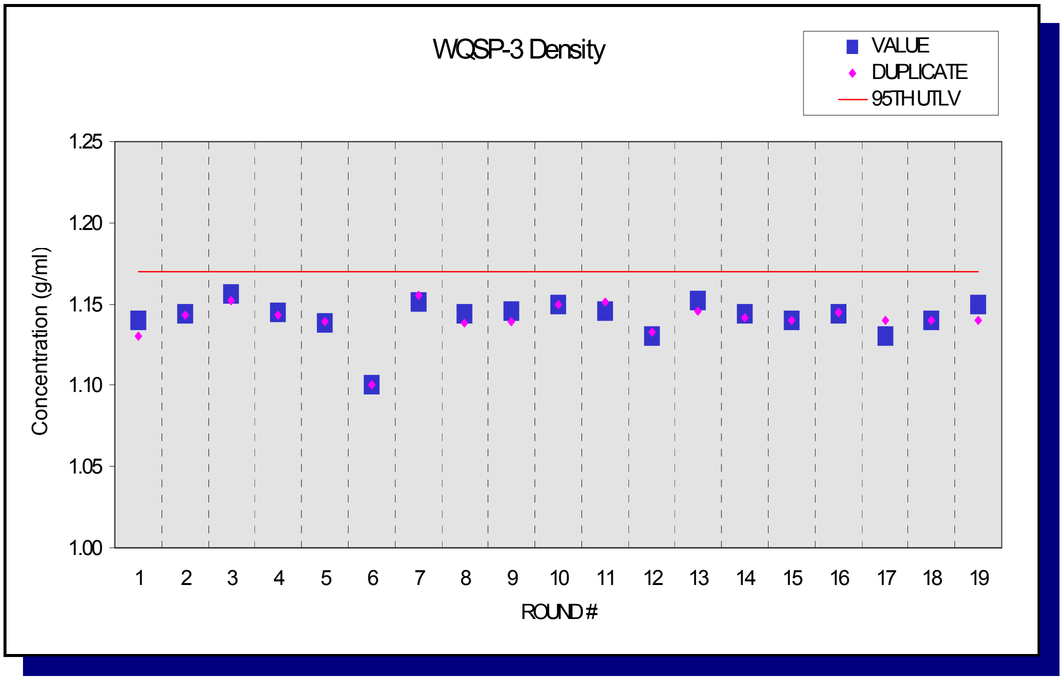

Figure E.32 - Time Trend Plot for Density at WQSP-3

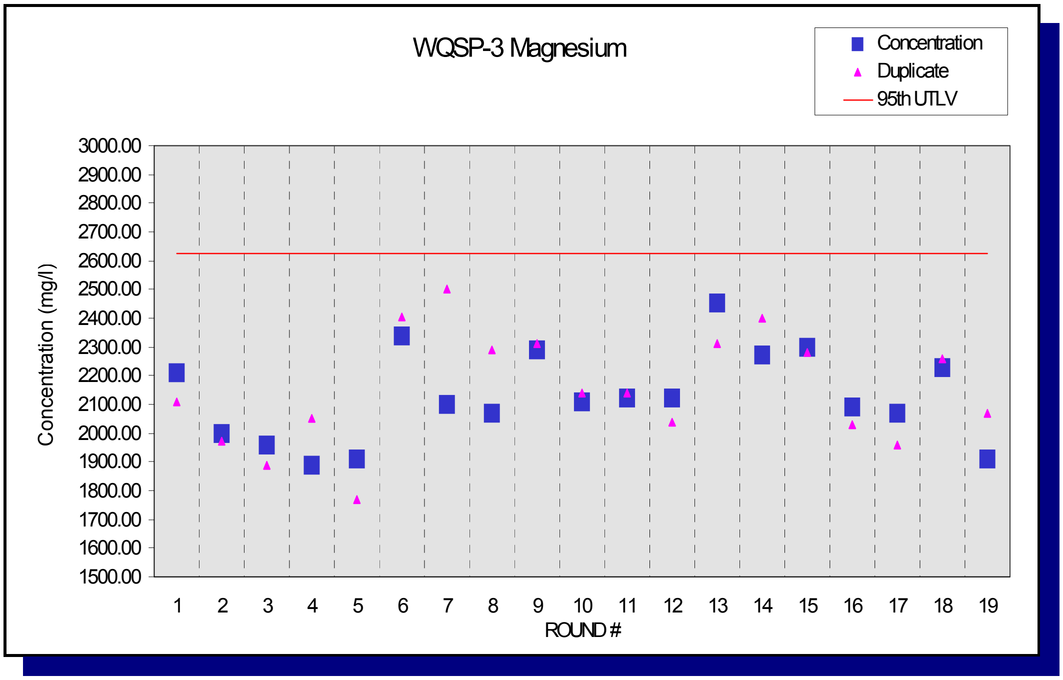

Figure E.33 - Time Trend Plot for Magnesium at WQSP-3

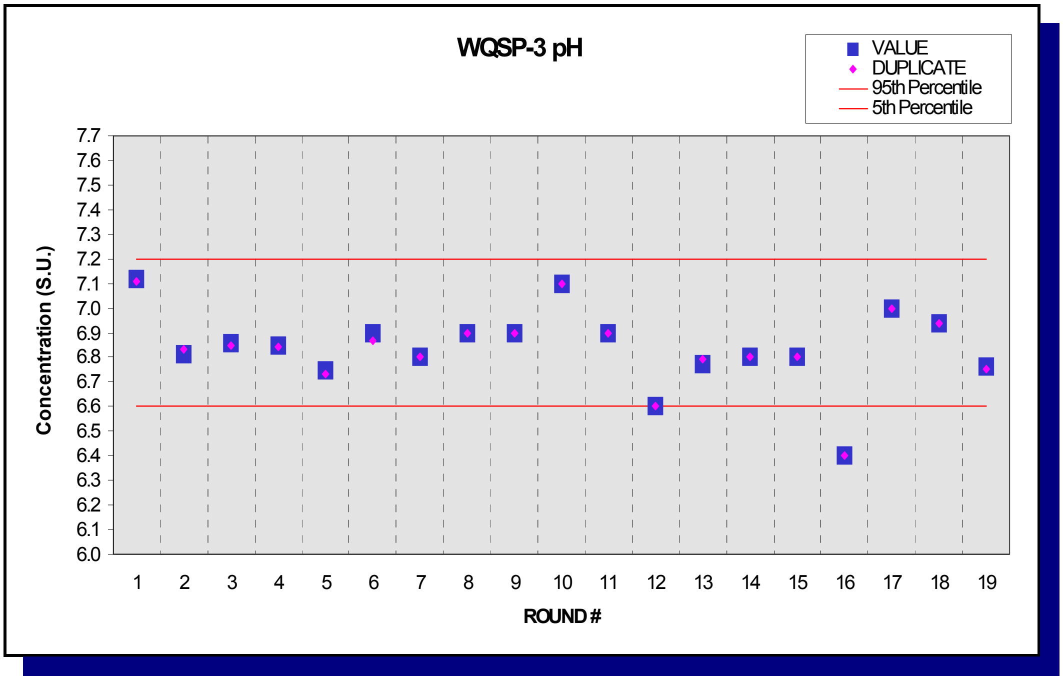

Figure E.34 - Time Trend Plot for pH at WQSP-3

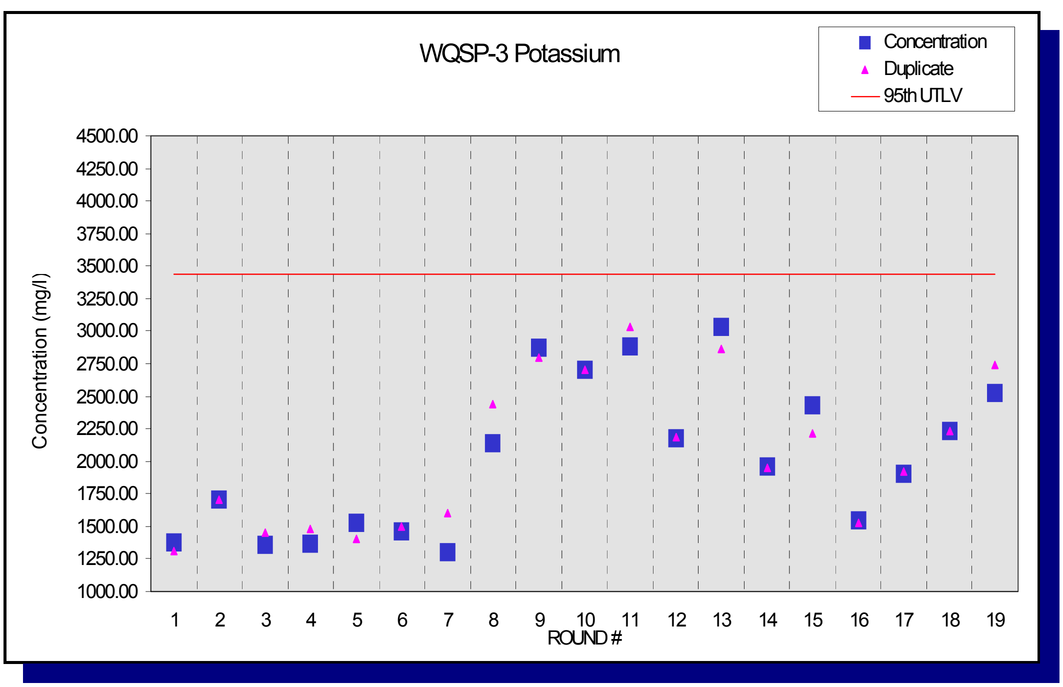

Figure E.35 - Time Trend Plot for Potassium at WQSP-3

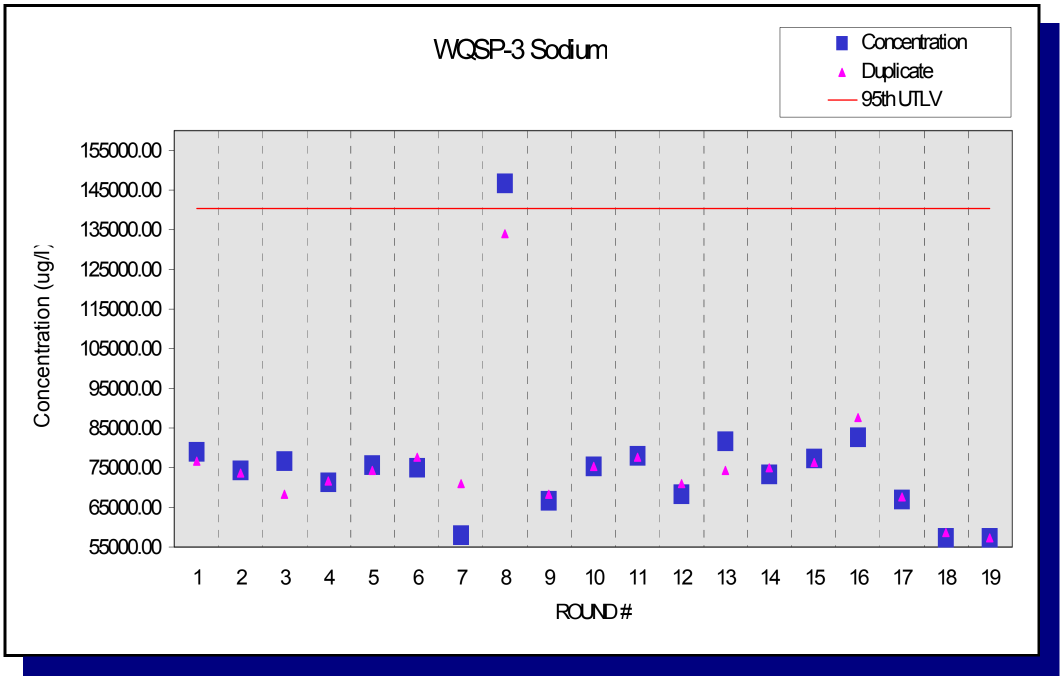

Figure E.36 - Time Trend Plot for Sodium at WQSP-3

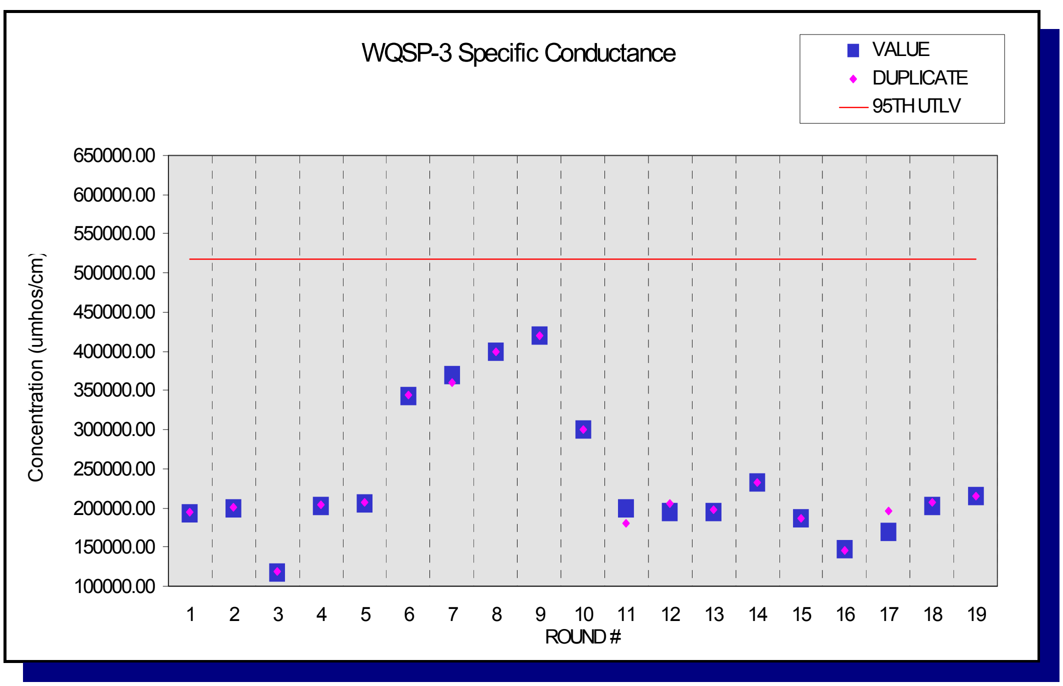

Figure E.37 - Time Trend Plot for Specific Conductance at WQSP-3

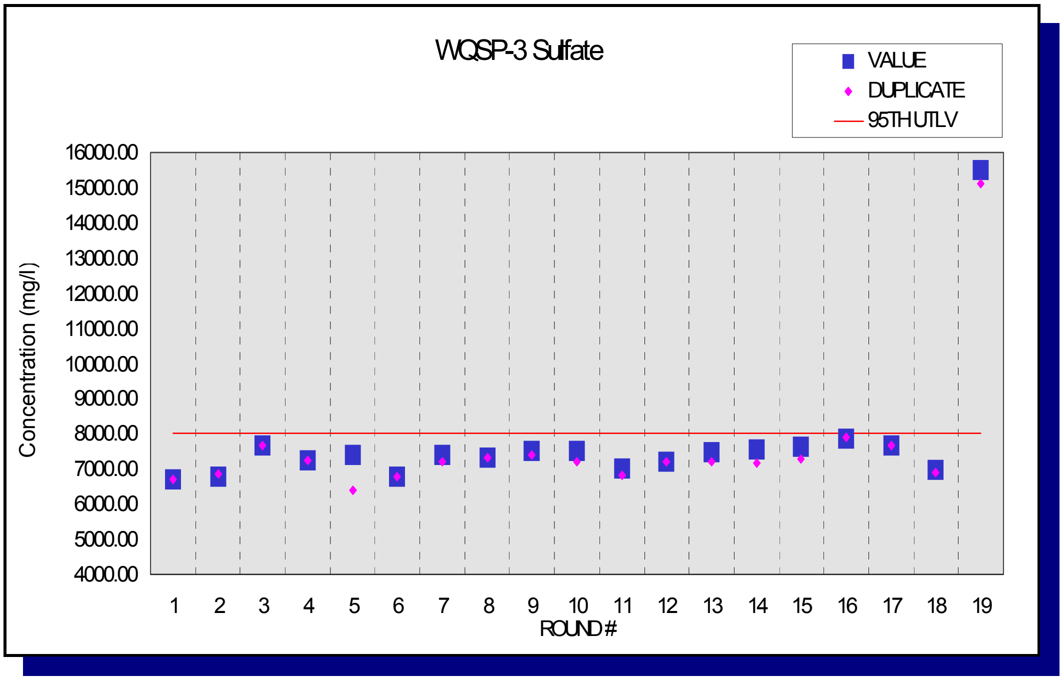

Figure E.38 - Time Trend Plot for Sulfate at WQSP-3

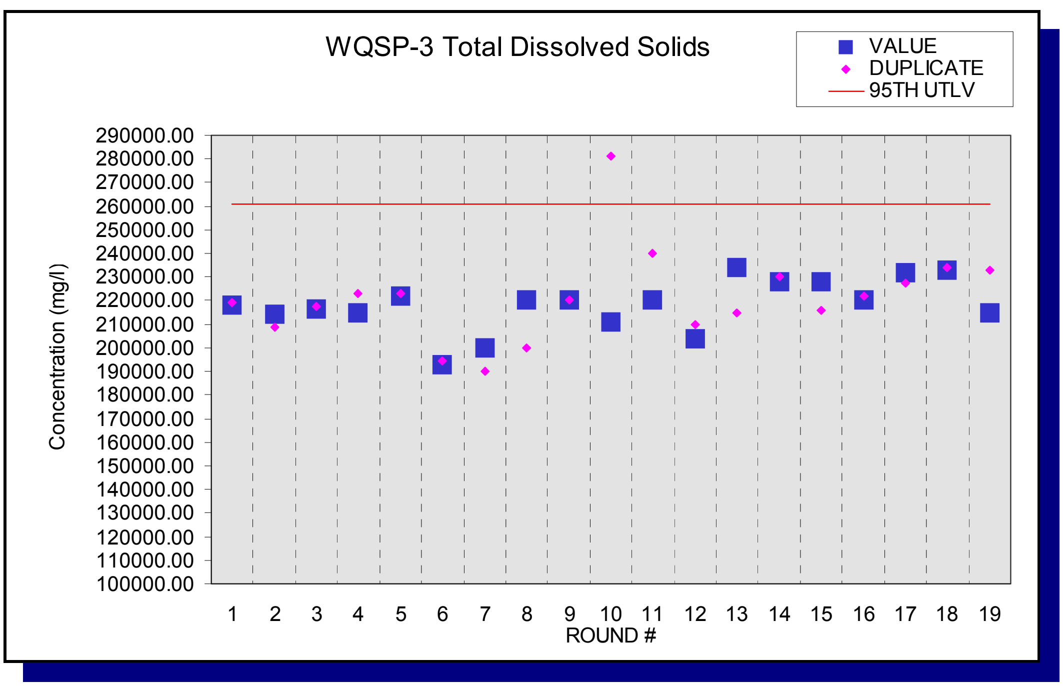

Figure E.39 - Time Trend Plot for Total Dissolved Solids at WQSP-3

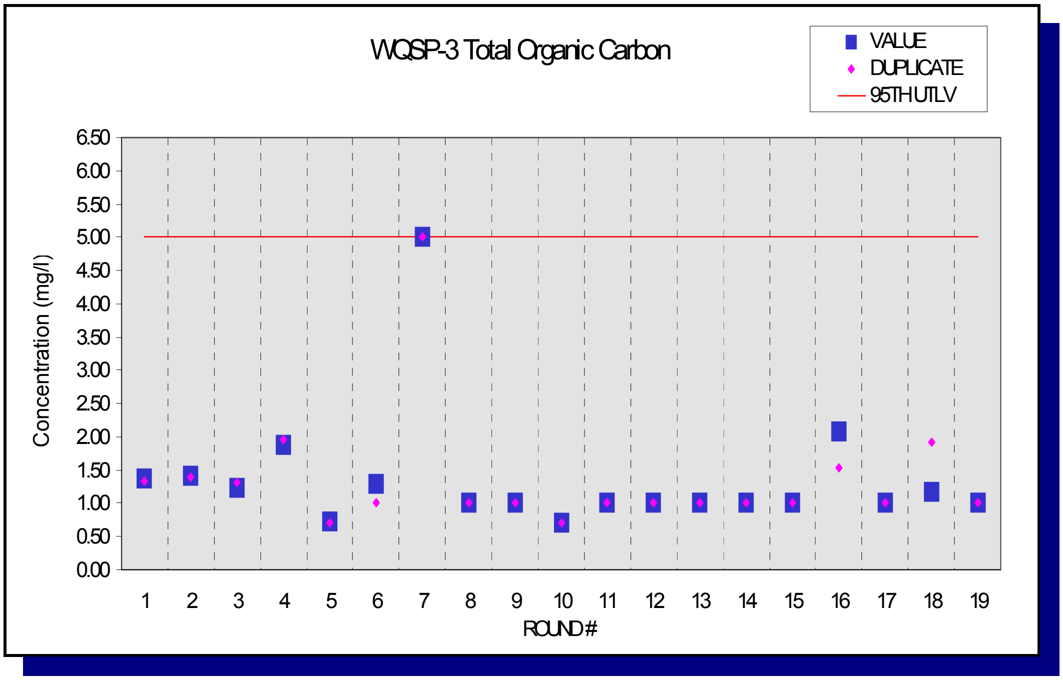

Figure E.40 - Time Trend Plot for Total Organic Carbon at WQSP-3

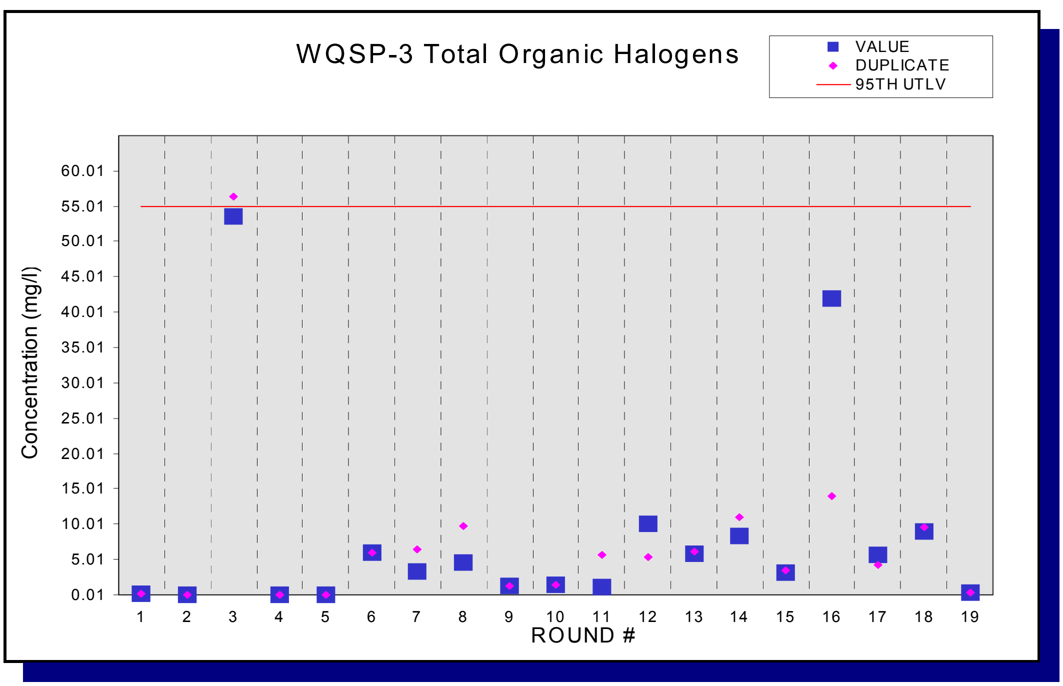

Figure E.41 - Time Trend Plot for Total Organic Halogens at WQSP-3

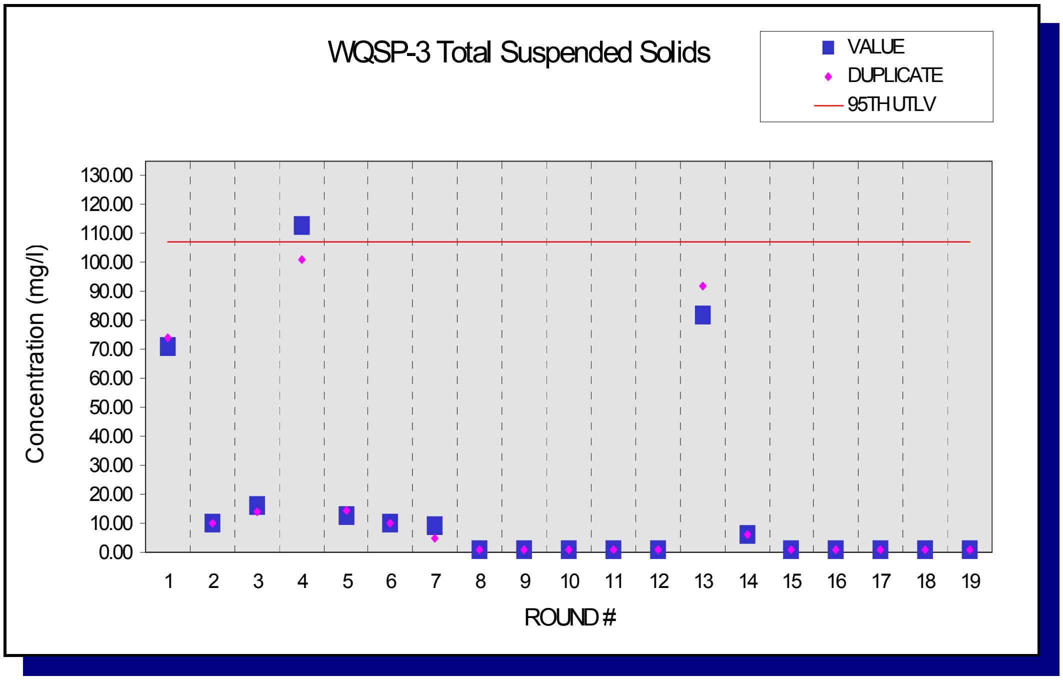

Figure E.42 - Time Trend Plot for Total Suspended Solids at WQSP-3

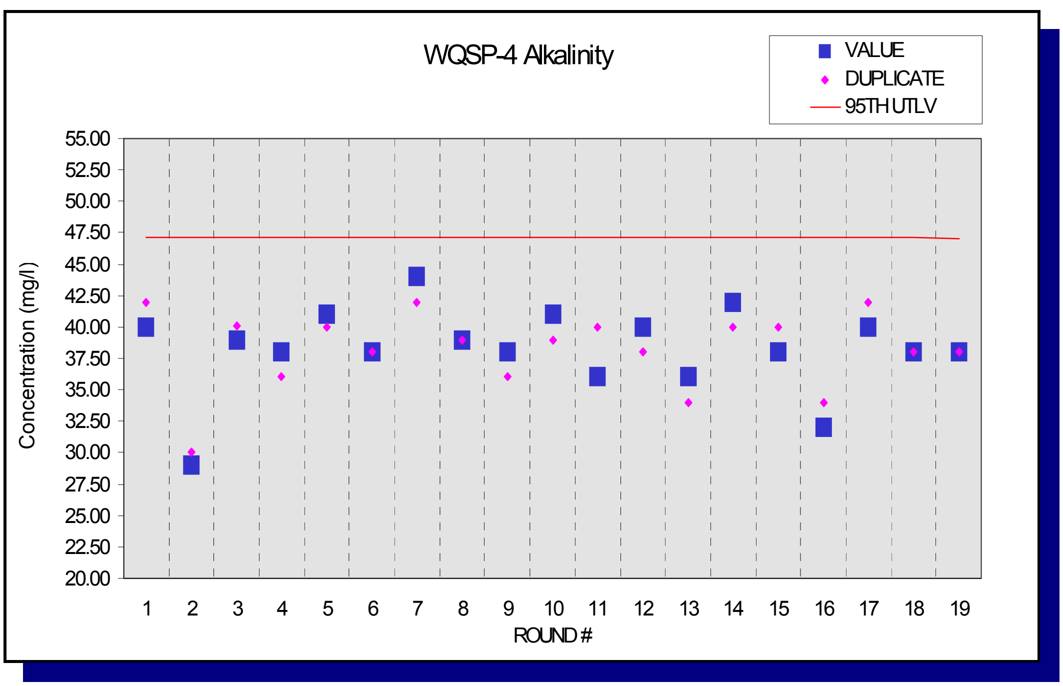

Figure E.43 - Time Trend Plot for Alkalinity at WQSP-4

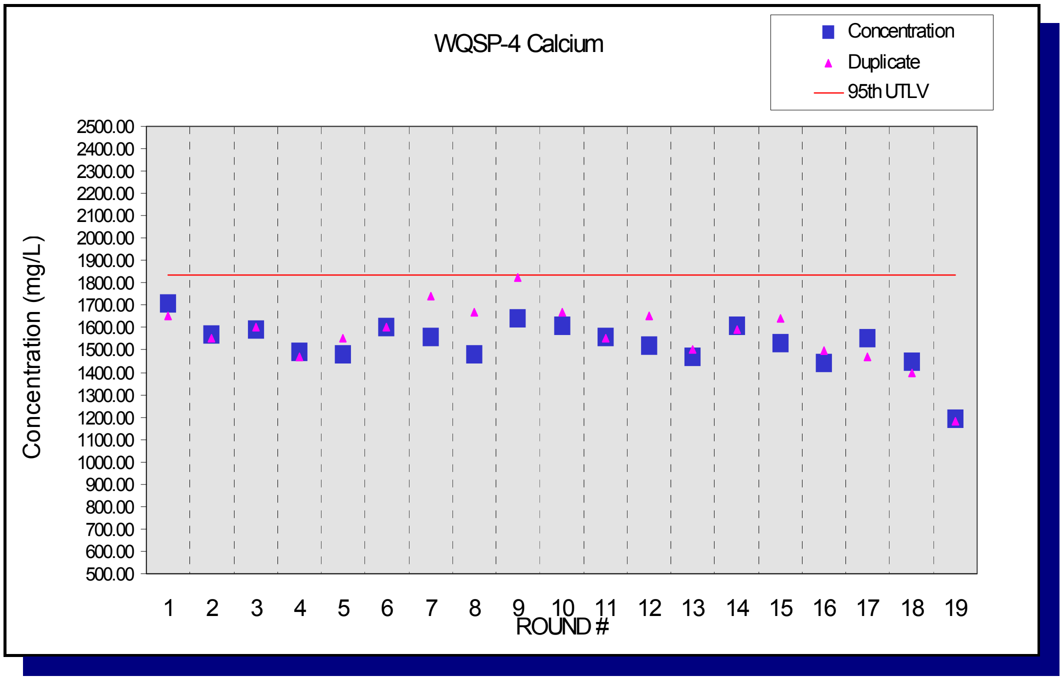

Figure E.44 - Time Trend Plot for Calcium at WQSP-4

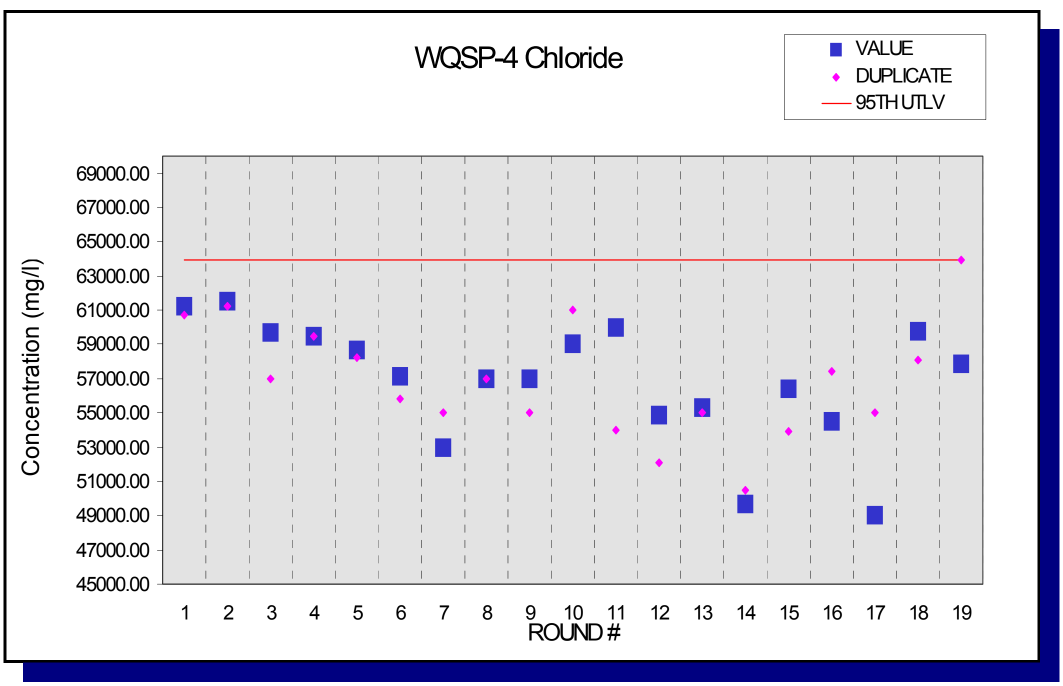

Figure E.45 - Time Trend Plot for Chloride at WQSP-4

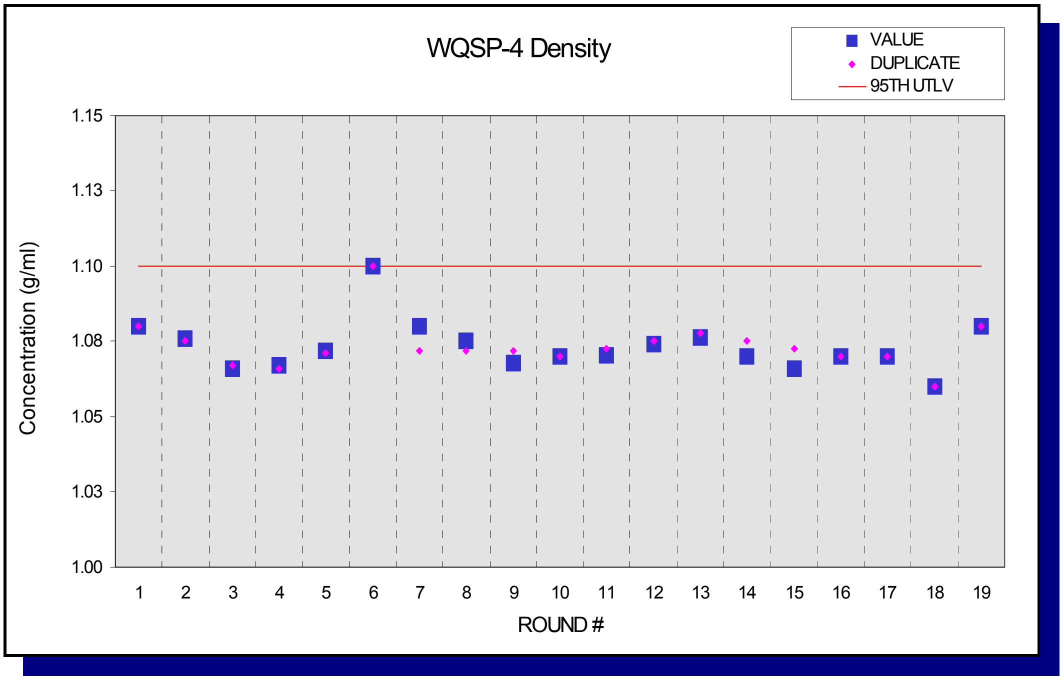

Figure E.46 - Time Trend Plot for Density at WQSP-4

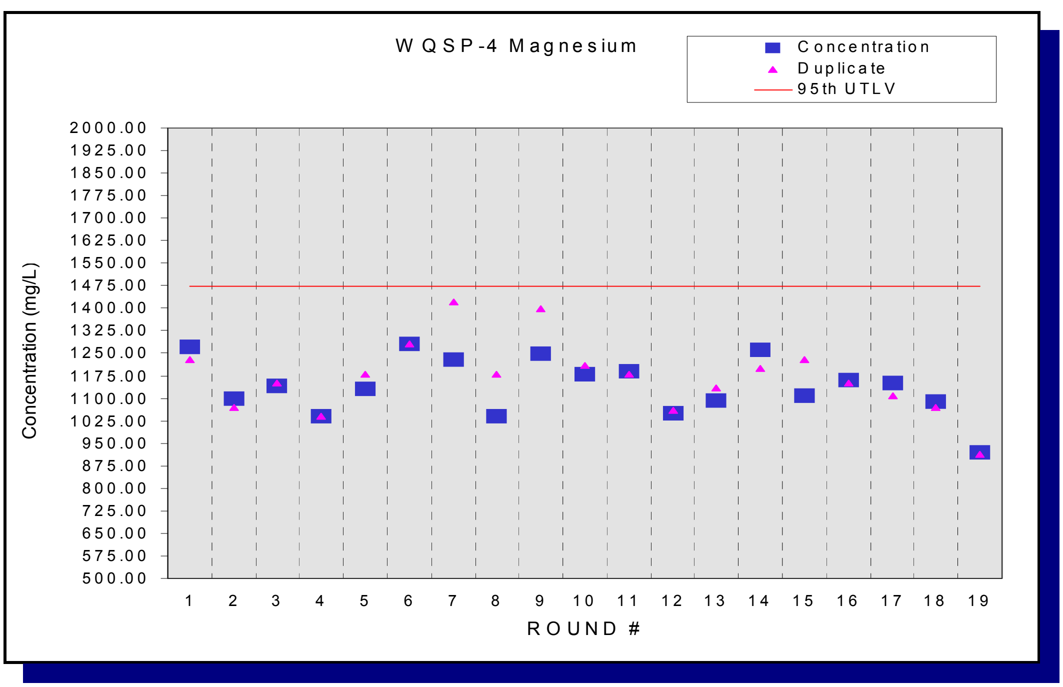

Figure E.47 - Time Trend Plot for Magnesium at WQSP-4

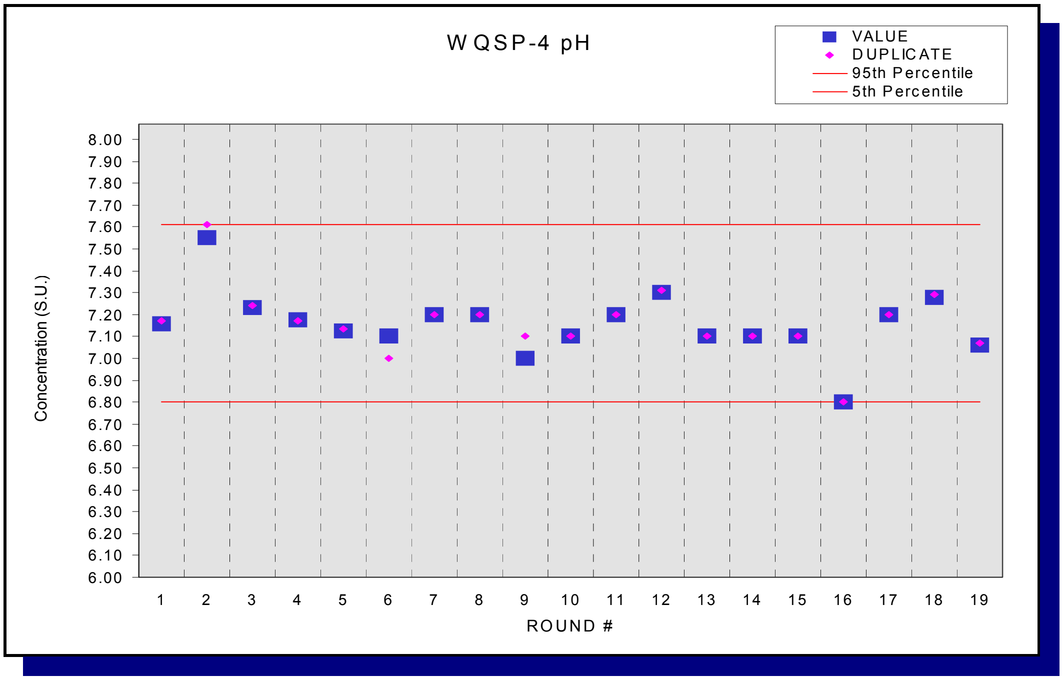

Figure E.48 - Time Trend Plot for pH at WQSP-4

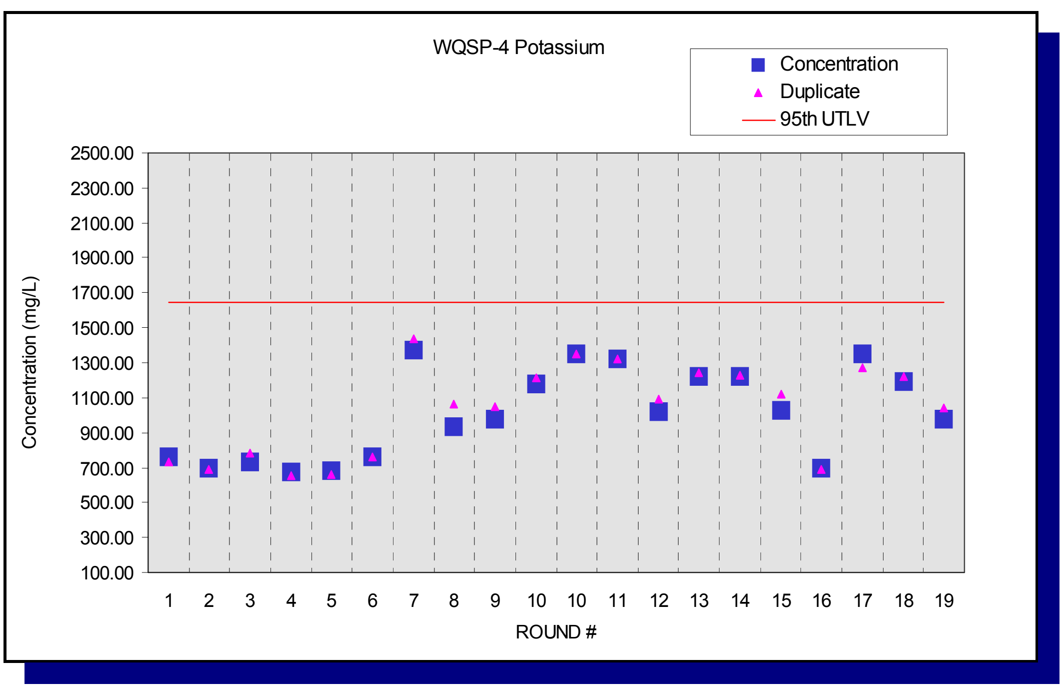

Figure E.49 - Time Trend Plot for Potassium at WQSP-4

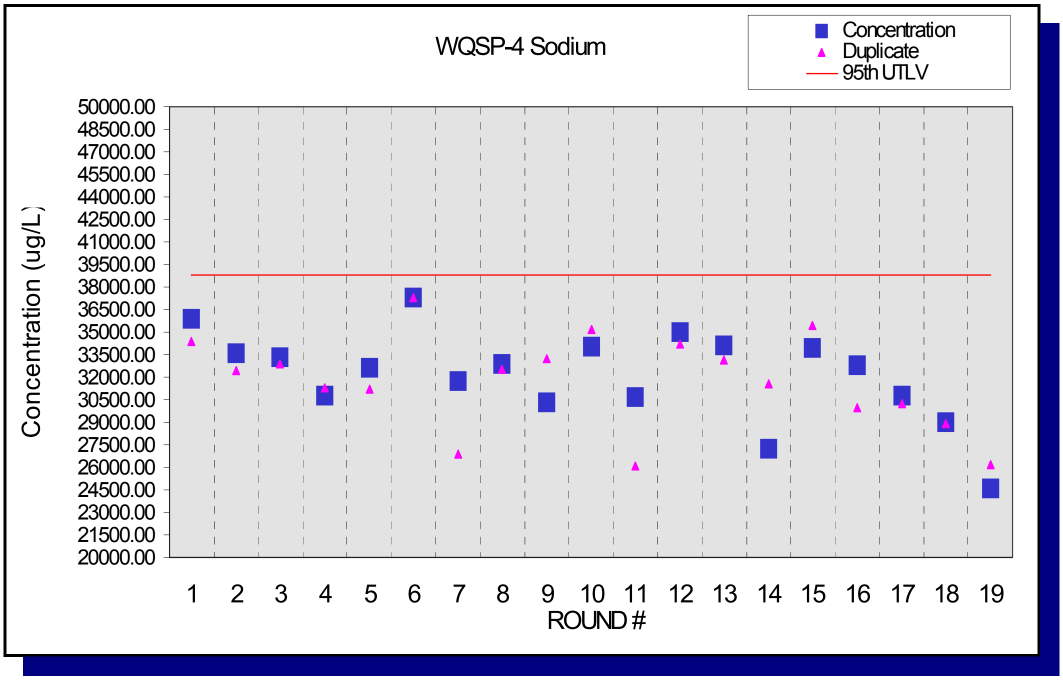

Figure E.50 - Time Trend Plot for Sodium at WQSP-4

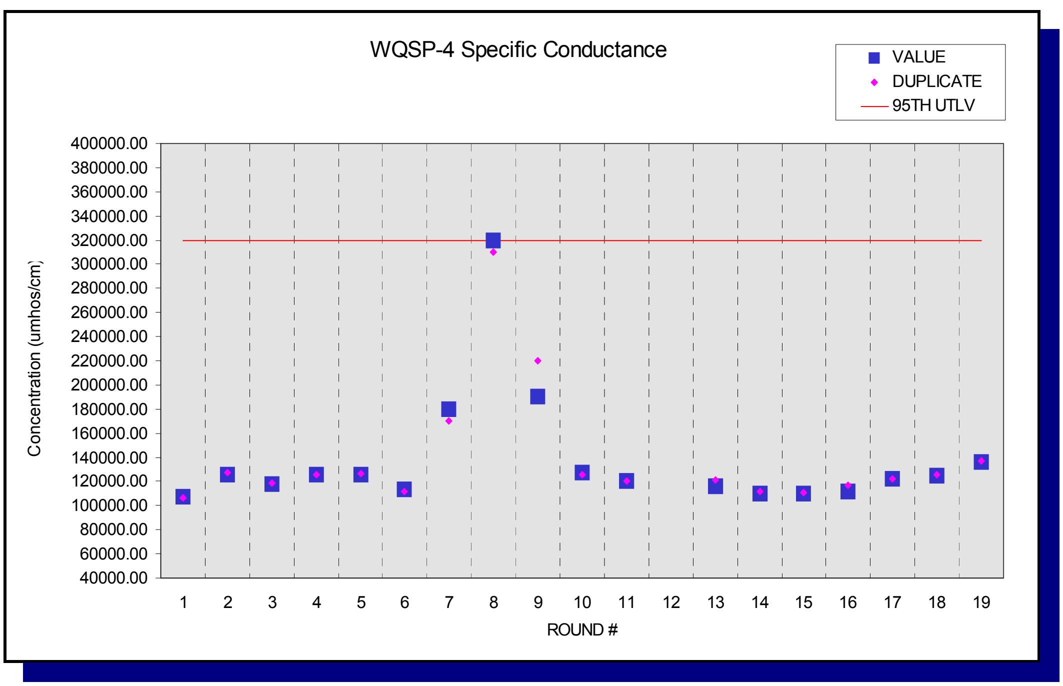

Figure E.51 - Time Trend Plot for Specific Conductance at WQSP-4

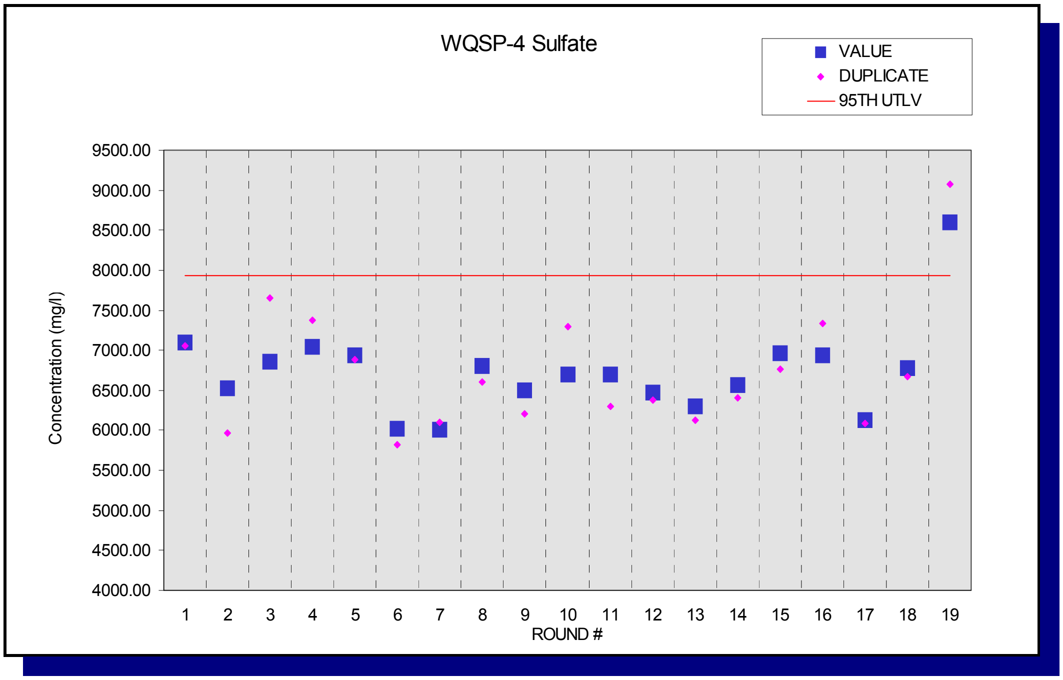

Figure E.52 - Time Trend Plot for Sulfate at WQSP-4

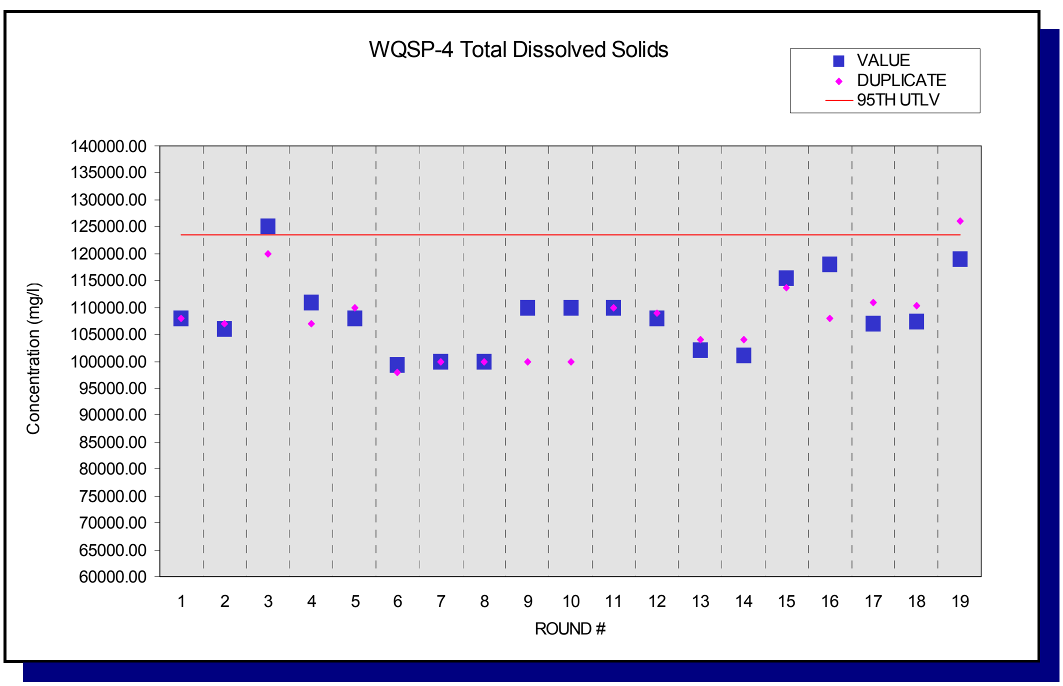

Figure E.53 - Time Trend Plot for Total Dissolved Solids at WQSP-4

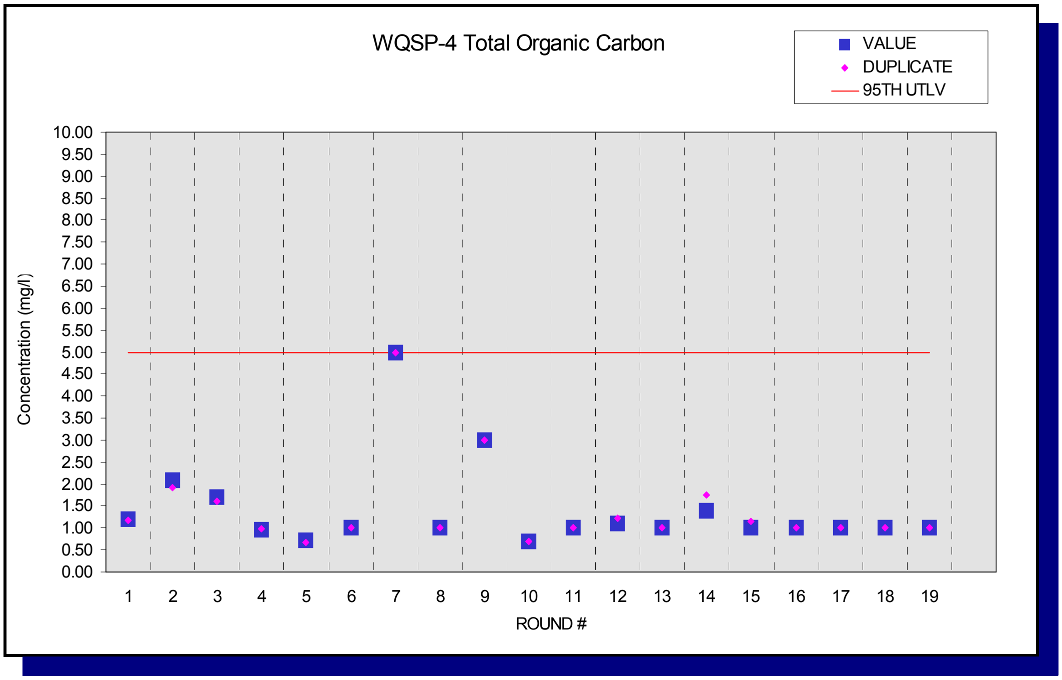

Figure E.54 - Time Trend Plot for Total Organic Carbon at WQSP-4

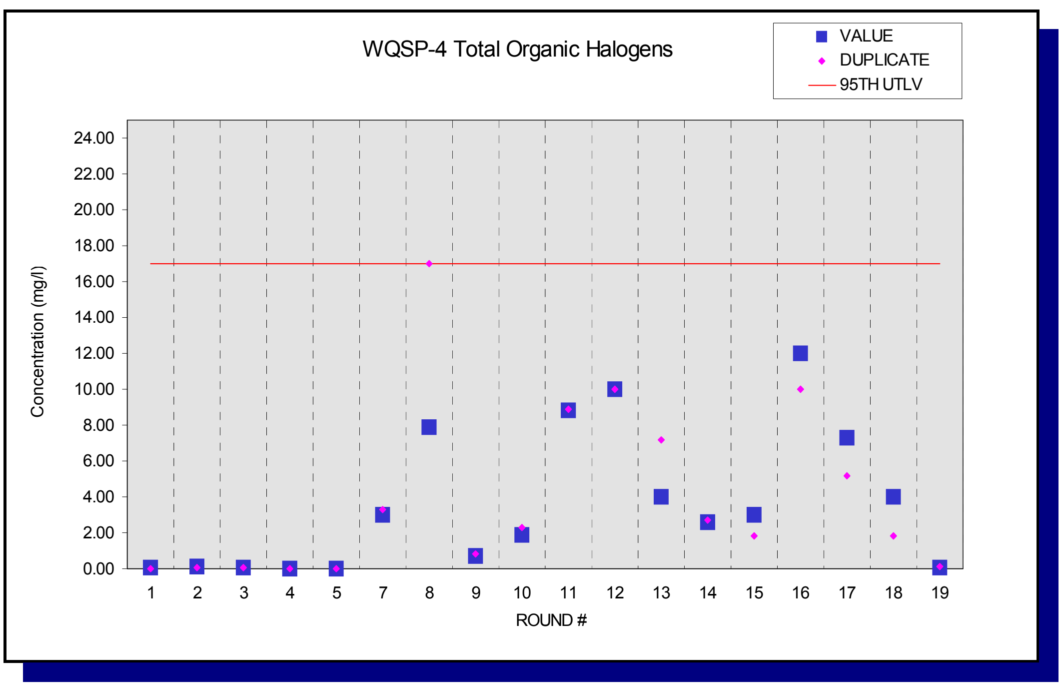

Figure E.55 - Time Trend Plot for Total Organic Halogens at WQSP-4

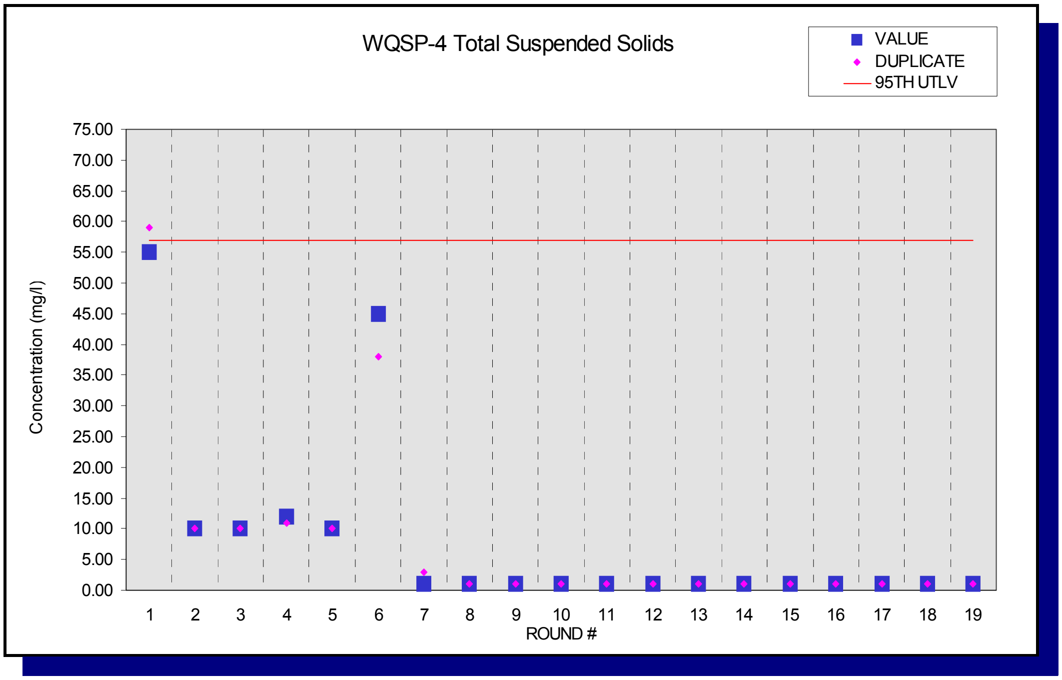

Figure E.56 - Time Trend Plot for Total Suspended Solids at WQSP-4

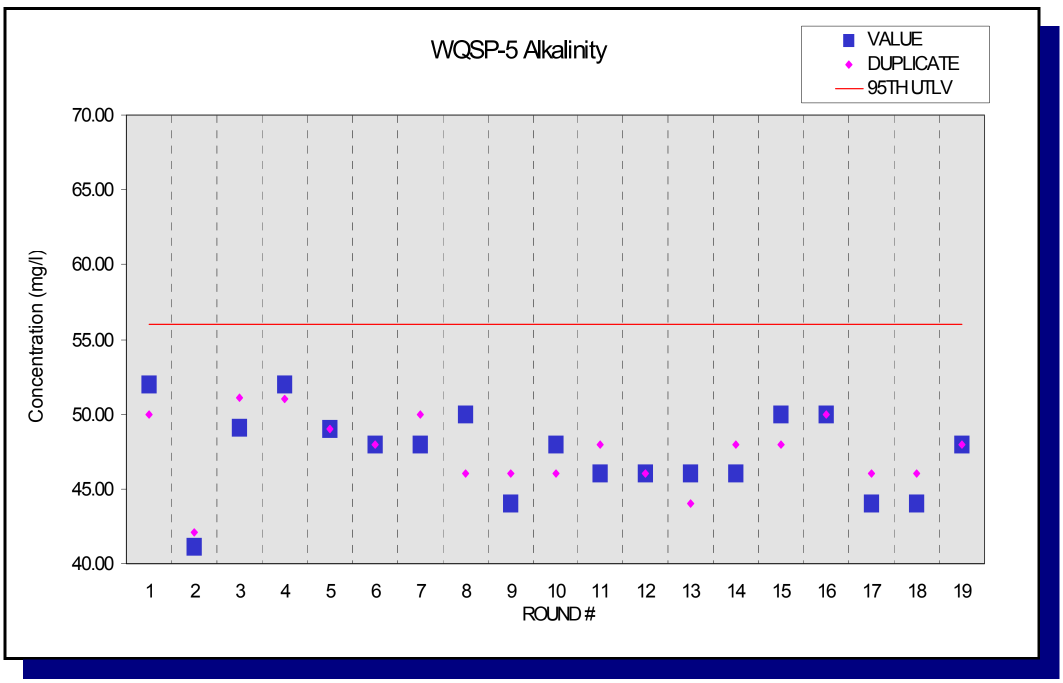

Figure E.57 - Time Trend Plot for Alkalinity at WQSP-5

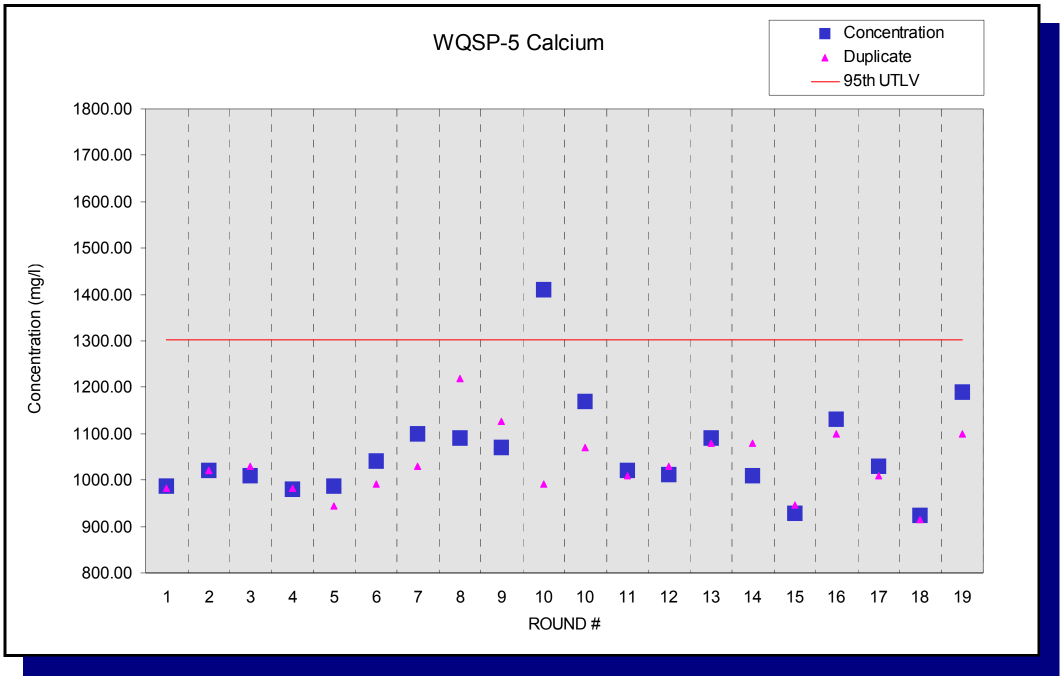

Figure E.58 - Time Trend Plot for Calcium at WQSP-5

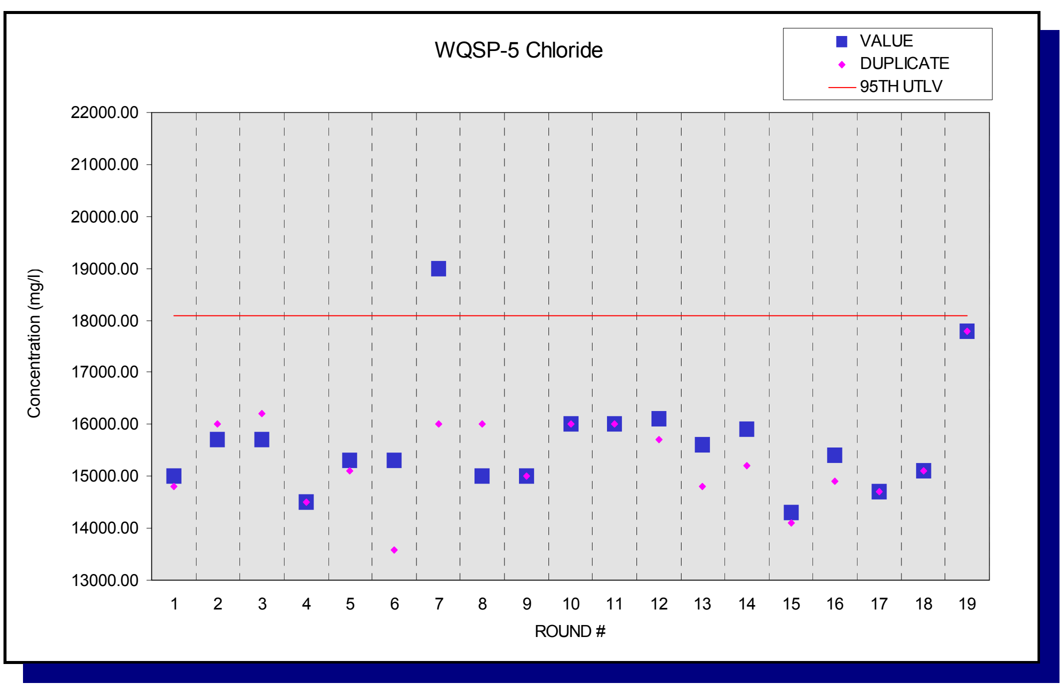

Figure E.59 - Time Trend Plot for Chloride at WQSP-5

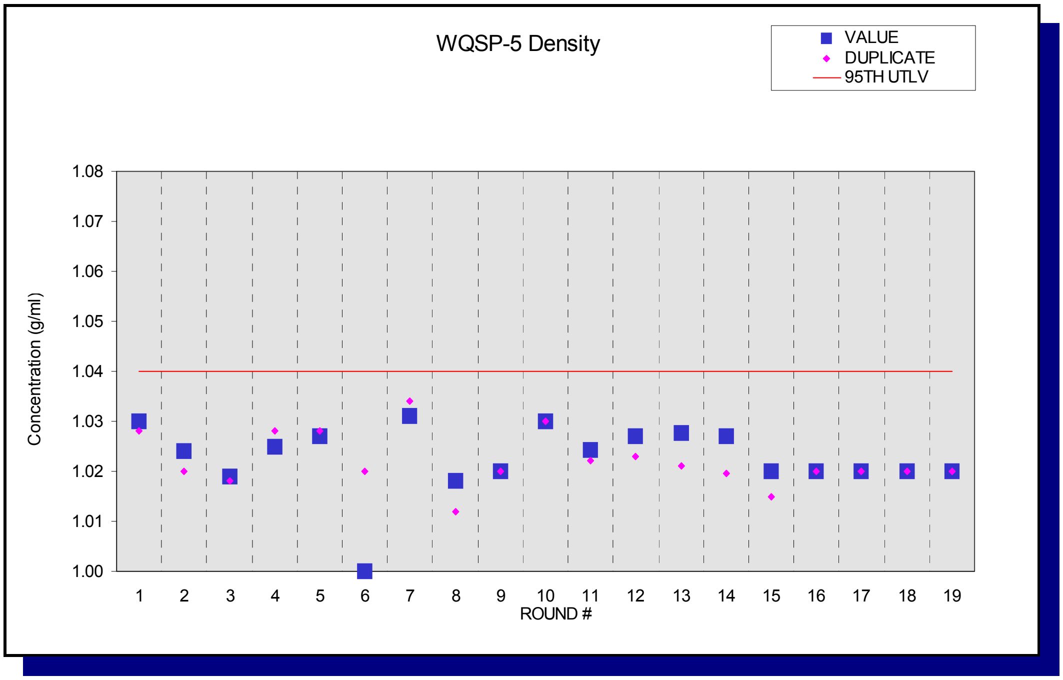

Figure E.60 - Time Trend Plot for Density at WQSP-5

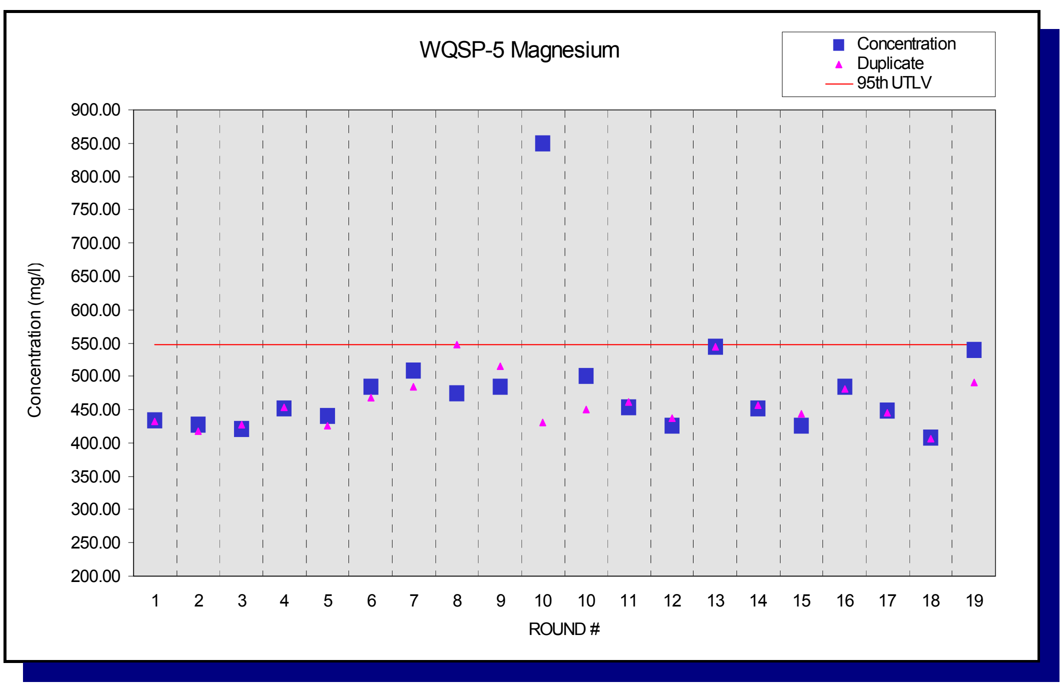

Figure E.61 - Time Trend Plot for Magnesium at WQSP-5

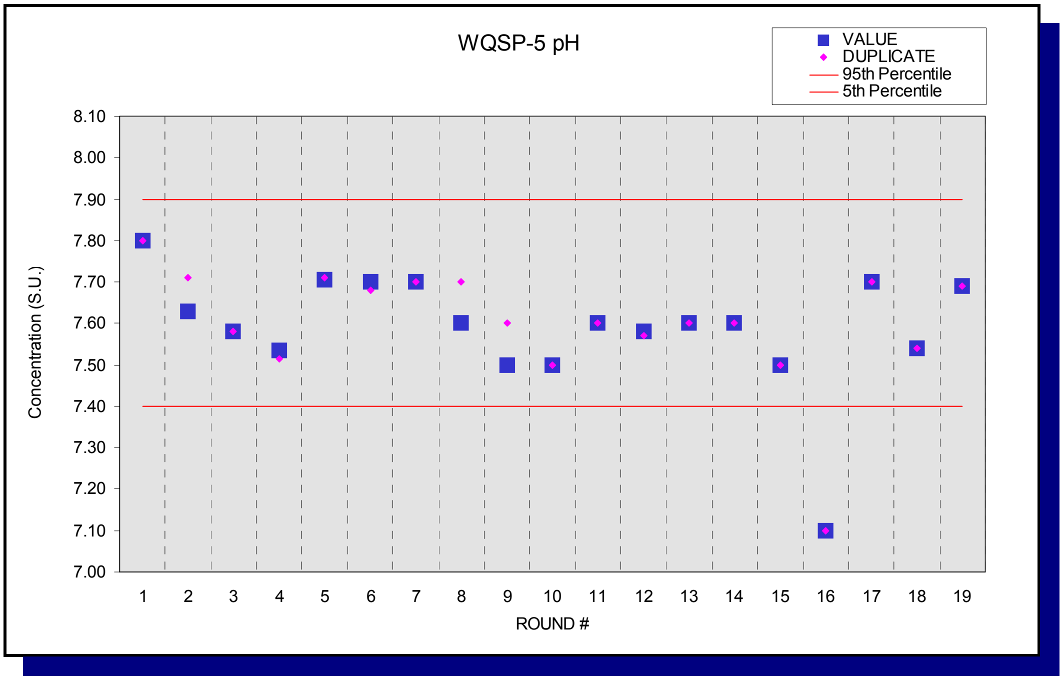

Figure E.62 - Time Trend Plot for pH at WQSP-5

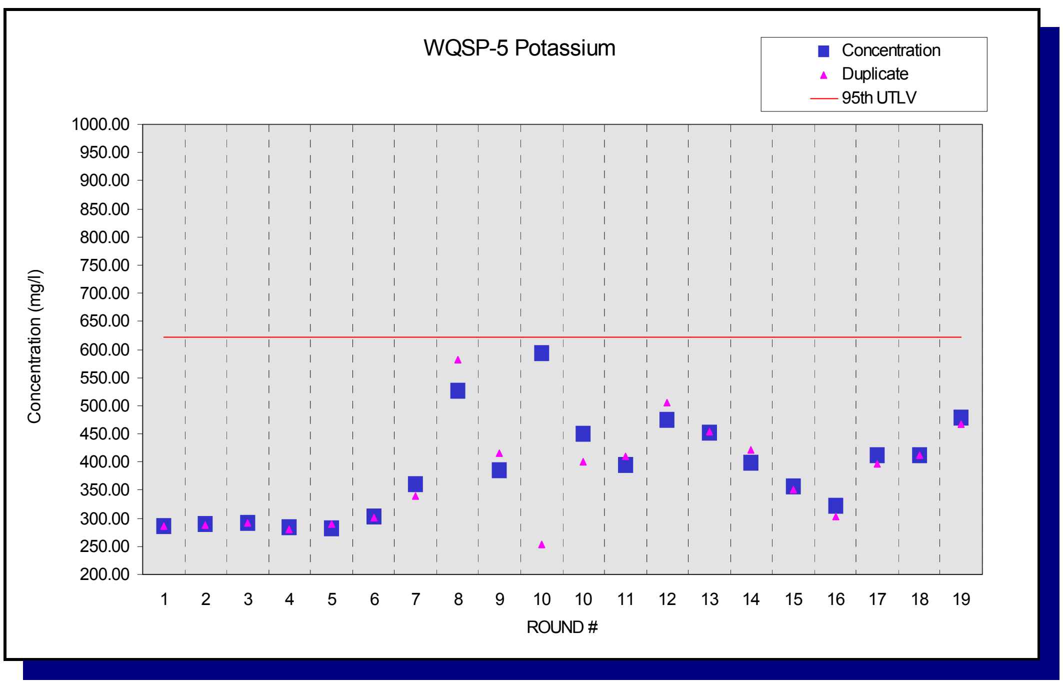

Figure E.63 - Time Trend Plot for Potassium at WQSP-5

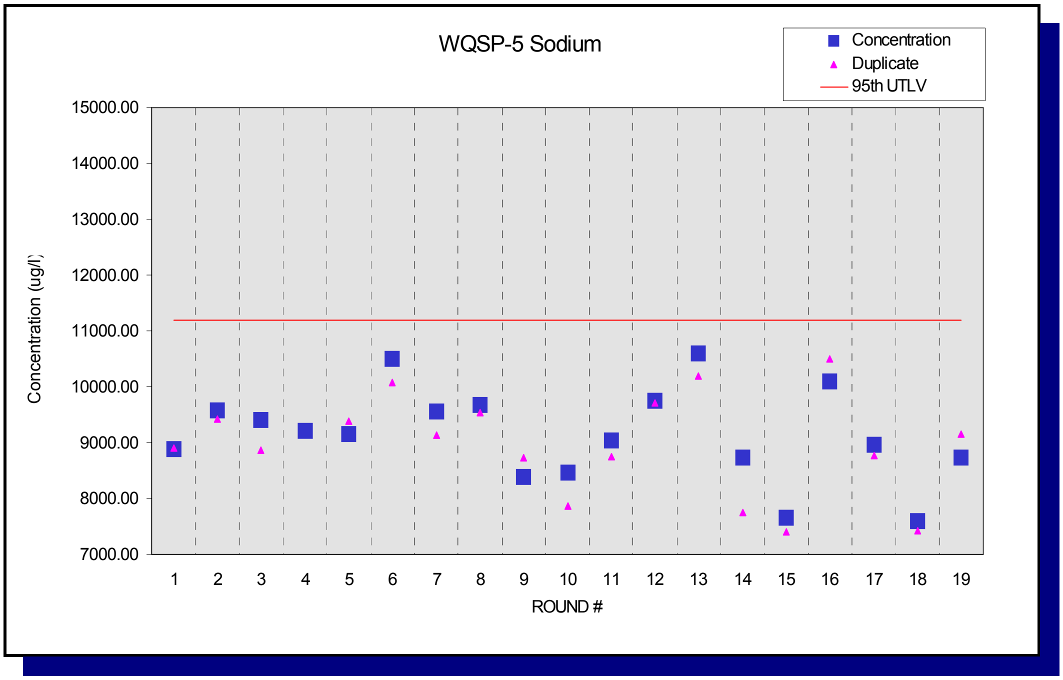

Figure E.64 - Time Trend Plot for Sodium at WQSP-5

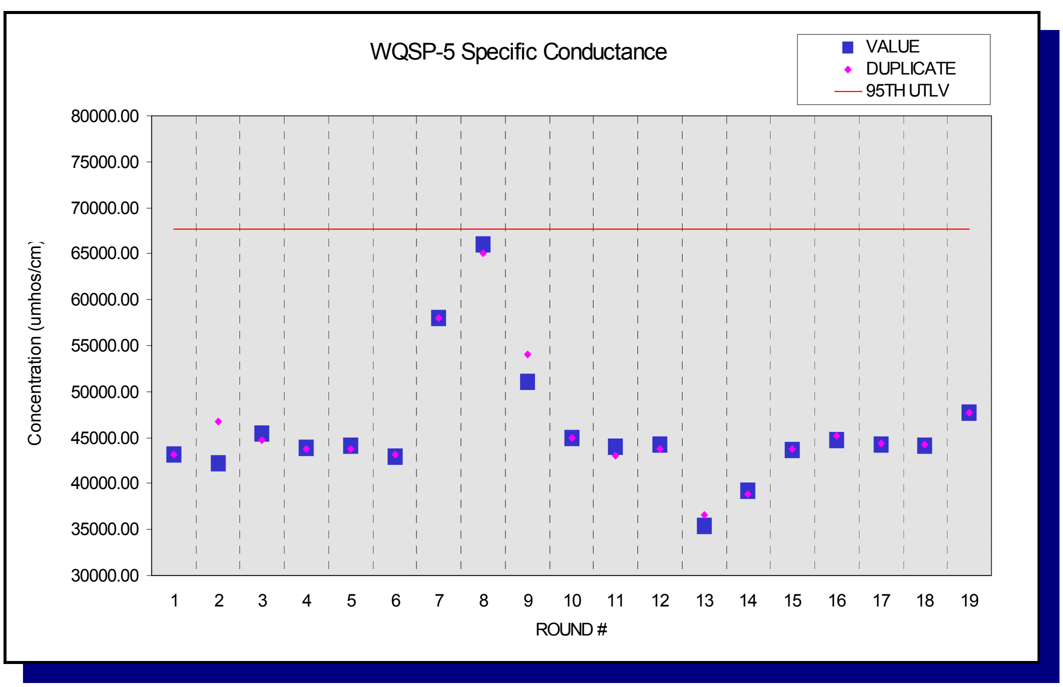

Figure E.65 - Time Trend Plot for Specific Conductance at WQSP-5

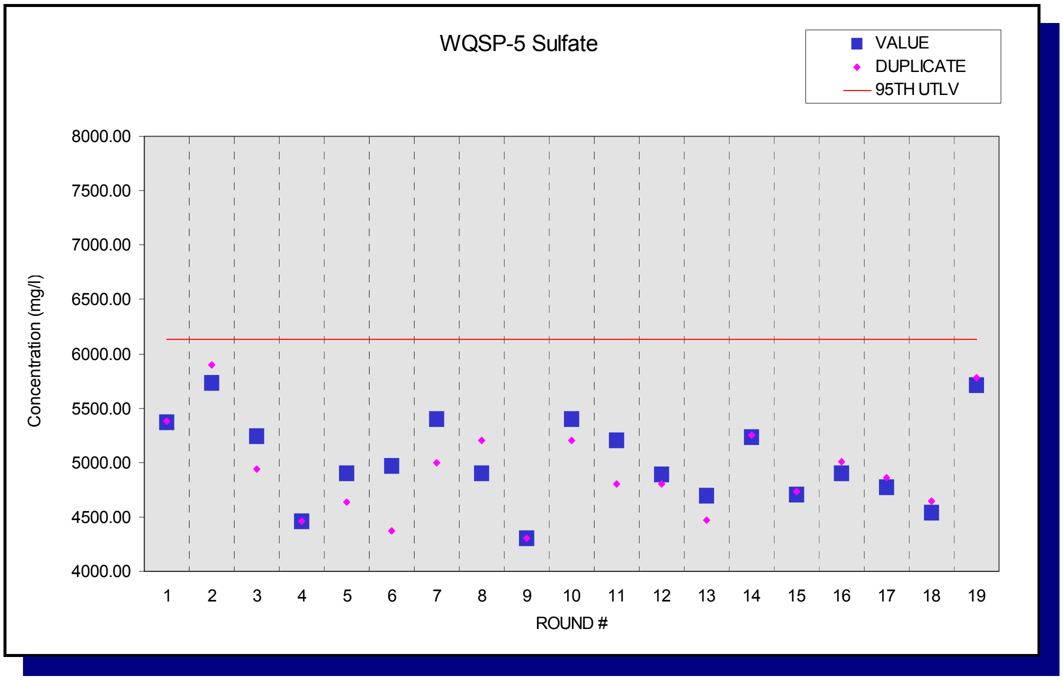

Figure E.66 - Time Trend Plot for Sulfate at WQSP-5

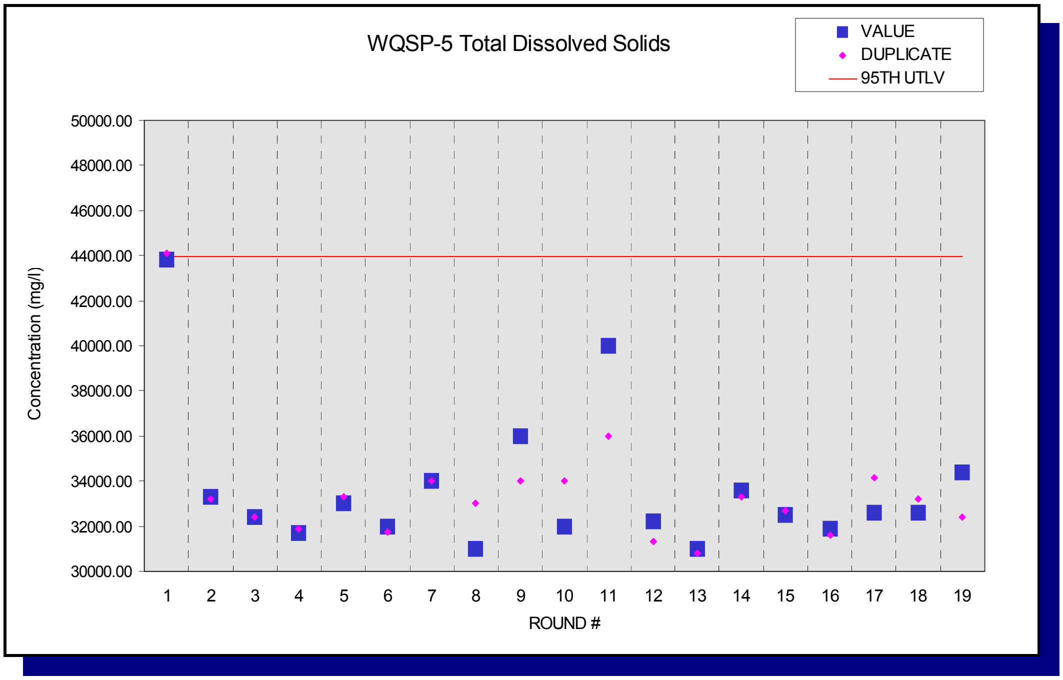

Figure E.67 - Time Trend Plot for Total Dissolved Solids at WQSP-5

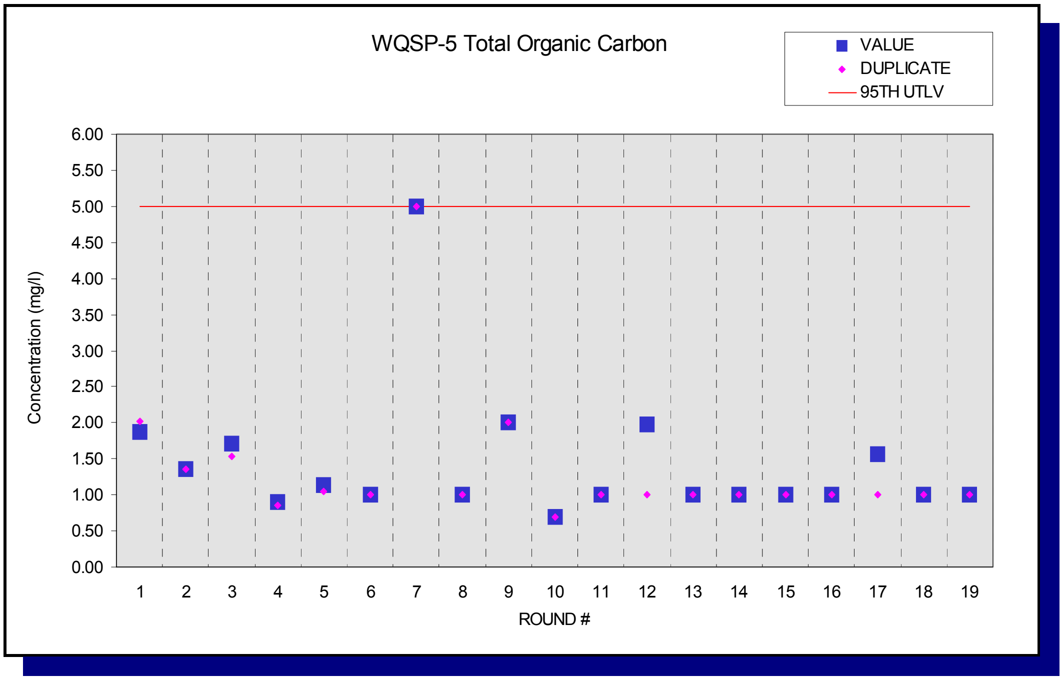

Figure E.68 - Total Organic Carbon at WQSP-5

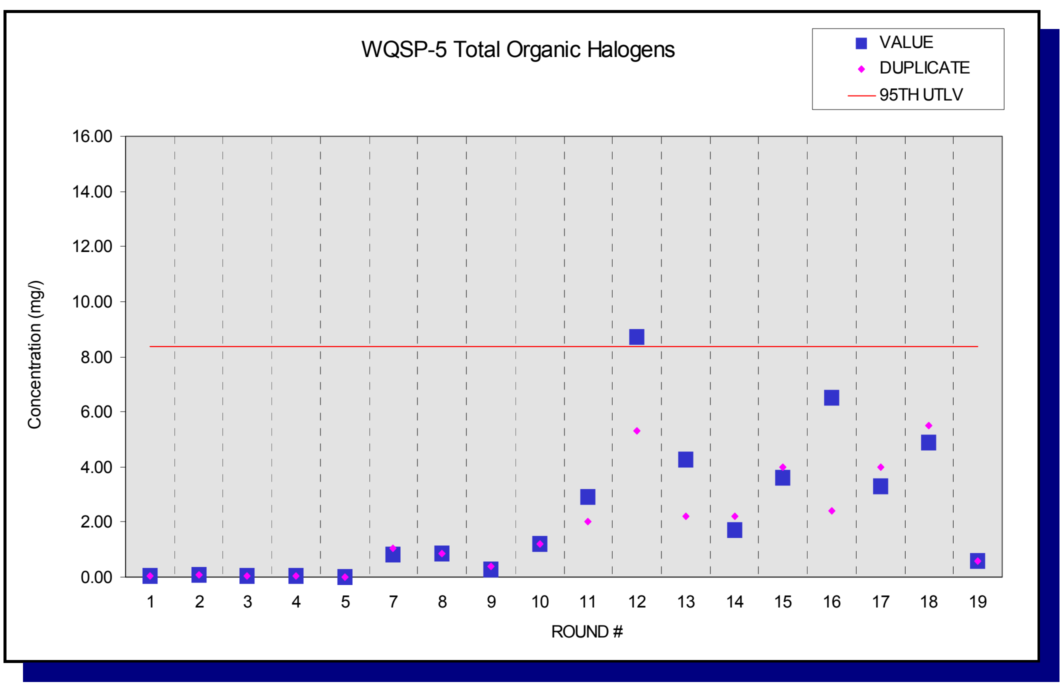

Figure E.69 - Time Trend Plot for Total Organic Halogens at WQSP-5

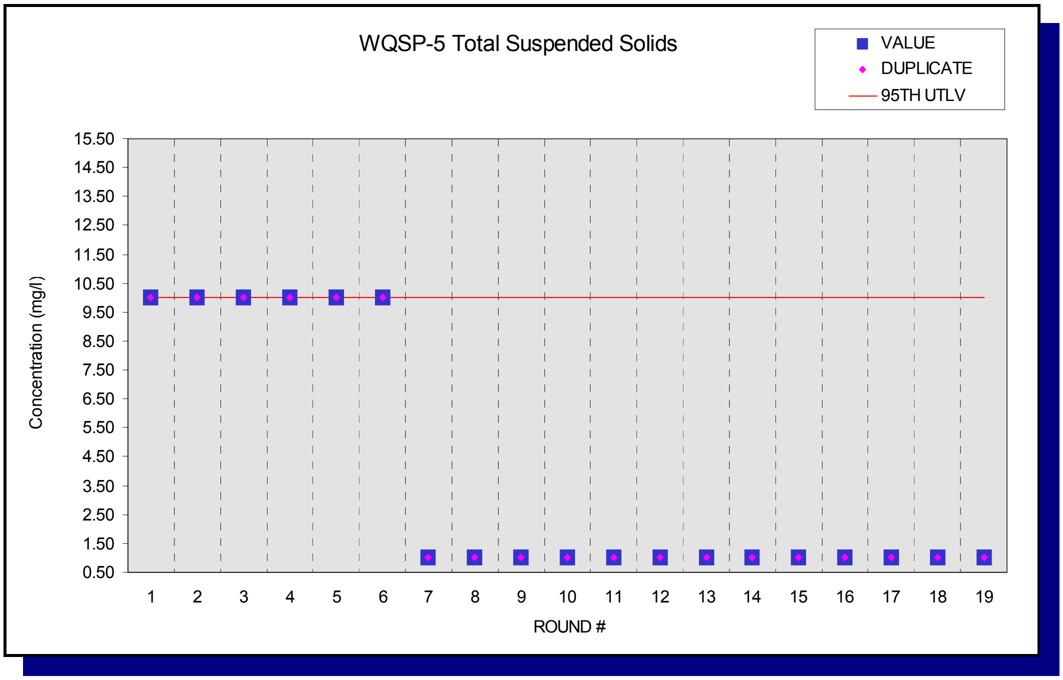

Figure E.70 - Time Trend Plot for Total Suspended Solids at WQSP-5

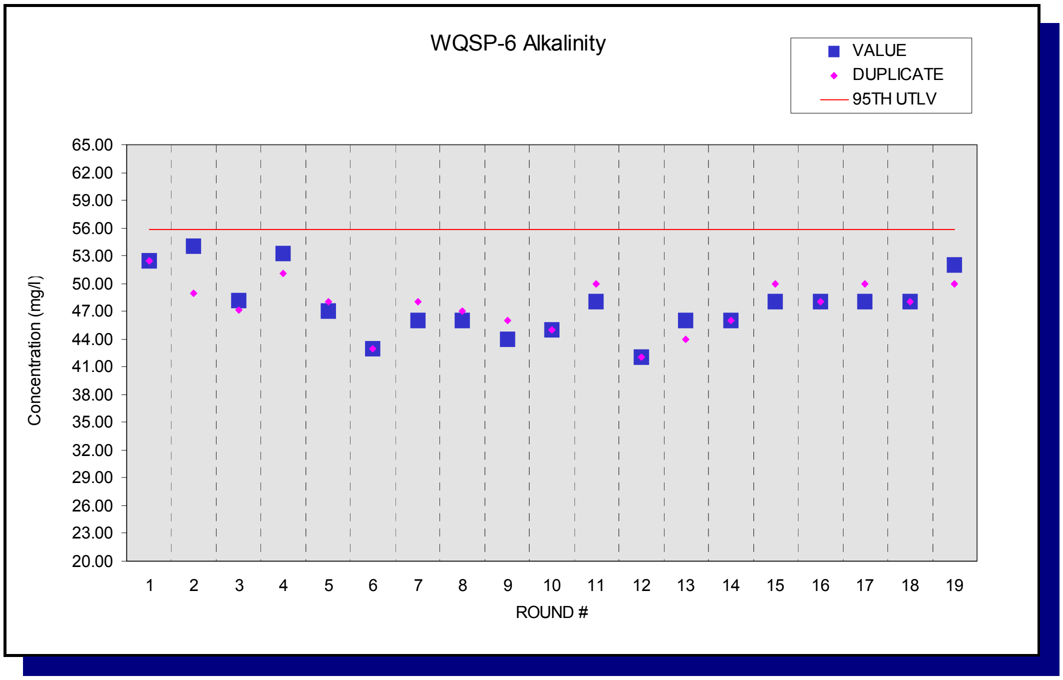

Figure E.71 -Time Trend Plot for Alkalinity at WQSP-6

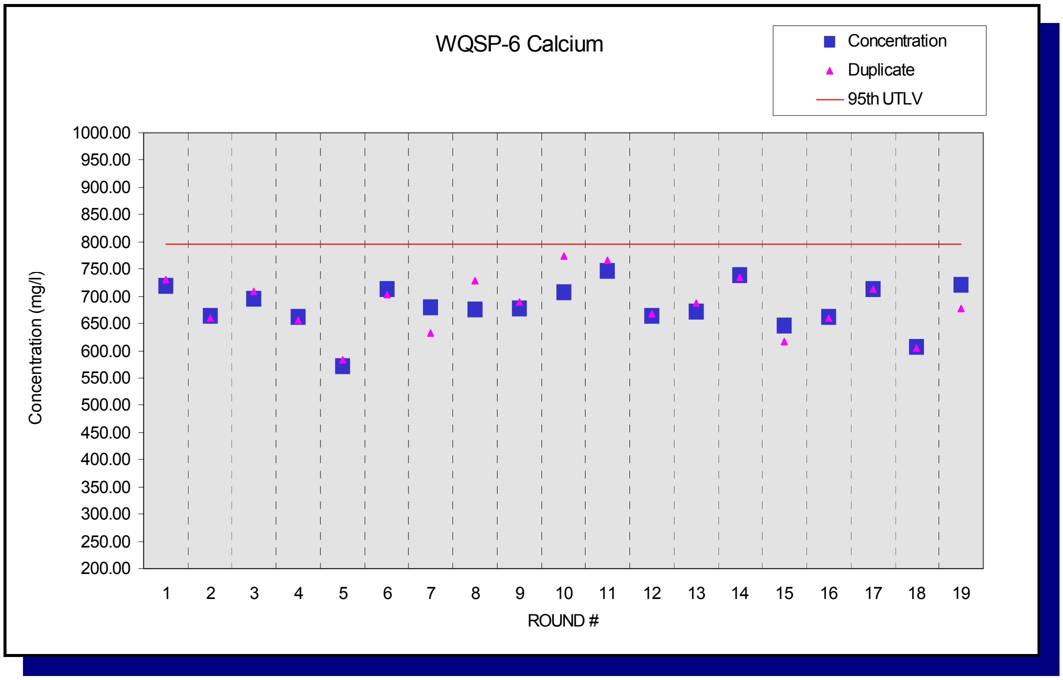

Figure E.72 - Time Trend Plot for Calcium at WQSP-6

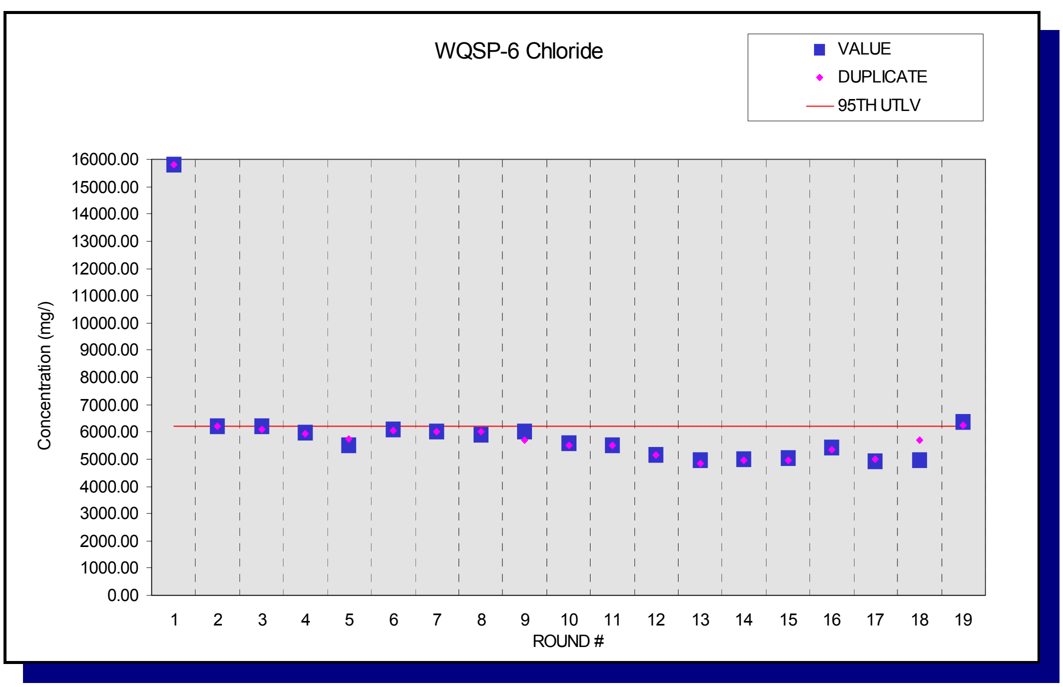

Figure E.73 - Time Trend Plot for Chloride at WQSP-6

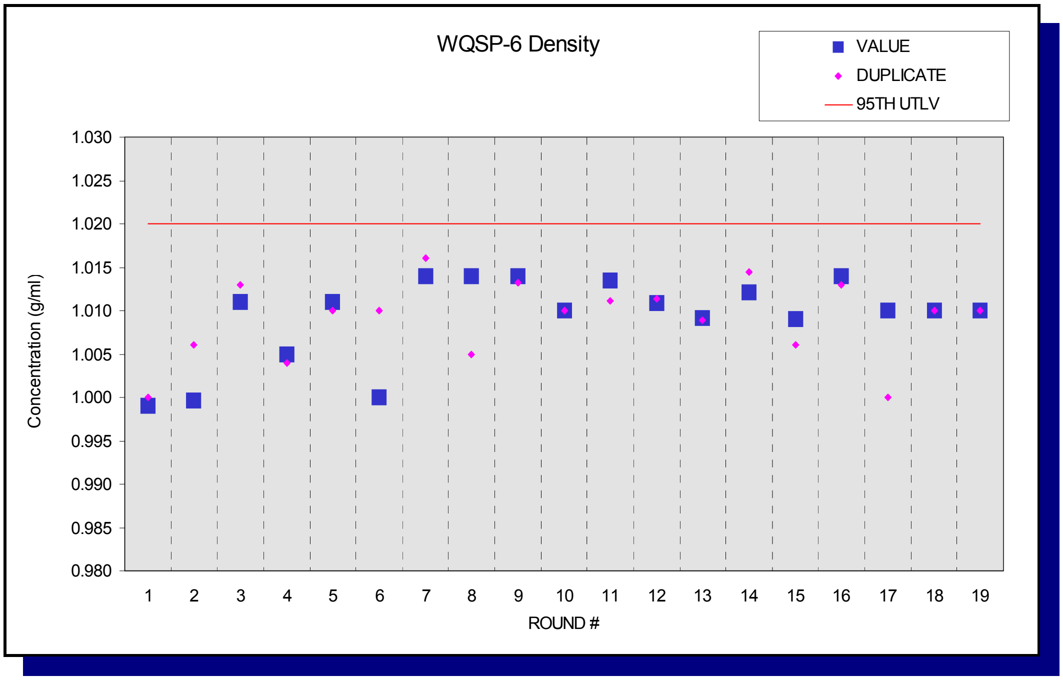

Figure E.74 - Time Trend Plot for Density at WQSP-6

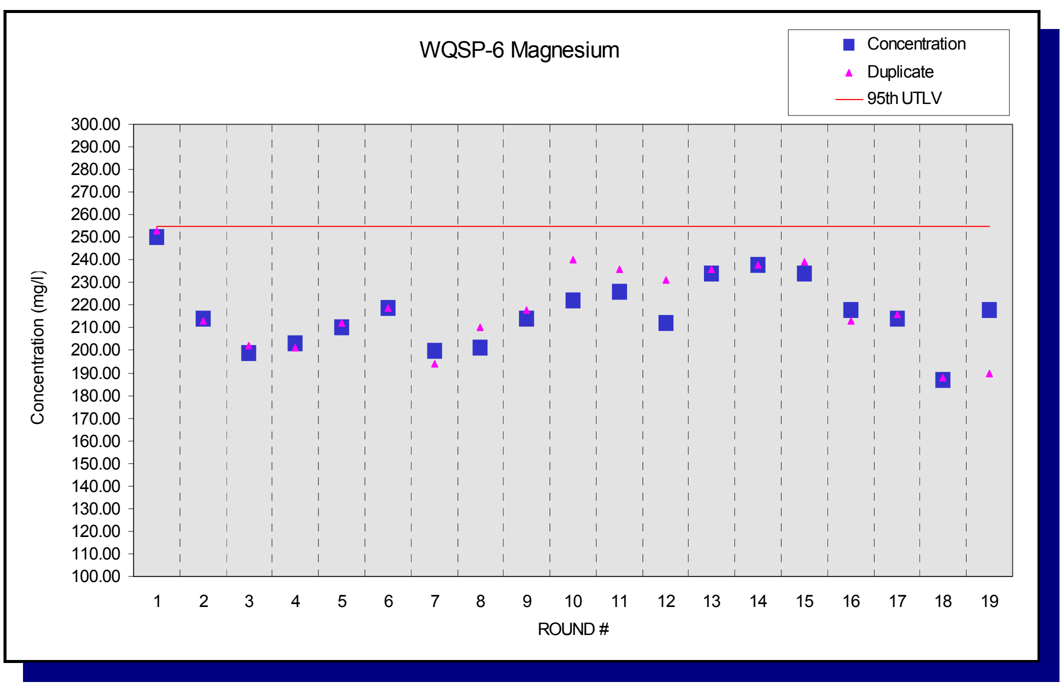

Figure E.75 - Time Trend Plot for Magnesium at WQSP-6

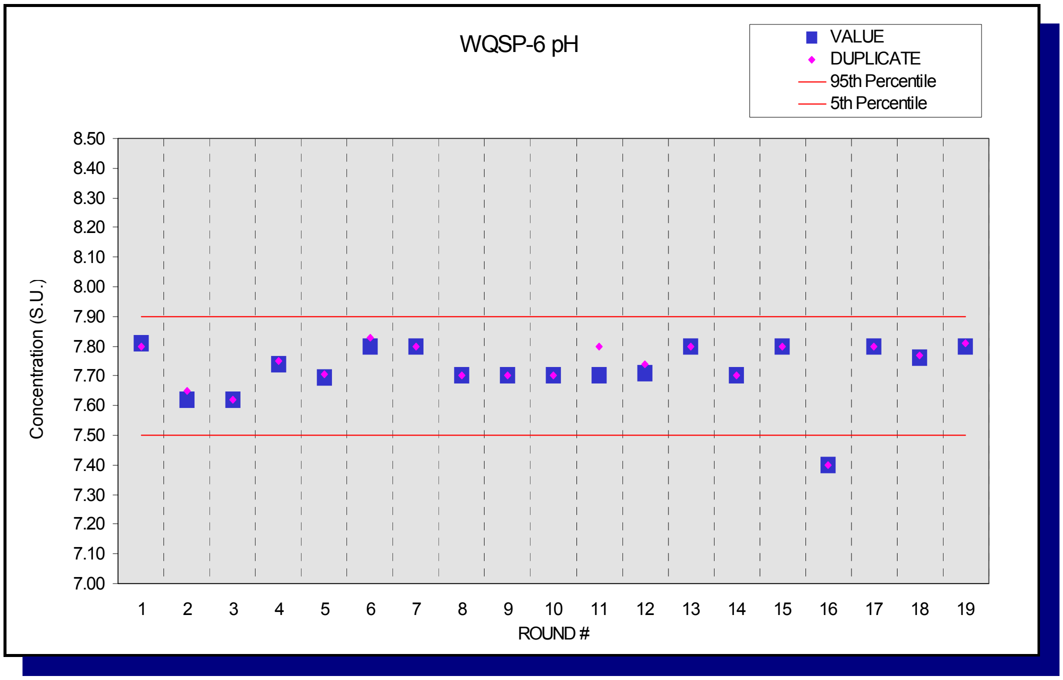

Figure E.76 - Time Trend Plot for pH at WQSP-6

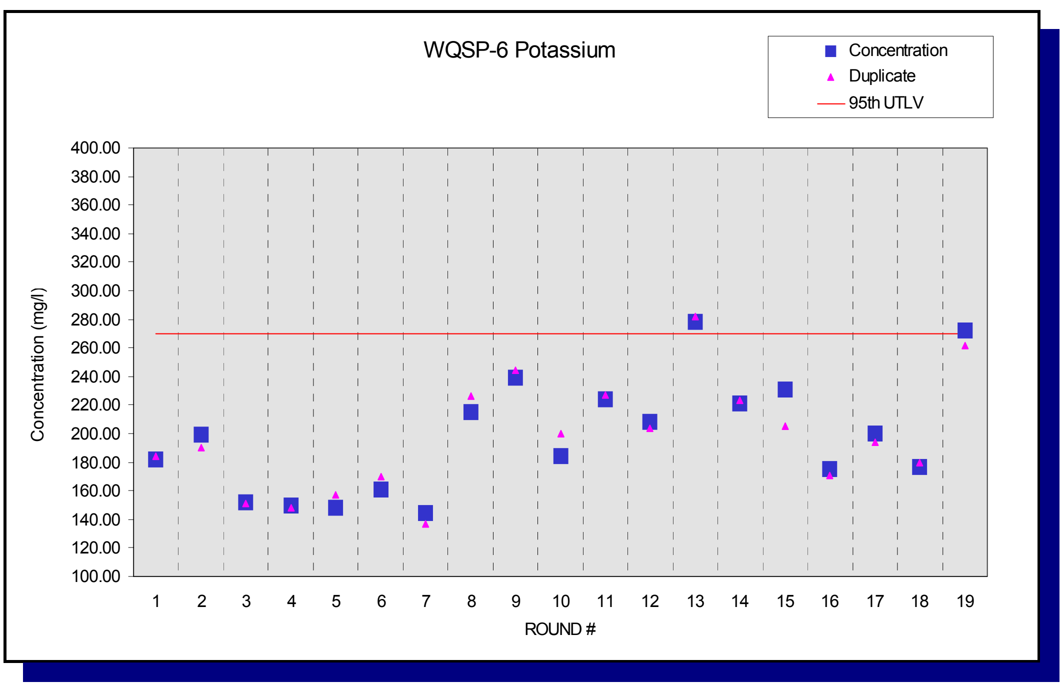

Figure E.77 - Time Trend Plot for Potassium at WQSP-6

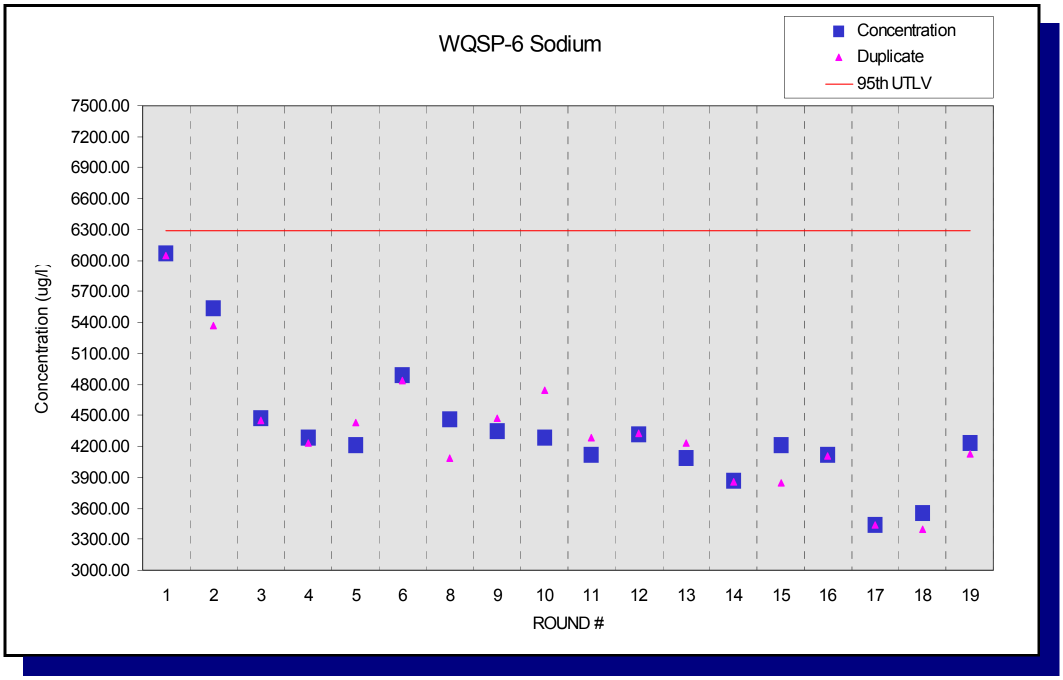

Figure E.78 - Time Trend Plot for Sodium at WQSP-6

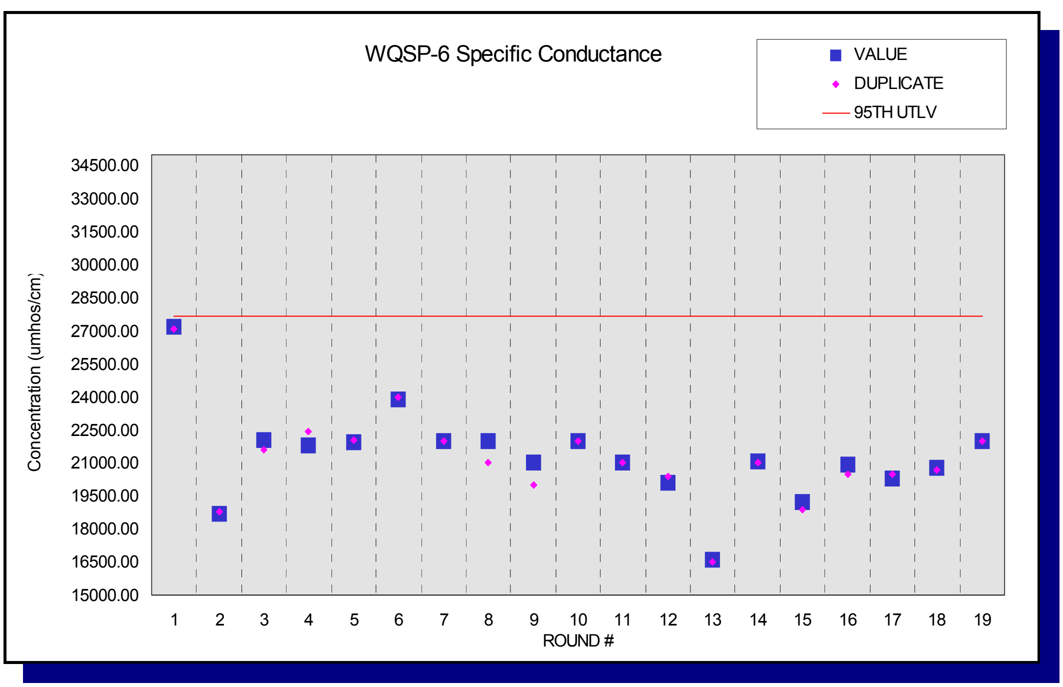

Figure E.79 - Time Trend Plot for Specific Conductance at WQSP-6

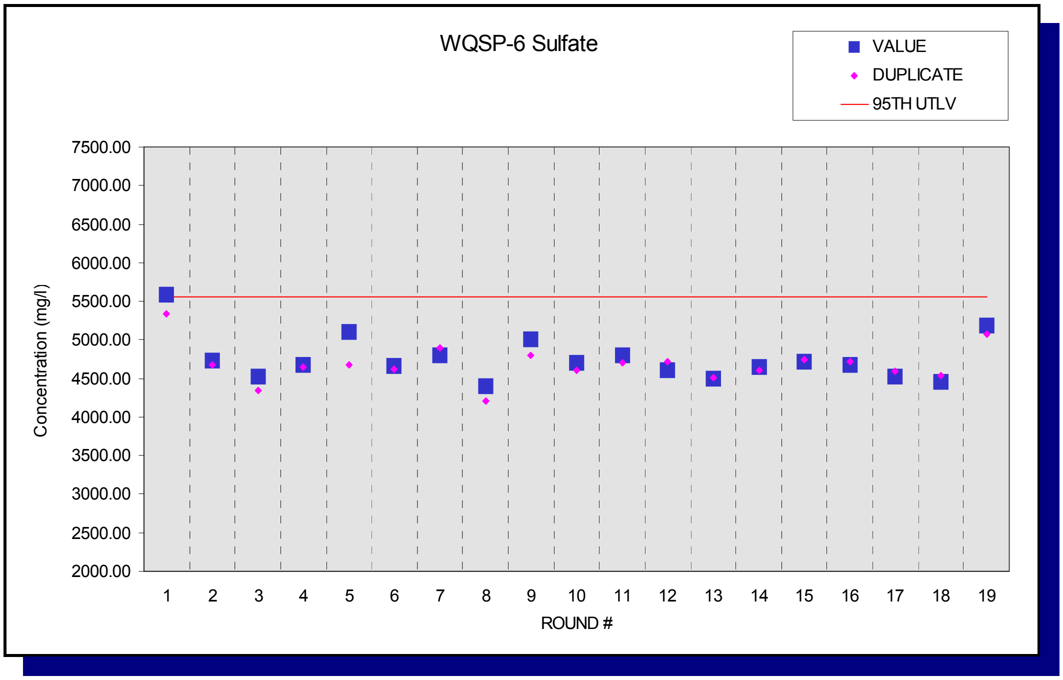

Figure E.80 - Time Trend Plot for Sulfate at WQSP-6

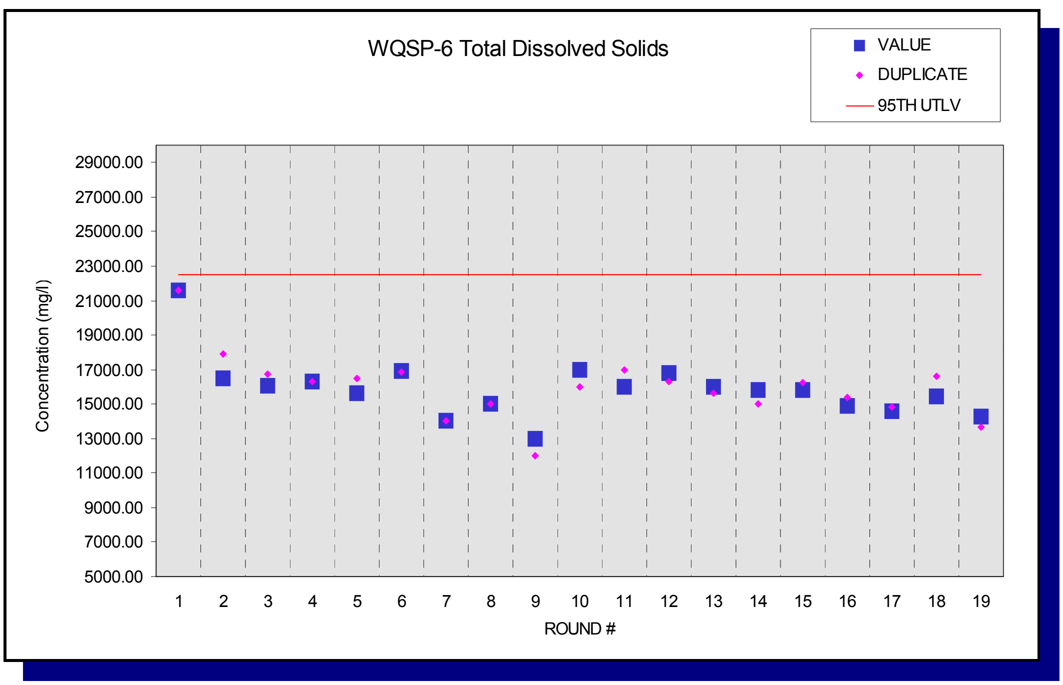

Figure E.81 - Time Trend Plot for Total Dissolved Solids at WQSP-6

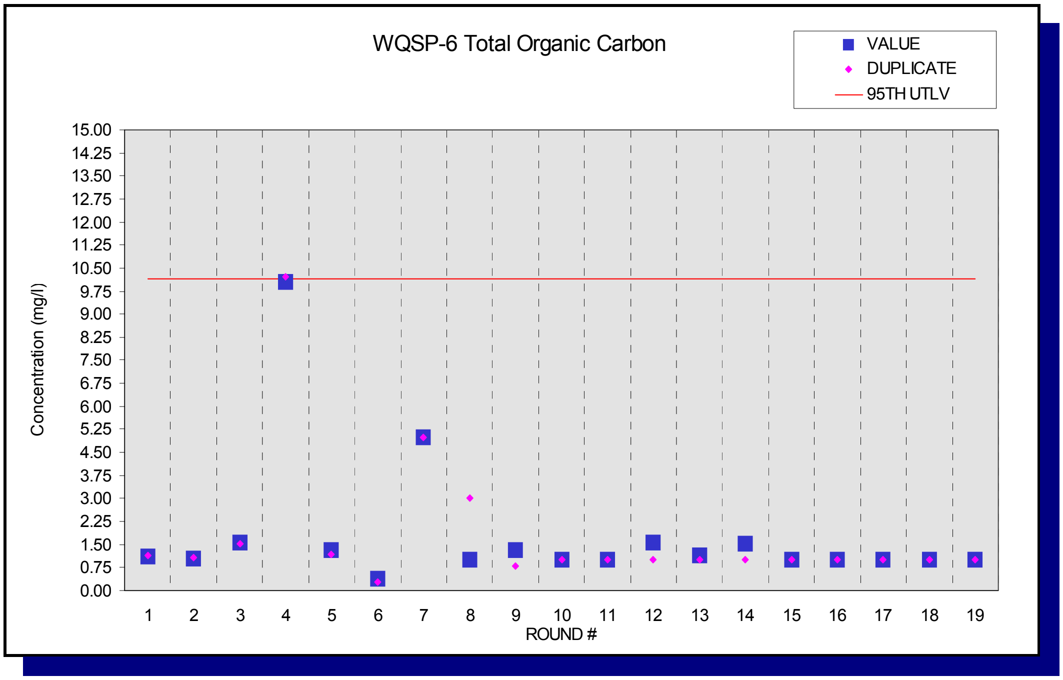

Figure E.82 - Time Trend Plot for Total Organic Carbon at WQSP-6

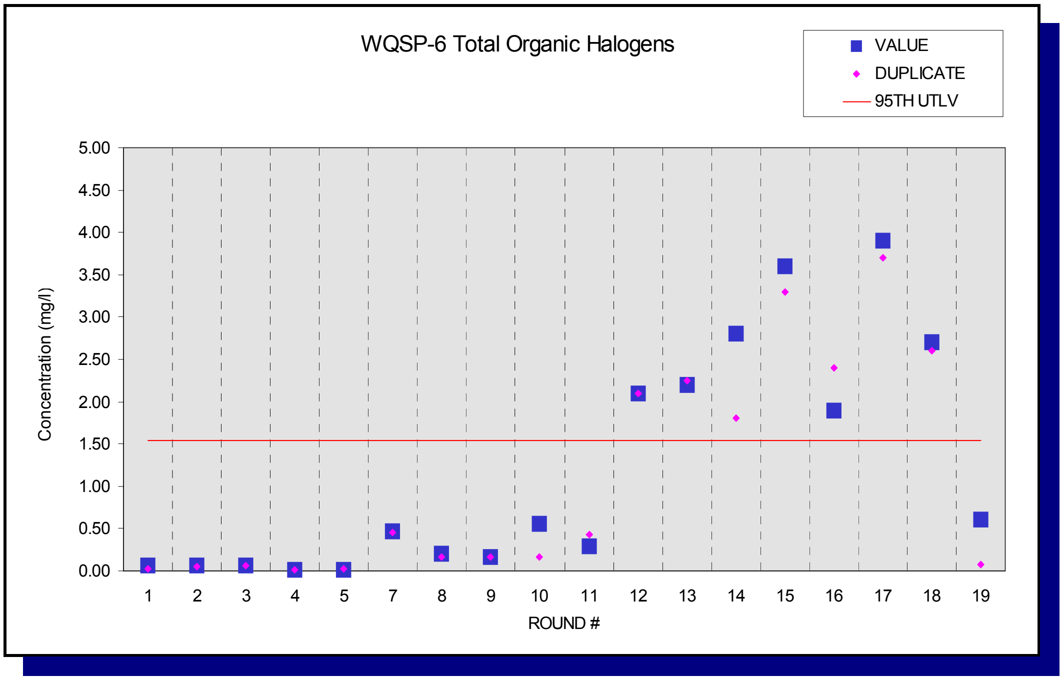

Figure E.83 - Time Trend Plot for Total Organic Halogens at WQSP-6

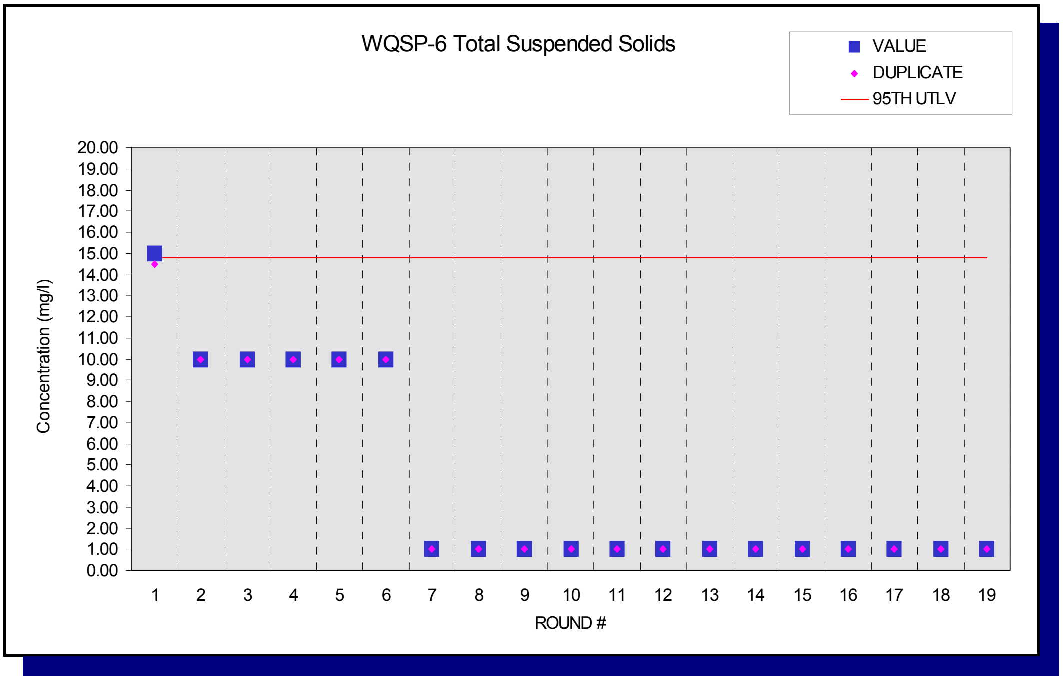

Figure E.84 - Time Trend Plot for Total Suspended Solids at WQSP-6

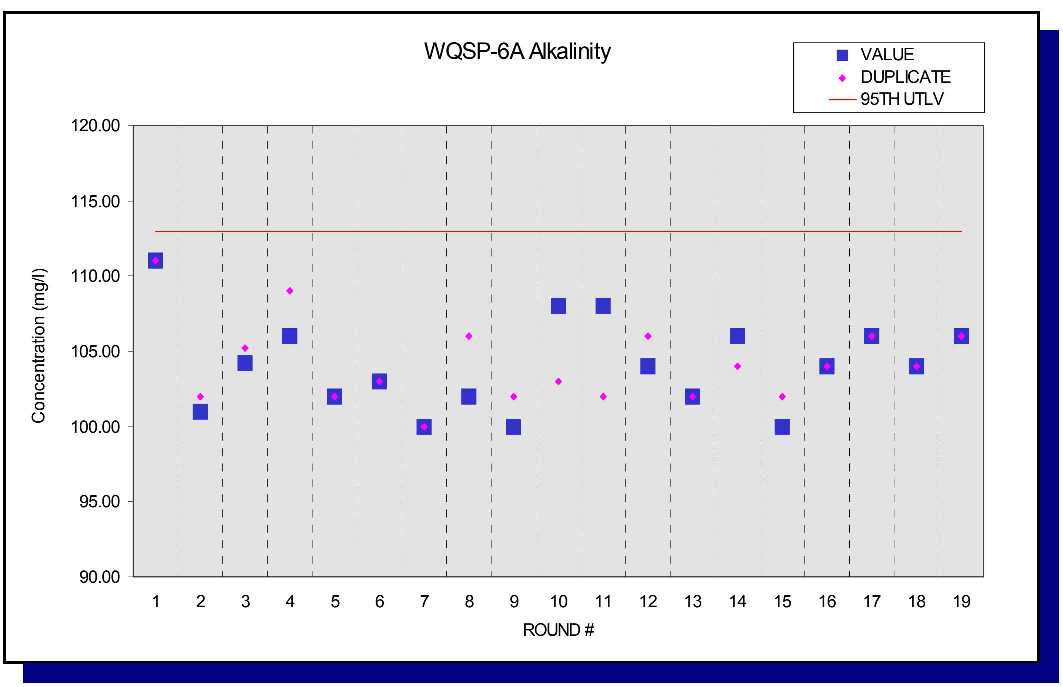

Figure E.85 - Time Trend Plot for Alkalinity at WQSP-6A

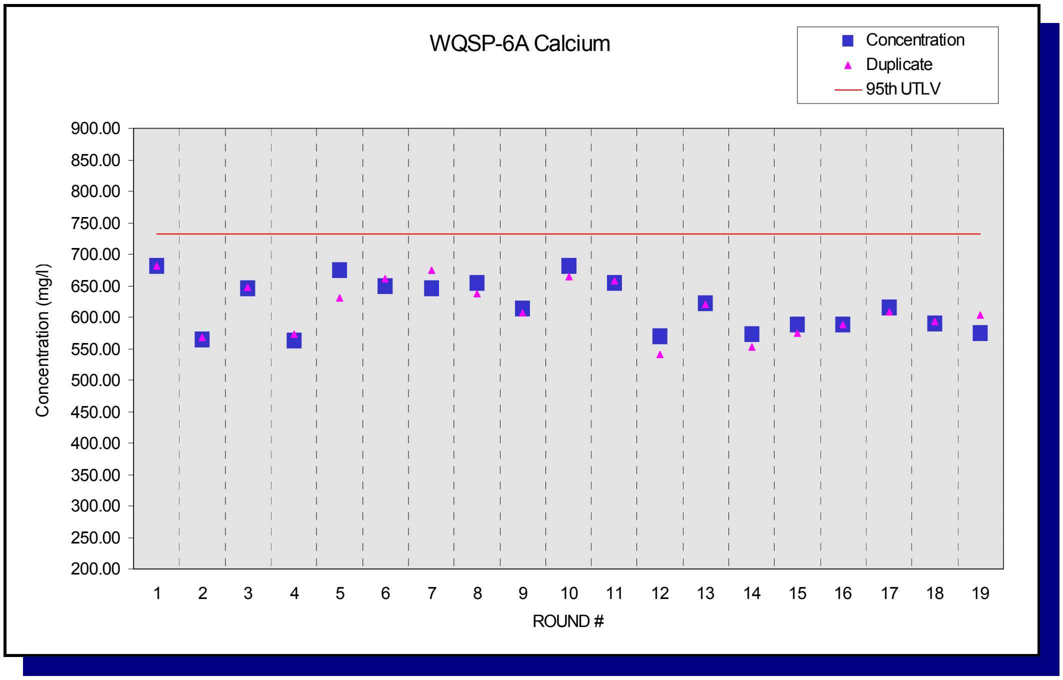

Figure E.86 - Time Trend Plot for Calcium at WQSP-6A

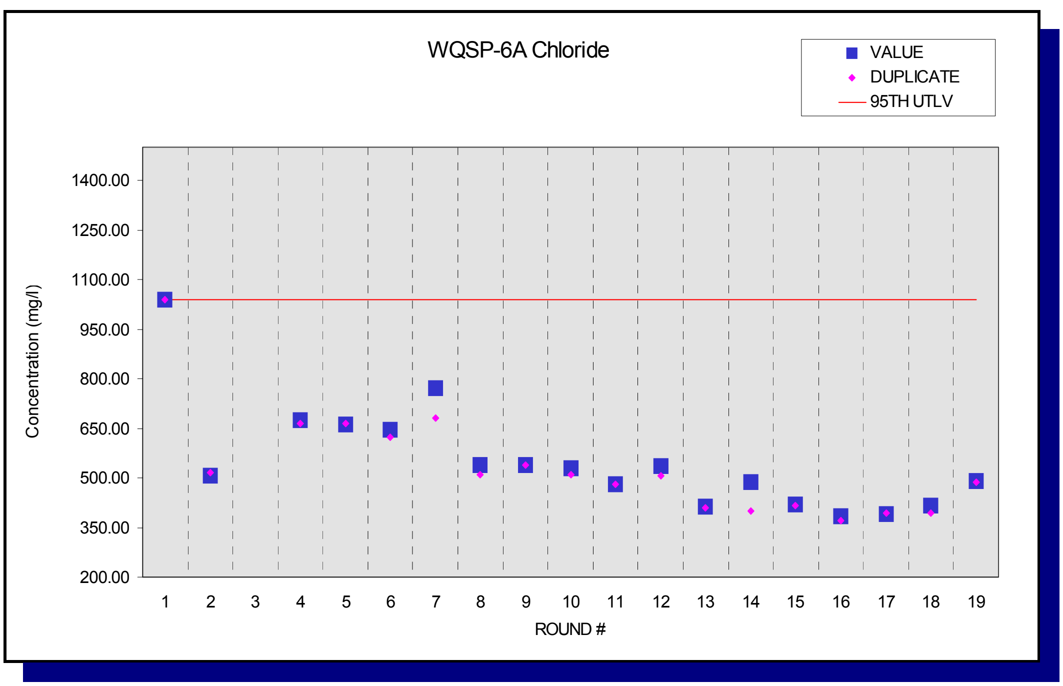

Figure E.87 - Time Trend Plot for Chloride at WQSP-6A

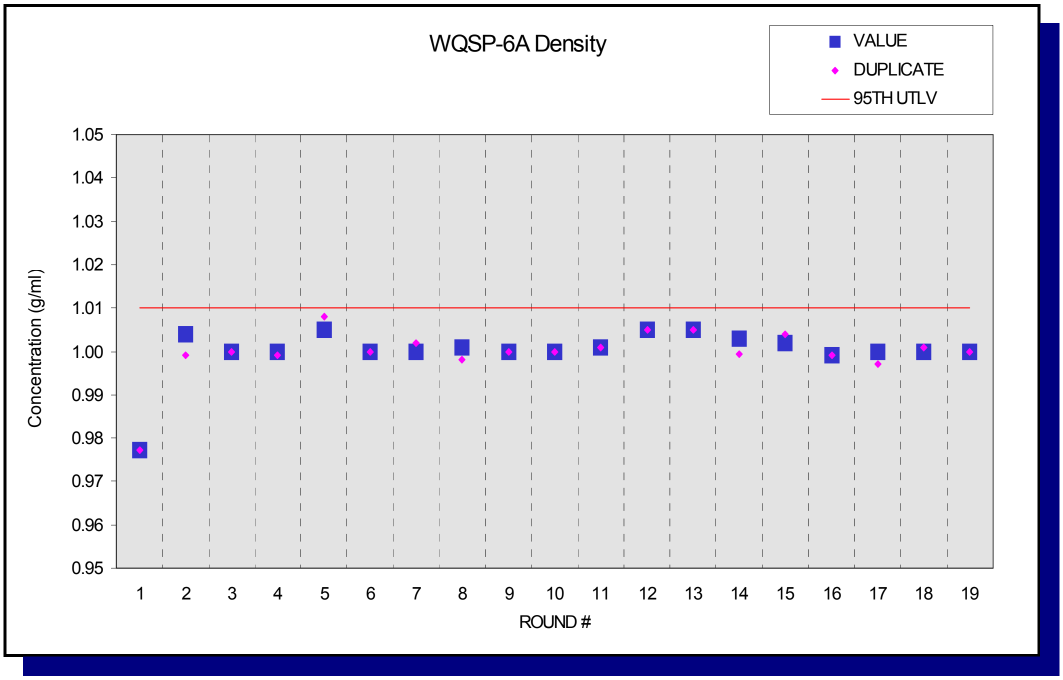

Figure E.88 - Time Trend Plot for Density at WQSP-6A

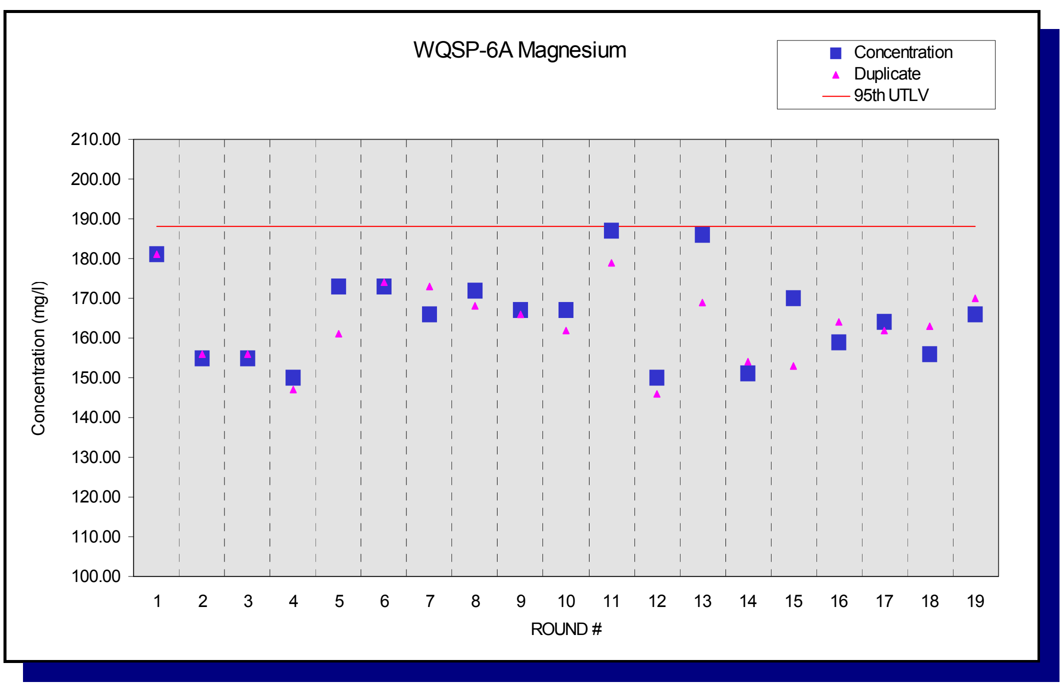

Figure E.89 - Time Trend Plot for Magnesium at WQSP-6A

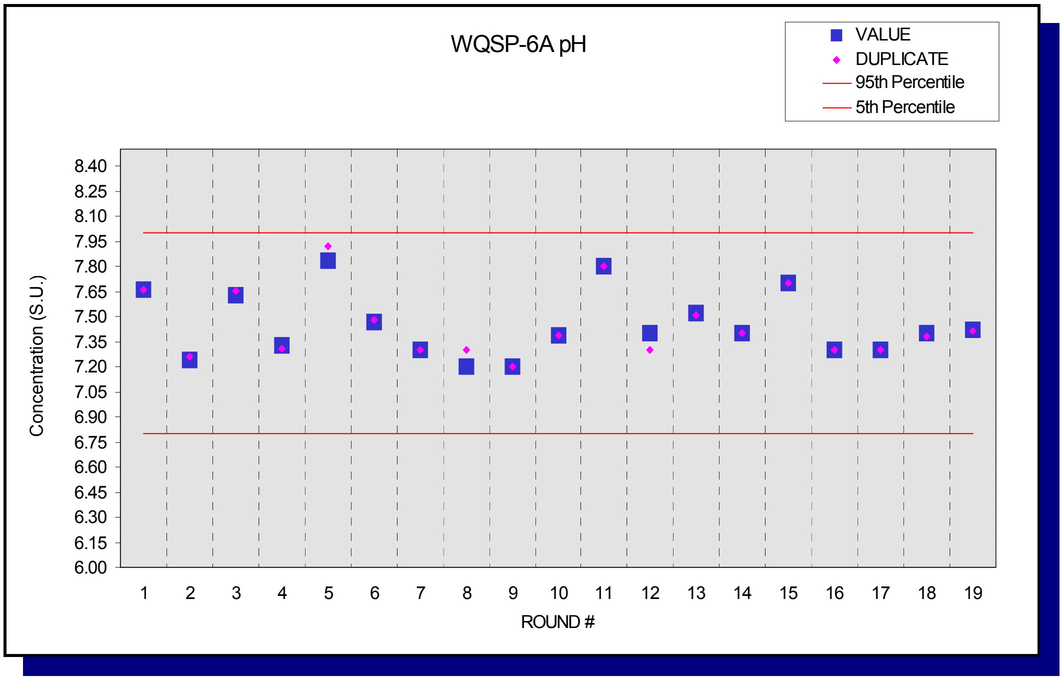

Figure E.90 - Time Trend Plot for pH at WQSP-6A

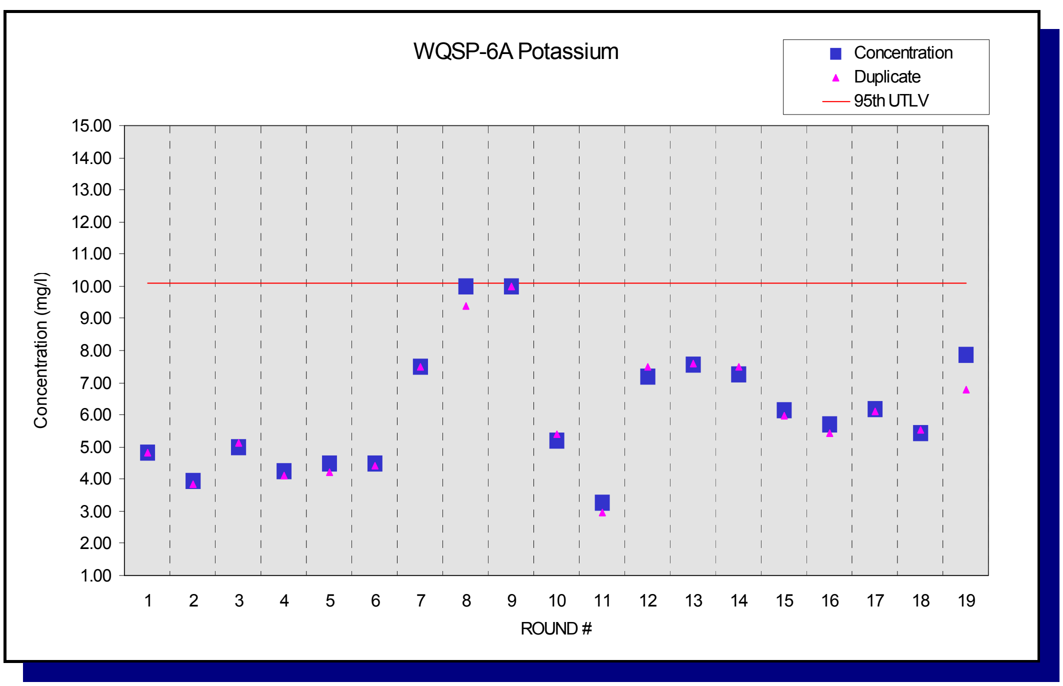

Figure E.91 - Time Trend Plot for Potassium at WQSP-6A

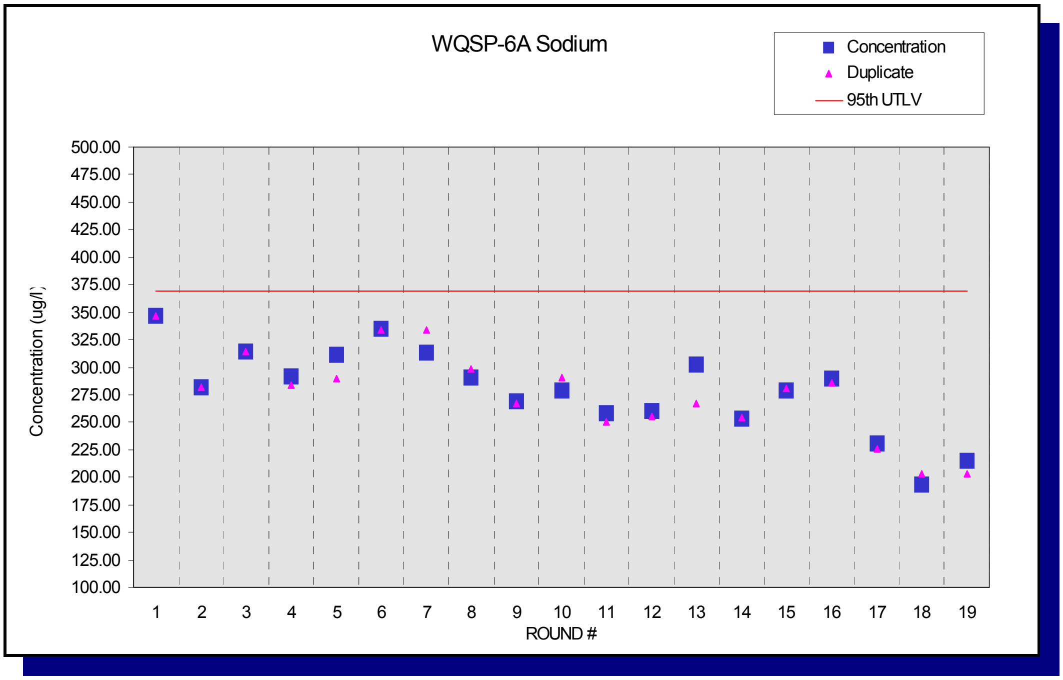

Figure E.92 - Time Trend Plot for Sodium at WQSP-6A

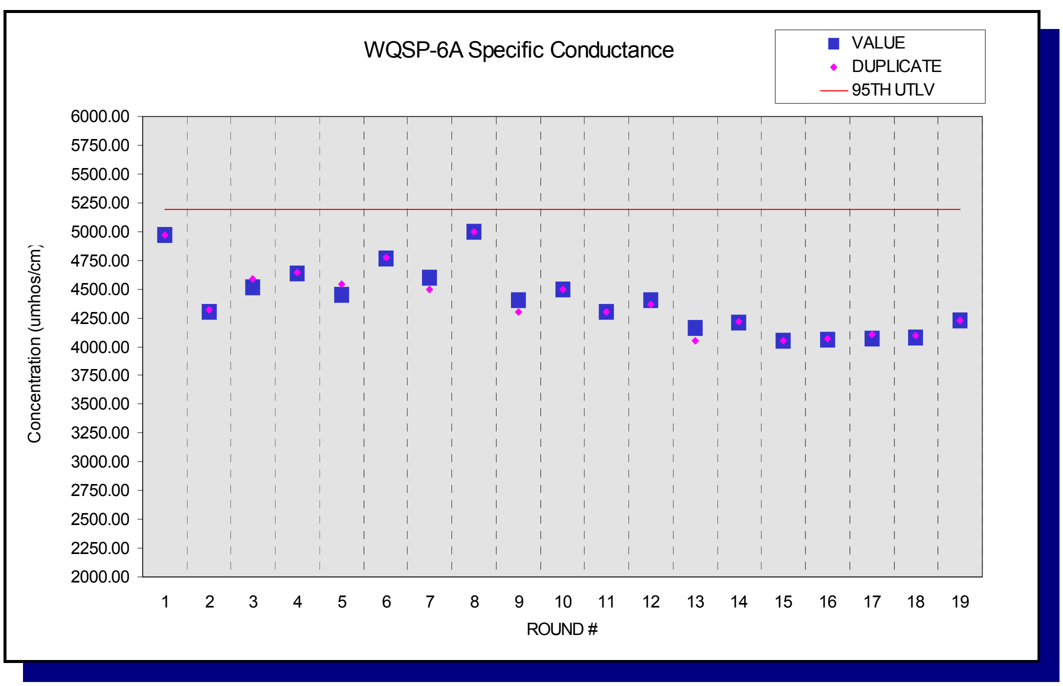

Figure E.93 - Time Trend Plot for Specific Conductance at WQSP-6A

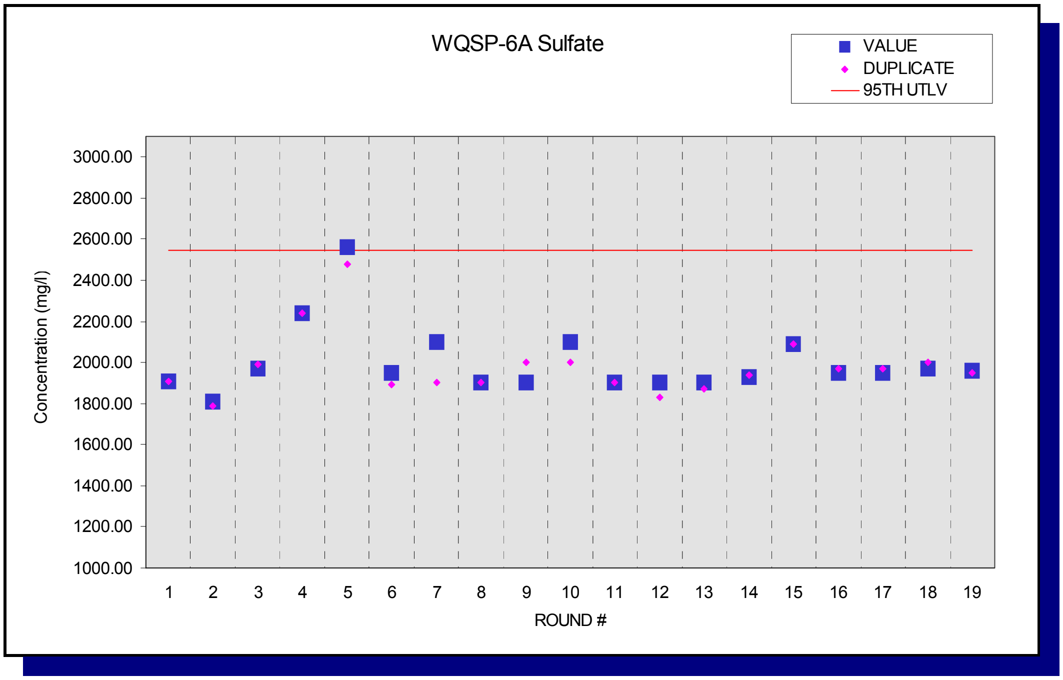

Figure E.94 - Time Trend Plot for Sulfate at WQSP-6A

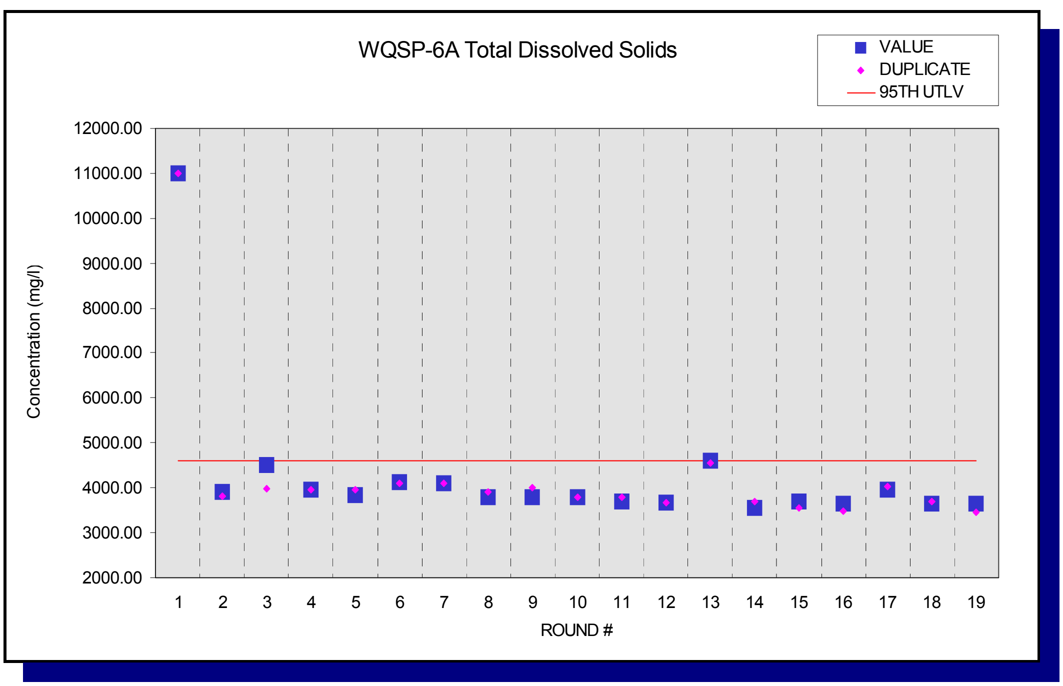

Figure E.95 - Time Trend Plot for Total Dissolved Solids at WQSP 6-A

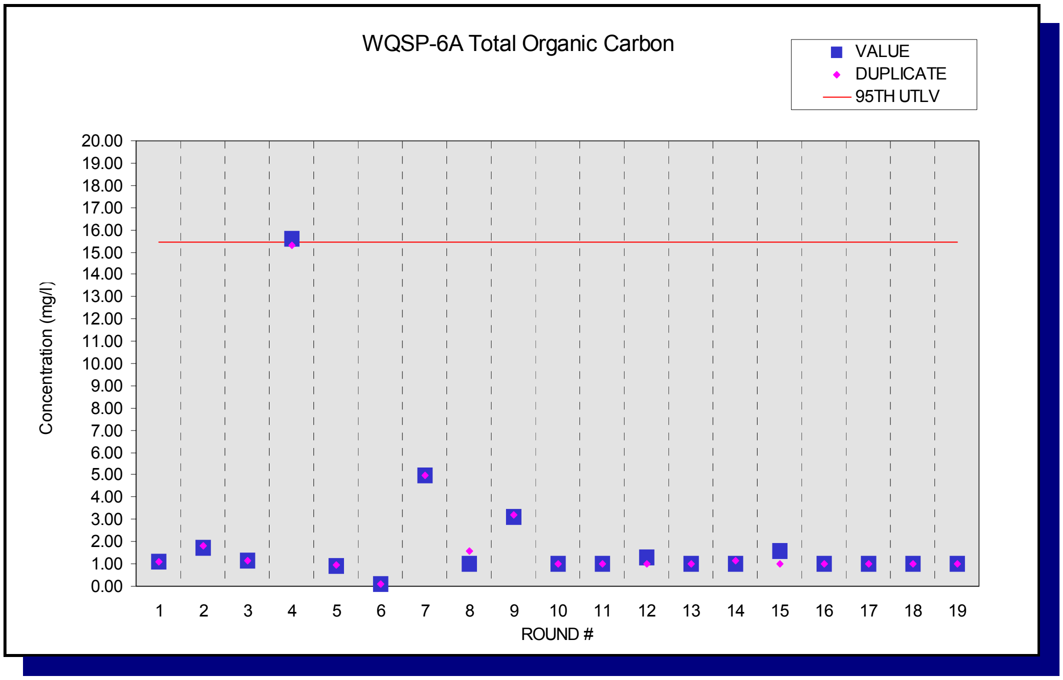

Figure E.96 - Time Trend Plot for Total Organic Carbon at WQSP-6A

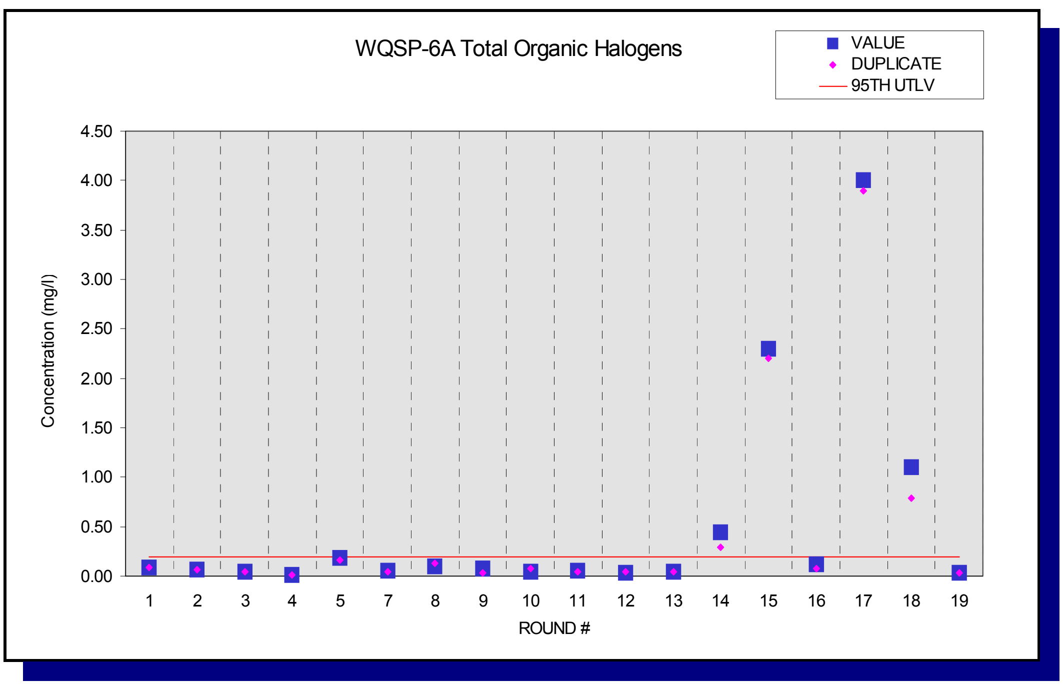

Figure E.97 - Time Trend Plot for Total Organic Halogens at WQSP-6A

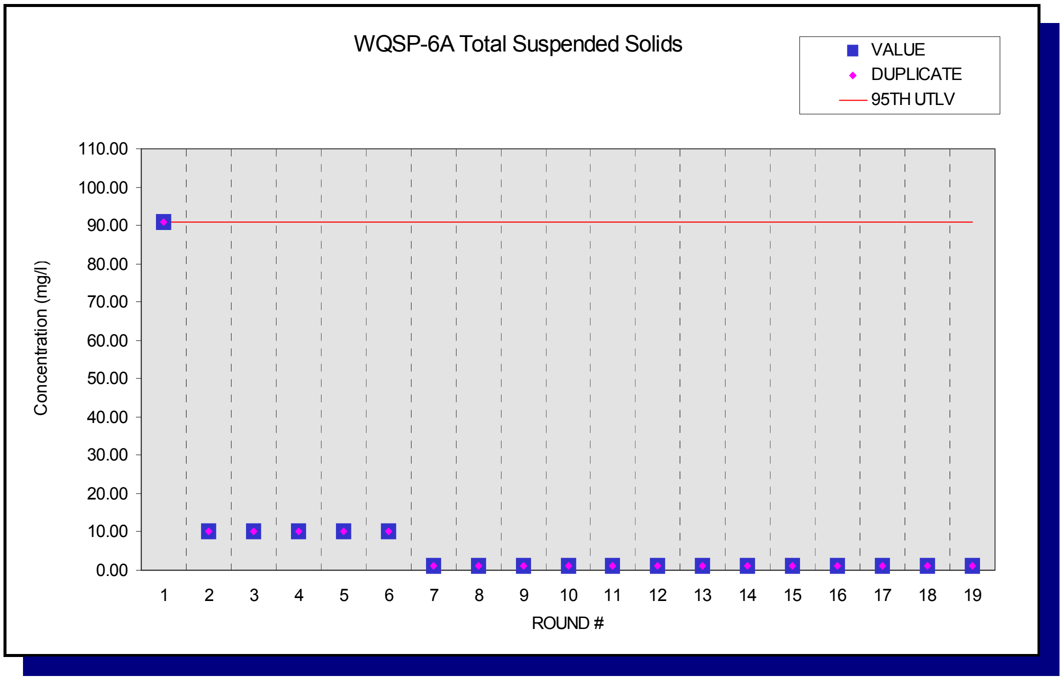

Figure E.98 - Time Trend Plot for Total Suspended Solids at WQSP-6A

Appendix F
Groundwater Data Tables

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

Parameter	Concentration Round 18 Sample	Concentration Round 18 Dup.	Concentration Round 19 Sample	Concentration Round 19 Dup.	Units	Reporting Limit Round 18	Reporting Limit Round 19	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	<20	<20	µg/l	5	20	<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	54	54	50	50	mg/l	4	4	55.7
Chloride	36400	36400	38800	39000	mg/l	2	2	40472
Density	1.04	1.04	1.05	1.05	g/ml	N/A[d]	N/A[d]	1.072
Nitrate (as N)	<0.10	<0.10	<0.10	<0.10	mg/l	0.1	0.1	<10
pH	7.18	7.19	7.13	7.14	SU[c]	N/A[d]	N/A[d]	6.89-7.65
Specific conductance	81000	81000	93800	93100	µmhos/cm	N/A	N/A	175000
Sulfate	4460	4490	5400	5120	mg/l	2	2	5757
Total dissolved solids	62800	63900	65900	66500	mg/l	10	10	80700
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	5

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

	Concentration					Reporting Limit		
	Round 18		Round 19					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 18	Round 19	95th UTLV[a]
Total organic halogen	6.3	9.9	0.09	0.03	mg/l	0.01	0.01	14.6
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	33.5
Antimony	<0.25	<0.25	<0.250	<0.250	mg/l	0.25	0.25	0.33
Arsenic	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	<0.1
Barium	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	<1.0
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.02
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.2
Calcium	1600	1680	1700	1580	mg/l	0.5	0.5	2,087
Chromium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.5
Iron	<0.50	<0.50	<0.50	<0.50	mg/l	0.50	0.50	1.32
Lead	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.105
Magnesium	978	1070	1140	1050	mg/l	0.5	0.5	1,247
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.490
Potassium	606	630	931	842	mg/l	0.5	0.5	799
Selenium	0.09	0.119	<0.025	<0.025	mg/l	0.05	0.025	0.15
Silver	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Sodium	16900	16700	20000	18400	mg/l	0.5	0.5	22,090
Thallium	0.05	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.980
Vanadium	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	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

	Concentration					Reporting Limit		
	Round 18		Round 19					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 18	Round 19	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

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

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
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	<20	<20	<5	<5	µg/l	20	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	<20	<20	<5	<5	µg/l	20	5	<RL
Pyridine	<5	<5	<5	<5	µg/l	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/l	5	5	<RL
Alkalinity	48	48	44	46	mg/l	4	4	70.3
Chloride	34400	34500	35800	40600	mg/l	2	2	39670
Density	1.04	1.04	1.05	1.05	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	7.3	7.3	7.2	7.2	SU[d]	N/A[c]	N/A[c]	7.00-7.60
Specific conductance	8000	80400	116000	117000	µmhos/cm	N/A[c]	N/A[c]	124000
Sulfate	5370	5460	5470	6300	mg/l	2	2	6590
Total dissolved solids	66000	59800	57800	58600	mg/l	10	10	80500
Total organic carbon	1.82	2.48	<1.0	<1.0	mg/l	1	1	7.97
Total organic halogen	8.1	7.0	0.06	0.09	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	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Arsenic	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.062
Barium	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	<1.0
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<1.0
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.5
Calcium	1500	1520	1530	1550	mg/l	0.5	0.5	1,827
Chromium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.5
Iron	0.63	<0.50	<0.50	<0.50	mg/l	0.50	0.50	1.32
Lead	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.163
Magnesium	1010	999	1080	1090	mg/l	0.5	0.5	1,244
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.490
Potassium	610	588	791	781	mg/l	0.5	0.5	845
Selenium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
Silver	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Sodium	17100	16900	19200	19300	mg/l	0.5	0.5	21,900
Thallium	<0.025	<0.025	0.090	0.125	mg/l	0.025	0.025	0.98
Vanadium	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
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	<40	<40	<20	<20	µg/l	5	5	<RL
2,4-Dinitrotoluene	<40	<40	<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	<20	<20	<5	<5	µg/l	5	5	<RL

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

Parameter	Concentration Round 18 Sample	Concentration Round 18 Dup.	Concentration Round 19 Sample	Concentration Round 19 Dup.	Units	Reporting Limit Round 18	Reporting Limit Round 19	95th UTLV[a]
Pyridine	<5	<5	<5	<5	µg/l	5	5	<RL
Isobutanol	<5	<5	<5	<5	µg/l	5	5	<RL
Alkalinity	38	36	32	32	mg/l	4	4	54.5
Chloride	121000	125000	141000	139000	mg/l	2	2	149100
Density	1.14	1.14	1.15	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	6.94	6.94	6.76	6.75	SU[d]	N/A[c]	N/A[c]	6.6-7.2
Specific conductance	202000	207000	215000	215000	µmhos/cm	N/A[c]	N/A[c]	517000
Sulfate	6980	6900	15500	15100	mg/l	2	2	8015
Total dissolved solids	233000	234000	215000	230000	mg/l	10	10	261000
Total organic carbon	1.17	1.91	<1.0	<1.0	mg/l	1	1	5
Total organic halogen	8.90	9.60	<0.30	<0.30	mg/l	0.30	0.30	55
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	107
Antimony	<0.250	<0.250	<0.250	<0.250	mg/l	0.25	0.25	<1.0
Arsenic	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	0.207
Barium	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	<1.0
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.1
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.5
Calcium	1480	1520	1210	1290	mg/l	0.5	0.5	1,680
Chromium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<2.0
Iron	<0.5	<0.5	3.26	<0.50	mg/l	0.5	0.5	<1.0
Lead	<0.05	<0.05	0.114	0.128	mg/l	0.05	0.05	0.80
Magnesium	2230	2260	1910	2070	mg/l	0.5	0.5	2,625
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	<5.00
Potassium	2230	2230	2520	2740	mg/l	0.5	0.5	3,438
Selenium	<0.025	<0.025	0.206	0.221	mg/l	0.025	0.025	<2.00
Silver	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.31
Sodium	57400	58600	57300	57200	mg/l	0.5	0.5	140,400
Thallium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	5.800
Vanadium	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
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	<40	<40	<20	<20	µg/l	5	5	<RL
2,4-Dinitrotoluene	<40	<40	<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	<20	<20	<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	38	38	38	38	mg/l	4	4	47.1
Chloride	59800	58100	57900	63900	mg/l	2	2	63960
Density	1.06	1.06	1.08	1.08	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	7.28	7.29	7.06	7.07	SU[d]	N/A[c]	N/A[c]	6.80-7.61
Specific conductance	125000	126000	136000	137000	µmhos/cm	N/A[c]	N/A[c]	319800
Sulfate	6770	6670	8590	9080	mg/l	2	2	7927
Total dissolved solids	107400	110400	119000	126000	mg/l	10	10	123500
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	5
Total organic halogen	4.0	1.80	0.08	0.13	mg/l	0.005	0.01	17
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	57
Antimony	<0.25	<0.25	<0.25	<0.25	mg/l	0.25	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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
Arsenic	<0.10	<0.10	<0.05	<0.05	mg/l	0.10	0.05	<0.50
Barium	0.10	0.10	<0.05	<0.05	mg/l	0.10	0.05	<1.0
Beryllium	<0.01	<0.01	<0.01	0.028	mg/l	0.01	0.01	0.25
Cadmium	<0.01	<0.01	<0.05	<0.05	mg/l	0.01	0.05	<0.50
Calcium	1450	1400	1190	1180	mg/l	0.5	0.5	1,834
Chromium	<0.025	<0.025	<0.10	<0.10	mg/l	0.025	0.10	<2.0
Iron	<0.50	<0.50	<0.50	<0.50	mg/l	0.5	0.5	<4.0
Lead	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.525
Magnesium	1090	1070	920	913	mg/l	0.5	0.5	1,472
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	<5.00
Potassium	1190	1220	975	1040	mg/l	0.5	0.5	1,648
Selenium	<0.025	<0.025	<0.01	<0.01	mg/l	0.025	0.01	2.009
Silver	<0.025	<0.025	<0.05	<0.05	mg/l	0.025	0.05	0.519
Sodium	29000	28900	24600	26200	mg/l	0.5	0.5	38,790
Thallium	<0.025	<0.025	<0.10	<0.10	mg/l	0.025	0.10	1.00
Vanadium	<0.05	<0.05	<0.10	<0.10	mg/l	0.05	0.10	<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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
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 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
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	<20	<20	<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	<20	<20	<20	<20	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	48	mg/l	4	4	56
Chloride	15100	15100	17800	17800	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	7.54	7.54	7.69	7.69	SU[d]	N/A[c]	N/A[c]	7.40-7.90
Specific conductance	44100	44200	47700	47700	µmhos/cm	N/A[c]	N/A[c]	67700
Sulfate	4540	4650	5710	5780	mg/l	2	2	6129
Total dissolved solids	32600	33200	34400	32400	mg/l	10	10	43950
Total organic carbon	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	5
Total organic halogen	4.9	5.5	<0.60	<0.60	mg/l	0.005	0.60	8.37
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	10
Antimony	<0.025	<0.025	<0.05	<0.05	mg/l	0.025	0.05	0.073
Arsenic	<0.10	<0.10	<0.05	<0.05	mg/l	0.10	0.05	0.5
Barium	<0.10	<0.10	<0.05	<0.05	mg/l	0.10	0.05	1
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	0.02
Cadmium	<0.01	<0.01	<0.05	<0.05	mg/l	0.01	0.05	0.05
Calcium	924	915	1190	1100	mg/l	0.5	0.5	1,303
Chromium	<0.025	<0.025	<0.10	<0.10	mg/l	0.025	0.10	0.50
Iron	<0.50	<0.50	<0.50	<0.50	mg/l	0.5	0.5	0.795
Lead	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.05
Magnesium	408	407	540	491	mg/l	0.5	0.5	547.0
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.10
Potassium	412	411	478	468	mg/l	0.5	0.5	622.0
Selenium	<0.025	<0.025	<0.05	<0.05	mg/l	0.025	0.05	0.10
Silver	<0.025	<0.025	<0.05	<0.05	mg/l	0.025	0.05	0.50

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

	Concentration							
	Round 18		Round 19			Reporting Limit		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 18	Round 19	95th UTLV[a]
Sodium	7600	7420	8730	9160	mg/l	0.5	0.5	11,190
Thallium	<0.025	<0.025	<0.10	<0.10	mg/l	0.025	0.10	0.209
Vanadium	<0.05	<0.05	<0.10	<0.10	mg/l	0.05	0.10	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

	Concentration							
	Round 18		Round 19			Reporting LIMIT		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 18	Round 19	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

Table F.6 - Analytical Results for Groundwater Sampled from Well WQSP-6

Parameter	Concentration Round 18 Sample	Round 18 Dup.	Round 19 Sample	Round 19 Dup.	Units	Reporting LIMIT Round 18	Reporting LIMIT Round 19	95th UTLV[a]
Isobutanol	<5	<5	<5	<5	µg/l	5	5	<RL
Alkalinity	48	48	52	50	mg/l	4	4	55.8
Chloride	4950	5700	6360	6230	mg/l	2	2	6200
Density	1.01	1.01	1.01	1.01	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	7.76	7.77	7.80	7.81	SU[d]	N/A[c]	N/A[c]	7.50-7.90
Specific conductance	20800	20700	22000	22000	µmhos/cm	N/A[c]	N/A[c]	27660
Sulfate	4450	4530	5180	5080	mg/l	2	2	5557
Total dissolved solids	15420	16600	14300	13650	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	2.7	2.6	<0.60	0.077	mg/l	0.005	0.60	1.54
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1	1	14.8
Antimony	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.14
Arsenic	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	<0.50
Barium	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.10	<1.0
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.020
Cadmium	0.013	0.014	<0.01	<0.01	mg/l	0.001	0.01	<0.050
Calcium	606	604	720	677	mg/l	0.5	0.5	796
Chromium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Iron	<0.50	4.84	<0.50	<0.50	mg/l	0.5	0.5	3.105
Lead	<0.05	<0.05	<0.05	0.05	mg/l	0.05	0.05	0.150
Magnesium	187	188	218	190	mg/l	0.5	0.5	255
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	<0.50
Potassium	177	180	272	262	mg/l	0.5	0.5	270
Selenium	<0.025	<0.025	0.045	0.040	mg/l	0.025	0.025	<0.10
Silver	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Sodium	3550	3400	4230	4130	mg/l	0.5	0.5	6,290
Thallium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.560
Vanadium	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	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					Reporting LIMIT		
	Round 18		Round 19					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 18	Round 19	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	<40	<40	<5	<5	µg/l	5	5	<RL
2,4-Dinitrotoluene	<20	<20	<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	<20	<20	<5	<5	µg/l	5	5	<RL
Pyridine	<5	<5	<5	<5	µg/l	5	5	<RL
Isobutanol	<5	<5	<5	<5	mg/l	5	5	<RL
Alkalinity	104	104	106	106	mg/l	4	4	113
Chloride	416	393	491	487	mg/l	2	2	1040
Density	1.00	1.00	1.00	1.00	g/ml	N/A[c]	N/A[c]	1.01
Nitrate (as N)	9.61	9.61	6.72	6.38	mg/l	0.1	0.1	12.2
pH	7.40	7.38	7.42	7.41	SU[d]	N/A[c]	N/A[c]	6.80-8.00
Specific conductance	4080	4100	4227	4227	µmhos/cm	N/A[c]	N/A[c]	5192
Sulfate	1970	2000	1960	1950	mg/l	2	2	2543
Total dissolved solids	3646	3698	3655	3460	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	1.10	0.79	<0.03	<0.03	mg/l	0.01	0.03	0.19
Total suspended solids	<1.0	<1.0	<1.0	<1.0	mg/l	1.0	1.0	91

Table F.7 - Analytical Results for Groundwater Sampled from Well WQSP-6A

Parameter	Concentration				Units	Reporting LIMIT		95th UTLV[a]
	Round 18		Round 19					
	Sample	Dup.	Sample	Dup.		Round 18	Round 19	
Antimony	<0.25	<0.25	<0.25	<0.25	mg/l	0.25	0.25	0.48
Arsenic	<0.10	<0.10	<0.10	<0.10	mg/l	0.1	0.1	<0.50
Barium	<0.10	<0.10	<0.10	<0.10	mg/l	0.10	0.1	<0.10
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/l	0.01	0.01	<0.05
Calcium	590	593	575	603	mg/l	0.5	0.5	733
Chromium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Iron	<0.50	<0.50	<0.50	<0.50	mg/l	0.50	0.50	<1.0
Lead	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	<0.05
Magnesium	156	163	166	170	mg/l	0.5	0.5	188
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/l	0	0	<0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/l	0.05	0.05	0.284
Potassium	5.43	5.53	7.85	6.77	mg/l	0.5	0.5	10.1
Selenium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.220
Silver	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	<0.50
Sodium	193	203	215	203	mg/l	0.5	0.5	369.0
Thallium	<0.025	<0.025	<0.025	<0.025	mg/l	0.025	0.025	0.058
Vanadium	<0.05	<0.05	< 0.05	<0.05	mg/l	0.05	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 2004

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	01/13/04	618.12	188.40	3039.13	926.33	3062.16
AEC-7	CUL	02/10/04	618.13	188.41	3039.12	926.32	3062.15
AEC-7	CUL	03/09/04	618.31	188.46	3038.94	926.27	3061.96
AEC-7	CUL	05/11/04	374.03	114.00	3283.26	1000.74	3328.26
AEC-7	CUL	06/07/04	377.22	114.98	3280.07	999.77	3324.79
AEC-7	CUL	07/06/04	362.20	110.40	3295.09	1004.34	3341.16
AEC-7	CUL	08/10/04	349.24	106.45	3308.05	1008.29	3355.29
AEC-7	CUL	09/14/04	634.62	193.43	3022.67	921.31	3044.22
AEC-7	CUL	10/12/04	631.27	192.41	3026.02	922.33	3047.87
AEC-7	CUL	11/08/04	629.00	191.72	3028.29	923.02	3050.35
AEC-7	CUL	12/07/04	617.71	188.28	3039.58	926.46	3062.65
C-2737 (PIP)	CUL	04/14/04	390.19	118.93	3009.11	917.18	3009.11
C-2737 (PIP)	CUL	05/12/04	390.40	118.99	3008.90	917.11	3013.98
C-2737 (PIP)	CUL	06/10/04	389.73	118.79	3009.57	917.32	3014.66
C-2737 (PIP)	CUL	07/08/04	389.95	118.86	3009.35	917.25	3014.44

Table F.8 - Groundwater Level Measurement Results for 2004

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 (PIP)	CUL	08/11/04	389.91	118.84	3009.39	917.26	3014.48
C-2737 (PIP)	CUL	09/17/04	389.65	118.77	3009.65	917.34	3014.74
C-2737 (PIP)	CUL	10/14/04	389.67	118.77	3009.63	917.34	3014.72
C-2737 (PIP)	CUL	11/10/04	389.69	118.78	3009.61	917.33	3014.70
C-2737 (PIP)	CUL	12/08/04	389.35	118.67	3009.95	917.43	3015.05
DOE-1	CUL	01/13/04	485.75	148.06	2980.29	908.39	3009.07
DOE-1	CUL	02/10/04	485.30	147.92	2980.74	908.53	3009.55
DOE-1	CUL	03/09/04	484.52	147.68	2981.52	908.77	3010.40
DOE-1	CUL	04/13/04	483.54	147.38	2982.50	909.07	3011.46
DOE-1	CUL	05/12/04	483.02	147.22	2983.02	909.22	3012.02
DOE-1	CUL	06/08/04	487.35	148.54	2978.69	907.90	3007.33
DOE-1	CUL	07/07/04	481.61	146.79	2984.43	909.65	3013.55
DOE-1	CUL	08/11/04	480.66	146.51	2985.38	909.94	3014.58
DOE-1	CUL	09/15/04	480.30	146.40	2985.74	910.05	3014.97
DOE-1	CUL	10/12/04	479.90	146.27	2986.14	910.18	3015.40
DOE-1	CUL	11/10/04	479.41	146.12	2986.63	910.32	3015.93
DOE-1	CUL	12/08/04	478.77	145.93	2987.27	910.52	3016.63
ERDA-9	CUL	01/13/04	400.38	122.04	3009.72	917.36	3025.22
ERDA-9	CUL	02/11/04	400.65	122.12	3009.45	917.28	3024.94
ERDA-9	CUL	03/09/04	400.90	122.19	3009.20	917.20	3024.68
ERDA-9	CUL	04/14/04	401.80	122.47	3008.30	916.93	3023.73
ERDA-9	CUL	05/12/04	401.30	122.32	3008.80	917.08	3024.26
ERDA-9	CUL	06/10/04	400.75	122.15	3009.35	917.25	3024.84
ERDA-9	CUL	07/07/04	400.66	122.12	3009.44	917.28	3024.93
ERDA-9	CUL	08/11/04	400.54	122.08	3009.56	917.31	3025.06
ERDA-9	CUL	09/14/04	400.36	122.03	3009.74	917.37	3025.25
ERDA-9	CUL	10/13/04	400.32	122.02	3009.78	917.38	3025.29
ERDA-9	CUL	11/09/04	400.41	122.04	3009.69	917.35	3025.19
ERDA-9	CUL	12/08/04	400.23	121.99	3009.87	917.41	3025.38
H-02a	CUL	03/10/04	338.30	103.11	3039.79	926.53	3043.34
H-02a	CUL	06/10/04	338.19	103.08	3039.90	926.56	3043.45
H-02a	CUL	09/17/04	338.12	103.06	3039.97	926.58	3043.52
H-02a	CUL	12/09/04	338.02	103.03	3040.07	926.61	3043.63
H-02b2	CUL	01/13/04	339.50	103.48	3038.81	926.23	3041.17
H-02b2	CUL	02/11/04	339.50	103.48	3038.81	926.23	3041.17
H-02b2	CUL	03/10/04	339.62	103.52	3038.69	926.19	3041.05
H-02b2	CUL	04/14/04	339.65	103.53	3038.66	926.18	3041.02
H-02b2	CUL	05/12/04	339.62	103.52	3038.69	926.19	3041.05
H-02b2	CUL	06/10/04	339.85	103.59	3038.46	926.12	3040.82
H-02b2	CUL	07/08/04	339.95	103.62	3038.36	926.09	3040.72
H-02b2	CUL	08/11/04	340.07	103.65	3038.24	926.06	3040.60
H-02b2	CUL	09/17/04	339.93	103.61	3038.38	926.10	3040.74

Table F.8 - Groundwater Level Measurement Results for 2004

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	10/13/04	339.63	103.52	3038.68	926.19	3041.04
H-02b2	CUL	11/10/04	339.61	103.51	3038.70	926.20	3041.06
H-02b2	CUL	12/09/04	339.96	103.62	3038.35	926.09	3040.71
H-02c	CUL	03/10/04	339.90	103.60	3038.51	926.14	3051.44
H-02c	CUL	06/10/04	340.02	103.64	3038.39	926.10	3051.31
H-02c	CUL	09/17/04	340.04	103.64	3038.37	926.10	3051.29
H-02c	CUL	12/09/04	340.04	103.64	3038.37	926.10	3051.29
H-03b2	CUL	01/13/04	390.44	119.01	2999.59	914.28	3010.96
H-03b2	CUL	02/11/04	390.52	119.03	2999.51	914.25	3010.88
H-03b2	CUL	03/10/04	390.66	119.07	2999.37	914.21	3010.73
H-03b2	CUL	04/14/04	390.60	119.05	2999.43	914.23	3010.80
H-03b2	CUL	05/12/04	391.12	119.21	2998.91	914.07	3010.26
H-03b2	CUL	06/09/04	390.74	119.10	2999.29	914.18	3010.65
H-03b2	CUL	07/08/04	390.59	119.05	2999.44	914.23	3010.81
H-03b2	CUL	08/11/04	390.52	119.03	2999.51	914.25	3010.88
H-03b2	CUL	09/17/04	390.42	119.00	2999.61	914.28	3010.98
H-03b2	CUL	10/14/04	390.64	119.07	2999.39	914.21	3010.75
H-03b2	CUL	11/10/04	390.58	119.05	2999.45	914.23	3010.82
H-03b2	CUL	12/09/04	389.96	118.86	3000.07	914.42	3011.46
H-03b3	CUL	03/10/04	385.02	117.35	3003.65	915.51	3013.51
H-03b3	CUL	06/09/04	385.14	117.39	3003.53	915.48	3013.38
H-03b3	CUL	09/17/04	384.83	117.30	3003.84	915.57	3013.70
H-03b3	CUL	12/09/04	384.36	117.15	3004.31	915.71	3014.19
H-04b	CUL	01/13/04	333.08	101.52	3000.27	914.48	3003.84
H-04b	CUL	02/11/04	333.14	101.54	3000.21	914.46	3003.78
H-04b	CUL	03/08/04	333.08	101.52	3000.27	914.48	3003.84
H-04b	CUL	04/13/04	332.57	101.37	3000.78	914.64	3004.36
H-04b	CUL	05/12/04	332.00	101.19	3001.35	914.81	3004.94
H-04b	CUL	06/10/04	331.90	101.16	3001.45	914.84	3005.04
H-04b	CUL	07/08/04	331.86	101.15	3001.49	914.85	3005.08
H-04b	CUL	08/11/04	331.84	101.14	3001.51	914.86	3005.10
H-04b	CUL	09/15/04	332.00	101.19	3001.35	914.81	3004.94
H-04b	CUL	10/14/04	331.65	101.09	3001.70	914.92	3005.30
H-04b	CUL	11/09/04	330.91	100.86	3002.44	915.14	3006.05
H-04b	CUL	12/08/04	330.56	100.75	3002.79	915.25	3006.41
H-05a	CUL	03/09/04	474.24	144.55	3032.00	924.15	3072.01
H-05a	CUL	06/07/04	473.98	144.47	3032.26	924.23	3072.30
H-05a	CUL	09/14/04	474.16	144.52	3032.08	924.18	3072.10
H-05a	CUL	12/07/04	473.98	144.47	3032.26	924.23	3072.30
H-05b	CUL	01/13/04	476.52	145.24	3029.52	923.40	3074.51
H-05b	CUL	02/11/04	476.55	145.25	3029.49	923.39	3074.48
H-05b	CUL	03/09/04	476.70	145.30	3029.34	923.34	3074.32

Table F.8 - Groundwater Level Measurement Results for 2004

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	04/13/04	476.50	145.24	3029.54	923.40	3074.54
H-05b	CUL	05/11/04	476.40	145.21	3029.64	923.43	3074.65
H-05b	CUL	06/07/04	476.46	145.23	3029.58	923.42	3074.58
H-05b	CUL	07/06/04	476.58	145.26	3029.46	923.38	3074.45
H-05b	CUL	08/10/04	476.73	145.31	3029.31	923.33	3074.28
H-05b	CUL	09/14/04	476.67	145.29	3029.37	923.35	3074.35
H-05b	CUL	10/13/04	476.53	145.25	3029.51	923.39	3074.50
H-05b	CUL	11/10/04	476.53	145.25	3029.51	923.39	3074.50
H-05b	CUL	12/07/04	476.38	145.20	3029.66	923.44	3074.67
H-06a	CUL	03/08/04	295.05	89.93	3053.06	930.57	3065.27
H-06a	CUL	06/07/04	294.97	89.91	3053.14	930.60	3065.35
H-06a	CUL	09/13/04	294.88	89.88	3053.23	930.62	3065.45
H-06a	CUL	12/06/04	293.10	89.34	3055.01	931.17	3067.29
H-06b	CUL	01/12/04	295.65	90.11	3052.60	930.43	3064.78
H-06b	CUL	02/09/04	295.85	90.18	3052.40	930.37	3064.57
H-06b	CUL	03/08/04	296.04	90.23	3052.21	930.31	3064.38
H-06b	CUL	04/12/04	295.77	90.15	3052.48	930.40	3064.66
H-06b	CUL	05/10/04	296.02	90.23	3052.23	930.32	3064.40
H-06b	CUL	06/07/04	296.01	90.22	3052.24	930.32	3064.41
H-06b	CUL	07/06/04	296.09	90.25	3052.16	930.30	3064.32
H-06b	CUL	08/10/04	296.32	90.32	3051.93	930.23	3064.08
H-06b	CUL	09/13/04	295.95	90.21	3052.30	930.34	3064.47
H-06b	CUL	10/11/04	294.94	89.90	3053.31	930.65	3065.52
H-06b	CUL	11/09/04	296.21	90.28	3052.04	930.26	3064.20
H-06b	CUL	12/06/04	294.27	89.69	3053.98	930.85	3066.21
H-07b1	CUL	03/08/04	166.84	50.85	2997.33	913.59	2997.78
H-07b1	CUL	06/07/04	166.10	50.63	2998.07	913.81	2998.52
H-07b1	CUL	09/13/04	166.03	50.61	2998.14	913.83	2998.59
H-07b1	CUL	12/07/04	163.72	49.90	3000.45	914.54	3000.91
H-07b2	CUL	01/12/04	167.76	51.13	2997.31	913.58	2997.22
H-07b2	CUL	02/09/04	167.81	51.15	2997.26	913.56	2997.17
H-07b2	CUL	03/08/04	168.00	51.21	2997.07	913.51	2996.98
H-07b2	CUL	04/12/04	167.59	51.08	2997.48	913.63	2997.39
H-07b2	CUL	05/10/04	167.32	51.00	2997.75	913.71	2997.66
H-07b2	CUL	06/07/04	167.28	50.99	2997.79	913.73	2997.70
H-07b2	CUL	07/06/04	167.44	51.04	2997.63	913.68	2997.54
H-07b2	CUL	08/09/04	167.58	51.08	2997.49	913.63	2997.40
H-07b2	CUL	09/13/04	167.15	50.95	2997.92	913.77	2997.83
H-07b2	CUL	10/12/04	166.50	50.75	2998.57	913.96	2998.48
H-07b2	CUL	11/08/04	165.73	50.51	2999.34	914.20	2999.25
H-07b2	CUL	12/07/04	164.87	50.25	3000.20	914.46	3000.11
H-09c (PIP)	CUL	01/12/04	419.33	127.81	2987.97	910.73	2988.21

Table F.8 - Groundwater Level Measurement Results for 2004

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-09c (PIP)	CUL	02/09/04	415.46	126.63	2991.84	911.91	2992.09
H-09c (PIP)	CUL	03/08/04	413.84	126.14	2993.46	912.41	2993.71
H-09c (PIP)	CUL	04/13/04	412.93	125.86	2994.37	912.68	2994.62
H-09c (PIP)	CUL	05/10/04	412.75	125.81	2994.55	912.74	2994.80
H-09c (PIP)	CUL	06/08/04	412.63	125.77	2994.67	912.78	2994.92
H-09c (PIP)	CUL	07/07/04	412.44	125.71	2994.86	912.83	2995.11
H-09c (PIP)	CUL	08/10/04	412.18	125.63	2995.12	912.91	2995.37
H-09c (PIP)	CUL	09/14/04	412.04	125.59	2995.26	912.96	2995.51
H-09c (PIP)	CUL	10/12/04	411.93	125.56	2995.37	912.99	2995.62
H-09c (PIP)	CUL	11/08/04	411.93	125.56	2995.37	912.99	2995.62
H-09c (PIP)	CUL	12/07/04	411.30	125.36	2996.00	913.18	2996.25
H-10c	CUL	01/12/04	662.00	201.78	3026.64	922.52	3026.64
H-10c	CUL	02/10/04	662.96	202.07	3025.68	922.23	3025.68
H-10c	CUL	03/09/04	663.54	202.25	3025.10	922.05	3025.10
H-10c	CUL	04/13/04	663.70	202.30	3024.94	922.00	3024.94
H-10c	CUL	05/11/04	663.81	202.33	3024.83	921.97	3024.83
H-10c	CUL	06/08/04	664.00	202.39	3024.64	921.91	3024.64
H-10c	CUL	07/07/04	663.58	202.26	3025.06	922.04	3025.06
H-10c	CUL	08/10/04	663.74	202.31	3024.90	921.99	3024.90
H-10c	CUL	09/14/04	663.30	202.17	3025.34	922.12	3025.34
H-10c	CUL	10/12/04	662.90	202.05	3025.74	922.25	3025.74
H-10c	CUL	11/08/04	663.40	202.20	3025.24	922.09	3025.24
H-10c	CUL	12/07/04	663.44	202.22	3025.20	922.08	3025.20
H-11b1	CUL	03/10/04	420.23	128.09	2991.39	911.78	3015.32
H-11b1	CUL	06/09/04	419.45	127.85	2992.17	912.01	3016.16
H-11b1	CUL	09/15/04	419.57	127.88	2992.05	911.98	3016.03
H-11b1	CUL	12/08/04	418.00	127.41	2993.62	912.46	3017.72
H-11b4	CUL	01/13/04	427.55	130.32	2983.34	909.32	3003.36
H-11b4	CUL	02/10/04	427.79	130.39	2983.10	909.25	3003.10
H-11b4	CUL	03/10/04	427.25	130.23	2983.64	909.41	3003.68
H-11b4	CUL	04/13/04	427.03	130.16	2983.86	909.48	3003.91
H-11b4	CUL	05/11/04	426.50	130.00	2984.39	909.64	3004.48
H-11b4	CUL	06/09/04	426.38	129.96	2984.51	909.68	3004.61
H-11b4	CUL	07/07/04	426.20	129.91	2984.69	909.73	3004.80
H-11b4	CUL	08/11/04	426.17	129.90	2984.72	909.74	3004.83
H-11b4	CUL	09/15/04	426.40	129.97	2984.49	909.67	3004.58
H-11b4	CUL	10/12/04	425.93	129.82	2984.96	909.82	3005.08
H-11b4	CUL	11/10/04	425.18	129.59	2985.71	910.04	3005.88
H-11b4	CUL	12/08/04	424.76	129.47	2986.13	910.17	3006.33
H-17	CUL	01/13/04	422.93	128.91	2962.38	902.93	3011.68
H-17	CUL	02/10/04	423.13	128.97	2962.18	902.87	3011.44
H-17	CUL	03/10/04	422.96	128.92	2962.35	902.92	3011.64

Table F.8 - Groundwater Level Measurement Results for 2004

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-17	CUL	04/13/04	422.49	128.77	2962.82	903.07	3012.19
H-17	CUL	05/11/04	422.06	128.64	2963.25	903.20	3012.69
H-17	CUL	06/09/04	421.84	128.58	2963.47	903.27	3012.95
H-17	CUL	07/07/04	421.72	128.54	2963.59	903.30	3013.09
H-17	CUL	08/11/04	421.60	128.50	2963.71	903.34	3013.23
H-17	CUL	09/15/04	421.78	128.56	2963.53	903.28	3013.02
H-17	CUL	10/12/04	421.44	128.45	2963.87	903.39	3013.41
H-17	CUL	11/10/04	420.92	128.30	2964.39	903.55	3014.02
H-17	CUL	12/08/04	420.43	128.15	2964.88	903.70	3014.59
H-19b0	CUL	01/13/04	428.04	130.47	2990.34	911.46	3012.15
H-19b0	CUL	02/11/04	428.14	130.50	2990.24	911.43	3012.04
H-19b0	CUL	03/09/04	428.42	130.58	2989.96	911.34	3011.74
H-19b0	CUL	04/13/04	428.22	130.52	2990.16	911.40	3011.96
H-19b0	CUL	05/12/04	428.31	130.55	2990.07	911.37	3011.86
H-19b0	CUL	06/09/04	428.10	130.48	2990.28	911.44	3012.08
H-19b0	CUL	07/07/04	427.99	130.45	2990.39	911.47	3012.20
H-19b0	CUL	08/11/04	427.91	130.43	2990.47	911.50	3012.29
H-19b0	CUL	09/16/04	427.88	130.42	2990.50	911.50	3012.32
H-19b0	CUL	10/13/04	428.02	130.46	2990.36	911.46	3012.17
H-19b0	CUL	11/09/04	427.76	130.38	2990.62	911.54	3012.45
H-19b0	CUL	12/09/04	427.21	130.21	2991.17	911.71	3013.03
H-19b2	CUL	03/09/04	429.76	130.99	2989.25	911.12	3011.09
H-19b2	CUL	06/09/04	429.45	130.90	2989.56	911.22	3011.42
H-19b2	CUL	09/16/04	429.21	130.82	2989.80	911.29	3011.68
H-19b2	CUL	12/09/04	428.58	130.63	2990.43	911.48	3012.35
H-19b3	CUL	03/09/04	429.97	131.05	2989.12	911.08	3010.85
H-19b3	CUL	06/09/04	429.65	130.96	2989.44	911.18	3011.19
H-19b3	CUL	09/16/04	429.42	130.89	2989.67	911.25	3011.44
H-19b3	CUL	12/09/04	428.76	130.69	2990.33	911.45	3012.14
H-19b4	CUL	03/09/04	429.23	130.83	2989.80	911.29	3011.42
H-19b4	CUL	06/09/04	428.90	130.73	2990.13	911.39	3011.78
H-19b4	CUL	09/16/04	428.68	130.66	2990.35	911.46	3012.01
H-19b4	CUL	12/09/04	428.00	130.45	2991.03	911.67	3012.74
H-19b5	CUL	03/09/04	429.29	130.85	2989.34	911.15	3010.87
H-19b5	CUL	06/09/04	428.96	130.75	2989.67	911.25	3011.23
H-19b5	CUL	09/16/04	428.75	130.68	2989.88	911.32	3011.45
H-19b5	CUL	12/09/04	428.03	130.46	2990.60	911.53	3012.22
H-19b6	CUL	03/09/04	429.89	131.03	2989.18	911.10	3010.85
H-19b6	CUL	06/09/04	429.57	130.93	2989.50	911.20	3011.19
H-19b6	CUL	09/16/04	429.33	130.86	2989.74	911.27	3011.44
H-19b6	CUL	12/09/04	428.68	130.66	2990.39	911.47	3012.14
H-19b7	CUL	03/09/04	429.97	131.05	2989.02	911.05	3010.72

Table F.8 - Groundwater Level Measurement Results for 2004

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-19b7	CUL	06/09/04	429.66	130.96	2989.33	911.15	3011.05
H-19b7	CUL	09/16/04	429.43	130.89	2989.56	911.22	3011.30
H-19b7	CUL	12/09/04	428.78	130.69	2990.21	911.42	3011.99
I-461	CUL	03/10/04	254.03	77.43	3035.45	925.21	3037.77
I-461	CUL	04/12/04	248.12	75.63	3041.36	927.01	3043.79
I-461	CUL	05/10/04	244.27	74.45	3045.21	928.18	3047.72
I-461	CUL	06/10/04	244.18	74.43	3045.30	928.21	3047.81
I-461	CUL	07/06/04	243.34	74.17	3046.14	928.46	3048.66
I-461	CUL	08/14/04	243.30	74.16	3046.18	928.48	3048.70
I-461	CUL	09/13/04	242.25	73.84	3047.23	928.80	3049.77
I-461	CUL	10/11/04	240.25	73.23	3049.23	929.41	3051.81
I-461	CUL	11/09/04	240.62	73.34	3048.86	929.29	3051.44
I-461	CUL	12/06/04	239.30	72.94	3050.18	929.69	3052.78
P-17	CUL	01/13/04	353.67	107.80	2983.57	909.39	2997.76
P-17	CUL	02/10/04	353.85	107.85	2983.39	909.34	2997.57
P-17	CUL	03/10/04	353.58	107.77	2983.66	909.42	2997.86
P-17	CUL	04/13/04	353.31	107.69	2983.93	909.50	2998.14
P-17	CUL	05/11/04	352.85	107.55	2984.39	909.64	2998.63
P-17	CUL	06/09/04	352.69	107.50	2984.55	909.69	2998.80
P-17	CUL	07/07/04	352.58	107.47	2984.66	909.72	2998.92
P-17	CUL	08/11/04	352.44	107.42	2984.80	909.77	2999.07
P-17	CUL	09/15/04	352.58	107.47	2984.66	909.72	2998.92
P-17	CUL	10/12/04	352.35	107.40	2984.89	909.79	2999.17
P-17	CUL	11/10/04	351.78	107.22	2985.46	909.97	2999.77
P-17	CUL	12/08/04	351.25	107.06	2985.99	910.13	3000.34
SNL-01	CUL	04/13/04	419.06	127.73	3093.78	942.98	3097.40
SNL-01	CUL	05/12/04	441.15	134.46	3071.69	936.25	3077.17
SNL-01	CUL	06/10/04	441.90	134.69	3070.94	936.02	3075.22
SNL-01	CUL	07/06/04	441.81	134.66	3071.03	936.05	3075.31
SNL-01	CUL	08/10/04	441.90	134.69	3070.94	936.02	3075.22
SNL-01	CUL	09/13/04	441.56	134.59	3071.28	936.13	3075.57
SNL-01	CUL	10/11/04	440.70	134.33	3072.14	936.39	3076.45
SNL-01	CUL	11/09/04	439.25	133.88	3073.59	936.83	3077.93
SNL-01	CUL	12/06/04	438.65	133.70	3074.19	937.01	3078.55
SNL-02	CUL	03/08/04	258.05	78.65	3064.98	934.21	3078.80
SNL-02	CUL	04/12/04	257.95	78.62	3065.08	934.24	3078.91
SNL-02	CUL	05/10/04	258.57	78.81	3064.46	934.05	3067.64
SNL-02	CUL	06/07/04	258.26	78.72	3064.77	934.14	3067.95
SNL-02	CUL	07/06/04	258.19	78.70	3064.84	934.16	3068.02
SNL-02	CUL	08/09/04	258.33	78.74	3064.70	934.12	3067.88
SNL-02	CUL	09/13/04	257.79	78.57	3065.24	934.29	3068.43
SNL-02	CUL	10/11/04	255.09	77.75	3067.94	935.11	3071.17

Table F.8 - Groundwater Level Measurement Results for 2004

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
SNL-02	CUL	11/09/04	254.38	77.54	3068.65	935.32	3071.89
SNL-02	CUL	12/06/04	253.13	77.15	3069.90	935.71	3073.16
SNL-03	CUL	01/13/04	432.69	131.88	3057.65	931.97	3071.69
SNL-03	CUL	02/10/04	432.32	131.77	3058.02	932.08	3072.08
SNL-03	CUL	03/08/04	432.15	131.72	3058.19	932.14	3072.26
SNL-03	CUL	05/11/04	424.93	129.52	3065.41	934.34	3079.78
SNL-03	CUL	06/07/04	425.07	129.56	3065.27	934.29	3079.63
SNL-03	CUL	07/06/04	425.12	129.58	3065.22	934.28	3074.79
SNL-03	CUL	08/10/04	425.37	129.65	3064.97	934.20	3074.54
SNL-03	CUL	09/13/04	425.08	129.56	3065.26	934.29	3074.83
SNL-03	CUL	10/11/04	424.67	129.44	3065.67	934.42	3075.26
SNL-03	CUL	11/09/04	424.05	129.25	3066.29	934.61	3075.89
SNL-03	CUL	12/06/04	423.23	129.00	3067.11	934.86	3076.74
SNL-05	CUL	06/07/04	313.60	95.59	3068.28	935.21	3070.30
SNL-05	CUL	09/13/04	313.55	95.57	3068.33	935.23	3070.35
SNL-05	CUL	10/11/04	312.79	95.34	3069.09	935.46	3071.12
SNL-05	CUL	11/09/04	311.89	95.06	3069.99	935.73	3072.02
SNL-05	CUL	12/06/04	311.06	94.81	3070.82	935.99	3072.86
SNL-09	CUL	01/12/04	315.80	96.26	3045.15	928.16	3054.10
SNL-09	CUL	02/09/04	315.87	96.28	3045.08	928.14	3054.02
SNL-09	CUL	03/08/04	315.80	96.26	3045.15	928.16	3054.10
SNL-09	CUL	04/12/04	312.68	95.30	3048.27	929.11	3057.33
SNL-09	CUL	05/10/04	312.69	95.31	3048.26	929.11	3052.54
SNL-09	CUL	06/07/04	312.55	95.27	3048.40	929.15	3052.67
SNL-09	CUL	07/06/04	312.96	95.39	3047.99	929.03	3052.25
SNL-09	CUL	08/10/04	313.13	95.44	3047.82	928.98	3052.08
SNL-09	CUL	09/13/04	312.71	95.31	3048.24	929.10	3052.50
SNL-09	CUL	10/11/04	311.56	94.96	3049.39	929.45	3053.67
SNL-12	CUL	01/12/04	343.10	104.58	2996.34	913.28	3000.86
SNL-12	CUL	02/09/04	343.06	104.56	2996.38	913.30	3000.90
SNL-12	CUL	03/08/04	342.41	104.37	2997.03	913.49	3001.56
SNL-12	CUL	04/13/04	340.50	103.78	2998.94	914.08	3003.51
SNL-12	CUL	05/10/04	340.12	103.67	2999.32	914.19	3000.24
SNL-12	CUL	06/08/04	340.05	103.65	2999.39	914.21	3000.31
SNL-12	CUL	07/06/04	339.94	103.61	2999.50	914.25	3000.42
SNL-12	CUL	10/12/04	339.41	103.45	3000.03	914.41	3000.95
SNL-12	CUL	11/08/04	338.45	103.16	3000.99	914.70	3001.91
SNL-12	CUL	12/07/04	337.91	102.99	3001.53	914.87	3002.45
WIPP-12	CUL	01/13/04	439.75	134.04	3032.31	924.25	3069.13
WIPP-12	CUL	02/11/04	440.00	134.11	3032.06	924.17	3068.85
WIPP-12	CUL	03/09/04	439.98	134.11	3032.08	924.18	3068.87
WIPP-12	CUL	04/14/04	440.09	134.14	3031.97	924.14	3068.75

Table F.8 - Groundwater Level Measurement Results for 2004

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-12	CUL	05/12/04	440.26	134.19	3031.80	924.09	3068.57
WIPP-12	CUL	06/09/04	440.41	134.24	3031.65	924.05	3068.40
WIPP-12	CUL	07/08/04	440.58	134.29	3031.48	924.00	3068.22
WIPP-12	CUL	08/11/04	440.67	134.32	3031.39	923.97	3068.12
WIPP-12	CUL	09/16/04	440.62	134.30	3031.44	923.98	3068.17
WIPP-12	CUL	10/13/04	440.39	134.23	3031.67	924.05	3068.43
WIPP-12	CUL	11/09/04	439.95	134.10	3032.11	924.19	3068.91
WIPP-12	CUL	12/08/04	439.77	134.04	3032.29	924.24	3069.11
WIPP-13	CUL	01/12/04	349.34	106.48	3056.37	931.58	3066.91
WIPP-13	CUL	02/09/04	349.65	106.57	3056.06	931.49	3066.59
WIPP-13	CUL	03/08/04	349.97	106.67	3055.74	931.39	3066.26
WIPP-13	CUL	04/13/04	349.71	106.59	3056.00	931.47	3066.53
WIPP-13	CUL	05/12/04	349.94	106.66	3055.77	931.40	3066.29
WIPP-13	CUL	06/07/04	349.95	106.66	3055.76	931.40	3066.28
WIPP-13	CUL	07/06/04	350.09	106.71	3055.62	931.35	3066.14
WIPP-13	CUL	08/10/04	350.22	106.75	3055.49	931.31	3066.01
WIPP-13	CUL	09/13/04	350.10	106.71	3055.61	931.35	3066.13
WIPP-13	CUL	10/11/04	349.58	106.55	3056.13	931.51	3066.66
WIPP-13	CUL	11/10/04	349.29	106.46	3056.42	931.60	3066.96
WIPP-13	CUL	12/07/04	348.87	106.34	3056.84	931.72	3067.40
WIPP-19	CUL	01/14/04	394.38	120.21	3040.76	926.82	3078.65
WIPP-19	CUL	02/11/04	394.54	120.26	3040.60	926.77	3078.47
WIPP-19	CUL	03/09/04	394.98	120.39	3040.16	926.64	3077.99
WIPP-19	CUL	04/14/04	395.00	120.40	3040.14	926.63	3077.97
WIPP-19	CUL	05/12/04	395.30	120.49	3039.84	926.54	3077.64
WIPP-19	CUL	06/09/04	395.21	120.46	3039.93	926.57	3077.73
WIPP-19	CUL	07/08/04	395.21	120.46	3039.93	926.57	3077.73
WIPP-19	CUL	08/11/04	395.38	120.51	3039.76	926.52	3077.55
WIPP-19	CUL	09/16/04	395.20	120.46	3039.94	926.57	3077.75
WIPP-19	CUL	10/13/04	394.87	120.36	3040.27	926.67	3078.11
WIPP-19	CUL	11/09/04	394.75	120.32	3040.39	926.71	3078.24
WIPP-19	CUL	12/08/04	394.56	120.26	3040.58	926.77	3078.45
WIPP-21	CUL	01/14/04	401.90	122.50	3017.06	919.60	3041.28
WIPP-21	CUL	02/11/04	402.06	122.55	3016.90	919.55	3041.10
WIPP-21	CUL	03/09/04	402.42	122.66	3016.54	919.44	3040.72
WIPP-21	CUL	04/14/04	404.23	123.21	3014.73	918.89	3038.78
WIPP-21	CUL	05/12/04	402.95	122.82	3016.01	919.28	3040.15
WIPP-21	CUL	06/09/04	402.40	122.65	3016.56	919.45	3040.74
WIPP-21	CUL	07/08/04	402.27	122.61	3016.69	919.49	3040.88
WIPP-21	CUL	08/11/04	402.25	122.61	3016.71	919.49	3040.90
WIPP-21	CUL	09/16/04	402.12	122.57	3016.84	919.53	3041.04
WIPP-21	CUL	10/13/04	401.94	122.51	3017.02	919.59	3041.23

Table F.8 - Groundwater Level Measurement Results for 2004

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	11/09/04	401.99	122.53	3016.97	919.57	3041.18
WIPP-21	CUL	12/08/04	401.81	122.47	3017.15	919.63	3041.37
WIPP-22	CUL	01/14/04	396.91	120.98	3031.21	923.91	3062.37
WIPP-22	CUL	02/11/04	397.08	121.03	3031.04	923.86	3062.19
WIPP-22	CUL	05/12/04	397.89	121.28	3030.23	923.61	3061.31
WIPP-22	CUL	06/09/04	397.67	121.21	3030.45	923.68	3061.55
WIPP-22	CUL	07/08/04	397.59	121.19	3030.53	923.71	3061.64
WIPP-22	CUL	08/11/04	397.70	121.22	3030.42	923.67	3061.52
WIPP-22	CUL	09/16/04	397.54	121.17	3030.58	923.72	3061.69
WIPP-22	CUL	10/13/04	397.28	121.09	3030.84	923.80	3061.97
WIPP-22	CUL	11/09/04	397.21	121.07	3030.91	923.82	3062.05
WIPP-22	CUL	12/08/04	396.98	121.00	3031.14	923.89	3062.30
WIPP-25 (PIP)	CUL	01/12/04	154.67	47.14	3059.72	932.60	3056.65
WIPP-25 (PIP)	CUL	02/09/04	154.88	47.21	3059.51	932.54	3056.44
WIPP-25 (PIP)	CUL	03/08/04	154.96	47.23	3059.43	932.51	3056.37
WIPP-25 (PIP)	CUL	04/12/04	154.62	47.13	3059.77	932.62	3056.70
WIPP-25 (PIP)	CUL	05/10/04	154.87	47.20	3059.52	932.54	3056.45
WIPP-25 (PIP)	CUL	06/07/04	155.19	47.30	3059.20	932.44	3056.14
WIPP-25 (PIP)	CUL	07/06/04	155.17	47.30	3059.22	932.45	3056.16
WIPP-25 (PIP)	CUL	08/09/04	155.28	47.33	3059.11	932.42	3056.05
WIPP-25 (PIP)	CUL	11/09/04	151.49	46.17	3062.90	933.57	3059.80
WIPP-25 (PIP)	CUL	12/06/04	150.81	45.97	3063.58	933.78	3060.47
WIPP-26	CUL	01/12/04	131.35	40.04	3021.85	921.06	3021.99
WIPP-26	CUL	02/09/04	131.50	40.08	3021.70	921.01	3021.83
WIPP-26	CUL	03/08/04	131.51	40.08	3021.69	921.01	3021.82
WIPP-26	CUL	04/12/04	130.27	39.71	3022.93	921.39	3023.07
WIPP-26	CUL	05/10/04	130.24	39.70	3022.96	921.40	3023.10
WIPP-26	CUL	06/07/04	130.67	39.83	3022.53	921.27	3022.67
WIPP-26	CUL	07/06/04	130.80	39.87	3022.40	921.23	3022.54
WIPP-26	CUL	08/09/04	131.41	40.05	3021.79	921.04	3021.93
WIPP-26	CUL	09/13/04	130.05	39.64	3023.15	921.46	3023.29
WIPP-26	CUL	10/12/04	128.17	39.07	3025.03	922.03	3025.17
WIPP-27 (PIP)	CUL	01/12/04	98.52	30.03	3080.46	938.92	3086.50
WIPP-27 (PIP)	CUL	02/09/04	98.41	30.00	3080.57	938.96	3086.61
WIPP-27 (PIP)	CUL	03/08/04	98.38	29.99	3080.60	938.97	3086.64
WIPP-27 (PIP)	CUL	04/12/04	98.28	29.96	3080.70	939.00	3086.75
WIPP-27 (PIP)	CUL	05/10/04	97.66	29.77	3081.32	939.19	3087.39
WIPP-27 (PIP)	CUL	06/07/04	97.57	29.74	3081.41	939.21	3087.48
WIPP-27 (PIP)	CUL	07/06/04	97.53	29.73	3081.45	939.23	3087.52
WIPP-27 (PIP)	CUL	09/15/04	96.66	29.46	3082.32	939.49	3088.41
WIPP-27 (PIP)	CUL	10/11/04	95.52	29.11	3083.46	939.84	3089.59
WIPP-27 (PIP)	CUL	11/08/04	94.44	28.79	3084.54	940.17	3090.70

Table F.8 - Groundwater Level Measurement Results for 2004

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-27 (PIP)	CUL	12/06/04	93.54	28.51	3085.44	940.44	3091.63
WIPP-29	CUL	01/12/04	11.48	3.50	2966.78	904.27	2969.89
WIPP-29	CUL	02/09/04	11.44	3.49	2966.82	904.29	2969.94
WIPP-29	CUL	03/08/04	11.07	3.37	2967.19	904.40	2970.38
WIPP-29	CUL	04/12/04	10.58	3.22	2967.68	904.55	2970.96
WIPP-29	CUL	05/10/04	10.96	3.34	2967.30	904.43	2970.51
WIPP-29	CUL	06/07/04	11.20	3.41	2967.06	904.36	2970.23
WIPP-29	CUL	07/06/04	11.24	3.43	2967.02	904.35	2970.18
WIPP-29	CUL	08/09/04	11.29	3.44	2966.97	904.33	2970.12
WIPP-29	CUL	09/13/04	11.05	3.37	2967.21	904.41	2970.40
WIPP-29	CUL	10/12/04	10.34	3.15	2967.92	904.62	2971.24
WIPP-29	CUL	11/08/04	10.79	3.29	2967.47	904.48	2970.71
WIPP-29	CUL	12/07/04	10.29	3.14	2967.97	904.64	2971.30
WIPP-30 (PIP)	CUL	01/13/04	359.02	109.43	3070.03	935.75	3077.14
WIPP-30 (PIP)	CUL	02/10/04	359.21	109.49	3069.84	935.69	3076.95
WIPP-30 (PIP)	CUL	03/08/04	359.45	109.56	3069.60	935.61	3076.70
WIPP-30 (PIP)	CUL	04/13/04	359.23	109.49	3069.82	935.68	3076.93
WIPP-30 (PIP)	CUL	05/10/04	359.32	109.52	3069.73	935.65	3076.84
WIPP-30 (PIP)	CUL	06/07/04	359.36	109.53	3069.69	935.64	3076.80
WIPP-30 (PIP)	CUL	07/06/04	359.43	109.55	3069.62	935.62	3076.72
WIPP-30 (PIP)	CUL	08/10/04	359.64	109.62	3069.41	935.56	3076.51
WIPP-30 (PIP)	CUL	09/13/04	359.33	109.52	3069.72	935.65	3076.83
WIPP-30 (PIP)	CUL	10/11/04	359.04	109.44	3070.01	935.74	3077.12
WIPP-30 (PIP)	CUL	11/09/04	358.36	109.23	3070.69	935.95	3077.82
WIPP-30 (PIP)	CUL	12/06/04	357.59	108.99	3071.46	936.18	3078.61
WQSP-1	CUL	01/14/04	365.20	111.31	3054.00	930.86	3070.70
WQSP-1	CUL	02/11/04	365.38	111.37	3053.82	930.80	3070.51
WQSP-1	CUL	03/09/04	365.79	111.49	3053.41	930.68	3070.08
WQSP-1	CUL	04/14/04	365.53	111.41	3053.67	930.76	3070.35
WQSP-1	CUL	05/12/04	365.75	111.48	3053.45	930.69	3070.12
WQSP-1	CUL	06/09/04	365.79	111.49	3053.41	930.68	3070.08
WQSP-1	CUL	07/08/04	365.80	111.50	3053.40	930.68	3070.07
WQSP-1	CUL	08/11/04	366.04	111.57	3053.16	930.60	3069.82
WQSP-1	CUL	09/14/04	365.68	111.46	3053.52	930.71	3070.20
WQSP-1	CUL	10/13/04	365.16	111.30	3054.04	930.87	3070.74
WQSP-1	CUL	11/09/04	364.94	111.23	3054.26	930.94	3070.97
WQSP-1	CUL	12/08/04	364.32	111.04	3054.88	931.13	3071.62
WQSP-2	CUL	01/14/04	404.35	123.25	3059.55	932.55	3079.30
WQSP-2	CUL	02/11/04	404.41	123.26	3059.49	932.53	3079.23
WQSP-2	CUL	03/09/04	404.71	123.36	3059.19	932.44	3078.92
WQSP-2	CUL	04/14/04	404.22	123.21	3059.68	932.59	3079.43
WQSP-2	CUL	05/12/04	405.32	123.54	3058.58	932.26	3078.28

Table F.8 - Groundwater Level Measurement Results for 2004

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-2	CUL	06/09/04	405.20	123.50	3058.70	932.29	3078.41
WQSP-2	CUL	07/08/04	405.12	123.48	3058.78	932.32	3078.49
WQSP-2	CUL	08/11/04	405.28	123.53	3058.62	932.27	3078.32
WQSP-2	CUL	09/14/04	404.86	123.40	3059.04	932.40	3078.76
WQSP-2	CUL	10/13/04	405.37	123.56	3058.53	932.24	3078.23
WQSP-2	CUL	11/09/04	404.98	123.44	3058.92	932.36	3078.64
WQSP-2	CUL	12/08/04	403.83	123.09	3060.07	932.71	3079.84
WQSP-3	CUL	01/14/04	467.49	142.49	3012.81	918.30	3070.09
WQSP-3	CUL	02/11/04	467.52	142.50	3012.78	918.30	3070.05
WQSP-3	CUL	03/09/04	467.75	142.57	3012.55	918.23	3069.79
WQSP-3	CUL	04/14/04	468.96	142.94	3011.34	917.86	3068.40
WQSP-3	CUL	05/12/04	468.36	142.76	3011.94	918.04	3069.09
WQSP-3	CUL	06/09/04	468.37	142.76	3011.93	918.04	3069.08
WQSP-3	CUL	07/08/04	468.36	142.76	3011.94	918.04	3069.09
WQSP-3	CUL	08/11/04	468.41	142.77	3011.89	918.02	3069.03
WQSP-3	CUL	09/14/04	468.17	142.70	3012.13	918.10	3069.31
WQSP-3	CUL	10/13/04	467.92	142.62	3012.38	918.17	3069.59
WQSP-3	CUL	11/09/04	469.19	143.01	3011.11	917.79	3068.14
WQSP-3	CUL	12/08/04	468.25	142.72	3012.05	918.07	3069.22
WQSP-4	CUL	01/14/04	445.20	135.70	2987.80	910.68	3012.78
WQSP-4	CUL	02/11/04	445.39	135.75	2987.61	910.62	3012.57
WQSP-4	CUL	03/09/04	445.73	135.86	2987.27	910.52	3012.21
WQSP-4	CUL	04/14/04	445.42	135.76	2987.58	910.61	3012.54
WQSP-4	CUL	05/12/04	445.58	135.81	2987.42	910.57	3012.37
WQSP-4	CUL	06/09/04	445.34	135.74	2987.66	910.64	3012.62
WQSP-4	CUL	07/08/04	445.23	135.71	2987.77	910.67	3012.74
WQSP-4	CUL	08/11/04	445.24	135.71	2987.76	910.67	3012.73
WQSP-4	CUL	09/14/04	445.12	135.67	2987.88	910.71	3012.86
WQSP-4	CUL	10/13/04	445.32	135.73	2987.68	910.64	3012.65
WQSP-4	CUL	11/09/04	444.93	135.61	2988.07	910.76	3013.07
WQSP-4	CUL	12/08/04	444.53	135.49	2988.47	910.89	3013.50
WQSP-5	CUL	01/14/04	380.69	116.03	3003.71	915.53	3010.79
WQSP-5	CUL	02/11/04	380.80	116.07	3003.60	915.50	3010.68
WQSP-5	CUL	03/09/04	381.16	116.18	3003.24	915.39	3010.31
WQSP-5	CUL	04/14/04	380.92	116.10	3003.48	915.46	3010.55
WQSP-5	CUL	05/12/04	381.73	116.35	3002.67	915.21	3009.72
WQSP-5	CUL	06/09/04	381.08	116.15	3003.32	915.41	3010.39
WQSP-5	CUL	07/08/04	380.96	116.12	3003.44	915.45	3010.51
WQSP-5	CUL	08/11/04	380.94	116.11	3003.46	915.45	3010.53
WQSP-5	CUL	09/14/04	380.68	116.03	3003.72	915.53	3010.80
WQSP-5	CUL	10/13/04	380.79	116.06	3003.61	915.50	3010.69
WQSP-5	CUL	11/09/04	381.08	116.15	3003.32	915.41	3010.39

Table F.8 - Groundwater Level Measurement Results for 2004

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-5	CUL	12/08/04	380.45	115.96	3003.95	915.60	3011.03
WQSP-6	CUL	01/14/04	346.63	105.65	3017.17	919.63	3020.92
WQSP-6	CUL	02/11/04	346.60	105.64	3017.20	919.64	3020.95
WQSP-6	CUL	03/09/04	346.79	105.70	3017.01	919.58	3020.76
WQSP-6	CUL	04/14/04	346.56	105.63	3017.24	919.65	3020.99
WQSP-6	CUL	05/12/04	346.37	105.57	3017.43	919.71	3021.18
WQSP-6	CUL	06/09/04	347.45	105.90	3016.35	919.38	3020.09
WQSP-6	CUL	07/08/04	346.96	105.75	3017.74	919.81	3021.50
WQSP-6	CUL	08/11/04	346.86	105.72	3017.84	919.84	3021.60
WQSP-6	CUL	09/14/04	346.55	105.63	3018.15	919.93	3021.91
WQSP-6	CUL	10/13/04	346.40	105.58	3018.30	919.98	3022.07
WQSP-6	CUL	11/09/04	350.36	106.79	3014.34	918.77	3018.05
WQSP-6	CUL	12/08/04	347.05	105.78	3017.65	919.78	3021.41
C-2737 (ANNULUS)	MAG	04/14/04	260.40	79.37	3138.90	956.74	N/A
C-2737 (ANNULUS)	MAG	05/12/04	259.10	78.97	3140.20	957.13	N/A
C-2737 (ANNULUS)	MAG	06/10/04	257.48	78.48	3141.82	957.63	N/A
C-2737 (ANNULUS)	MAG	07/08/04	257.33	78.43	3141.97	957.67	N/A
C-2737 (ANNULUS)	MAG	08/11/04	257.18	78.39	3142.12	957.72	N/A
C-2737 (ANNULUS)	MAG	09/17/04	256.90	78.30	3142.40	957.80	N/A
C-2737 (ANNULUS)	MAG	10/14/04	256.67	78.23	3142.63	957.87	N/A
C-2737 (ANNULUS)	MAG	11/10/04	256.45	78.17	3142.85	957.94	N/A
C-2737 (ANNULUS)	MAG	12/08/04	256.15	78.07	3143.15	958.03	N/A
H-02b1	MAG	01/13/04	233.12	71.05	3145.34	958.70	N/A
H-02b1	MAG	02/11/04	233.32	71.12	3145.14	958.64	N/A
H-02b1	MAG	03/10/04	233.40	71.14	3145.06	958.61	N/A
H-02b1	MAG	04/14/04	233.60	71.20	3144.86	958.55	N/A
H-02b1	MAG	05/12/04	233.71	71.23	3144.75	958.52	N/A
H-02b1	MAG	06/10/04	234.02	71.33	3144.44	958.43	N/A
H-02b1	MAG	07/08/04	234.09	71.35	3144.37	958.40	N/A
H-02b1	MAG	08/11/04	234.33	71.42	3144.13	958.33	N/A
H-02b1	MAG	09/17/04	234.53	71.48	3143.93	958.27	N/A
H-02b1	MAG	10/13/04	234.57	71.50	3143.89	958.26	N/A
H-02b1	MAG	11/10/04	234.68	71.53	3143.78	958.22	N/A
H-02b1	MAG	12/09/04	234.70	71.54	3143.76	958.22	N/A
H-03b1	MAG	01/13/04	257.65	78.53	3132.99	954.94	N/A
H-03b1	MAG	02/11/04	254.27	77.50	3136.37	955.97	N/A
H-03b1	MAG	03/10/04	251.23	76.57	3139.41	956.89	N/A
H-03b1	MAG	04/14/04	250.69	76.41	3139.95	957.06	N/A
H-03b1	MAG	05/12/04	250.05	76.22	3140.59	957.25	N/A
H-03b1	MAG	06/09/04	249.60	76.08	3141.04	957.39	N/A
H-03b1	MAG	07/08/04	249.28	75.98	3141.36	957.49	N/A
H-03b1	MAG	08/11/04	249.06	75.91	3141.58	957.55	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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-03b1	MAG	09/17/04	247.17	75.34	3143.47	958.13	N/A
H-03b1	MAG	10/14/04	246.17	75.03	3144.47	958.43	N/A
H-03b1	MAG	11/10/04	245.77	74.91	3144.87	958.56	N/A
H-03b1	MAG	12/09/04	245.45	74.81	3145.19	958.65	N/A
H-04c	MAG	01/13/04	192.04	58.53	3142.00	957.68	N/A
H-04c	MAG	02/11/04	192.30	58.61	3141.74	957.60	N/A
H-04c	MAG	03/08/04	192.40	58.64	3141.64	957.57	N/A
H-04c	MAG	04/13/04	192.32	58.62	3141.72	957.60	N/A
H-04c	MAG	05/12/04	192.41	58.65	3141.63	957.57	N/A
H-04c	MAG	06/10/04	192.50	58.67	3141.54	957.54	N/A
H-04c	MAG	07/08/04	192.71	58.74	3141.33	957.48	N/A
H-04c	MAG	08/11/04	192.87	58.79	3141.17	957.43	N/A
H-04c	MAG	09/15/04	192.87	58.79	3141.17	957.43	N/A
H-04c	MAG	10/14/04	192.67	58.73	3141.37	957.49	N/A
H-04c	MAG	11/09/04	192.79	58.76	3141.25	957.45	N/A
H-04c	MAG	12/08/04	192.70	58.73	3141.34	957.48	N/A
H-05c	MAG	01/13/04	349.53	106.54	3156.51	962.10	N/A
H-05c	MAG	02/11/04	349.52	106.53	3156.52	962.11	N/A
H-05c	MAG	03/09/04	349.71	106.59	3156.33	962.05	N/A
H-05c	MAG	04/13/04	349.54	106.54	3156.50	962.10	N/A
H-05c	MAG	05/11/04	349.45	106.51	3156.59	962.13	N/A
H-05c	MAG	06/08/04	349.51	106.53	3156.53	962.11	N/A
H-05c	MAG	07/06/04	349.61	106.56	3156.43	962.08	N/A
H-05c	MAG	08/10/04	349.78	106.61	3156.26	962.03	N/A
H-05c	MAG	09/13/04	349.65	106.57	3156.39	962.07	N/A
H-05c	MAG	10/13/04	349.43	106.51	3156.61	962.13	N/A
H-05c	MAG	11/10/04	349.51	106.53	3156.53	962.11	N/A
H-05c	MAG	12/07/04	349.36	106.48	3156.68	962.16	N/A
H-06c	MAG	01/12/04	282.32	86.05	3066.20	934.58	N/A
H-06c	MAG	02/09/04	282.39	86.07	3066.13	934.56	N/A
H-06c	MAG	03/08/04	282.37	86.07	3066.15	934.56	N/A
H-06c	MAG	04/12/04	282.02	85.96	3066.50	934.67	N/A
H-06c	MAG	05/10/04	281.96	85.94	3066.56	934.69	N/A
H-06c	MAG	06/07/04	281.98	85.95	3066.54	934.68	N/A
H-06c	MAG	07/06/04	282.08	85.98	3066.44	934.65	N/A
H-06c	MAG	08/10/04	282.20	86.01	3066.32	934.61	N/A
H-06c	MAG	09/13/04	281.96	85.94	3066.56	934.69	N/A
H-06c	MAG	10/11/04	281.76	85.88	3066.76	934.75	N/A
H-06c	MAG	11/09/04	281.75	85.88	3066.77	934.75	N/A
H-06c	MAG	12/06/04	281.43	85.78	3067.09	934.85	N/A
H-08a	MAG	01/12/04	405.91	123.72	3027.08	922.65	N/A
H-08a	MAG	02/10/04	406.03	123.76	3026.96	922.62	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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-08a	MAG	03/08/04	406.00	123.75	3026.99	922.63	N/A
H-08a	MAG	04/12/04	405.94	123.73	3027.05	922.64	N/A
H-08a	MAG	05/10/04	405.90	123.72	3027.09	922.66	N/A
H-08a	MAG	06/09/04	405.89	123.72	3027.10	922.66	N/A
H-08a	MAG	07/07/04	405.96	123.74	3027.03	922.64	N/A
H-08a	MAG	08/10/04	405.93	123.73	3027.06	922.65	N/A
H-08a	MAG	09/13/04	405.94	123.73	3027.05	922.64	N/A
H-08a	MAG	10/12/04	405.84	123.70	3027.15	922.68	N/A
H-08a	MAG	11/08/04	405.75	123.67	3027.24	922.70	N/A
H-08a	MAG	12/07/04	405.68	123.65	3027.31	922.72	N/A
H-09c (ANNULUS)	MAG	01/12/04	272.74	83.13	3134.56	955.41	N/A
H-09c (ANNULUS)	MAG	02/09/04	272.74	83.13	3134.56	955.41	N/A
H-09c (ANNULUS)	MAG	03/08/04	272.87	83.17	3134.43	955.37	N/A
H-09c (ANNULUS)	MAG	04/13/04	272.60	83.09	3134.70	955.46	N/A
H-09c (ANNULUS)	MAG	05/10/04	271.91	82.88	3135.39	955.67	N/A
H-09c (ANNULUS)	MAG	06/08/04	272.13	82.95	3135.17	955.60	N/A
H-09c (ANNULUS)	MAG	07/07/04	272.32	83.00	3134.98	955.54	N/A
H-09c (ANNULUS)	MAG	08/10/04	272.42	83.03	3134.88	955.51	N/A
H-09c (ANNULUS)	MAG	09/14/04	272.15	82.95	3135.15	955.59	N/A
H-09c (ANNULUS)	MAG	10/12/04	272.03	82.91	3135.27	955.63	N/A
H-09c (ANNULUS)	MAG	11/08/04	272.09	82.93	3135.21	955.61	N/A
H-09c (ANNULUS)	MAG	12/07/04	271.79	82.84	3135.51	955.70	N/A
H-10a	MAG	01/12/04	466.06	142.06	3222.61	982.25	N/A
H-10a	MAG	02/10/04	466.09	142.06	3222.58	982.24	N/A
H-10a	MAG	03/09/04	466.20	142.10	3222.47	982.21	N/A
H-10a	MAG	04/13/04	466.29	142.13	3222.38	982.18	N/A
H-10a	MAG	05/11/04	466.41	142.16	3222.26	982.14	N/A
H-10a	MAG	06/08/04	466.54	142.20	3222.13	982.11	N/A
H-10a	MAG	07/07/04	466.75	142.27	3221.92	982.04	N/A
H-10a	MAG	08/10/04	466.89	142.31	3221.78	982.00	N/A
H-10a	MAG	09/14/04	467.02	142.35	3221.65	981.96	N/A
H-10a	MAG	10/12/04	466.86	142.30	3221.81	982.01	N/A
H-10a	MAG	11/08/04	466.80	142.28	3221.87	982.03	N/A
H-10a	MAG	12/07/04	466.65	142.23	3222.02	982.07	N/A
H-11b2	MAG	01/13/04	279.09	85.07	3132.55	954.80	N/A
H-11b2	MAG	02/10/04	279.10	85.07	3132.54	954.80	N/A
H-11b2	MAG	03/10/04	279.08	85.06	3132.56	954.80	N/A
H-11b2	MAG	04/13/04	278.92	85.01	3132.72	954.85	N/A
H-11b2	MAG	05/11/04	278.73	84.96	3132.91	954.91	N/A
H-11b2	MAG	06/09/04	278.77	84.97	3132.87	954.90	N/A
H-11b2	MAG	07/07/04	278.90	85.01	3132.74	954.86	N/A
H-11b2	MAG	08/11/04	278.93	85.02	3132.71	954.85	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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-11b2	MAG	09/15/04	278.74	84.96	3132.90	954.91	N/A
H-11b2	MAG	10/12/04	278.64	84.93	3133.00	954.94	N/A
H-11b2	MAG	11/10/04	278.57	84.91	3133.07	954.96	N/A
H-11b2	MAG	12/08/04	278.40	84.86	3133.24	955.01	N/A
H-14	MAG	01/13/04	237.90	72.51	3109.21	947.69	N/A
H-14	MAG	02/11/04	237.76	72.47	3109.35	947.73	N/A
H-14	MAG	03/08/04	237.68	72.44	3109.43	947.75	N/A
H-14	MAG	04/13/04	237.44	72.37	3109.67	947.83	N/A
H-14	MAG	05/12/04	237.29	72.33	3109.82	947.87	N/A
H-14	MAG	06/09/04	237.60	72.42	3109.51	947.78	N/A
H-14	MAG	07/06/04	237.51	72.39	3109.60	947.81	N/A
H-14	MAG	08/10/04	237.26	72.32	3109.85	947.88	N/A
H-14	MAG	09/14/04	237.00	72.24	3110.11	947.96	N/A
H-14	MAG	10/14/04	236.03	71.94	3111.08	948.26	N/A
H-14	MAG	11/10/04	236.59	72.11	3110.52	948.09	N/A
H-14	MAG	12/08/04	236.51	72.09	3110.60	948.11	N/A
H-18	MAG	01/12/04	339.44	103.46	3074.77	937.19	N/A
H-18	MAG	02/09/04	339.63	103.52	3074.58	937.13	N/A
H-18	MAG	03/08/04	339.91	103.60	3074.30	937.05	N/A
H-18	MAG	04/12/04	339.50	103.48	3074.71	937.17	N/A
H-18	MAG	05/10/04	339.65	103.53	3074.56	937.13	N/A
H-18	MAG	06/07/04	339.63	103.52	3074.58	937.13	N/A
H-18	MAG	07/06/04	339.77	103.56	3074.44	937.09	N/A
H-18	MAG	08/10/04	340.14	103.67	3074.07	936.98	N/A
H-18	MAG	09/13/04	339.90	103.60	3074.31	937.05	N/A
H-18	MAG	10/13/04	339.42	103.46	3074.79	937.20	N/A
H-18	MAG	11/09/04	339.17	103.38	3075.04	937.27	N/A
H-18	MAG	12/08/04	338.90	103.30	3075.31	937.35	N/A
WIPP-18	MAG	01/14/04	316.19	96.37	3142.57	957.86	N/A
WIPP-18	MAG	02/11/04	316.05	96.33	3142.71	957.90	N/A
WIPP-18	MAG	03/09/04	316.02	96.32	3142.74	957.91	N/A
WIPP-18	MAG	04/14/04	315.69	96.22	3143.07	958.01	N/A
WIPP-18	MAG	05/12/04	315.49	96.16	3143.27	958.07	N/A
WIPP-18	MAG	06/09/04	315.14	96.05	3143.62	958.18	N/A
WIPP-18	MAG	07/08/04	314.92	95.99	3143.84	958.24	N/A
WIPP-18	MAG	08/11/04	314.84	95.96	3143.92	958.27	N/A
WIPP-18	MAG	09/16/04	314.81	95.95	3143.95	958.28	N/A
WIPP-18	MAG	10/13/04	313.92	95.68	3144.84	958.55	N/A
WIPP-18	MAG	11/09/04	314.44	95.84	3144.32	958.39	N/A
WIPP-18	MAG	12/08/04	314.20	95.77	3144.56	958.46	N/A
WIPP-25 (ANNULUS)	MAG	11/09/04	152.75	46.56	3061.64	933.19	N/A
WIPP-25 (ANNULUS)	MAG	12/06/04	152.86	46.59	3061.53	933.15	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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	01/13/04	313.44	95.54	3076.57	937.74	N/A
H-03d/DL (PVC)	DL	02/11/04	313.43	95.53	3076.58	937.74	N/A
H-03d/DL (PVC)	DL	03/10/04	313.26	95.48	3076.75	937.79	N/A
H-03d/DL (PVC)	DL	04/14/04	313.10	95.43	3076.91	937.84	N/A
H-03d/DL (PVC)	DL	05/12/04	312.91	95.37	3077.10	937.90	N/A
H-03d/DL (PVC)	DL	06/09/04	312.80	95.34	3077.21	937.93	N/A
H-03d/DL (PVC)	DL	07/08/04	312.68	95.30	3077.33	937.97	N/A
H-03d/DL (PVC)	DL	08/11/04	312.51	95.25	3077.50	938.02	N/A
H-03d/DL (PVC)	DL	09/17/04	312.36	95.21	3077.65	938.07	N/A
H-03d/DL (PVC)	DL	10/14/04	312.22	95.16	3077.79	938.11	N/A
H-03d/DL (PVC)	DL	11/10/04	312.13	95.14	3077.88	938.14	N/A
H-03d/DL (PVC)	DL	12/09/04	312.01	95.10	3078.00	938.17	N/A
WQSP-6a	DL	01/14/04	166.60	50.78	3198.10	974.78	N/A
WQSP-6a	DL	02/11/04	166.55	50.76	3198.15	974.80	N/A
WQSP-6a	DL	03/09/04	166.87	50.86	3197.83	974.70	N/A
WQSP-6a	DL	04/14/04	166.73	50.82	3197.97	974.74	N/A
WQSP-6a	DL	05/12/04	166.53	50.76	3198.17	974.80	N/A
WQSP-6a	DL	06/09/04	166.65	50.79	3198.05	974.77	N/A
WQSP-6a	DL	07/08/04	166.62	50.79	3197.18	974.50	N/A
WQSP-6a	DL	08/11/04	166.76	50.83	3197.04	974.46	N/A
WQSP-6a	DL	09/13/04	166.50	50.75	3197.30	974.54	N/A
WQSP-6a	DL	10/13/04	166.59	50.78	3197.21	974.51	N/A
WQSP-6a	DL	11/08/04	166.75	50.83	3197.05	974.46	N/A
WQSP-6a	DL	12/08/04	166.66	50.80	3197.14	974.49	N/A
H-08c	RUS/SAL	01/12/04	452.30	137.86	2980.60	908.49	N/A
H-08c	RUS/SAL	02/10/04	452.41	137.89	2980.49	908.45	N/A
H-08c	RUS/SAL	03/08/04	452.36	137.88	2980.54	908.47	N/A
H-08c	RUS/SAL	04/13/04	452.31	137.86	2980.59	908.48	N/A
H-08c	RUS/SAL	05/10/04	452.23	137.84	2980.67	908.51	N/A
H-08c	RUS/SAL	06/09/04	452.17	137.82	2980.73	908.53	N/A
H-08c	RUS/SAL	07/07/04	452.17	137.82	2980.73	908.53	N/A
H-08c	RUS/SAL	08/10/04	452.06	137.79	2980.84	908.56	N/A
H-08c	RUS/SAL	09/13/04	452.04	137.78	2980.86	908.57	N/A
H-08c	RUS/SAL	10/12/04	451.93	137.75	2980.97	908.60	N/A
H-08c	RUS/SAL	11/08/04	451.80	137.71	2981.10	908.64	N/A
H-08c	RUS/SAL	12/07/04	451.72	137.68	2981.18	908.66	N/A
AEC-8	B/C	01/13/04	477.74	145.62	3059.36	932.49	N/A
AEC-8	B/C	02/10/04	478.05	145.71	3059.05	932.40	N/A
AEC-8	B/C	03/09/04	477.98	145.69	3059.12	932.42	N/A
AEC-8	B/C	04/13/04	477.50	145.54	3059.60	932.57	N/A
AEC-8	B/C	05/11/04	477.94	145.68	3059.16	932.43	N/A
AEC-8	B/C	06/08/04	476.27	145.17	3060.83	932.94	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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	07/06/04	476.59	145.26	3060.51	932.84	N/A
AEC-8	B/C	08/10/04	474.75	144.70	3062.35	933.40	N/A
AEC-8	B/C	09/13/04	473.24	144.24	3063.86	933.86	N/A
AEC-8	B/C	10/13/04	471.93	143.84	3065.17	934.26	N/A
AEC-8	B/C	11/10/04	470.55	143.42	3066.55	934.68	N/A
AEC-8	B/C	12/07/04	469.28	143.04	3067.82	935.07	N/A
CB-1 (PIP)	B/C	01/13/04	313.67	95.61	3014.71	918.88	N/A
CB-1 (PIP)	B/C	03/10/04	600.38	183.00	2728.00	831.49	N/A
CB-1 (PIP)	B/C	04/13/04	603.26	183.87	2725.12	830.62	N/A
CB-1 (PIP)	B/C	05/11/04	603.79	184.04	2724.59	830.46	N/A
CB-1(PIP)	B/C	06/09/04	604.08	184.12	2724.79	830.52	N/A
CB-1 (PIP)	B/C	07/07/04	604.18	184.15	2724.69	830.49	N/A
CB-1 (PIP)	B/C	08/11/04	604.04	184.11	2724.83	830.53	N/A
CB-1(PIP)	B/C	09/15/04	603.53	183.96	2725.34	830.68	N/A
CB-1(PIP)	B/C	10/12/04	603.25	183.87	2725.62	830.77	N/A
CB-1(PIP)	B/C	11/10/04	603.17	183.85	2725.70	830.79	N/A
CB-1(PIP)	B/C	12/08/04	603.01	183.80	2725.86	830.84	N/A
DOE-2	B/C	04/13/04	761.05	231.97	2657.91	810.13	N/A
DOE-2	B/C	05/12/04	761.87	232.22	2657.09	809.88	N/A
DOE-2	B/C	06/08/04	757.98	231.03	2660.98	811.07	N/A
DOE-2	B/C	07/08/04	753.82	229.76	2665.14	812.33	N/A
DOE-2	B/C	08/10/04	750.24	228.67	2668.72	813.43	N/A
DOE-2	B/C	09/14/04	747.76	227.92	2671.20	814.18	N/A
DOE-2	B/C	10/11/04	746.19	227.44	2672.77	814.66	N/A
DOE-2	B/C	11/10/04	744.69	226.98	2674.27	815.12	N/A
DOE-2	B/C	12/07/04	743.51	226.62	2675.45	815.48	N/A
C-2505	SR/DL	03/10/04	45.55	13.88	3367.50	1026.41	N/A
C-2505	SR/DL	04/14/04	45.61	13.90	3367.44	1026.40	N/A
C-2505	SR/DL	06/10/04	45.26	13.80	3367.79	1026.50	N/A
C-2505	SR/DL	09/17/04	45.52	13.87	3367.53	1026.42	N/A
C-2505	SR/DL	12/09/04	44.94	13.70	3368.11	1026.60	N/A
C-2506	SR/DL	03/10/04	44.89	13.68	3367.98	1026.56	N/A
C-2506	SR/DL	04/14/04	44.96	13.70	3367.91	1026.54	N/A
C-2506	SR/DL	06/10/04	44.64	13.61	3368.23	1026.64	N/A
C-2506	SR/DL	09/17/04	44.91	13.69	3367.96	1026.55	N/A
C-2506	SR/DL	12/09/04	44.34	13.51	3368.53	1026.73	N/A
C-2507	SR/DL	03/10/04	45.64	13.91	3364.37	1025.46	N/A
C-2507	SR/DL	04/14/04	45.71	13.93	3364.30	1025.44	N/A
C-2507	SR/DL	06/10/04	45.30	13.81	3364.71	1025.56	N/A
C-2507	SR/DL	09/17/04	45.43	13.85	3364.58	1025.52	N/A
C-2507	SR/DL	12/09/04	44.86	13.67	3365.15	1025.70	N/A
C-2811	SR/DL	03/10/04	59.85	18.24	3339.07	1017.75	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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-2811	SR/DL	04/14/04	59.89	18.25	3339.03	1017.74	N/A
C-2811	SR/DL	06/10/04	59.49	18.13	3339.43	1017.86	N/A
C-2811	SR/DL	09/17/04	59.23	18.05	3339.69	1017.94	N/A
C-2811	SR/DL	12/09/04	58.02	17.68	3340.90	1018.31	N/A
PZ-01	SR/DL	03/10/04	42.20	12.86	3371.21	1027.54	N/A
PZ-01	SR/DL	04/14/04	42.28	12.89	3371.13	1027.52	N/A
PZ-01	SR/DL	06/10/04	42.23	12.87	3371.18	1027.54	N/A
PZ-01	SR/DL	09/17/04	42.23	12.87	3371.18	1027.54	N/A
PZ-01	SR/DL	12/09/04	41.98	12.80	3371.43	1027.61	N/A
PZ-02	SR/DL	03/10/04	43.42	13.23	3370.00	1027.18	N/A
PZ-02	SR/DL	04/14/04	43.51	13.26	3369.91	1027.15	N/A
PZ-02	SR/DL	06/10/04	43.38	13.22	3370.04	1027.19	N/A
PZ-02	SR/DL	09/17/04	43.43	13.24	3369.99	1027.17	N/A
PZ-02	SR/DL	12/09/04	42.85	13.06	3370.57	1027.35	N/A
PZ-03	SR/DL	03/10/04	44.83	13.66	3371.32	1027.58	N/A
PZ-03	SR/DL	04/14/04	44.86	13.67	3371.29	1027.57	N/A
PZ-03	SR/DL	06/10/04	44.70	13.62	3371.45	1027.62	N/A
PZ-03	SR/DL	09/17/04	44.64	13.61	3371.51	1027.64	N/A
PZ-03	SR/DL	12/09/04	44.32	13.51	3371.83	1027.73	N/A
PZ-04	SR/DL	03/10/04	47.45	14.46	3364.65	1025.55	N/A
PZ-04	SR/DL	04/14/04	47.45	14.46	3364.65	1025.55	N/A
PZ-04	SR/DL	06/10/04	47.19	14.38	3364.91	1025.62	N/A
PZ-04	SR/DL	09/17/04	47.25	14.40	3364.85	1025.61	N/A
PZ-04	SR/DL	12/09/04	46.45	14.16	3365.65	1025.85	N/A
PZ-05	SR/DL	03/10/04	42.53	12.96	3372.78	1028.02	N/A
PZ-05	SR/DL	04/14/04	42.60	12.98	3372.71	1028.00	N/A
PZ-05	SR/DL	06/10/04	42.46	12.94	3372.85	1028.04	N/A
PZ-05	SR/DL	09/17/04	42.36	12.91	3372.95	1028.08	N/A
PZ-05	SR/DL	12/09/04	41.57	12.67	3373.74	1028.32	N/A
PZ-06	SR/DL	03/10/04	43.80	13.35	3369.69	1027.08	N/A
PZ-06	SR/DL	04/14/04	43.88	13.37	3369.61	1027.06	N/A
PZ-06	SR/DL	06/10/04	43.70	13.32	3369.79	1027.11	N/A
PZ-06	SR/DL	09/17/04	43.71	13.32	3369.78	1027.11	N/A
PZ-06	SR/DL	12/09/04	42.90	13.08	3370.59	1027.36	N/A
PZ-07	SR/DL	03/10/04	37.59	11.46	3376.40	1029.13	N/A
PZ-07	SR/DL	04/14/04	37.67	11.48	3376.32	1029.10	N/A
PZ-07	SR/DL	06/10/04	37.39	11.40	3376.60	1029.19	N/A
PZ-07	SR/DL	09/17/04	37.29	11.37	3376.70	1029.22	N/A
PZ-07	SR/DL	12/09/04	36.93	11.26	3377.06	1029.33	N/A
PZ-09	SR/DL	03/10/04	56.64	17.26	3364.57	1025.52	N/A
PZ-09	SR/DL	04/14/04	56.65	17.27	3364.56	1025.52	N/A
PZ-09	SR/DL	06/10/04	56.43	17.20	3364.78	1025.58	N/A

Table F.8 - Groundwater Level Measurement Results for 2004

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-09	SR/DL	09/17/04	56.26	17.15	3364.95	1025.64	N/A
PZ-09	SR/DL	12/09/04	55.41	16.89	3365.80	1025.90	N/A
PZ-10	SR/DL	03/10/04	38.52	11.74	3367.28	1026.35	N/A
PZ-10	SR/DL	04/14/04	38.58	11.76	3367.22	1026.33	N/A
PZ-10	SR/DL	06/10/04	37.79	11.52	3368.01	1026.57	N/A
PZ-10	SR/DL	09/17/04	37.88	11.55	3367.92	1026.54	N/A
PZ-10	SR/DL	12/09/04	35.11	10.70	3370.69	1027.39	N/A
PZ-11	SR/DL	03/10/04	45.18	13.77	3373.77	1028.33	N/A
PZ-11	SR/DL	04/14/04	45.23	13.79	3373.72	1028.31	N/A
PZ-11	SR/DL	06/10/04	44.98	13.71	3373.97	1028.39	N/A
PZ-11	SR/DL	09/17/04	45.02	13.72	3373.93	1028.37	N/A
PZ-11	SR/DL	12/09/04	44.70	13.62	3374.25	1028.47	N/A
PZ-12	SR/DL	03/10/04	53.81	16.40	3355.18	1022.66	N/A
PZ-12	SR/DL	04/14/04	53.73	16.38	3355.26	1022.68	N/A
PZ-12	SR/DL	06/10/04	52.65	16.05	3356.34	1023.01	N/A
PZ-12	SR/DL	09/17/04	53.25	16.23	3355.74	1022.83	N/A
PZ-12	SR/DL	12/09/04	51.83	15.80	3357.16	1023.26	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 C for the sampling location codes.

Location	Quarter	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
		^{241}Am			^{238}Pu		
CBD	1	5.29E-08	9.38E-08	1.69E-07	0.00E+00	N/A[d]	1.14E-07
	2	2.59E-08	7.65E-08	1.49E-04	6.78E-08	1.32E-07	6.19E-05
	3	2.80E-08	4.92E-08	2.48E-04	-6.12E-09	9.89E-08	8.67E-05
	4	5.51E-08	6.05E-08	1.98E-04	-5.95E-08	1.21E-07	9.92E-05
MLR	1	1.73E-08	7.74E-08	1.66E-07	6.56E-08	7.64E-08	1.67E-07
	2	2.10E-08	6.83E-08	1.49E-04	-2.07E-08	4.22E-08	6.19E-05
	3	1.19E-08	5.40E-08	2.48E-04	2.60E-08	1.12E-07	8.67E-05
	4	2.49E-08	5.35E-08	1.98E-04	-5.22E-08	1.31E-07	9.91E-05
SEC	1	2.37E-08	4.75E-08	2.27E-07	4.97E-08	5.80E-08	1.27E-07
	2	-6.25E-09	2.21E-08	1.49E-04	-1.13E-08	3.58E-08	6.20E-05
	3	5.12E-09	5.12E-08	2.48E-04	1.30E-08	1.12E-07	8.67E-05
	4	1.88E-08	4.72E-08	1.98E-04	4.73E-08	1.76E-07	9.91E-05
SMR	1	1.61E-08	7.20E-08	1.54E-07	-1.56E-08	5.40E-08	1.19E-07
	2	2.50E-08	6.00E-08	1.49E-04	-6.65E-09	7.30E-08	6.19E-05
	3	3.72E-08	6.50E-08	2.48E-04	7.17E-08	1.98E-07	8.68E-05
	4	-1.49E-08	3.16E-08	1.98E-04	4.69E-08	1.53E-07	9.91E-05
WEE	1	3.62E-08	7.27E-08	1.74E-07	1.83E-08	8.18E-08	1.40E-07
	2	-1.70E-08	5.46E-08	1.49E-04	1.50E-08	8.56E-08	6.19E-05
	3	-3.86E-09	9.90E-08	2.48E-04	-7.93E-09	2.03E-07	8.68E-05
	4	1.96E-08	6.94E-08	1.98E-04	-1.14E-08	7.38E-08	9.90E-05
WFF	1	0.00E+00	N/A	1.89E-07	1.47E-08	6.59E-08	1.13E-07
	2	8.16E-09	6.98E-08	1.49E-04	-9.16E-09	7.62E-08	6.19E-05
	3	3.68E-08	6.31E-08	2.48E-04	1.09E-08	9.39E-08	8.67E-05
	4	3.02E-08	5.32E-08	1.98E-04	-1.58E-08	4.83E-08	9.90E-05
WSS	1	-4.57E-08	6.85E-08	1.46E-07	-3.07E-08	4.37E-08	1.18E-07
	2	1.48E-08	5.03E-08	1.49E-04	1.41E-09	4.99E-08	6.19E-05
	3	-4.55E-09	4.81E-08	2.48E-04	-4.33E-08	7.51E-08	8.67E-05
	4	4.06E-08	6.74E-08	1.98E-04	2.30E-08	1.62E-07	9.91E-05
WAB	1	6.37E-05	1.28E-04	6.11E-04	1.54E-04	2.19E-04	5.89E-04
	2	7.26E-05	3.65E-04	5.58E-04	1.11E-04	5.09E-04	6.40E-04
	3	2.91E-04	6.26E-04	4.64E-04	3.92E-04	9.10E-04	8.62E-04
	4	2.44E-04	3.96E-04	4.83E-04	1.51E-04	9.89E-04	8.36E-04
	Minimum[e]		6.85E-08	1.46E-07	-5.95E-08	1.21E-07	9.92E-05
	Maximum[e]		6.05E-08	1.98E-04	7.17E-08	1.98E-07	8.68E-05
	Mean[f]	1.63E-08	4.32E-08	1.49E-04	6.46E-09	6.80E-08	6.20E-05
		$^{239+240}Pu$			^{234}U		
CBD	1	4.46E-08	5.19E-08	8.86E-08	2.89E-06	7.05E-07	2.45E-07
	2	4.79E-08	8.44E-08	1.11E-04	3.27E-06	4.92E-07	1.05E-03
	3	1.05E-08	5.99E-08	7.43E-05	2.30E-06	3.99E-07	1.02E-03
	4	1.42E-07	2.44E-07	9.92E-05	2.38E-06	5.09E-07	7.92E-04
MLR	1	4.35E-08	8.73E-08	1.30E-07	2.68E-06	6.73E-07	2.66E-07
	2	7.73E-08	9.33E-08	1.11E-04	2.31E-06	4.06E-07	1.05E-03
	3	-8.23E-09	3.17E-08	7.43E-05	2.37E-06	4.04E-07	1.02E-03
	4	-2.48E-08	5.85E-08	9.91E-05	2.45E-06	4.70E-07	7.92E-04

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix C for the sampling location codes.

Location	Quarter	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
SEC	1	1.65E-08	3.31E-08	9.85E-08	2.51E-06	5.72E-07	1.93E-07
	2	6.88E-08	1.10E-07	1.11E-04	1.98E-06	3.32E-07	1.05E-03
	3	-1.13E-08	4.37E-08	7.44E-05	2.18E-06	4.58E-07	1.02E-03
	4	2.64E-08	1.21E-07	9.91E-05	1.88E-06	3.70E-07	7.92E-04
SMR	1	0.00E+00	N/A	9.26E-08	2.30E-06	5.46E-07	2.08E-07
	2	3.69E-08	7.63E-08	1.11E-04	3.18E-06	4.91E-07	1.05E-03
	3	-3.46E-08	8.93E-08	7.44E-05	2.33E-06	3.92E-07	1.02E-03
	4	3.01E-08	1.02E-07	9.91E-05	2.49E-06	5.45E-07	7.92E-04
WEE	1	3.64E-08	7.30E-08	1.09E-07	2.26E-06	5.48E-07	2.06E-07
	2	6.80E-08	7.86E-08	1.11E-04	2.62E-06	4.70E-07	1.05E-03
	3	-4.22E-08	1.08E-07	7.44E-05	2.39E-06	4.91E-07	1.02E-03
	4	9.00E-09	4.16E-08	9.90E-05	2.64E-06	4.27E-07	7.92E-04
WFF	1	0.00E+00	N/A	8.75E-08	2.13E-06	5.37E-07	2.28E-07
	2	4.63E-08	6.66E-08	1.11E-04	2.50E-06	4.13E-07	1.05E-03
	3	6.10E-08	1.10E-07	7.43E-05	2.16E-06	3.67E-07	1.02E-03
	4	-6.94E-09	1.92E-08	9.90E-05	1.95E-06	3.48E-07	7.92E-04
WSS	1	1.53E-08	3.07E-08	9.12E-08	2.55E-06	5.79E-07	1.88E-07
	2	4.79E-08	6.60E-08	1.11E-04	2.97E-06	6.20E-07	1.05E-03
	3	-2.02E-08	5.12E-08	7.43E-05	2.28E-06	3.71E-07	1.02E-03
	4	2.29E-08	8.13E-08	9.91E-05	2.07E-06	3.99E-07	7.92E-04
WAB	1	0.00E+00	N/A	4.57E-04	6.24E-03	1.76E-03	9.04E-04
	2	-1.02E-04	2.89E-04	6.87E-04	1.50E-02	2.62E-03	1.36E-03
	3	-3.16E-05	1.86E-04	8.47E-04	1.46E-02	2.96E-03	1.02E-03
	4	1.91E-04	6.05E-04	8.33E-04	1.52E-02	3.44E-03	1.32E-03
	Minimum		1.08E-07	7.44E-05	1.88E-06	3.70E-07	7.92E-04
	Maximum		2.44E-07	9.92E-05	3.27E-06	4.92E-07	1.05E-03
	Mean	2.51E-08	7.72E-08	7.11E-05	2.43E-06	6.70E-07	7.16E-04
			^{235}U			^{238}U	
CBD	1	1.72E-07	1.34E-07	2.22E-07	2.87E-06	7.02E-07	2.37E-07
	2	2.44E-07	1.48E-07	2.23E-04	3.01E-06	4.71E-07	4.83E-04
	3	6.25E-08	7.36E-08	1.73E-04	2.08E-06	3.79E-07	5.07E-04
	4	9.30E-08	1.18E-07	1.11E-04	2.17E-06	4.87E-07	3.71E-04
MLR	1	5.33E-08	7.60E-08	2.41E-07	2.67E-06	6.70E-07	2.57E-07
	2	1.03E-07	9.93E-08	2.23E-04	2.52E-06	4.23E-07	4.83E-04
	3	1.04E-07	9.40E-08	1.73E-04	2.13E-06	3.82E-07	5.07E-04
	4	1.91E-07	1.45E-07	1.11E-04	2.42E-06	4.66E-07	3.71E-04
SEC	1	3.87E-08	5.51E-08	1.75E-07	2.45E-06	5.61E-07	1.87E-07
	2	4.89E-08	5.95E-08	2.23E-04	2.14E-06	3.45E-07	4.83E-04
	3	2.57E-07	1.76E-07	1.73E-04	2.80E-06	5.17E-07	5.07E-04
	4	1.28E-07	1.10E-07	1.11E-04	1.97E-06	3.77E-07	3.71E-04
SMR	1	1.67E-07	1.21E-07	1.89E-07	2.31E-06	5.47E-07	2.01E-07
	2	1.82E-07	1.30E-07	2.23E-04	3.22E-06	4.93E-07	4.83E-04
	3	1.19E-07	9.88E-08	1.73E-04	2.02E-06	3.64E-07	5.07E-04
	4	6.28E-08	1.08E-07	1.11E-04	3.02E-06	5.99E-07	3.71E-04
WEE	1	1.03E-07	9.41E-08	1.87E-07	2.42E-06	5.77E-07	1.99E-07
	2	2.26E-07	1.54E-07	2.23E-04	2.16E-06	4.24E-07	4.83E-04
	3	2.72E-07	1.87E-07	1.73E-04	2.03E-06	4.51E-07	5.07E-04
	4	1.02E-07	9.29E-08	1.11E-04	2.36E-06	4.02E-07	3.71E-04

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix C for the sampling location codes.

Location	Quarter	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
WFF	1	2.29E-07	1.50E-07	2.07E-07	2.20E-06	5.48E-07	2.20E-07
	2	2.05E-07	1.31E-07	2.23E-04	2.64E-06	4.24E-07	4.83E-04
	3	5.31E-08	6.77E-08	1.73E-04	1.99E-06	3.52E-07	5.07E-04
	4	1.06E-07	9.33E-08	1.11E-04	1.91E-06	3.42E-07	3.71E-04
WSS	1	7.53E-08	7.64E-08	1.70E-07	2.34E-06	5.41E-07	1.82E-07
	2	2.32E-07	1.95E-07	2.23E-04	3.17E-06	6.43E-07	4.83E-04
	3	1.46E-07	1.03E-07	1.73E-04	2.20E-06	3.63E-07	5.07E-04
	4	4.57E-08	6.68E-08	1.11E-04	2.30E-06	4.22E-07	3.71E-04
WAB	1	1.81E-04	2.58E-04	8.19E-04	5.85E-03	1.68E-03	8.73E-04
	2	8.15E-04	6.95E-04	6.07E-04	1.31E-02	2.44E-03	7.93E-04
	3	6.94E-04	7.54E-04	6.78E-04	1.51E-02	3.02E-03	9.15E-04
	4	6.34E-04	8.57E-04	7.59E-04	1.50E-02	3.40E-03	8.94E-04
	Minimum		5.51E-08	1.75E-07	1.91E-06	3.42E-07	3.71E-04
	Maximum		1.87E-07	1.73E-04	3.22E-06	4.93E-07	4.83E-04
	Mean	1.36E-07	1.43E-07	1.27E-04	2.41E-06	7.43E-07	3.40E-04
			^{40}K			^{60}Co	
CBD	1	2.13E-04	2.41E-04	3.85E-04	1.26E-05	3.51E-05	3.90E-05
	2	6.24E-04	3.99E-04	4.53E-04	-5.39E-06	4.10E-05	4.42E-05
	3	3.09E-04	2.12E-04	2.70E-04	-4.26E-06	2.22E-05	2.46E-05
	4	2.98E-04	2.10E-04	2.67E-04	-1.82E-07	2.11E-05	2.41E-05
MLR	1	5.58E-04	3.98E-04	4.48E-04	6.64E-06	3.91E-05	4.31E-05
	2	4.96E-04	3.65E-04	4.09E-04	3.69E-05	3.58E-05	4.07E-05
	3	1.55E-04	1.73E-04	2.76E-04	1.92E-05	2.32E-05	2.84E-05
	4	1.39E-04	1.43E-04	2.26E-04	4.24E-06	2.09E-05	2.43E-05
SEC	1	2.52E-04	1.27E-04	1.74E-04	-4.92E-06	2.22E-05	2.45E-05
	2	6.16E-04	3.53E-04	3.99E-04	4.70E-05	3.45E-05	3.96E-05
	3	2.91E-04	3.67E-04	4.13E-04	2.89E-05	3.54E-05	4.01E-05
	4	9.58E-04	3.56E-04	4.10E-04	-2.08E-05	2.60E-05	3.86E-05
SMR	1	2.75E-04	1.38E-04	1.90E-04	8.33E-06	2.02E-05	2.41E-05
	2	1.87E-04	1.14E-04	1.64E-04	-1.53E-05	2.34E-05	2.43E-05
	3	5.52E-04	3.78E-04	4.33E-04	4.87E-05	3.75E-05	4.31E-05
	4	5.44E-04	3.37E-04	3.89E-04	2.04E-05	3.47E-05	3.90E-05
WEE	1	2.91E-04	2.64E-04	4.17E-04	-1.90E-06	3.45E-05	3.75E-05
	2	7.97E-04	3.51E-04	4.00E-04	1.20E-05	3.49E-05	3.87E-05
	3	8.71E-04	4.88E-04	5.60E-04	1.21E-05	4.57E-05	5.07E-05
	4	6.26E-04	3.43E-04	3.96E-04	-1.81E-06	3.50E-05	3.81E-05
WFF	1	1.98E-04	1.25E-04	1.81E-04	4.27E-06	2.20E-05	2.57E-05
	2	8.79E-05	2.06E-04	2.45E-04	2.35E-05	1.90E-05	2.43E-05
	3	2.52E-04	1.30E-04	1.80E-04	6.13E-06	2.02E-05	2.38E-05
	4	9.51E-05	2.03E-04	2.42E-04	-4.07E-06	2.08E-05	2.31E-05
WSS	1	2.75E-04	1.21E-04	1.57E-04	1.35E-05	2.00E-05	2.44E-05
	2	1.66E-04	2.17E-04	2.62E-04	4.89E-06	2.20E-05	2.56E-05
	3	6.25E-04	3.54E-04	4.07E-04	3.60E-06	3.45E-05	3.79E-05
	4	2.16E-04	1.40E-04	2.07E-04	-1.07E-06	2.12E-05	2.40E-05
WAB	1	7.49E-01	1.50E+00	1.80E+00	1.03E-01	1.56E-01	1.88E-01
	2	1.89E+00	1.84E+00	2.91E+00	1.12E-01	2.53E-01	2.82E-01

Table G.1 - Radionuclide Concentrations (Bq/m^3) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix C for the sampling location codes.

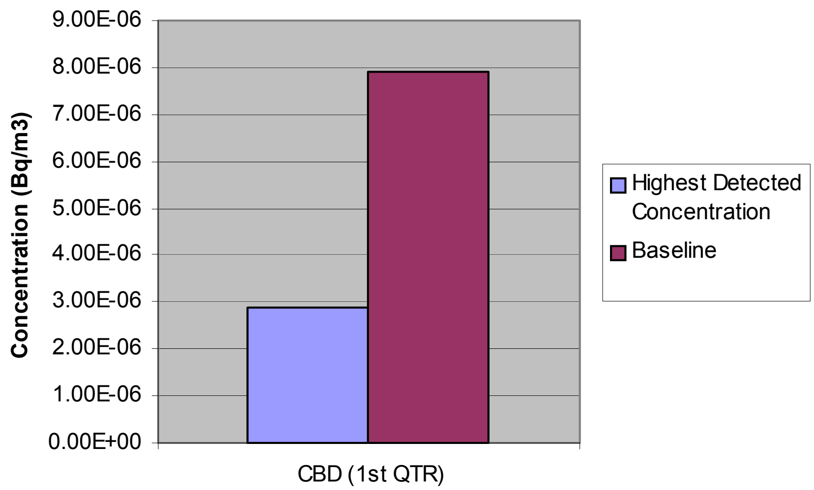
Location	Quarter	[RN][a]	2 × TPU[b]	MDC[c]	[RN]	2 × TPU	MDC
	3	6.31E+00	2.62E+00	3.02E+00	-1.79E-02	2.69E-01	2.92E-01
	4	6.04E+00	2.67E+00	3.07E+00	1.02E-01	2.51E-01	2.80E-01
	Minimum		2.06E-04	2.45E-04	-2.08E-05	2.60E-05	3.86E-05
	Maximum		3.56E-04	4.10E-04	4.87E-05	3.75E-05	4.31E-05
	Mean	3.92E-04	4.79E-04	3.20E-04	9.04E-06	3.25E-05	3.27E-05
			^{137}Cs			^{90}Sr	
CBD	1	3.09E-07	3.20E-05	3.63E-05	-1.09E-06	4.77E-06	2.32E-06
	2	-2.11E-05	3.96E-05	4.25E-05	-2.98E-06	5.09E-06	2.97E-06
	3	1.27E-06	1.64E-05	1.95E-05	-2.02E-06	3.28E-06	1.86E-06
	4	2.76E-06	1.55E-05	1.85E-05	9.31E-08	2.87E-06	1.07E-06
MLR	1	2.62E-05	3.21E-05	4.03E-05	-1.42E-06	5.74E-06	3.04E-06
	2	-3.71E-05	3.54E-05	3.63E-05	-9.17E-07	4.22E-06	2.73E-06
	3	2.06E-06	1.69E-05	2.01E-05	-1.94E-06	3.77E-06	2.32E-06
	4	1.31E-05	1.49E-05	1.84E-05	-5.50E-07	2.79E-06	1.04E-06
SEC	1	9.82E-06	1.52E-05	1.86E-05	-3.48E-06	4.82E-06	2.43E-06
	2	-1.92E-05	3.29E-05	3.51E-05	-1.89E-06	4.00E-06	2.29E-06
	3	-3.34E-05	3.42E-05	3.61E-05	-1.28E-06	3.24E-06	1.88E-06
	4	1.82E-06	3.14E-05	3.59E-05	-7.97E-07	3.18E-06	1.33E-06
SMR	1	1.12E-05	1.51E-05	1.85E-05	-2.61E-06	5.11E-06	2.73E-06
	2	8.63E-06	1.46E-05	1.78E-05	-1.51E-07	4.08E-06	2.41E-06
	3	-2.30E-05	3.52E-05	3.82E-05	-1.54E-06	3.66E-06	2.17E-06
	4	3.22E-06	3.00E-05	3.61E-05	5.37E-07	2.65E-06	8.84E-07
WEE	1	-3.25E-05	3.47E-05	3.60E-05	-1.91E-06	5.05E-06	2.59E-06
	2	-3.95E-05	3.50E-05	3.56E-05	-3.76E-06	4.12E-06	2.38E-06
	3	-4.22E-05	4.41E-05	4.67E-05	-1.57E-06	4.85E-06	3.01E-06
	4	-1.62E-05	3.15E-05	3.46E-05	4.37E-08	3.04E-06	1.21E-06
WFF	1	-7.39E-07	1.58E-05	1.85E-05	1.05E-07	5.55E-06	2.85E-06
	2	2.10E-06	1.51E-05	1.79E-05	7.04E-08	4.18E-06	2.66E-06
	3	1.14E-06	1.52E-05	1.81E-05	-2.87E-06	3.26E-06	1.91E-06
	4	-8.97E-06	1.58E-05	1.76E-05	-6.16E-07	2.79E-06	1.03E-06
WSS	1	5.83E-06	1.51E-05	1.82E-05	-1.36E-06	5.02E-06	2.53E-06
	2	8.45E-06	1.48E-05	1.81E-05	-2.11E-06	4.56E-06	2.88E-06
	3	-1.51E-05	3.19E-05	3.52E-05	-1.28E-06	3.42E-06	2.02E-06
	4	-1.16E-06	1.59E-05	1.86E-05	-3.09E-07	2.73E-06	9.95E-07
WAB	1	6.75E-03	1.09E-01	1.29E-01	-9.98E-03	1.73E-02	8.63E-03
	2	-2.74E-01	2.59E-01	2.65E-01	1.16E-02	3.01E-02	1.79E-02
	3	-1.48E-01	2.41E-01	2.63E-01	-2.06E-03	2.51E-02	1.46E-02
	4	3.28E-03	2.05E-01	2.55E-01	6.05E-03	2.19E-02	8.22E-03
	Minimum		4.41E-05	4.67E-05	-3.76E-06	4.12E-06	2.38E-06
	Maximum	2.62E-05	3.21E-05	4.03E-05	5.37E-07	2.65E-06	8.84E-07
	Mean	-6.87E-06	3.53E-05	2.80E-05	-1.34E-06	2.23E-06	2.13E-06

[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 the uncertainty when the activity is 0.
[e] Minimum and maximum reported for each radionuclide are based on [RN] while the associated 2 x TPU and MDC values are inherited with the specific [RN].
[f] Arithmetic average for concentration and MDC; TPU represents the standard deviation of the mean in this cell.

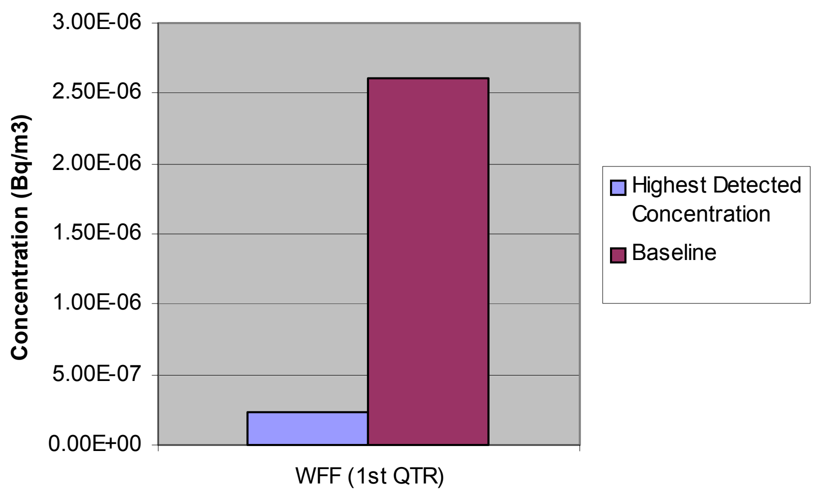
Appendix H
Comparison of Detected Radionuclides to the Radiological Baseline

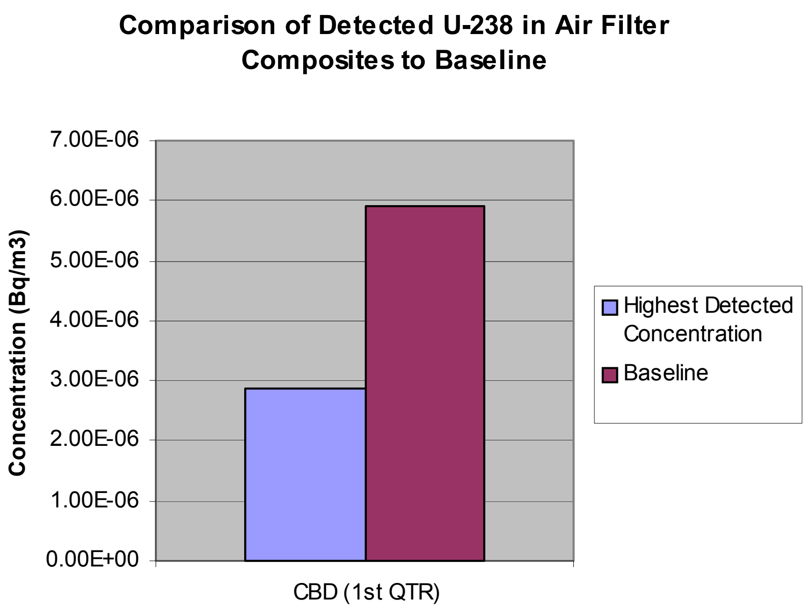
The figures in this appendix show the highest detected radionuclides from 2004 environmental monitoring sample analysis results compared to the radiological baseline values established for these isotopes (DOE/WIPP 92-037). Figures address air filter composite, groundwater, surface water, sediment, soil, and vegetation results. Note, all results with the exception of vegetation were compared to the baseline 99 percentile probability value. The baseline did not include probability distributions for vegetation, therefore the vegetation sample results are compared to the baseline mean values for this matrix. There are no figures illustrating the results for deer samples as the baseline did not include analysis of deer. A detailed discussion of environmental monitoring radionuclide sample results is contained in Chapter 4.

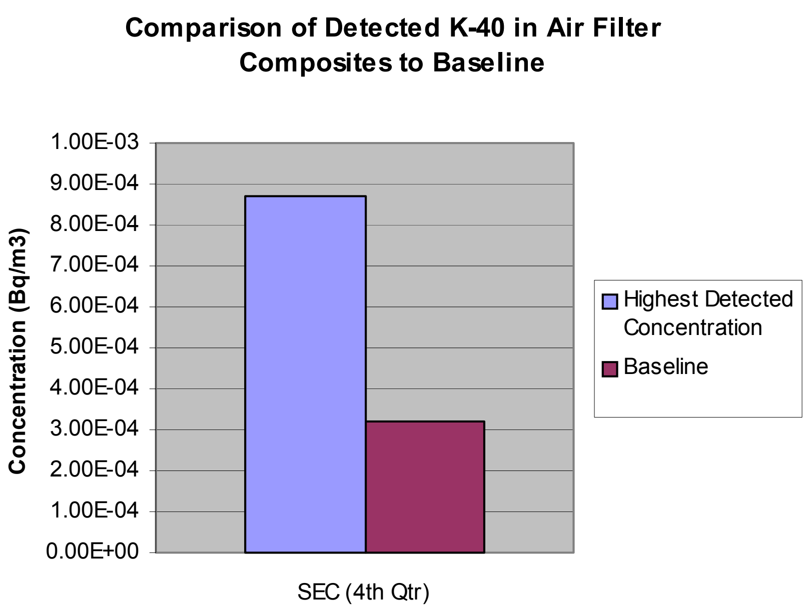
Comparison of Detected U-234 in Air Filter Composites to Baseline

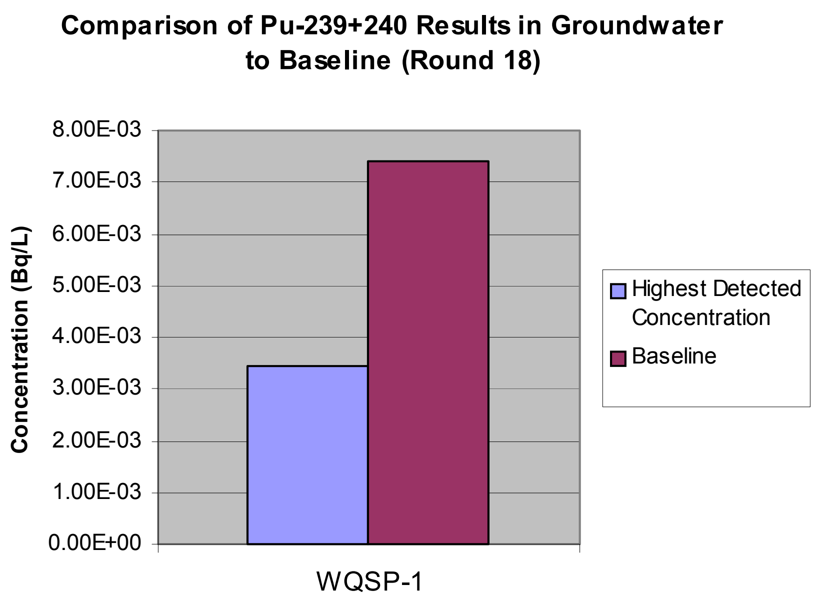


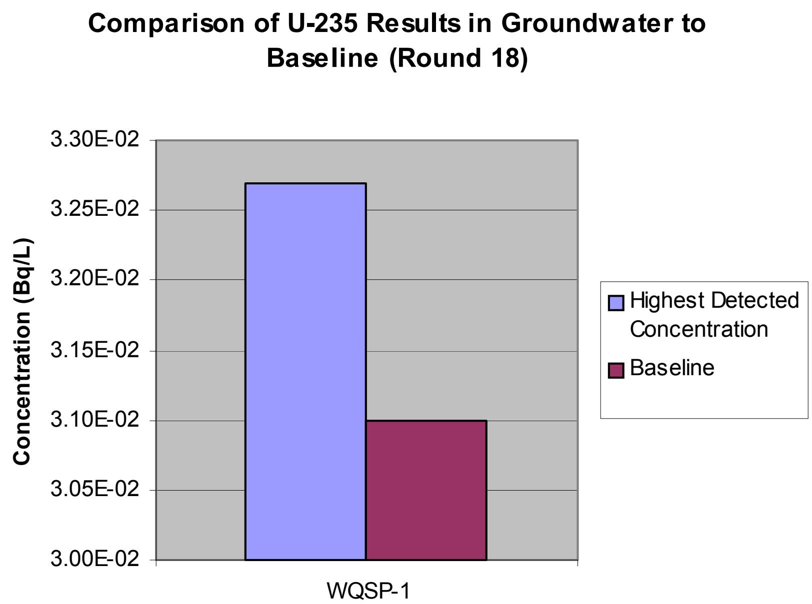
Comparison of Detected U-235 in Air Filter Composites to Baseline

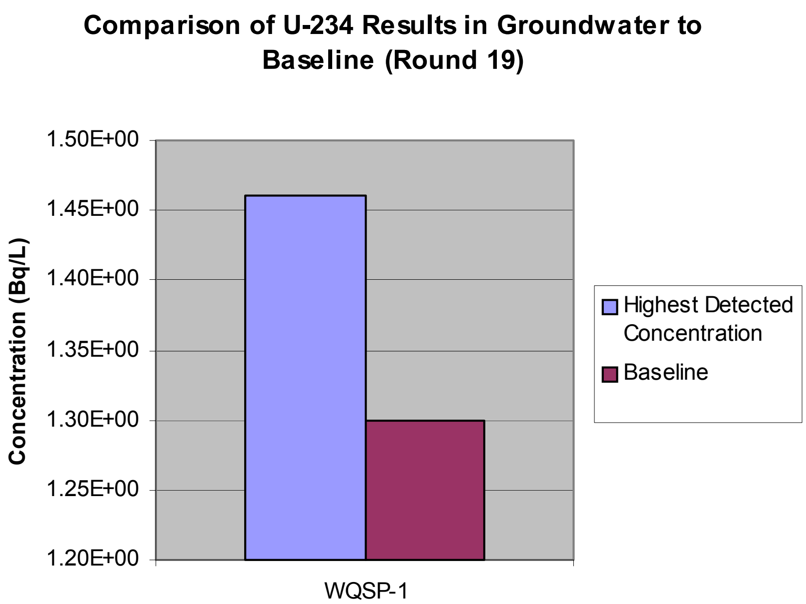


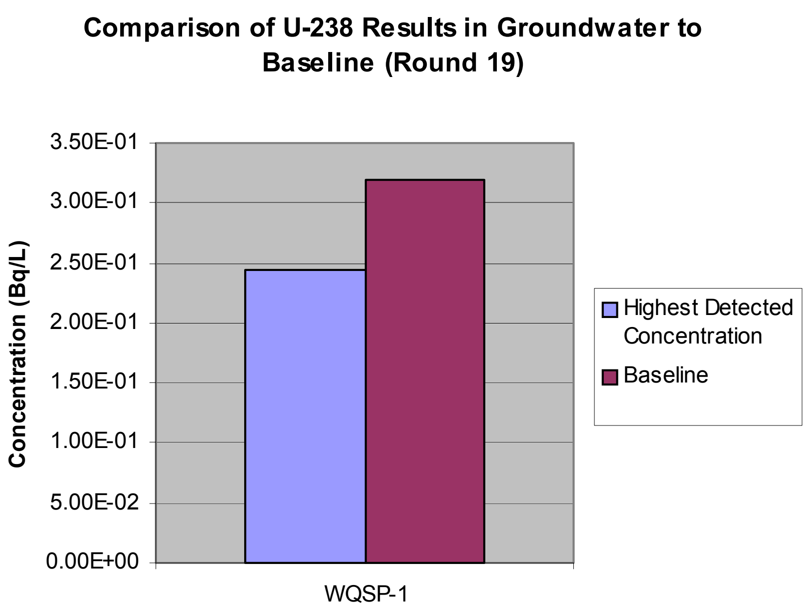

Comparison of Detected U-238 in Air Filter Composites to Baseline
7.00E-06
6.00E-06
5.00E-06
4.00E-06
3.00E-06
2.00E-06
1.00E-06
0.00E+00
Concentration (Bq/m3)
CBD (1st QTR)
Highest Detected Concentration
Baseline

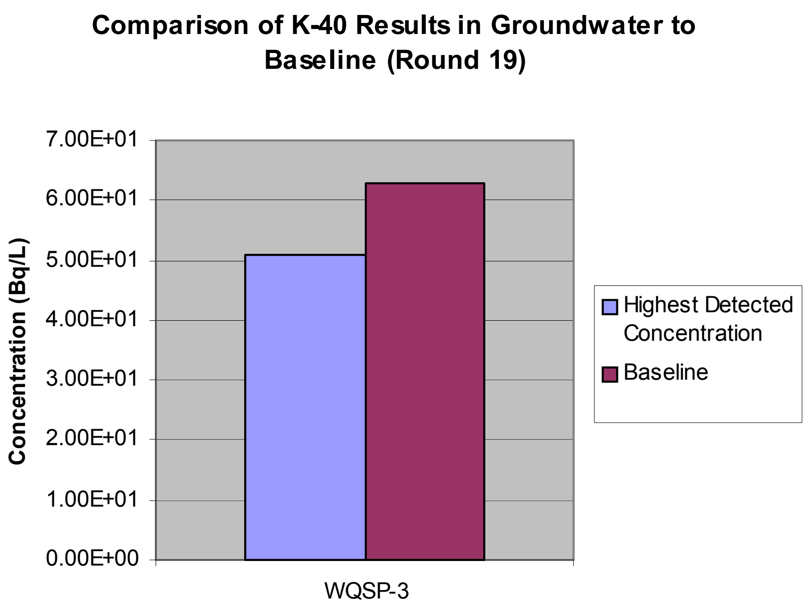

Comparison of Detected K-40 in Air Filter Composites to Baseline
1.00E-03
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Concentration (Bq/m3)
SEC (4th Qtr)
Highest Detected Concentration
Baseline

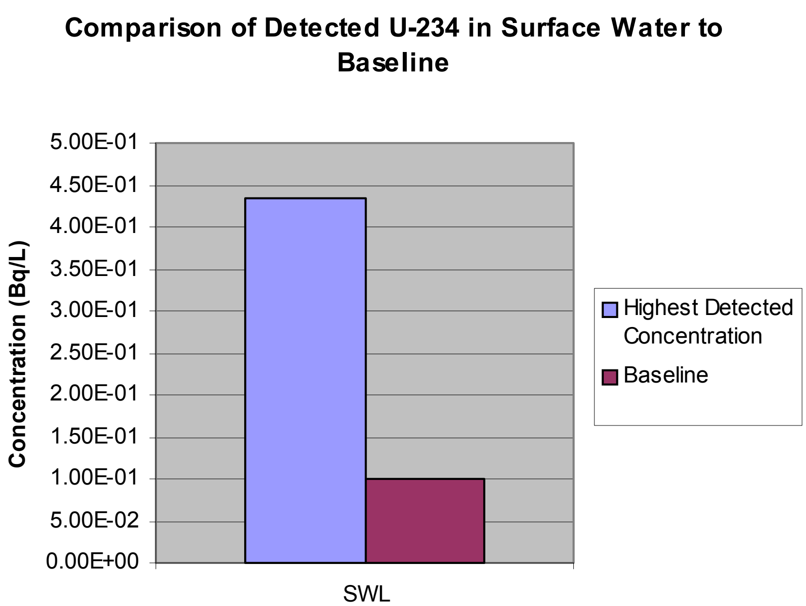

Comparison of Pu-239+240 Results in Groundwater to Baseline (Round 18)
Concentration (Bq/L)
8.00E-03
7.00E-03
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
WQSP-1
Highest Detected Concentration
Baseline

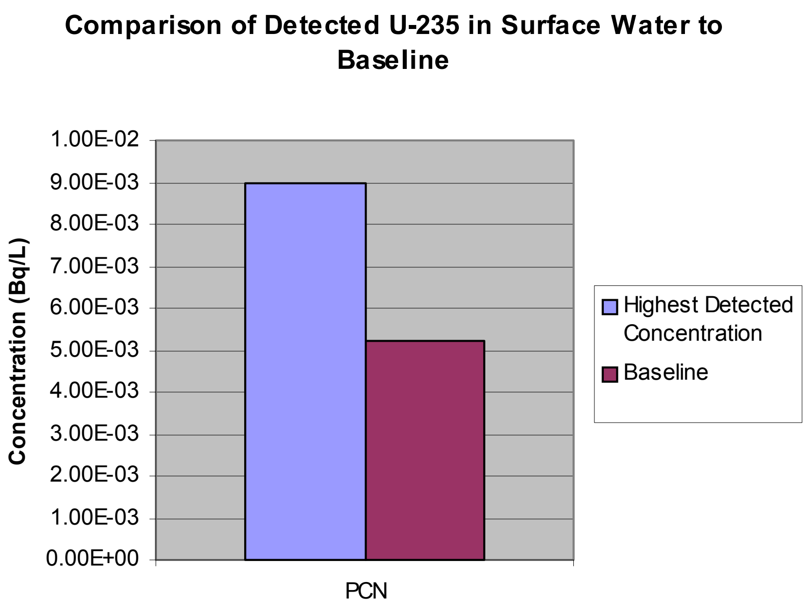

Comparison of U-235 Results in Groundwater to Baseline (Round 18)
Concentration (Bq/L)
3.30E-02
3.25E-02
3.20E-02
3.15E-02
3.10E-02
3.05E-02
3.00E-02
WQSP-1
Highest Detected Concentration
Baseline

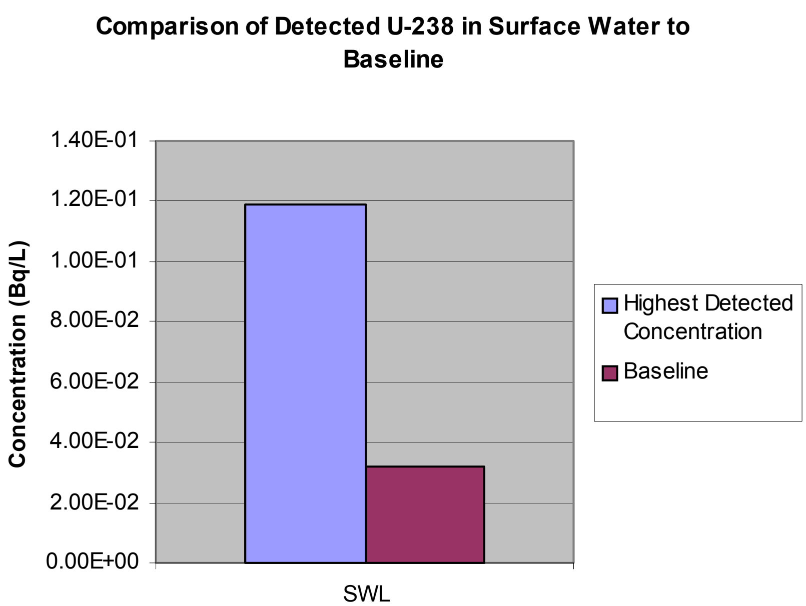

Comparison of U-234 Results in Groundwater to Baseline (Round 19)
Concentration (Bq/L)
1.50E+00
1.45E+00
1.40E+00
1.35E+00
1.30E+00
1.25E+00
1.20E+00
WQSP-1
Highest Detected Concentration
Baseline

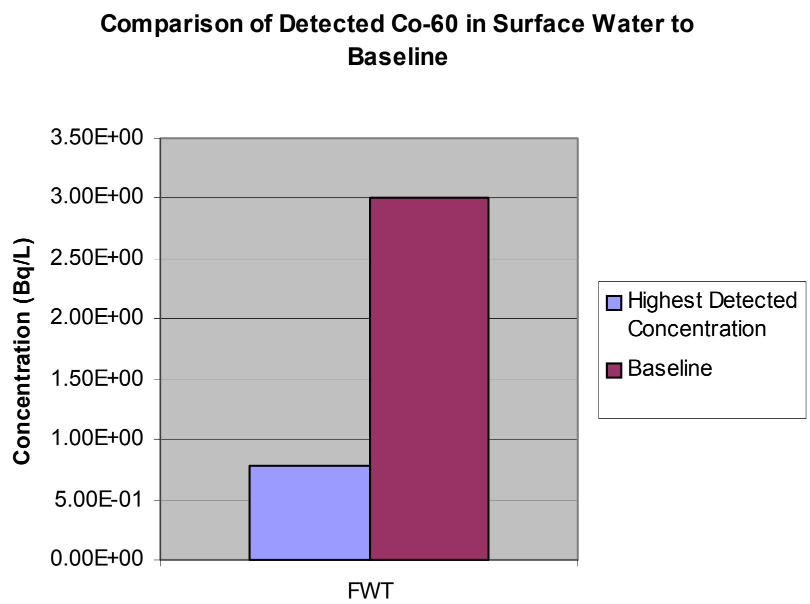

Comparison of U-238 Results in Groundwater to Baseline (Round 19)
Concentration (Bq/L)
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
WQSP-1
Highest Detected Concentration
Baseline

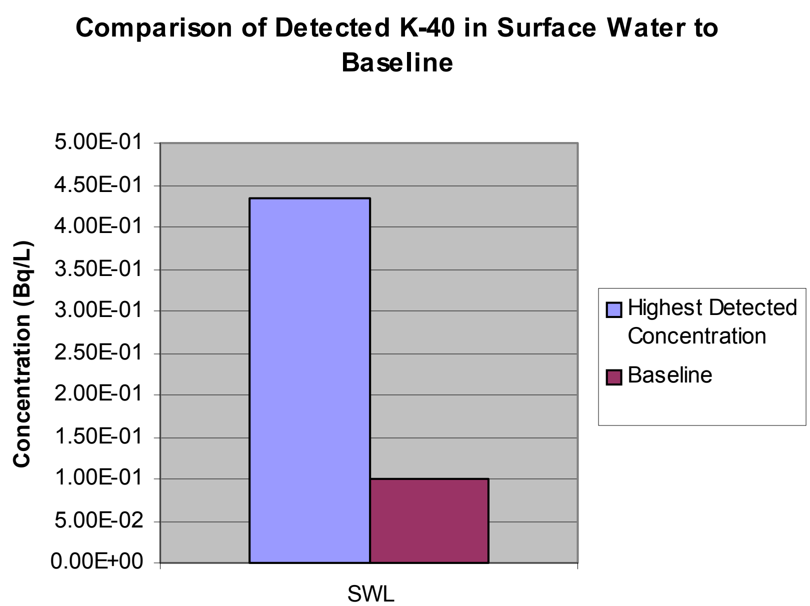

Comparison of K-40 Results in Groundwater to Baseline (Round 19)
Concentration (Bq/L)
7.00E+01
6.00E+01
5.00E+01
4.00E+01
3.00E+01
2.00E+01
1.00E+01
0.00E+00
WQSP-3
Highest Detected Concentration
Baseline

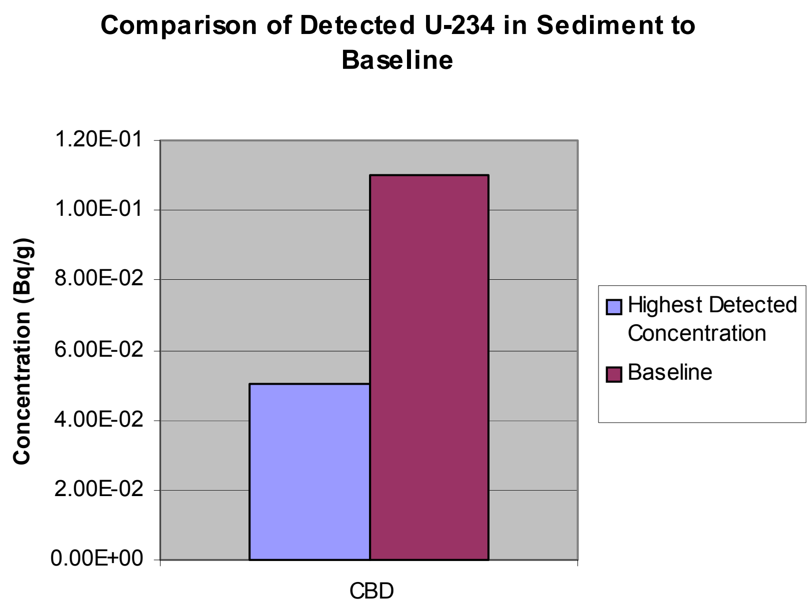

Comparison of Detected U-234 in Surface Water to Baseline
Concentration (Bq/L)
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
SWL
Highest Detected Concentration
Baseline

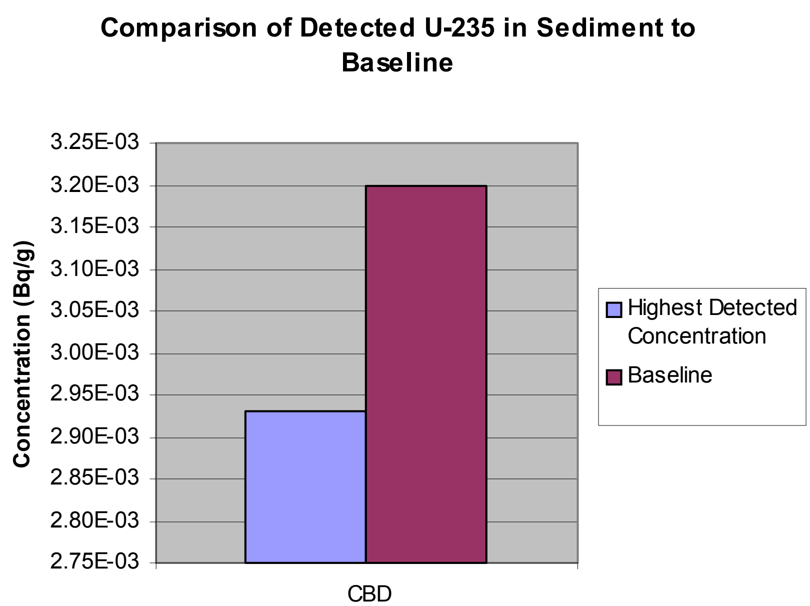

Comparison of Detected U-235 in Surface Water to Baseline
Concentration (Bq/L)
1.00E-02
9.00E-03
8.00E-03
7.00E-03
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
PCN
Highest Detected Concentration
Baseline

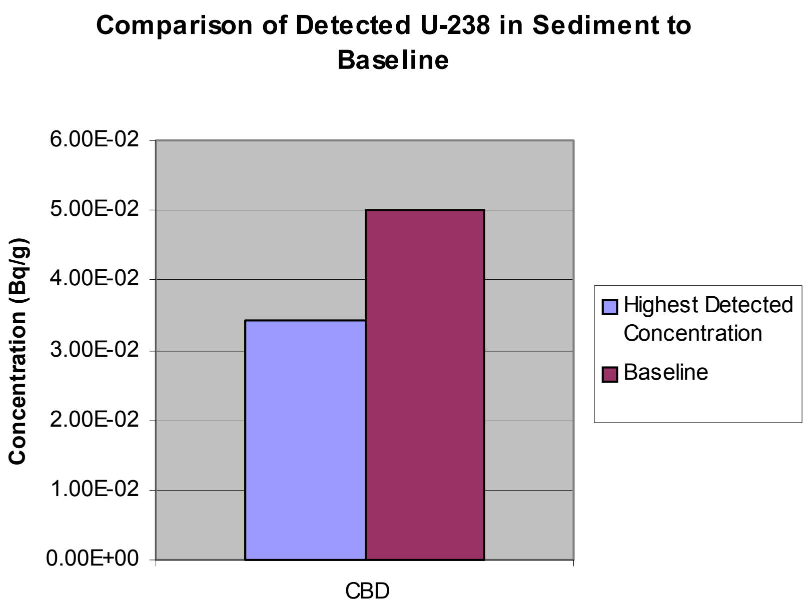

Comparison of Detected U-238 in Surface Water to Baseline
Concentration (Bq/L)
1.40E-01
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
SWL
Highest Detected Concentration
Baseline

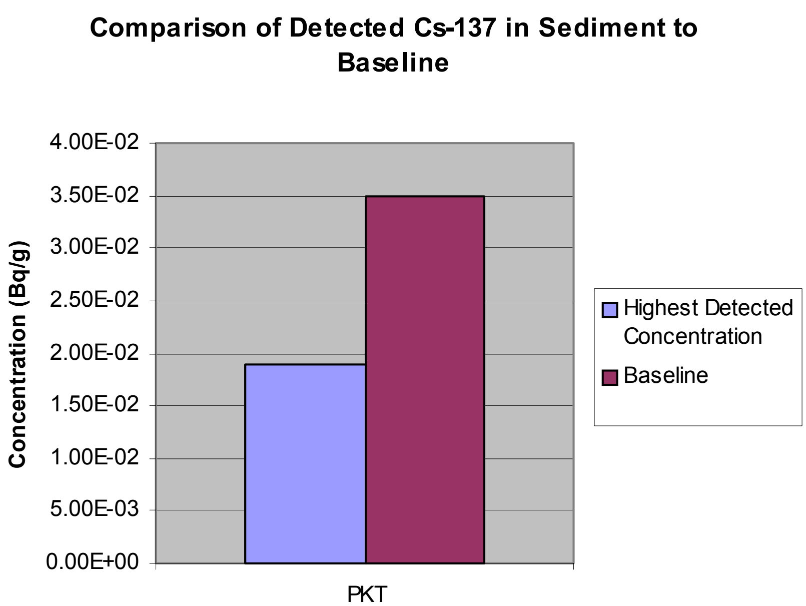

Comparison of Detected Co-60 in Surface Water to Baseline
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Concentration (Bq/L)
FWT
Highest Detected Concentration
Baseline


Comparison of Detected K-40 in Surface Water to Baseline
5.00E-01
4.50E-01
4.00E-01
3.50E-01
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Concentration (Bq/L)
SWL
Highest Detected Concentration
Baseline

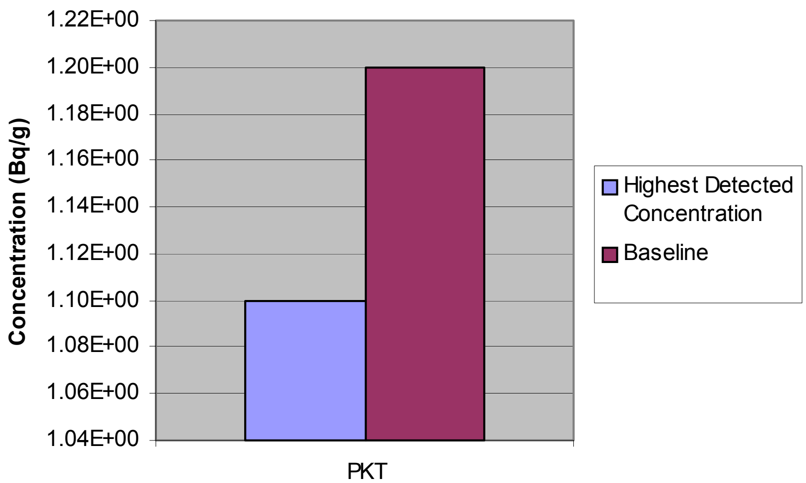

Comparison of Detected U-234 in Sediment to Baseline
Concentration (Bq/g)
1.20E-01
1.00E-01
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
CBD
Highest Detected Concentration
Baseline


Comparison of Detected U-235 in Sediment to Baseline
Concentration (Bq/g)
3.25E-03
3.20E-03
3.15E-03
3.10E-03
3.05E-03
3.00E-03
2.95E-03
2.90E-03
2.85E-03
2.80E-03
2.75E-03
CBD
Highest Detected Concentration
Baseline

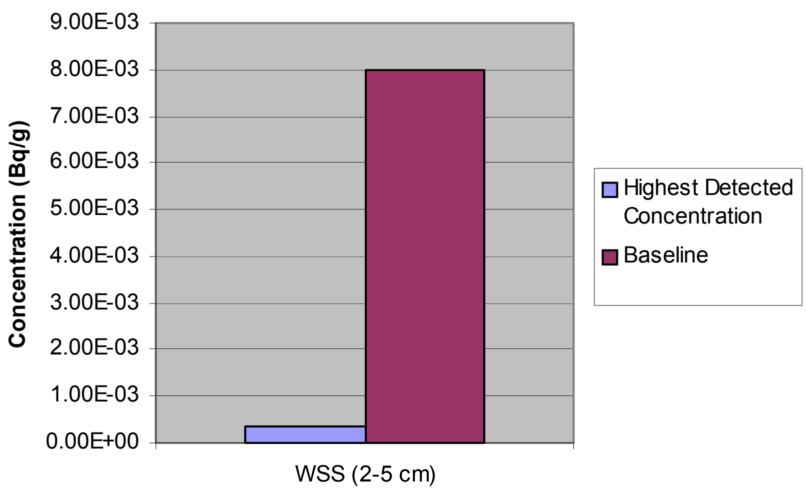

Comparison of Detected U-238 in Sediment to Baseline
Concentration (Bq/g)
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
CBD
Highest Detected Concentration
Baseline

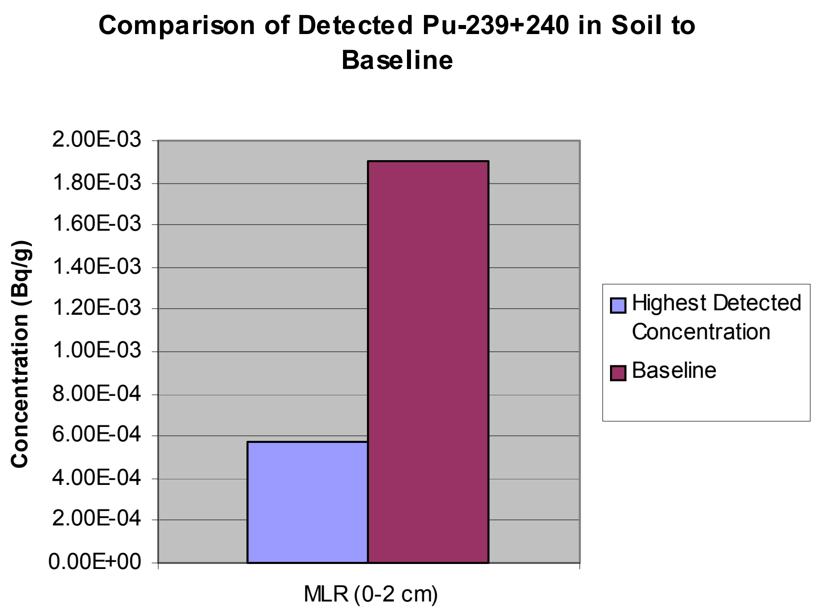

Comparison of Detected Cs-137 in Sediment to Baseline
Concentration (Bq/g)
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
PKT
Highest Detected Concentration
Baseline

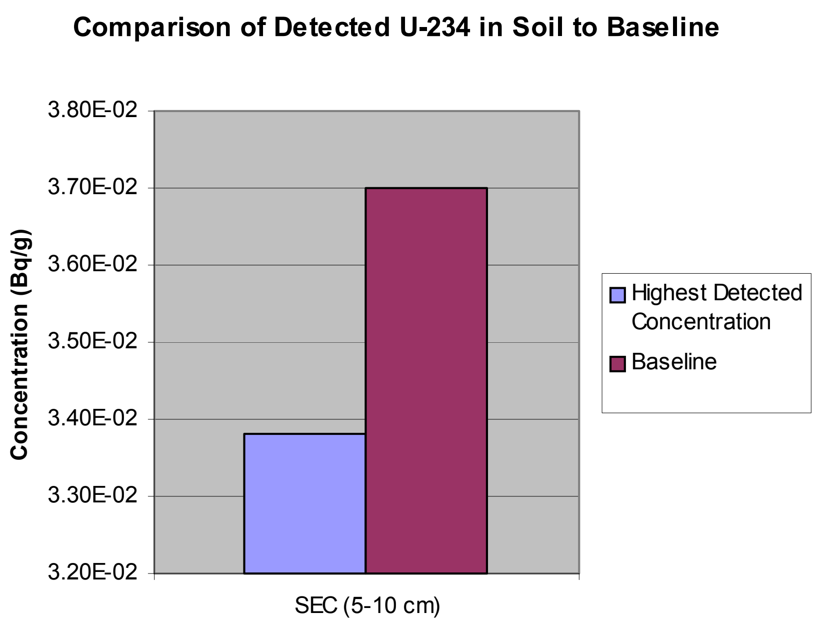
Comparison of Detected K-40 in Sediment to Baseline



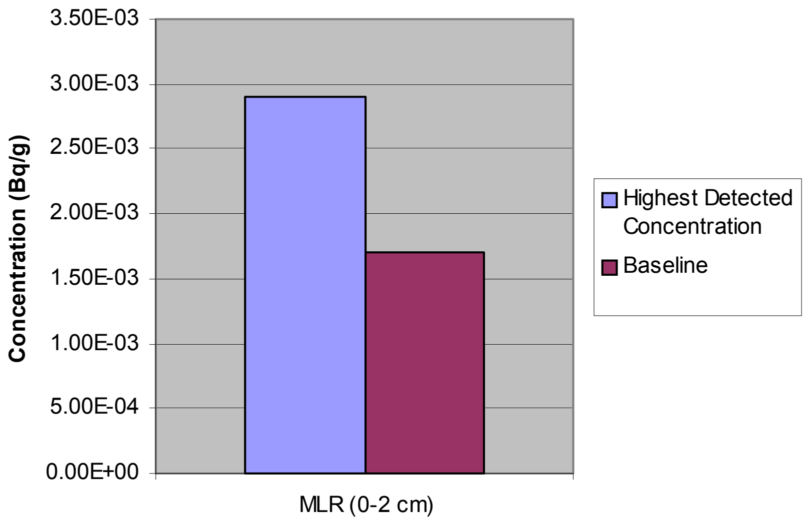
Comparison of Detected Am-241 in Soil to Baseline



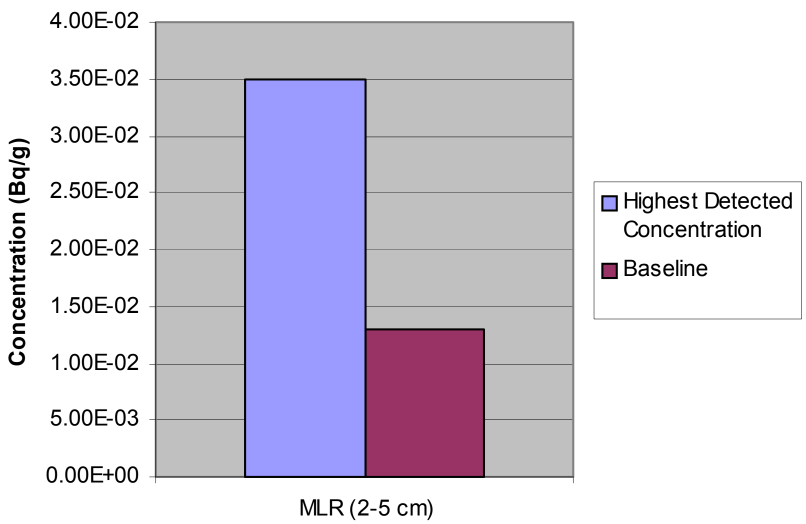

Comparison of Detected Pu-239+240 in Soil to Baseline
Concentration (Bq/g)
2.00E-03
1.80E-03
1.60E-03
1.40E-03
1.20E-03
1.00E-03
8.00E-04
6.00E-04
4.00E-04
2.00E-04
0.00E+00
MLR (0-2 cm)
Highest Detected Concentration
Baseline


Comparison of Detected U-234 in Soil to Baseline
Concentration (Bq/g)
3.80E-02
3.70E-02
3.60E-02
3.50E-02
3.40E-02
3.30E-02
3.20E-02
SEC (5-10 cm)
Highest Detected Concentration
Baseline

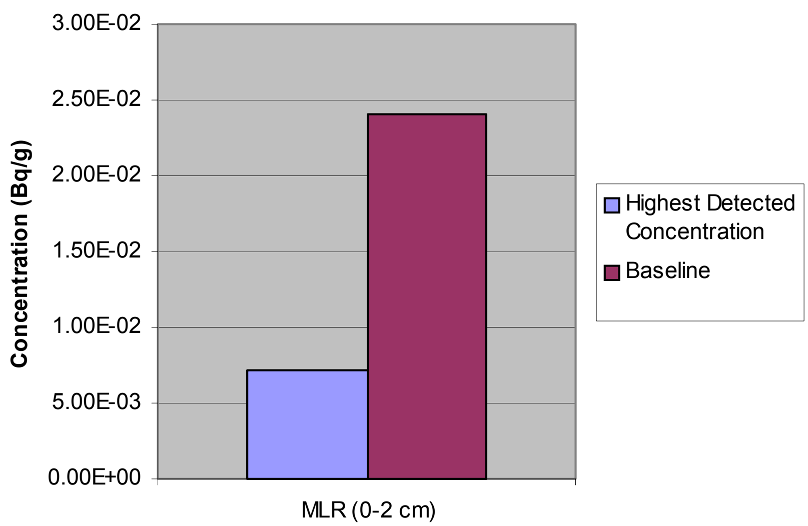
Comparison of Detected U-235 in Soil to Baseline



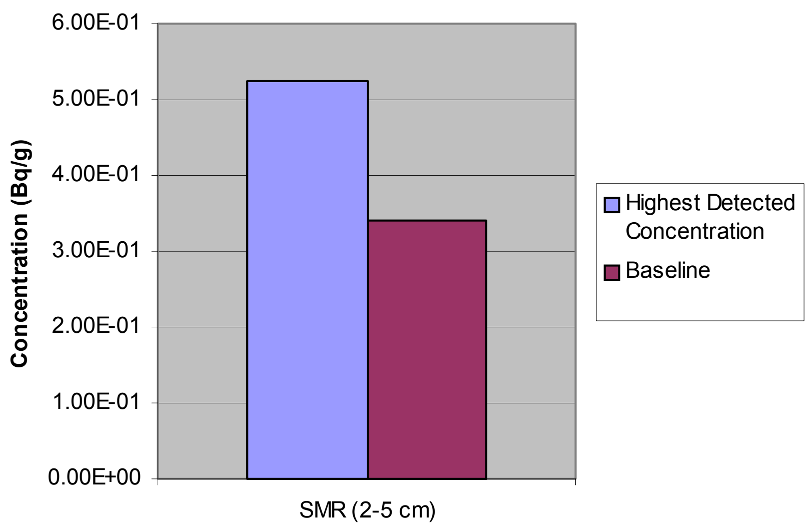
Comparison of Detected U-238 in Soil to Baseline

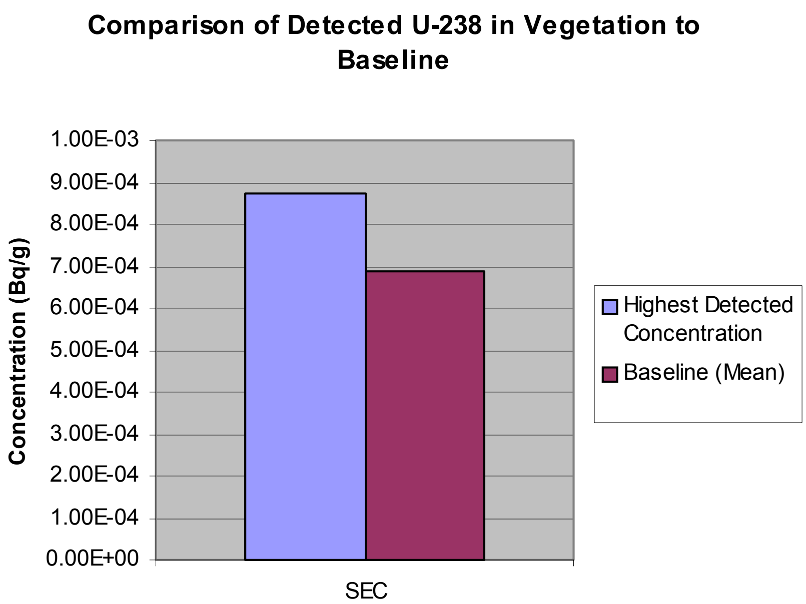


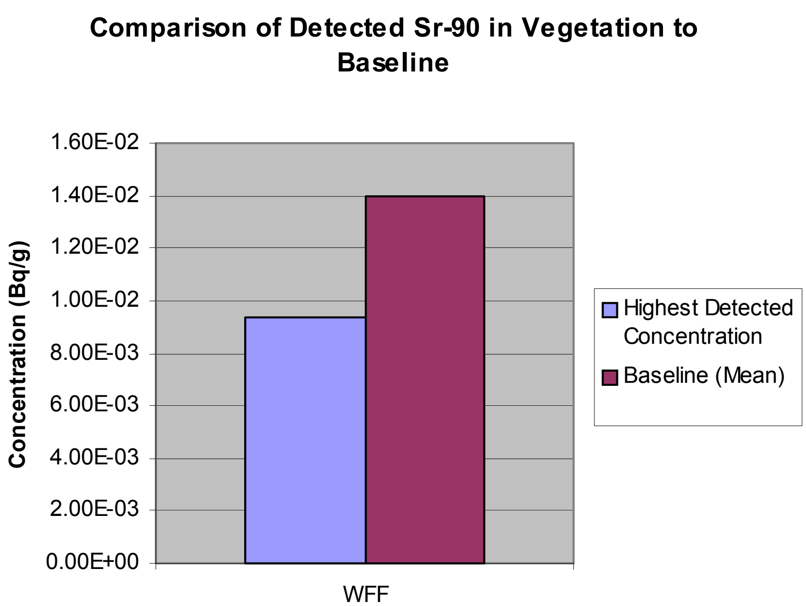
Comparison of Detected Cs-137 in Soil to Baseline

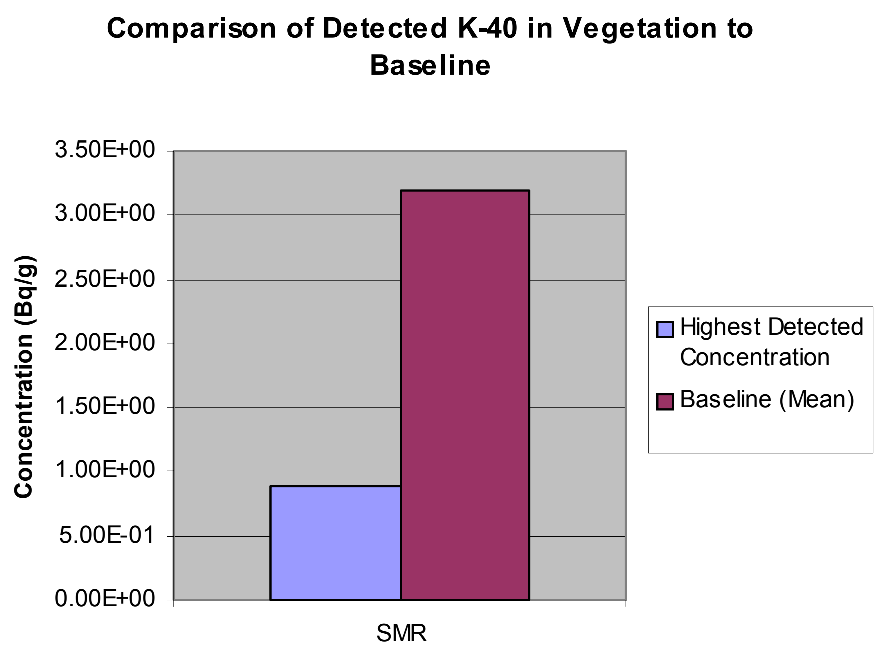


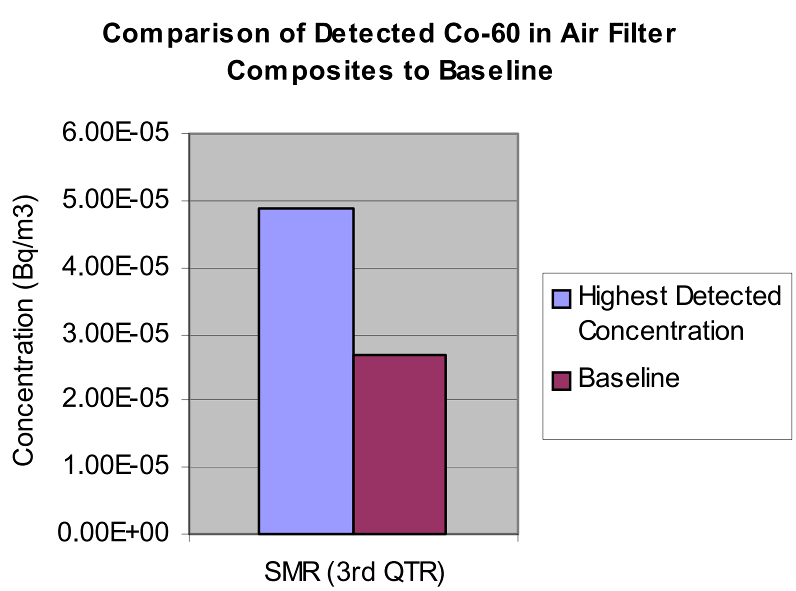
Comparison of Detected K-40 in Soil to Baseline




Comparison of Detected U-238 in Vegetation to Baseline
Concentration (Bq/g)
1.00E-03
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
SEC
Highest Detected Concentration
Baseline (Mean)


Comparison of Detected Sr-90 in Vegetation to Baseline
Concentration (Bq/g)
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
WFF
Highest Detected Concentration
Baseline (Mean)


Comparison of Detected K-40 in Vegetation to Baseline
Concentration (Bq/g)
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
SMR
Highest Detected Concentration
Baseline (Mean)


Comparison of Detected Co-60 in Air Filter Composites to Baseline
Concentration (Bq/m3)
6.00E-05
5.00E-05
4.00E-05
3.00E-05
2.00E-05
1.00E-05
0.00E+00
SMR (3rd QTR)
Highest Detected Concentration
Baseline