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Waste Isolation Pilot Plant Annual Site Environmental Report for 2007

U.S. Department of Energy

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ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASURE

ANOVA	analysis of variance
ANSI	American National Standards Institute
AOC	Area of Concern
ASER	annual site environmental report
ASME	American Society of Mechanical Engineers
BCG	biota concentration guide
bgl	below ground level
BLM	U.S. Department of the Interior, Bureau of Land Management
Bq	becquerel/becquerels
Bq/L	becquerels per liter
Bq/m^3	becquerels per cubic meter
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
CY	calendar year
d	day
DMP	detection monitoring program
DOE	U.S. Department of Energy
DOELAP	DOE Laboratory Accreditation Program
DP	discharge permit
E	East
EDE	effective dose equivalent
EH	DOE Environment, Safety, and Health
EIS	Environmental Impact Statement
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ft	foot/feet
ft^3	cubic feet
FY	fiscal year

HEPA	high-efficiency particulate air (filter)
HWDU	hazardous waste disposal unit
HWFP	Hazardous Waste Facility Permit
IAEA	International Atomic Energy Agency
in.	inch(es)
ISMS	Integrated safety management system
ISO	International Organization for Standardization
kg	kilogram/kilograms
km	kilometer/kilometers
km^2	square kilometers
L	liter/liters
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LWA	Land Withdrawal Act
m	meter/meters
m^2	square meters
m^3	cubic meters
m/d	meters per day
m/s	meters per second
MAPEP	Mixed Analyte Performance Evaluation Program
MCD	maximum concentration detected
MDC	minimum detectable concentration
MEI	maximally exposed individual
MeV	million electron volts
mg	milligram/milligram
mg/L	milligrams per liter
MgO	magnesium oxide
mi	mile/miles
mi^2	square miles
mL	milliliter/milliliters
MOU	memorandum of understanding
mph	miles per hour
mrem	millirem/millirem
MRL	method reporting limit
MSDS	material safety data sheet
N/A	not applicable
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
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
NPDES	National Pollutant Discharge Elimination System
NQA	Nuclear Quality Assurance
NRC	U.S. Nuclear Regulatory Commission
NRIP	National Institute of Standards and Technology Radiochemistry Intercomparison Program
oz	ounce/ounces
P2	pollution prevention
PCB	polychlorinated biphenyl
pCi	picoCuries
PIP	production-injection packer
ppbv	parts per billion by volume
PPOA	Pollution Prevention Opportunity Assessment
Pub. L.	Public Law
QA	quality assurance
QC	quality control
rad	radiation absorbed dose
RBL	room based limits
RCRA	Resource Conservation and Recovery Act
rem	Roentgen equivalent man
RER	relative error ratio
RH	remote-handled
RPD	relative percent difference
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
SPDV	site and preliminary design validation
SS	surface soil
SSW	shallow subsurface water
SU	standard unit
SWMU	solid waste management unit
SVOC	semivolatile organic compound

TDS	total dissolved solids
TOC	total organic compound
TPU	total propagated uncertainty
TRU	transuranic (waste)
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TSS	total suspended solids
U.S.	United States
U.S.C.	*United States Code*
USFWS	U.S. Fish and Wildlife Service
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
WTS	Washington TRU Solutions LLC

Symbols

°C	Degrees Celsius
°F	Degrees Fahrenheit
<	less than
$\leq$	less than or equal to
µCi	microCurie
µg	microgram
µmhos	micromhos
%	Percent
$\pm$	plus or minus
[RN]	Radionuclide concentration
σ	sigma

EXECUTIVE SUMMARY

Purpose

The purpose of the *Waste Isolation Pilot Plant Annual Site Environmental Report for 2007* (ASER) is to provide information required by U.S. Department of Energy (DOE) Order 231.1A, *Environment, Safety, and Health Reporting*. Specifically, the ASER presents summary environmental data that:

- Characterize site environmental management performance.
- Summarize environmental occurrences and responses reported during the calendar year.
- Confirm compliance with environmental standards and requirements.
- Highlight significant facility programs and efforts.
- Describe how compliance and environmental improvement is accomplished through the WIPP Environmental Management System (EMS).

The DOE Carlsbad Field Office (CBFO) and the management and operating contractor (MOC), Washington TRU Solutions LLC (WTS), maintain and preserve the environmental resources at the Waste Isolation Pilot Plant (WIPP). DOE Order 231.1A; DOE Order 450.1, *Environmental Protection Program*; and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, require that the affected environment at and near DOE facilities be monitored to ensure the safety and health of the public and preservation of the environment.

This report was prepared in accordance with DOE Order 231.1A, which requires that DOE facilities submit an ASER to the DOE Headquarters Chief Health, Safety, and Security Officer. The WIPP Hazardous Waste Facility Permit (HWFP) (NM4890139088-TSDF [treatment, storage, and disposal facility]) further requires that the ASER be provided to the New Mexico Environment Department (NMED).

Major Site Programs

Mission

The WIPP mission 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. In 2007, 7,922 cubic meters (m^3) of TRU waste were disposed of at the WIPP facility, including 7,887 m^3 of contact-handled (CH) TRU waste and 34.8 m^3 of remote-handled (RH) TRU waste. From the first receipt of waste in March 1999 through the end of 2007, 52,608 m^3 of TRU waste had been disposed of at the WIPP facility.

Monitoring and Surveillance

It is the policy of the DOE to conduct its operations at the WIPP facility in compliance with applicable environmental laws and regulations, and to protect human health and the environment. This is accomplished through a rigorous EMS. A key element of the EMS is measuring and monitoring environmental performance. At WIPP, this consists of radiological and nonradiological environmental monitoring and surveillance and assessment of compliance with applicable environmental regulations. As part of this EMS, the DOE collects data needed to detect and quantify potential impacts that WIPP facility operations may have on the surrounding environment. The *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) (WIPP Environmental Monitoring Plan) outlines major environmental monitoring and surveillance activities at the WIPP facility and the WIPP facility quality assurance/quality control (QA/QC) program as it relates to environmental monitoring.

WIPP employees conduct both effluent monitoring (i.e., point source monitoring at release points such as the exhaust shaft) to detect radionuclides and quantify dose rates, and traditional pathway and receptor monitoring in the broader environment. The WIPP environmental monitoring program is designed to monitor pathways that radionuclides and other contaminants could take to reach the environment surrounding the WIPP facility. Pathways monitored include air, groundwater, surface water, soils, sediments, vegetation, and game animals. The goal of this monitoring is to determine if the local ecosystem has been, or is being, adversely impacted by WIPP facility operations and, if so, to evaluate the geographic extent and the effects on the environment.

The *Waste Isolation Pilot Plant Land Management Plan* (DOE/WIPP-93-004) (LMP) was created in compliance 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 project lands. The LMP includes a land reclamation program that addresses both the short-term and long-term effects of WIPP facility operations. WIPP personnel also conduct surveillance in the region surrounding the site to protect the WIPP facility from trespass.

In this report, the WIPP facility environmental monitoring and surveillance programs are grouped as follows:

Environmental Radiological Programs

- Effluent
- Airborne particulates
- Groundwater
- Surface water
- Sediments
- Soil
- Biota

Environmental Nonradiological Programs

- Land management
- Meteorology
- Volatile organic compounds
- Seismic activity
- Liquid effluent

Groundwater Protection Programs

- Groundwater quality
- Groundwater levels
- Pressure density surveys
- Shallow subsurface water quality
- Shallow subsurface water levels

Pollution Prevention (P2) Program

- Waste Generation
- Waste Recycling
- Energy Use
- Use of Environmentally Preferred Products

In 2007, the results of each of these monitoring and surveillance programs, observations, and analytical data, demonstrated that (1) compliance with applicable environmental requirements was achieved and (2) the operations at the WIPP facility have not had a negative impact on human health or the environment.

<u>Environmental Compliance</u>

The WIPP facility is required to comply with applicable federal and state laws and DOE orders. In order to accomplish and document compliance with certain requirements, the following submittals, which are required on a routine basis, were among those prepared in 2007:

<u>New Mexico Submittals</u>

A. Hazardous Waste Facility Permit

- 2006 Annual Site Environmental Report
- Semiannual Confirmatory Volatile Organic Compound (VOC) Report
- Mine Ventilation Rate Monitoring Report

- Quarterly Solid Waste Management Unit (SWMU) Activities Progress Reports
- Waste Minimization Statement
- WIPP Groundwater Detection Monitoring Semiannual Groundwater Monitoring Reports
- Geotechnical Data Report
- Monthly Water Level Reports

B. Discharge Permit (DP-831)

- Semiannual Discharge Monitoring Reports

C. Superfund Amendments and Reauthorization Act of 1986

- Emergency and Hazardous Chemical Inventory Report
- Toxic Chemical Release Inventory Report
- 2007 Annual Polychlorinated Biphenyls Report

<u>Environmental Protection Agency Submittals</u>

- Delaware Basin Monitoring Annual Report
- WIPP Subsidence Monument Leveling Survey
- 2007 Annual Change Report
- Toxic Chemical Release Inventory Report

Other correspondence, regulatory submittals, monitoring reports, and the results of the U.S. Environmental Protection Agency (EPA) Annual Inspection, as well as other inspections, are described in Chapters 2 and 3 of this report.

In addition, WIPP maintains an in-depth, integrated evaluation program that consists of audits, assessments, surveillances and inspections. Over 60 percent of all evaluations performed over the last three years incorporated a level of compliance checks. This system, coupled with the WIPP corrective action system, assures that potential compliance issues are identified, and corrective/preventive actions are tracked through a formal process.

The following compliance issues were identified in 2007. The issues have either been appropriately addressed, or formal corrective action and improvements plans are in progress and slated for completion in 2008.

- Acceptance of a drum of waste from Idaho National Laboratory for which all characterization activities had not been completed. This was self-discovered and reported to regulatory agencies. Immediate action was taken to respond, including cessation of waste shipment and emplacement. The drum was removed and returned to Idaho. A formal root cause analysis indicated that no further action was applicable to the WIPP site.

- Discharge of approximately 150 gallons of leaded brine water into the H-19 evaporation pond without securing the authorizations required by the technical procedure controlling the discharges. The water contained lead in excess of the 5.0 milligrams per liter (mg/L) limit. This occurrence was self-discovered, and work was stopped immediately. The occurrence was documented and corrective actions were managed through the WIPP issues management process, which included completion of a formal root cause analysis. In addition, sediment and water samples were collected from the pond. The results demonstrated that no threat to human health or the environment resulted from the incident.

- Issuance of a Notice of Violation (NOV) by the NMED alleging deficiencies within the WIPP groundwater monitoring program. WIPP performed in-depth reviews of its groundwater program and initiated program improvements, then asked the NMED to rescind the NOV. A response from the NMED is pending.

- Issuance of a Compliance Order by the NMED alleging that 121 drums of waste received by WIPP from the Los Alamos National Laboratory from August 2005 through February 2006 were not characterized in accordance with permit requirements. In its response, WIPP asserted that permit requirements were met. A technical analysis was performed, which determined that the acceptance and emplacement of the drums did not pose an elevated risk to human health or the environment.

- Issuance of an administrative NOV by the NMED for failing to take bacterial samples of drinking water in December 2006. WIPP immediately met regulatory requirements for posting public notification. Daily logs indicated that proper levels of water system chlorination were achieved at all times. No further actions were required as WIPP had returned to a compliant status.

- Disposal of three shipments of waste containing polychlorinated biphenyls (PCBs) without providing Certificates of Disposal back to the generator site as required by Title 40, *Code of Federal Regulations* (CFR) §761.218, "Certificate of Deposit," paragraph (b). This issue was self-identified, the EPA was notified, and the Certificates of Disposal were submitted to the generator site. To prevent this problem from occurring in the future, PCB shipments are now flagged and email reminders are sent to staff members to generate and send out the appropriate Certificates of Disposal.

Key Initiatives

Environmental Management System

The WIPP EMS provides the mechanism for achieving the WIPP policy to maintain compliance with applicable requirements, be a good environmental steward and continually improve environmental performance. The EMS is described in the *Waste Isolation Pilot Plant Environmental Management System Description* (DOE/WIPP-05-3318). In addition, the EMS continued to conform to the guiding principles of the International Organization for Standardization (ISO) 14001, *Environmental Management Systems - Specification with Guidance for Use* (ISO, 2004). The WIPP EMS continued to meet the requirements of DOE Order 450.1 during 2007 and remains integrated with the safety management system as described in *Integrated Safety Management System Description* (DOE/CBFO-98-2276).

Environmental performance is monitored through the environmental data generated from implementation of WIPP major environmental programs and EMS system indicators. Monitoring results and analysis demonstrate the EMS continues to be suitable and effective for achieving the WIPP environmental policy. This conclusion was confirmed through the completion of the *CBFO Annual Review of the WIPP Integrated Safety Management System* of September 2007 and the *WIPP Environmental Management System Annual Report for Fiscal Year 2007* (DOE/WIPP-08-3333). The annual reviews also focused on opportunities for improvement of environmental performance. These opportunities are being implemented through action plans.

Highlights of the EMS for 2007 are as follows:

- WIPP accomplished five of seven environmental goals. Each of the two remaining goals were 50 percent complete and were carried forward into 2008 for completion. Two notable achievements accomplished were (1) implementing a system for applying clean storm water rather than domestic water for reclamation of the salt pile and (2) testing use of biodiesel in the commuter buses that transport employees to the WIPP site.

- WIPP had no reportable, unauthorized contaminant releases to the environment in 2007, as has been the case for over seven years.

- The 2007 environmental monitoring data continue to demonstrate that there has been no adverse impact to human health or the environment from WIPP facility operations.

- The WIPP integrated evaluation system remains healthy, with 68 percent of all evaluations including some level of environmental compliance or performance checks.

- The nonconformance and corrective action element of the EMS is fully integrated with the WIPP issues management program, the overall system for corrective action. Of all the issues identified and managed through this program, 68 percent were self-discovered.

- WIPP reduced its freshwater use for the fifth consecutive year. The 2007 reduction was 9 percent compared to 2006.

- As a result of prudent conservation practices, energy use increases have been less than expected as waste emplacement and mining rates increased. Carbon emissions associated with energy have remained in the range of three thousand metric tons per year for the past six years.

- A gap analysis of the WIPP EMS compared to Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy and Transportation Management*, was completed and the revisions to the EMS were initiated. Minimal revisions were required.

Summary of Releases and Radiological Doses to the Public

Doses to the Public and the Environment

The radiation dose to members of the public from WIPP facility operations has been calculated from WIPP facility effluent monitoring results and demonstrates compliance with federal regulations.

Dose Limits

The regulatory limit for the WIPP facility is established in 10 CFR Part 191, Subpart A, "Environmental Standards for Management and Storage." The referenced standard requires 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) ("rem" is roentgen equivalent man) to the whole body and 75 mrem to any critical organ. In addition, in a 1995 memorandum of understanding (MOU) between the EPA and the DOE, the DOE agreed that the WIPP facility 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). The NESHAP standard for radionuclides requires 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 effective dose equivalent (EDE) of 10 mrem per year.

Background Radiation

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 aboveground nuclear weapons tests and from the 1986 Chernobyl nuclear accident are present in the environment. A potential source of radiation in the environment near and at the WIPP site is the result of Project Gnome. Under Project Gnome, a nuclear device was detonated in bedded salt on December 10, 1961, approximately 9 kilometers (km) (5.4 miles [mi]) from the WIPP site. The Project Gnome shot vented into the atmosphere; therefore, environmental samples taken at the WIPP site may contain residual contamination from this occurrence. Together, natural radiation and residual fallout are called "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 millisieverts (mSv) (300 mrem) (National Council on Radiation Protection and Measurement [NCRP, 1987a]). Site-specific background gamma measurements on the surface, conducted by Sandia National Laboratories, showed an average dose rate of 7.65 microR/hour (Minnema and Brewer, 1983), which would equate to the background gamma radiation dose of 0.67 mSv (67.0 mrem) per year. A comprehensive radiological baseline study before WIPP facility disposal operations began was also documented in *Statistical Summary of the Radiological Baseline Program for the Waste Isolation Pilot Plant* (DOE/WIPP-92-037), which provides the basis for environmental background comparison after WIPP facility disposal operations commenced.

<u>Dose from Air Emissions</u>

WIPP personnel have identified air emissions as the major pathway of concern for radionuclide transport during the receipt and emplacement of waste at the WIPP facility. To determine the radiation dose received by members of the public from WIPP facility operations, WIPP personnel 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 EDE 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 dose that encompasses dose from inhalation, plume submersion, deposition, and ingestion of air-emitted radionuclides.

<u>Total Dose from WIPP Facility Operations</u>

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

Game animals sampled during 2007 were deer, quail, fish, and rabbit. The radionuclides detected were not different from baseline levels. By extrapolation, no dose from WIPP facility-related radionuclides has been received by any individual from this pathway (e.g., the ingestion of meat from game animals) during 2007.

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, or by 40 CFR Part 61, Subpart H. The results indicate that the hypothetical maximally exposed individual (MEI) who resides year-round at the fence line, 350 meters (m) from the exhaust shaft, receives a dose that is less than 1.52E-06 mSv (1.52E-04 mrem) per year for the whole body and less than 1.46E-05 mSv (1.46E-03 mrem) per year to 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 mi) west-northwest of WIPP was calculated to be less than 7.01E-08 mSv (7.01E-06 mrem) per year for the 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 calendar years (CYs) 1999 through 2007. 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 milligray/day (mGy/d) (1 radiation absorbed dose per day [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 ASER 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 the WIPP site during 2007. The screening results indicate that radiation in the environment surrounding the WIPP site 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 2007.

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CHAPTER 1 - INTRODUCTION

The purpose of this report is to provide information needed by the U.S. Department of Energy (DOE) to assess Waste Isolation Pilot Plant (WIPP) 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, *Environment, Safety, and Health Reporting*. This report documents the WIPP environmental monitoring and results for calendar year (CY) 2007.

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

Located in southeastern New Mexico, the WIPP facility is the nation's first underground repository permitted to safely and permanently dispose of transuranic (TRU) radioactive and mixed waste generated through defense activities and programs. TRU waste is defined in the WIPP Land Withdrawal Act of 1992 (LWA) (Pub. L. 102-579) 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 twenty 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 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. The waste must also meet the criteria in *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant* (DOE/WIPP-02-3122).

TRU waste is disposed of 655 meters (m) (2,150 feet [ft]) below the surface in excavated disposal rooms in the Salado Formation, which is a thick sequence of Permian Age evaporite salt beds. At the conclusion of the WIPP disposal phase, 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 and the surrounding salt will flow around the drums and seal them within the Salado Formation. A detailed description of the WIPP geology and hydrology may be found in Chapter 2 of *Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application 2004* (DOE/WIPP-04-3231).

1.1 WIPP Mission

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

1.2 WIPP 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 the WIPP site were deposited in thick beds during the evaporation of the Permian Sea. These geologic formations consist mainly of sodium chloride, the same substance as table salt. However, the salt is not granular, but in the form of solid rock. The main salt formation is approximately 610 meters (m) (2,000 feet [ft]) thick, and begins 259 m (850 ft) below the earth's surface. Formed during the Permian Age, the large expanses of uninterrupted salt beds provide a geologic environment that is 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), subsequently redesignated as the Carlsbad Field Office (CBFO), to lead the transuranic (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 the WIPP facility the following morning, and the first wastes were placed underground later that day. On April 27, the first out-of-state shipment arrived at the WIPP site from the Idaho National Engineering and Environmental Laboratory. Later in the year, on October 27, the Secretary of the New Mexico Environment Department (NMED) issued the WIPP Hazardous Waste Facility Permit (HWFP) (NM4890139088-TSDF [treatment, storage, and disposal facility]), which allowed contact-handled (CH) TRU mixed waste to be managed, stored, and disposed of at the WIPP facility. Mixed waste is waste that contains both hazardous and radioactive waste. CH TRU mixed waste is TRU mixed waste with a surface dose rate less than 200 millirem (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.

On October 16, 2006, the Secretary of the NMED issued a revised HWFP allowing the WIPP facility to receive remote-handled (RH) TRU mixed waste. RH TRU waste allowable at the WIPP facility has a surface dose rate greater than or equal to 200 mrem per hour and up to 1,000 rem per hour.

1.3 Site Description

Located in Eddy County in the Chihuahuan Desert of southeastern New Mexico (Figure 1.1), the WIPP site encompasses 41.4 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).

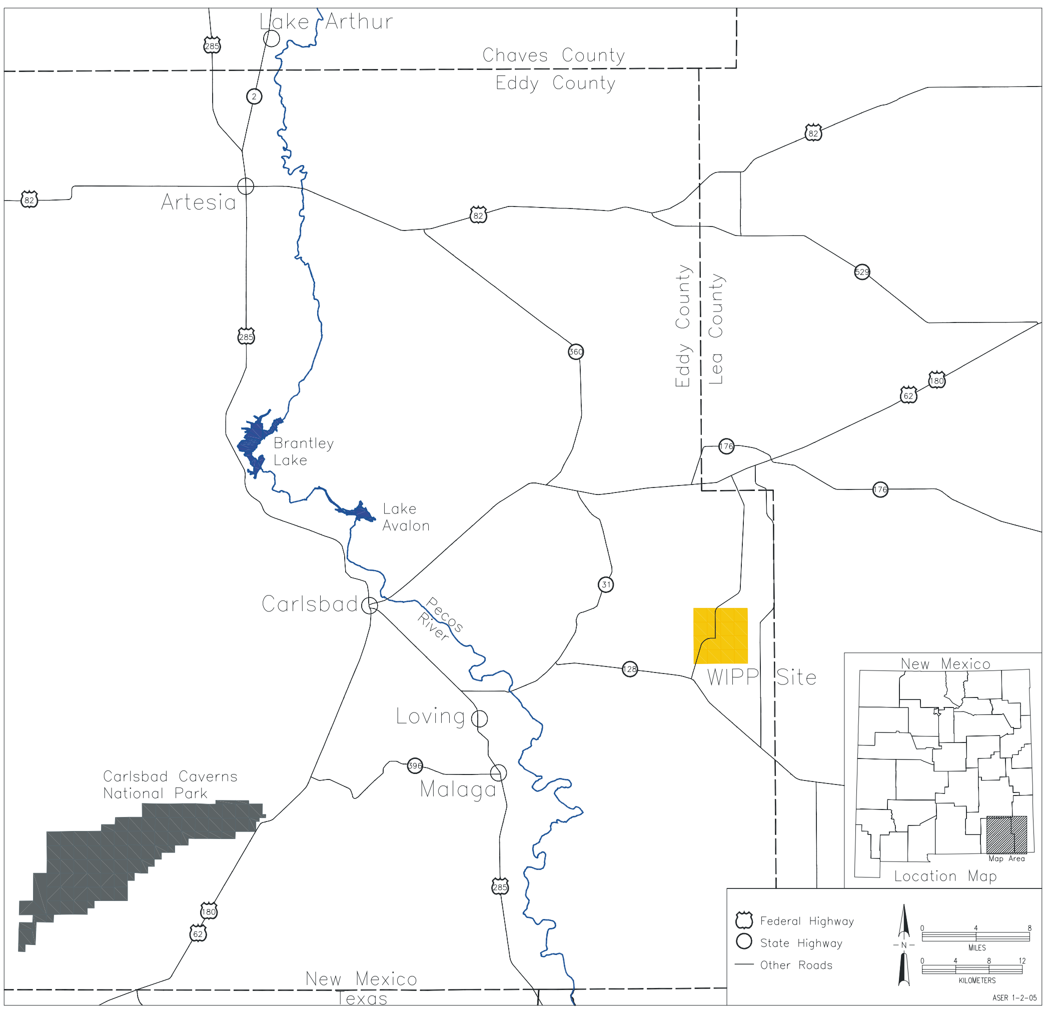

Figure 1.1 - WIPP Location

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 (0.463 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, with the exception of two mineral leases. 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 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

Four property areas are defined within the WIPP boundary (Figure 1.2).

<u>Property Protection Area</u>

The interior core of the facility encompasses 0.129 km^2 (0.05 mi^2) (35 acres) surrounded by a chain link fence. Security is provided for this area 24 hours a day.

<u>Exclusive Use Area</u>

The Exclusive Use Area is comprised of 1.2 km^2 (297 acres). It is surrounded by a barbed wire fence and is restricted exclusively for the use of the DOE and its contractors and subcontractors in support of the project. This area is marked by DOE warning (e.g., "no trespassing") signs and is patrolled by WIPP security personnel to prevent unauthorized activities or uses.

<u>Off-Limits Area</u>

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

<u>WIPP Land Withdrawal Area</u>

The WIPP site boundary delineates the perimeter of the 41.4 km^2 (16 mi^2) (10,240 acres) WIPP Land Withdrawal Area. This tract includes the Property Protection Area, the Exclusive Use Area, and the Off-Limits Area, as well as outlying areas.

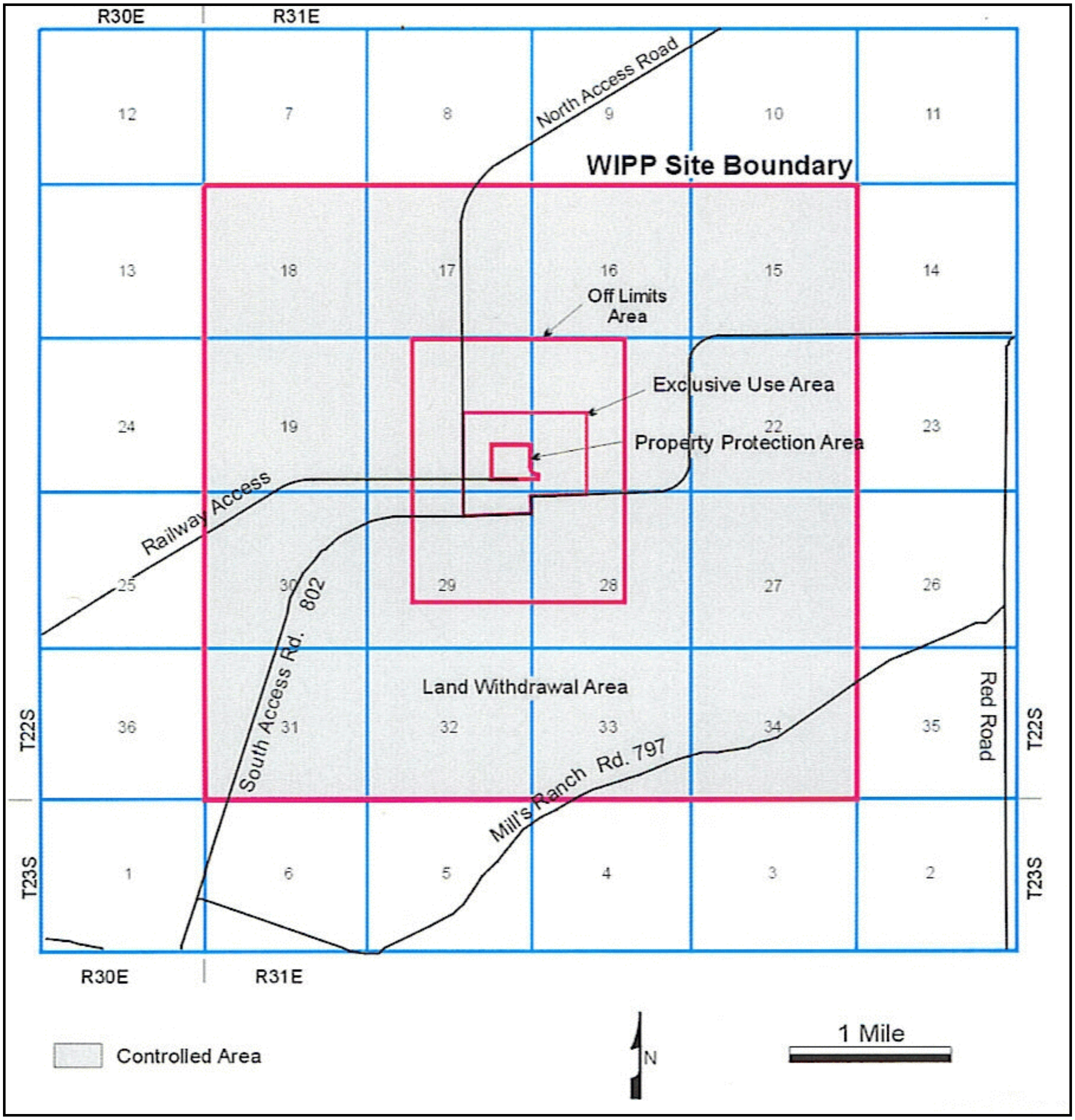

Figure 1.2 - WIPP Property Areas

<u>Special Management Areas</u>

Certain properties used in the operation of WIPP (e.g., reclamation sites, well pads, roads) are, or may be, identified as Special Management Areas in accordance with the *Waste Isolation Pilot Plant Land Management Plan* (LMP) (DOE/WIPP-93-004), which is described further in Section 5.2. A Special Management Area 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 a Special Management Area. In 2007, there were no areas designated as Special Management Areas.

1.3.2 Population

There are 25 residents living within 16 km (10 mi) of the WIPP site (source: DOE/WIPP-93-004). 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.

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. According to 2000 census data, 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 the WIPP site. The nearest major populated area is Carlsbad, 42 km (26 mi) west of the WIPP site. The estimated population of Carlsbad is 25,625.

1.4 WIPP Environmental Stewardship

The DOE 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. The DOE conducts effluent monitoring, environmental surveillance, land management, and assessments to verify that these objectives are met. Environmental monitoring includes collecting and analyzing environmental samples from various media and evaluating whether WIPP activities have caused any adverse environmental impacts.

1.4.1 Environmental Monitoring Plan

The WIPP Environmental Monitoring Plan (DOE/WIPP-99-2194) outlines the program for monitoring the environment at and around the WIPP site, including the major environmental monitoring and surveillance activities at the WIPP facility. The plan also discusses the WIPP quality assurance/quality control (QA/QC) program as it relates to environmental monitoring. The purpose of the plan is to specify how effects of WIPP facility operations on the local ecosystem are to be determined. Effluent and environmental monitoring data are necessary to demonstrate compliance with applicable environmental protection regulations. The frequency of 2007 sampling is provided in Table 1.1.

Table 1.1 - Environmental Monitoring Sampling[1]

Program	Type of Sample	Number of Sampling Locations	Sampling Frequency
Radiological	Airborne effluent	3	Periodic/confirmatory
	Airborne particulate	7	Weekly
	Sewage treatment system (DP-831)[2]	3	Semiannual
	H-19 (DP-831)[2]	1	Semiannual
	Liquid effluent	1 (WHB sump)	If needed
	Biotic		
	• Quail • Rabbits • Beef/Deer • Fish • Vegetation	WIPP vicinity WIPP vicinity WIPP vicinity 3 6	Annual As available As available Annual Annual
	Soil	6	Annual
	Surface water	Maximum of 14	Annual
	Sediment	Maximum of 12; 13 if sediment is present at sewage lagoon outfall	Annual
	Groundwater	7	Semiannual
Nonradiological	Meteorology	1	Continuous
	Volatile organic compounds (VOCs)		
	• VOCs - Repository • VOCs - Disposal Room	2 # of active panel disposal rooms	Semiweekly Bi-weekly
	Groundwater	7	Semiannual
	Shallow subsurface water (SSW)	Maximum of 10	Semiannual
	Surface water (DP-831)	5	After a storm major event or annually, whichever is more frequent

[1]The number of certain types of samples taken can be driven by site conditions. For example, during dry periods there may be no surface water or sediment to sample at certain locations. Likewise, the number of samples for biota will also vary. For example, the number of rabbits available as samples of opportunity will vary as will fishing conditions that are affected by weather and algae levels in the water.

[2]Includes a nonradiological program component.

The plan 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 at the WIPP facility. The plan also describes monitoring of VOCs, groundwater chemistry, and other nonradiological environmental parameters, and collection of meteorological data.

1.4.2 WIPP Environmental Monitoring Program and Surveillance Activities

WIPP employees monitor air, surface water, groundwater, sediments, soils, and biota (e.g., vegetation, select mammals, quail, 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.

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 the WIPP site consist of sampling and analyses designed to detect and quantify impacts of construction and operational activities, and verify compliance with applicable requirements.

1.5 Environmental Performance

DOE Order 450.1, *Environmental Protection Program,* describes the DOE 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 Environmental Management System (EMS).

In 2007, WIPP maintained compliance with applicable environmental laws, regulations, and permit conditions, except as noted in Sections 2.1.2, 2.1.7, and 2.1.9. Furthermore, analyses of the WIPP environmental monitoring data have demonstrated that WIPP operations have not had an adverse impact on the environment. Implementation of the WIPP Environmental Monitoring Plan fulfills the environmental monitoring requirements of DOE Order 450.1. Detailed information on WIPP programs are contained in the remaining chapters.

1.6 Organization of This Annual Site Environmental Report

This annual site environmental report (ASER) is organized as follows:

- Chapter 2 is the Compliance Summary.
- Chapter 3 presents the WIPP Environmental Management System.
- Chapter 4 presents the WIPP Environmental Radiological Protection Program and Dose Assessment.
- Chapter 5 presents the WIPP Environmental Nonradiological Program information and results.
- Chapter 6 presents the WIPP Groundwater Protection Program and results.
- Chapter 7 contains information on Quality Assurance and results.

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CHAPTER 2 - COMPLIANCE SUMMARY

The WIPP facility is required to comply with the applicable regulations promulgated pursuant to federal and state statutes, DOE orders, and Executive Orders (EOs). Compliance with regulatory requirements is incorporated into facility plans and implementing procedures. Methods for maintaining compliance with environmental requirements include the use of engineered controls and written procedures, routine training of facility personnel, ongoing self-assessments, and personnel accountability. The following sections list the environmental statutes/regulations applicable to WIPP, and describe significant accomplishments and ongoing compliance activities. A detailed breakdown of WIPP compliance with environmental laws is available in the *Waste Isolation Pilot Plant Biennial Environmental Compliance Report* (DOE/WIPP-08-2171).

2.1 Compliance Status

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

2.1.1 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 Title 40 *Code of Federal Regulations* (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."

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

The WIPP facility is required by the Superfund Amendments and Reauthorization Act of 1986 Title III (42 U.S.C. §11101) (also known as the Emergency Planning and Community Right-to-Know Act [EPCRA], which is implemented by 40 CFR Parts 302-313) to submit (1) a list of hazardous chemicals present at the facility in excess of 10,000 pounds for which Material Safety Data Sheets are required, (2) an Emergency and Hazardous Chemical Inventory Form (Tier II Form) 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 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 regional fire departments.

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. The Tier II Form is submitted annually to each fire department with which the CBFO maintains a memorandum of understanding and to the Local Emergency Planning Committee and the 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. The last notification was made in 1999.

Title 40 CFR Part 313, "Toxics Release Inventory," identifies requirements for facilities to submit a toxic chemical release report to the U.S. Environmental Protection Agency (EPA) and the resident state if toxic chemicals are used at the facility in excess of established threshold amounts. The Toxic Chemical Release Report was submitted to the EPA and to the SERC prior to the July 1, 2007, reporting deadline. Table 2.1 presents the 2007 EPCRA reporting status. A response of "yes" indicates that the report was required and submitted.

Table 2.1 - Status of EPCRA Reporting

EPCRA Regulations - 40 CFR Parts	Description of Reporting	Status
302-303	Planning Notification	Further Notification Not Required
304	Extremely Hazardous Substance Release Notification	Not Required
311-312	Material Safety Data Sheet/Chemical Inventory (Tier II Form)	Yes
313	Toxics Release Inventory Reporting	Yes

<u>Accidental Releases of Reportable Quantities of Hazardous Substances</u>

During 2007, there were no releases of hazardous substances exceeding the reportable quantity limits.

2.1.2 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §§6901, et seq.) was enacted in 1976. Implementing regulations were promulgated 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 or specific exemptions apply. 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 in New Mexico are outlined in 20.4.1.500 New Mexico Administrative Code (NMAC), which adopts, by reference, 40 CFR Part 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." The hazardous waste management permitting program is administered through 20.4.1.900 NMAC, which adopts, by reference, 40 CFR Part 270, "EPA Administered Permit Programs: The Hazardous Waste Permit Program."

Hazardous Waste Facility Permit

The NMED issued the WIPP HWFP on October 27, 1999, and it became effective November 26, 1999. The HWFP authorized WIPP to receive, store, and dispose of CH TRU mixed waste. The NMED modified the HWFP on October 16, 2006, to also allow receipt, storage, and disposal of RH TRU mixed waste. Two storage units (the parking area container storage unit and the Waste Handling Building container storage unit) are permitted for storage of TRU mixed waste. Seven underground hazardous waste disposal units are currently permitted for the disposal of CH and RH TRU mixed waste.

On November 26, 2007, the NMED issued a Compliance Order alleging that in June of 2007 the Permittees emplaced a drum of CH TRU waste with liquids in excess of the HWFP waste acceptance limits. This event had been self-discovered within three weeks of the acceptance and placement and had been reported to the NMED. WIPP took immediate action to respond to this situation, including immediately stopping any further waste emplacement and shipments. In addition, the drum in question was removed and returned to Idaho in mid-August. The root cause analysis indicated that no further action was applicable to the WIPP site. Actions to correct and prevent recurrences have been made in the generator site program in accordance with a root cause analysis.

On November 26, 2007, the NMED issued a Notice of Violation (NOV) alleging deficiencies within the WIPP groundwater monitoring program. The Permittees have asserted that the NOV was unwarranted and requested that it be rescinded. However, WIPP has also established a schedule for program improvements to address the specific issues raised by the NMED. Several of the actions have been completed. A response from the NMED is pending.

Also on November 26, 2007, the NMED issued a Compliance Order alleging that 121 drums of TRU waste from Los Alamos National Laboratory did not satisfy permit requirements. The Permittees asserted that no violations of the HWFP had occurred. The Permittees performed an analysis and determined that the acceptance and emplacement of the containers did not pose an elevated risk to human health and the environment. Submittal of technical justification to the NMED and resolution of this matter was pending at the end of this reporting period - CY 2007.

Modification Requests

In 2007, the Permittees submitted twelve HWFP modification notification/requests to the NMED. These submittals consisted of six Class 1 change notifications, two Class 1* modification requests, three Class 2 modification requests, and one Class 3 modification request. Class 1 changes may be implemented upon submittal to the regulator. Class 1* permit changes are modifications that, although minor in nature, still warrant approval from the regulator before implementation. Class 2 changes are modifications to the Permit that allow for significant, but not major changes to the authorization basis for the facility. Class 3 changes substantially alter the facility or its operation. Table 2.2 provides details on the modification requests submitted to NMED in 2007.

Table 2.2 - Permit Modification Notifications and Requests Submitted in 2007

Class	Description	Date Submitted
1*	This change requested a revision to the closure schedule for Panels 1-8. The NMED approved this modification on February 27, 2007.	January 11, 2007
1	This change corrected references, removed inconsistencies, corrected figures.	January 18, 2007
1	This change corrected figures to reflect the ability to use Panel 4 for waste disposal.	January 19, 2007
1	This change inserted a new Part A Form in Attachment O.	January 26, 2007
2	This change included requests to revise training requirements for waste confirmation; revise preventative maintenance procedure frequencies; remove the description of the Brush Truck; revise Incident Level II requirements; revise Emergency Operations Center staff requirements; and revise the Contingency Plan. The NMED approved this modification, with changes, on June 22, 2007.	March 21, 2007
1	This change revised procedures for maintaining records.	July 25, 2007
1	This change revised to a 45-day public comment period.	August 14, 2007
3	This change requested no further action status for fifteen solid waste management units (SWMUs) and eight Areas of Concern (AOCs) at the WIPP facility. This change was pending at the end of 2007.	September 4, 2007
1	Change in Washington TRU Solutions LLC General Manager	September 11, 2007
1*	This change reflected the change in operational control. This change was pending at the end of 2007.	November 19, 2007
2	This change was to initiate a hydrogen and methane monitoring program. This change was pending at the end of 2007.	November 20, 2007
2	Electronic Operating Record. This change was pending at the end of 2007.	November 20, 2007

Underground Storage Tanks

Title 40 CFR Part 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)," addresses 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, and implements the EPA program through 20.5 NMAC, "Petroleum Storage Tanks." WIPP maintains two petroleum USTs registered with the NMED.

The NMED conducted an inspection of the USTs on March 26, 2007. The tanks were determined to be maintained in compliance with the applicable regulations.

Hazardous Waste Generator Compliance

Nonradioactive hazardous waste is currently generated through routine facility operations, and is managed in satellite accumulation areas, a "less-than-90-day" accumulation area on the surface, and a "less-than-90-day" accumulation area underground.

Hazardous waste generated at the WIPP facility is accumulated, characterized, packaged, labeled, and manifested to off-site treatment, storage, and disposal facilities in accordance with the requirements codified in 20.4.1.300 NMAC, which adopts, by reference, 40 CFR Part 262, "Standards Applicable to Generators of Hazardous Waste."

In 2007, a leaking cesium-137 (^{137}Cs) source contaminated some lead shot that was previously used as shielding. This mixed waste was disposed of at an off-site disposal facility permitted for the disposal of mixed waste.

WIPP Solid Waste Management Units and Areas of Concern

A no further action report and petition was submitted to the NMED in October 2002 for the purpose of removing the fifteen SWMUs and eight AOCs from the requirement for further remediation. On April 20, 2007, the NMED reviewed and approved the WIPP no further action petition for SWMUs and AOCs. Since the NMED approved the petition, the processing of a Class 3 HWFP modification request to remove the aforementioned SWMUs and AOCs from regulation under the HWFP is proceeding (see Table 2.2).

Program Deliverables and Schedule

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

- The annual Waste Minimization Certification Statement was completed and placed in the operating record as of November 2007 and was transmitted 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 and the mine ventilation rate monitoring. The WIPP facility continued to comply with these requirements by preparation and submission of annual reports in October 2007, representing results for July 1, 2006, through June 30, 2007.
- HWFP Module V, Section V.J.2.a, requires reports of the analytical results for semiannual detection monitoring program (DMP) well samples and

duplicates, as well as results of the statistical analysis of the samples from which the determination was made that there is or is no statistically significant evidence of contamination. These reports for Sampling Rounds 24 and 25 were submitted to the NMED in 2007. Sampling results are also summarized in Appendices E and F of this ASER.

- HWFP Module V, Section V.J.2.b. requires monthly submittal of groundwater surface elevation results. This includes groundwater surface elevations calculated from field measurements and fresh-water head elevations calculated as specified in Permit Attachment L, Section L-4c(1). Twelve monthly reports were submitted to the NMED in 2007 as required.

- HWFP Module V, Section V.J.2.c. requires that groundwater flow and radionuclide sampling results be included in the ASER by October 1 of each year. These 2007 data are presented in Chapters 6 and 4 of this ASER, respectively.

2.1.3 National Environmental Policy Act

The National Environmental Policy Act (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 1500-1508. The DOE codified its requirements for implementing the council's regulations in 10 CFR Part 1021, "National Environmental Policy Act Implementing Procedures." Title 10 CFR §1021.331 requires that, following completion of each environmental impact statement (EIS) and its associated record of decision, the DOE prepare a mitigation action plan that addresses mitigation commitments expressed in the record of decision. The first WIPP mitigation action plan was prepared in 1991. Additionally, the CBFO tracks the performance of mitigation commitments in the WIPP annual mitigation report. This report is issued in July of each year.

Day-to-day operational compliance with the NEPA at the WIPP facility is achieved through implementation of a NEPA compliance plan and procedure. Fifty-three projects were reviewed and approved by the CBFO NEPA Compliance Officer through the NEPA screening and approval process in 2007. These projects were primarily equipment upgrades at the WIPP site. These approvals were in addition to routine activities which have been predetermined to be bounded by existing NEPA documentation and which do not require additional evaluation by the CBFO NEPA Compliance Officer. The CBFO NEPA Compliance Officer also routinely participates in the development of NEPA documents from the DOE and other federal agencies for actions that may have environmental impacts on WIPP.

In September 2007, the DOE issued a supplement analysis, which examined the impacts of transporting some wastes in oversize boxes directly to WIPP using the TRUPACT-III transportation container (*Supplement Analysis for the Transportation of Transuranic Waste in TRUPACT-III Containers* [DOE/EIS-0026-SA-06]). The Supplement Analysis concluded that an additional EIS would not be required.

2.1.4 Clean Air Act

The Clean Air Act (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 Clean Air Act. Radiological effluent monitoring in compliance with EPA standards is discussed in Section 2.1.14.

The Clean Air Act 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, the 25-ton-per-year limit for any combination of hazardous air pollutant emissions, or the 10-ton-per-year emission limit for criteria pollutants except for total suspended particulate matter and particulate matter less than 10 microns in diameter. Particulate matter is produced from fugitive sources related to the management of salt tailings extracted from the underground. Consultation with the NMED Air Quality Bureau resulted in a March 2006 determination that a permit is not required for fugitive emissions of particulate matter that result from WIPP operations. 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 Clean Air Act permits. In 1993, WIPP did 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 in 2007.

2.1.5 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), "Scope of the NPDES [National Pollutant Discharge Elimination System] Permit Requirement," which states that "The NPDES program requires permits for the discharge of 'pollutants' from any 'point source' into 'waters of the United States.'"

The WIPP facility 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, lined evaporation ponds.

2.1.6 New Mexico Water Quality Act

The New Mexico Water Quality Act (NMSA 1978, §§74-6-1, et seq.) 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, "Ground and Surface Water Protection." The WIPP facility does not have any discharges to surface water, but does have a discharge permit designed to prevent impacts to groundwater.

The WIPP facility was issued a discharge permit (DP-831) from the NMED Ground Water Quality Bureau for the operation of the WIPP sewage treatment facility in January 1992. The 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, water removed from sumps in the underground, and condensation from the mine ventilation system's duct work.

A discharge permit modification was issued on December 22, 2003, which incorporated subsurface discharges from the salt tailings pile where mined salt from the underground facilities are stored at the WIPP site. The permit modification incorporated the following storm water management activities into DP-831:

- Covering the existing salt pile with a 60-mil, high-density polyethylene liner covered with two feet of soil and seeded to establish native vegetation

- Constructing a new salt storage area (Salt Storage Extension) upon a 60-mil HDPE liner that drains storm water runoff to a double-lined pond with leak detection for evaporation

- Lining three other ponds with synthetic liners to collect and evaporate storm water runoff, minimizing infiltration to the subsurface

At their request (September 2004), a permit modification application was submitted to the Ground Water Quality Bureau on March 4, 2005, which 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.

- A description of the SWMUs outlined in the RCRA Facility Assessment and the HWFP.

On August 5, 2005, the Ground Water Quality Bureau requested additional information, which was provided on September 12, 2005. The revised permit was issued on December 29, 2006. The revised permit required the submittal of a plan and schedule to install three new groundwater monitoring wells in the vicinity of the site and preliminary design validation (SPDV) mined tailings pile within 90 days of the issuance of the permit. During this reporting period, the plan and schedule were submitted and the three wells were installed as required.

During this reporting period, the liners in two of seven sewage treatment lagoons were replaced (one settling pond and one polishing pond). The WIPP facility has committed to replacing or repairing the liners in the seven sewage lagoons over a period of five years. Three ponds remain to be repaired or relined by 2010.

Two semiannual discharge monitoring reports were submitted to the NMED for the 2007 reporting period to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in DP-831. The monitoring results are presented in Section 5.6.

The discharge permit was last renewed in April 2003 and expires on April 29, 2008. A discharge permit renewal application was submitted to the NMED in December of 2007.

On November 9, 2007 an employee inadvertently discharged approximately 150 gallons of leaded brine into an evaporation pond. The NMED was promptly notified. Sediment and water samples were collected from the pond and demonstrated that no threat to human health or the environment had resulted from the incident.

2.1.7 Safe Drinking Water Act

The Safe Drinking Water Act (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, "Drinking Water," 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 the WIPP site by the city of Carlsbad; however, the WIPP facility is classified as a nontransient, noncommunity water system subject to the New Mexico drinking water regulations.

The WIPP facility 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. Drinking water was last sampled in August 2005. 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 2008.

Bacterial samples were collected and residual chlorine levels were tested monthly throughout 2007. Chlorine levels were reported to the NMED monthly. All bacteriological analytical results were below the Safe Drinking Water Act regulatory limits.

In March 2007, WIPP received an administrative NOV for failing to take bacterial samples in December 2006. WIPP immediately met regulatory requirements for posting public notification. Daily logs indicated that proper levels of water system chlorination were achieved at all times. No further actions were required as WIPP had returned to a compliant status.

2.1.8 National Historic Preservation Act

The National Historic Preservation Act (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 required to support WIPP operations in 2007.

2.1.9 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.

Polychlorinated biphenyls (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." On May 15, 2003, EPA Region VI approved the disposal of waste containing PCBs at the WIPP facility. The WIPP site began receiving PCB-contaminated waste on February 5, 2005.

On January 5, 2007, the DOE notified the EPA by phone of three instances in which PCB waste was disposed of at WIPP, but Certificates of Disposal were not sent back to the generator site within 30 days as required by 40 CFR 761.218(b). On that same day, Certificates of Disposal were prepared and submitted to the generator for shipments IN060503, IN060686 and IN060739. Written notification to the EPA of this instance followed on January 12, 2007.

On May 30 and June 4, 2007, the DOE requested modifications to the Conditions of Approval for PCB disposal regarding RH labeling and spill clean-up. On September 20, 2007, EPA Region VI approved the modifications. The required PCB annual report, containing information on PCB waste received and disposed of at the WIPP facility in 2006, was submitted to EPA Region VI on June 30, 2007.

2.1.10 Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §§136, et seq.) authorizes the EPA to regulate the registration, certification, use, storage, disposal, transportation, and recall of pesticides (40 CFR Parts 150-189).

All applications of restricted-use pesticides at the WIPP facility are conducted by commercial pesticide contractors who are required to meet federal and state standards. General-use pesticides are stored according to label instructions. Used, empty cans are discarded by WIPP personnel into satellite accumulation area containers and managed as hazardous waste.

2.1.11 Endangered Species Act

The Endangered Species Act (16 U.S.C. §§1531, et seq.) was enacted in 1973 to prevent the extinction of certain species of animals and plants. This act provides strong measures to help alleviate the loss of species and their habitats, and places restrictions on activities that may affect endangered and threatened animals and plants to help ensure their continued survival. With limited exceptions, this act prohibits activities that could impact protected species, unless a permit is granted from the U.S. Fish and Wildlife Service (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.

Although there are no known species of plants or animals at the WIPP site that are protected by the Endangered Species Act, the Lesser Prairie Chicken, which is a candidate for listing under the act, does have favorable habitat within the WIPP LWA and other surrounding areas impacted by WIPP operational activities (e.g., drilling boreholes). Therefore, the DOE has instituted measures, in consultation with the BLM, to protect the Lesser Prairie Chicken and its habitat. Thus, adherence to established BLM time periods during which off-site field activities may not be performed during the Lesser Prairie Chicken's breeding season are in effect for the WIPP site. In 2007, there were no instances associated with WIPP operational activities that had any implications associated with the act.

2.1.12 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, 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 (50 CFR Part 20, "Migratory Bird Hunting").

During 2007, WIPP obtained a migratory bird permit, which allows for the relocation of certain bird species which are found nesting on equipment and could be in danger due to routine operations. In July 2007, a mourning dove egg and nest were removed from a trailer jockey located in the WIPP parking lot. The USFWS was informed prior to the activity taking place and the subsequent action was reported on the Migratory Bird Annual Report for 2007. No other activities involving migratory birds took place at WIPP during the reporting period.

2.1.13 Federal Land Policy and Management Act

The objective of the Federal Land Policy and Management Act (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 the act, *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, and operates in accordance with, the WIPP LMP, which is described in further detail in Section 5.2.

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 environmental permits, including rights-of-way, is in Appendix B of this report.

2.1.14 Atomic Energy Act

The Atomic Energy Act 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 Atomic Energy Act, as amended; the Nuclear Waste Policy Act of 1982 (42 U.S.C. §§10101, et seq.), as amended (Pub. L. 97-425); the Reorganization Plan of 1970, and the WIPP LWA. Under the WIPP LWA, Congress required the DOE to submit a compliance certification application to demonstrate WIPP compliance with the EPA radioactive waste disposal standards. Congress also required that the EPA certify the DOE's compliance before operations could commence and to recertify every five years after operations commence.

Title 40 CFR 191, Subpart A, "Environmental Standards for Management and Storage" standards limit annual radiation doses to members of the public from the management and storage operations at disposal facilities operated by the DOE and not regulated by either the U.S. Nuclear Regulatory Commission or 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. Compliance with 40 CFR Part 191, Subpart A, is established by radiological monitoring and sampling of effluent downstream at Station A. To assess releases along the air pathway, the DOE also implements a biota sampling program and an off-site radiological air monitoring program. The results of monitoring and dose calculations have confirmed that there have been no releases of radionuclides that may adversely impact the public. WIPP personnel have conducted periodic confirmatory monitoring 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.

WIPP is subject to EPA inspections in accordance with 40 CFR §194.21, "Inspections." On July 10-12, 2007, the EPA conducted an inspection to assess the implementation of monitoring programs developed by DOE to monitor geomechanical, hydrological, waste activity, drilling-related, and subsidence parameters. The EPA did not have any findings or concerns resulting from this inspection. Additional information concerning this inspection can be found in EPA Docket A-98-49, Item II-B3-102.

The WIPP-specific criteria also established reporting requirements for the DOE. The criterion of 40 CFR §194.4, "Conditions of Compliance Certification," 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 2007, the DOE did not submit any reports on significant planned or unplanned changes to the EPA, nor did they report any releases or expected releases. In November 2007, the DOE submitted *The Annual Change Report - 2006-200*7, DOE/WIPP-07-3317, documenting nonsignificant changes to the certification that occurred between July 1, 2006, and June 30, 2007.

Notifications, nonsignificant changes, and relevant reports issued in 2007 included:

- Issuance of the *Geotechnical Analysis Report for July 2005 – June 2006*, DOE/WIPP-07-3177, in March 2007.

- Issuance of the *Delaware Basin Monitoring Annual Report*, DOE/WIPP-07-2308, in September 2007.

- Issuance of the *Waste Isolation Pilot Plant 2006 Site Environmental Report*, DOE/WIPP-07-2225, in September 2007.

- Issuance of the *WIPP Subsidence Monument Leveling Survey 2007*, DOE/WIPP-08-2293, on December 2007.

2.1.15 DOE Orders

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

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

This order specifies collection and reporting of information on environment, safety, and health that are required by law or regulation, or that are 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 Annual NEPA Planning Summary, the WIPP Environmental Monitoring Plan, the ASER, 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.

2.1.15.2 DOE Order 414.1C, *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.

2.1.15.3 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 of 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 WIPP LWA prevail. The WIPP facility implements the requirements of this order through the Waste Acceptance Criteria and procedures governing the management and disposal of site-generated radioactive waste.

2.1.15.4 DOE Order 450.1, *Environmental Protection Program*

This order requires that DOE sites implement sound stewardship practices that are protective of the air, water, land, natural and cultural resources, and cost effectively meet or exceed compliance requirements. It requires that this be accomplished by implementing an EMS that is part of the site Integrated Safety Management System (ISMS) by December 31, 2005. In October 2005, the WIPP facility self-declared compliance with the order's requirements. The WIPP facility maintained compliance with the order's requirements during 2007 as confirmed in the *Annual Review of the*

WIPP Integrated Safety Management System of September 2007. Chapter 3 provides the detailed discussion of the WIPP EMS.

2.1.15.5 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 through compliance plans and a screening procedure. These tools are used to evaluate environmental impacts associated with proposed activities and to determine if additional analyses are required.

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

This order, along with portions of DOE 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, *Waste Isolated Pilot Plant Contact Handled (CH) Documented Safety Analysis*. Monitoring activities to document compliance with the order are described in the WIPP ALARA (as low as reasonably achievable) program manual, the WIPP Environmental Monitoring Plan, the records management program, and the radiation safety manual.

2.1.16 Executive Orders

EOs are generally used to direct federal agencies and officials in their execution of congressionally established laws or policies. Compliance with the EOs in this section is accomplished through the WIPP programs, plans, and procedures that comply with the EO's implementing DOE order. Compliance is confirmed through the WIPP assessment process.

2.1.16.1 Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*

In January 2007, this EO was issued, replacing five prior EOs that established requirements for greening the government (EOs 13101,13123, 13134, 13148, 13149) relative to waste prevention, recycling, federal acquisition, energy management, use of biobased products and energy, fleet and transportation efficiency and environmental management systems. During 2007, WIPP performed a gap analysis compared to the EO. Modifications to WIPP's EMS were initiated to address the EO requirements that had not already been addressed. Modifications to the EMS included broadening the EMS scope to include environmental aspects of energy and transportation functions, adding the order's sustainability requirements in the legal requirements element, and using the annual goals and target setting process to improve WIPP's performance in relevant sustainability areas. Although this EO will result in further improvements in the greening the government areas noted previously, the WIPP's basic EMS structure will remain. Requirements are implemented into operations through the WIPP's energy management, fleet and vehicle management, affirmative procurement, and pollution prevention (P2) programs, and annual EMS goals established in one or more of these areas.

WIPP recognizes that employee awareness is key to meeting requirements of this EO. In 2007, actions to increase employee awareness included:

- Monthly P2 News articles were published.
- P2 was the focus of the Earth Day celebration.
- P2 information was updated in the General Employee Training courses in preparation for employees 2007 basic and/or refresher training.
- The P2 website was kept up to date in an easy to use format and included practical tools and information for personnel.

P2 Opportunity Assessments (PPOAs) are another key mechanism used to improve environmental performance. Five PPOAs were completed and were implemented in accordance with assessment recommendations. These are summarized below.

<u>Biodiesel Testing on Commuter Buses</u>

WIPP worked with the commuter bus company to test biodiesel in the coach buses that are used to transport employees to and from the WIPP site. A large coach bus was filled with a B20 biodiesel blend and a second bus was filled with #2 diesel to test the difference and functionality between the two fuels in this particular make of coaches. The biodiesel bus performed normally, with no issues noted. At this time, the commuter bus company has not continued to use biodiesel in the buses due to the multiple customers that use the same buses and the lack of commercial sources of biodiesel for contracted trips. As biodiesel becomes commercially available in the southwest, WIPP may be able to establish contractual requirements for using biodiesel in the buses. Plans for FY 2009 are to use biodiesel in the tractor and diesel truck use for site environmental fieldwork.

<u>Paper Saving from QA Issues Management Process</u>

WIPP's QA Department manages the WIPP issues management process, which is used to identify potential issues, establish corrective actions and resolve issues. This process historically is facilitated with paper copies of issues packages that results in the use of 78,000 pieces of paper per year. In FY 2007, QA began scanning the issues packages into an electronic file and projecting the packages onto a screen for review rather than passing out a paper copy to each committee member.

Electronic Projectors Installed for Meetings

In 2007, a projector was installed in a main conference room at WIPP where daily meetings are held. The meetings had previously been conducted using paper handouts of each department's daily work plan. With the installation of an electronic projector, as well as a wireless internet connection for easier use, WIPP has managed to save approximately 65,520 sheets of paper per year.

Wind Farm Installation

The possibility of installing wind turbines to power WIPP's energy needs was investigated. Due to WIPP's scale and the area's wind resources, it was found that wind turbines would not be cost-effective, and wind energy service providers in the area were not interested in a project of this scale. WIPP will continue to purchase its energy resources from its current energy provider, which uses renewable resources to generate approximately 7 percent of the energy it provides.

Recycled Stormwater

WIPP evaluated the use of clean stormwater from the stormwater collection system to aid in the reclamation of the soil capped portion of the salt pile. In the past, WIPP has made efforts to establish native vegetation on top of the salt pile for purposes of reclamation, erosion control, and dust suppression. These efforts have relied on rainfall as the source of irrigation and have not been successful in establishing enough vegetation to prevent erosion. Currently, WIPP has three storm water collection ponds and two evaporation ponds. In FY 2007, WIPP purchased a sprinkler and pump system to irrigate the top of the salt pile using water from the stormwater ponds to establish vegetation on the soil capped portion of the salt pile. Use of the stormwater will help to establish native vegetation without tapping into the WIPP potable water system, thus saving water resources.

The WIPP recycling program continued to be healthy and improved in 2007 as described in Section 3.2.13 and Figure 3.2.

P2 Integration

WIPP is continually improving the site's program for acquiring environmentally preferable products that include recycled content, bio-based, and energy-efficient products. Implementation of this program is achieved through acquisition procedures and training, and integration of affirmative procurement requirements into contracts.

In 2007, language was incorporated into the janitorial contract, which specifies the use of environmentally preferable cleaning products and includes quarterly reporting requirements. Currently, WIPP purchases office supplies and construction materials that are environmentally preferable; however, an effective tracking system is not in place. In 2007, a reporting format was developed and provided to WIPP's local office supply vendors to track office supply purchases and quantify the purchase of recycled content materials in specific office supply categories. Reporting of office supply purchases will begin in 2008, and a similar reporting format will be provided to WIPP's construction contractor to track construction material purchases.

In addition, WIPP designates Electronic Product Environmental Assessment Tool certified computers as the site standard. Purchasers are required to request special approval for computers that are not specified in the standard.

2.2 Other Significant Accomplishments and Ongoing Compliance Activities

Environmental Compliance Assessments

Assessments (evaluations) of activities at the WIPP facility are routinely performed to evaluate that processes are in place to comply with applicable environmental regulatory requirements. This is accomplished through a multi-tiered evaluation system with all evaluations included in the CBFO Integrated Evaluation Plan. Chapter 3 provides an overview of the WIPP Integrated Evaluation Plan, as well as the system for assuring preventive and corrective actions are accomplished.

Specific assessments, focused solely on environmental compliance, include those performed in accordance with the Environmental Assessment Plan (WP 02-EC.13). Three assessments were performed under the Environmental Assessment Plan during 2007. These assessments focused on compliance related to the VOC Monitoring Program, RCRA waste management (primarily site-generated waste), and hazardous material sampling. These three assessments concluded that requirements were adequately integrated and effectively implemented, with the exceptions of five findings. None of the findings indicated noncompliance with the regulatory requirements. Corrective actions for the findings are being managed through the issues management program.

DOE Audits/Assessments

Four audits, assessments, or surveillance audits were conducted by the CBFO during FY 2007 focused solely on environmental compliance. No corrective action requests resulted from these activities.

CHAPTER 3 - ENVIRONMENTAL MANAGEMENT SYSTEM

3.1 Introduction

EMSs are widely recognized by both government and industry as effective mechanisms for achieving an organization's policy commitments for environmental performance. An EMS is based on using the continuous improvement cycle for environmental performance. The cycle begins with the environmental policy, which sets the organization's commitments to environmental performance via policy. The policy is then implemented and performance improved through the Plan, Do, Check, Adjust cycle. During the "Act" function of the cycle, management reviews environmental performance and the effectiveness of the system, identifying desired improvements. These improvements initiate the next continuous improvement cycle. This chapter is based on the annual review of the WIPP EMS for FY 2007.

EO 13148 required that federal agencies implement an EMS. Further, the DOE issued DOE Order 450.1, which required that DOE sites implement an EMS that is integrated with their ISMS by December 31, 2005. The WIPP EMS is in compliance with the order's requirements.

EO 13423, which requires that an EMS be used as the primary management approach for addressing environmental aspects of operations and activities, including those related to energy and transportation functions, was issued in January 2007. The EO also establishes objectives and targets to ensure implementation of the sustainable practices required by the EO. The DOE has been working to incorporate the EO requirements through a Transformational Energy Action Management (TEAM) initiative and revisions to DOE Orders 450.1 and 430.2b, *Departmental Energy, Renewable Energy and Transportation Management*. WIPP completed a gap analysis compared to the EO requirements and is in the process of adjusting its system to bring it into conformance with new requirements when they are formally issued through the DOE orders. See Section 2.1.16.1 for additional detail.

3.2 WIPP EMS Elements

The WIPP EMS is structured using the International Organization for Standardization (ISO) 14001:2004 continuous improvement cycle of Plan, Do, Check, Adjust, with each phase of the cycle being accomplished through implementation of one or more of the system elements. These elements and their relationship to the continuous improvement cycle are represented in Figure 3.1.

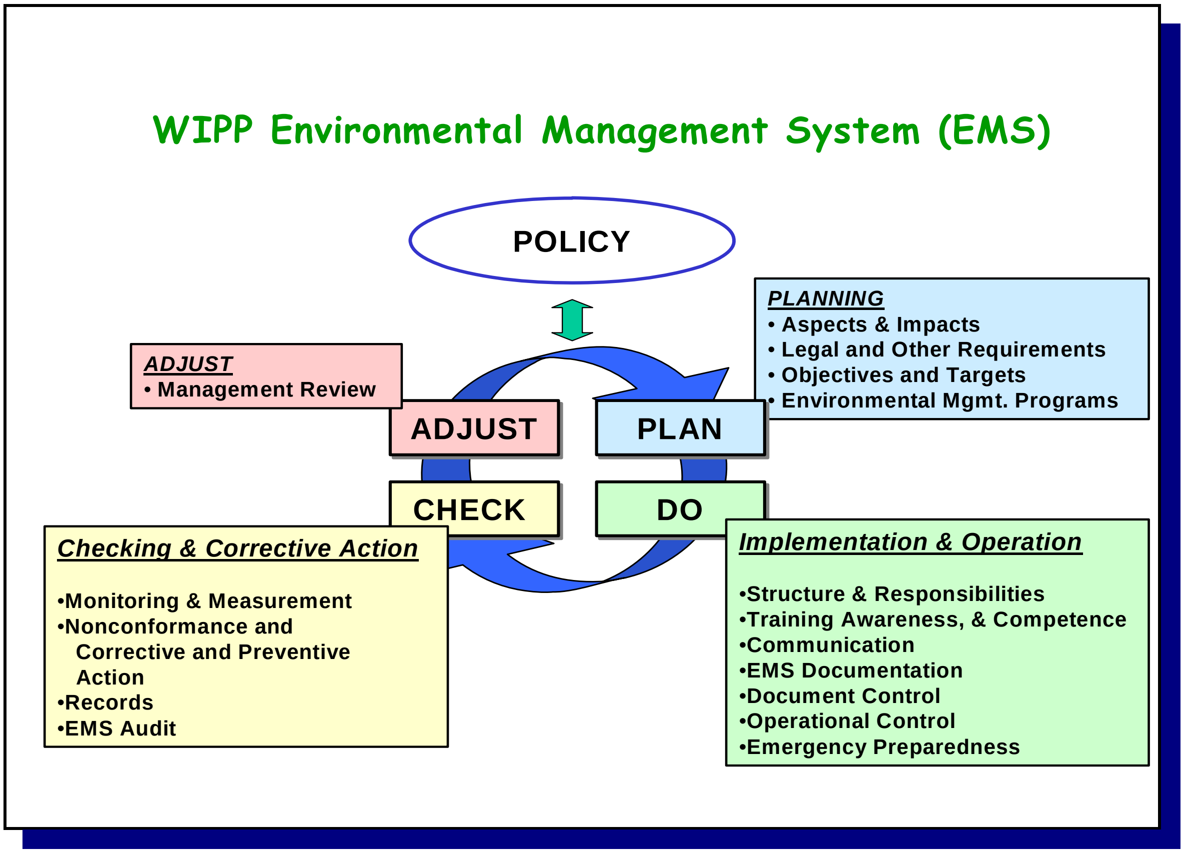

Figure 3.1 - WIPP Environmental Management System

3.2.1 Policy

The WIPP environmental policy, jointly issued by the CBFO and Washington TRU Solutions LLC (WTS) establishes protection of workers, the public, and the environment as the highest priority in carrying out its mission. The environmental policy provides the foundation for the EMS, and identifies the EMS as the mechanism to meet WIPP commitments to:

- Comply with requirements applicable to WIPP.
- Be good environmental stewards (by working with stakeholders, correcting incidents, minimizing harm to environmental resources, and using safe, responsible, and cost-effective P2 measures).
- Seek continual improvement in environmental performance.

3.2.2 Aspects and Impacts

Environmental aspects are an organization's activities, products, or services that can interact with, and have the potential for impact to, the environment. If the potential impact could be significant, the EMS leads to implementing measures designed to avoid or minimize negative, or maximize positive impacts. Since the EMS was first implemented, activities, aspects, and impacts for WIPP have remained relatively constant as a result of the stability of the WIPP mission. The following are the WIPP aspects that continue to be identified as having potentially significant impacts.

- ***Aspect:*** Safe management of TRU wastes

  Potential impact: Decreased risk to people and the environment both at WIPP and generator sites

- ***Aspect:*** Potential release of pollutants from managing TRU and TRU mixed wastes, hazardous materials, site-generated hazardous and nonhazardous wastes, solid waste management units, and the wastewater treatment system

  Potential impact: Contamination of soil, water, air, or biota

- ***Aspect:*** Use of electricity

  Potential impact: Loss of use of natural resources

- ***Aspect:*** Storm water runoff

  ***Potential impact*:** Contamination of soil, water, or biota

- ***Aspect:*** Land management

  Potential impact: Compromised stewardship of wildlife, fauna, habitat, and/or historically or culturally significant sites

The overall project aspects and impacts are reviewed annually, and project-specific impacts are reviewed through the project review process. Significance is determined by considering both environmental and business factors such as the probability of occurrence, the scale and severity of the potential impact, associated regulatory and legal requirements and issues, concerns of interested parties, and public and stakeholder opinions.

3.2.3 Legal and Other Requirements

Environmental requirements are identified as they are issued as draft and proposed, and in final rules and orders. Identification is accomplished through monthly review of the environmentally related notices in the *Federal Register* and the New Mexico Administrative Code, and new and proposed changes to existing DOE orders. Subject matter experts are consulted to confirm applicability and assess potential impacts. Plans, procedures, and training are then modified to institutionalize compliance with the new or revised requirements as appropriate. Environmental requirements and compliance status are summarized for WIPP and are available to the public in the *Waste Isolation Pilot Plant Biennial Environmental Compliance Report*

(DOE/WIPP-08-2171) and Chapter 2 of this report. During 2007, the most significant revisions to environmental requirements applicable to WIPP were established relative to EO 13423, Strengthening Federal Environmental Energy and Transportation Management, which was issued in January 2007, with subsequent implementation documents issued through the DOE Secretary's Transformation Energy Action Management initiative.

3.2.4 Objectives and Targets

WIPP establishes objectives and targets in the context of significant environmental aspects and impacts during the annual fiscal year programmatic planning process. Approved objectives and targets are then incorporated into the Complex-Wide Integration Tool, where progress is tracked throughout the year. New or revised WIPP objectives and targets are developed with milestones. New or revised WIPP objectives and targets are developed with milestones. For FY 2007, 88 percent of WIPP milestones were linked to managing potentially significant environmental aspects.

Sitewide environmental goals (objectives) related to sustainable practices are also set each fiscal year. Seven goals were jointly established by the CBFO and WTS for FY 2007. These goals directly supported three of the five DOE department-level performance-based goals for P2 and sustainable environmental stewardship, as delineated in DOE Order 450.1. WIPP fully achieved five goals with the remaining two goals being 50 percent complete. The partially completed goals will be carried over for completion into FY 2008.

Table 3.1 - Site Environmental P2 Goals Scorecard – FY 2007

DOE Goal Category	Goal	Status
Waste Prevention	1. Evaluate at least one waste stream, and identify and begin implementing a plan for its reduction by departments not completing the goal in FY 2006.	***Achieved.*** *The remaining two departments completed a paper saving goal in FY 2007.*
	2. Take appropriate actions to maintain employee P2 awareness.	***Achieved.*** *Awareness efforts included publishing the monthly P2 News, handout of a P2 awareness item on Earth Day and America Recycles Day, and use of highway signs to promote P2 awareness.*
Environmentally Preferred Purchasing	3. Test use of biodiesel with New Mexico Transportation in commuter bus service for WIPP site.	***Achieved.*** *Use of biodiesel in a commuter bus began in July 2007 and continued successfully for three months.*
	4. By the end of FY 2007, have in place a reporting system for all local office supply purchases.	***Fifty percent complete.*** *The reporting format, file and instructions have been completed. Implementation with the office supply vendors will be accomplished in FY 2008.*

Table 3.1 - Site Environmental P2 Goals Scorecard – FY 2007		
DOE Goal Category	**Goal**	**Status**
	5. By the end of FY 2007, have in place a reporting system pilot program for reporting selected categories of purchased material and the method of material disposal.	***Fifty percent complete.*** *The reporting format, file and instructions have been completed. Implementation of the system will be accomplished in FY 2008.*
Environmental Stewardship (water, energy, and fuel efficiency; resource conservation)	6. Establish appropriate authorization and apply storm water runoff to the mined tailings pile for maintaining ground cover (erosion control) with the first application occurring in the first half of FY 2007.	***Achieved.*** *Application of storm water runoff began in FY 2007.*
	7. Zero reportable, unauthorized contaminant releases.	***Achieved.*** *There were no reportable or unauthorized contaminant releases in FY 2007.*

Although not an FY 2007 goal, in early 2007 the contract for the janitorial service was due for rebid and, as a result, it was determined that rather than have the existing janitorial service test products, WIPP would accomplish the same objective (increasing use of environmentally preferred products), by incorporating requirements for environmentally preferred products into the proposal and selection process for the new contract. This was accomplished.

3.2.5 Environmental Management Program

The business process for developing current and out-year programs, along with their associated project milestones, includes steps for identifying resource needs and assuring that they are obtained. In addition, the WIPP P2 Committee assists organizations in planning for and achieving P2 goals.

Programs and procedures have been developed and are implemented as necessary to meet compliance requirements. Programs, procedures, and training include those for natural resources protection, P2, affirmative procurement, waste management, management of mined materials (i.e., salt), and environmental monitoring. Provision of resources for implementation of these plans is accomplished through the normal budget setting process.

3.2.6 Structure and Responsibility

Management's role is to provide the resources essential to implement and control the EMS. These resources include training, funding, human resources, specialized skills, and technology. To help facilitate this at WIPP, management has designated EMS Coordinators in both the CBFO and WTS organizations. The coordinators are responsible for maintaining the EMS in accordance with the principles of ISO 14001 and DOE requirements, as well as for monitoring and reporting to management on the effectiveness of the system.

EMS responsibilities shared by all employees are included in the General Employee Training module. This training module is reviewed and updated each year to assure that responsibilities for protection of the environment and minimizing any potentially significant impacts are current. Specific roles and responsibilities related to compliance issues are integrated into work procedures necessary to carry out the project.

3.2.7 Training, Awareness, and Competency

Awareness and initial training on the EMS is included in the General Employee Training as discussed in Section 3.2.6. Employees are trained for conformance to programs and procedures applicable to their job scope.

The WIPP training program is comprehensive, mature, and based on the DOE methodology for job scope, needs analysis, and program design. Specific training and qualification requirements have been set for personnel whose work has the potential to result in significant environmental impact. These personnel include the waste handling, waste management, mining, and maintenance staffs. The frequency of the training required for qualification for specific jobs is established and WTS Technical Training initiates and carries out the training based on the defined frequency.

3.2.8 Communication

Internal communication related to the EMS, including compliance and P2, is accomplished via multiple mechanisms. The primary way WIPP communicates requirements and expectations is through the programs, plans, and procedures that integrate environmental requirements into daily work. Other methods include meetings, employee performance reviews, internal newsletters, the WIPP Intranet, and awareness posters, signs and banners. A key communication tool is the P2 News, which focuses on environmental awareness. The WIPP Plan of the Day meeting is also a key communication tool that allows operating and support staff to understand each day's work plan and the interactions necessary to execute the plan in a safe, environmentally sound manner.

Communication with the public occurs as WIPP invites review and input on draft NEPA documents. The process for implementing the NEPA also assures that information is provided to the public related to significant environmental activities. Also, the DOE provides access to archives of DOE guidance and documents at www.energy.gov, and DOE NEPA documents are found at www.gc.energy.gov/NEPA. During 2007 a special internet site was developed to communicate with WIPP stakeholders. This easily accessed site describes HWFP activities, communicates meeting dates and solicits stakeholder input. This site is maintained at www.wipp.energy.gov/stakeholders/notice.aspx. A toll-free information line (800-336-9477) is maintained and made available to the public for inquiries regarding any topic or issue. Additionally, documents such as this report and the Biennial Environmental Compliance Report, reports submitted to regulatory agencies, and selected information contained in the WIPP Waste Information System are available to the public.

3.2.9 EMS Documentation

The WIPP EMS is documented through the *Waste Isolation Pilot Plant Environmental Management System Description* (DOE/WIPP-05-3318). The programs, procedures, and reports that implement each EMS element are documented in a WIPP EMS Map organized according to the ISO 14001 standard's framework. This document is reviewed annually during the preparation of the EMS Annual Report for needed improvements. The EMS document is updated, as needed, after the annual management review of the system. During 2007, the EMS document was reviewed. Changes required for compliance with new requirements of EO 13423 were initiated and will be completed in 2008.

3.2.10 Document Control and Records

WIPP has a mature system for document management as established through its records management program and procedure writer's guide. WIPP maintains an electronic document control system to manage development, review, approval and revision of documents. This enables systematic review and input by affected organizations, with documentation for each step of the review and approval process.

3.2.11 Operating Control

The EMS Aspects and Impacts Table identifies the organizations that are associated with managing WIPP activities so that potential impacts are mitigated. WIPP has three core programs (design, operation and maintenance) that implement actions to minimize risk by assuring that the integrity of facilities and assets is maintained. The documents implementing these programs are Engineering Conduct of Operations (WP 09), Conduct of Operations (WP 10-2), and Maintenance Operations Instruction Manual (WP 04-CO), with their supporting procedures and work instructions.

3.2.12 Emergency Preparedness and Response

WIPP emergency preparedness and response capabilities are maintained through planning, training, drills, drill analysis and implementing improvement actions. Extensive planning is evidenced by the overarching emergency management program and sub-tier plans for managing the transfer of information during and after an event (e.g., mine rescue, fires and responding to incidents/accidents associated with transportation of TRU waste from the generator sites to WIPP). Planning and implementation involves the many organizations and individuals that would play a part in responding to an incident including the communications, operations, environmental compliance and safety departments. Supporting these plans are numerous procedures for handling specific types of emergencies identified through the *Waste Isolation Pilot Plant Contact-Handled Waste Handling Emergency Planning Hazards Assessment* (DOE/WIPP-02-3286), and the *Waste Isolation Pilot Plant Remote-Handled Waste Handling Emergency Planning Hazards Assessment* (DOE/WIPP-05-3331). These encompass mine rescue, surface and underground fires, hazardous material spill response, and severe weather, as well as security and medical emergencies. Ancillary procedures related to event recovery, categorization of operational incidents, and reporting occurrences are also in place.

Training and practicing response skills are a high priority at WIPP. The WIPP training program for the various facets of emergency management consists of twenty self-study or classroom training courses provided to key personnel. Over the course of FY 2007, there were over 500 participants in emergency preparedness and response training courses.

Emergency Management conducts drills and exercises according to an annual drill and exercise plan. Members of the emergency response organization are required to participate in a minimum of one drill each year to demonstrate proficiency in their assigned role. A full-participation exercise is conducted each year to test integrated capabilities. Performance during the exercise is critiqued by an independent group and any findings are addressed and managed through the commitment tracking system.

3.2.13 Measuring and Monitoring (Environmental Performance Measurement)

Environmental performance is monitored to assure that the WIPP carries out its mission in alignment with its environmental policy to comply with all requirements, be a good environmental steward and continually improve environmental performance. Analysis of data in these arenas becomes the basis for determining the effectiveness of the EMS in achieving policy commitments.

Monitoring Environmental Performance

Initial implementation of the WIPP Environmental Monitoring Plan during the planning and preoperational phases of the project established the WIPP baseline environmental conditions. Continuing implementation monitors for environmental effects during the site operations phase. The plan directs the programs for monitoring of radiological and nonradiological effects and land management, as well as providing the criteria and methods for data analysis and QA. Data from the radiological, nonradiological, and land management monitoring programs for 2007 indicate that there has been no impact to human health or the environment from WIPP facility operations. Detailed analysis and summaries of the monitoring results are included in Chapters 4, 5, and 6.

WIPP personnel monitor the environmental performance areas of material recycling versus disposal, and water and energy resource usage. The percentage of materials recycled versus the total amount of materials generated increased from 54 percent in FY 2006 to 63 percent in FY 2007, as shown in Figure 3.2. This increase in the recycling rate indicates that the recycling program continues to be successful.

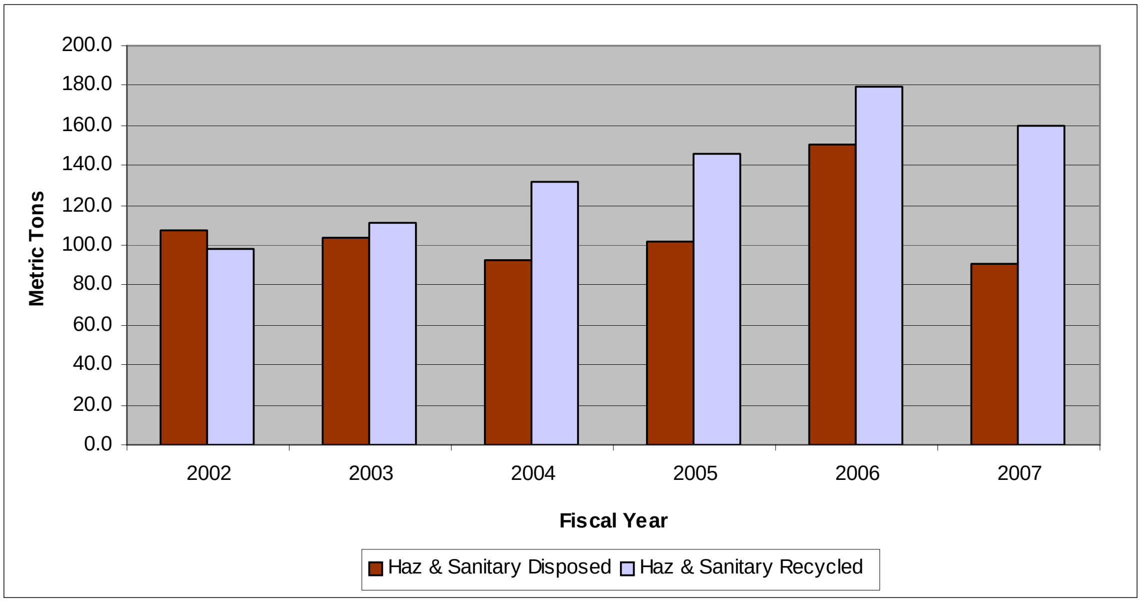

Figure 3.2 - FY 2007 Disposed Versus Recycled Materials

WIPP employees continue to reduce the use of fresh water, with the most significant decrease occurring between FY 2003 and FY 2004 as illustrated in Figure 3.3. This decrease was achieved as a result of process changes for maintenance of sewage lagoon ponds. Smaller, but steady declines have been achieved from FY 2004 through FY 2007. These result from implementing remaining water use reduction opportunities in the personal versus process use areas.

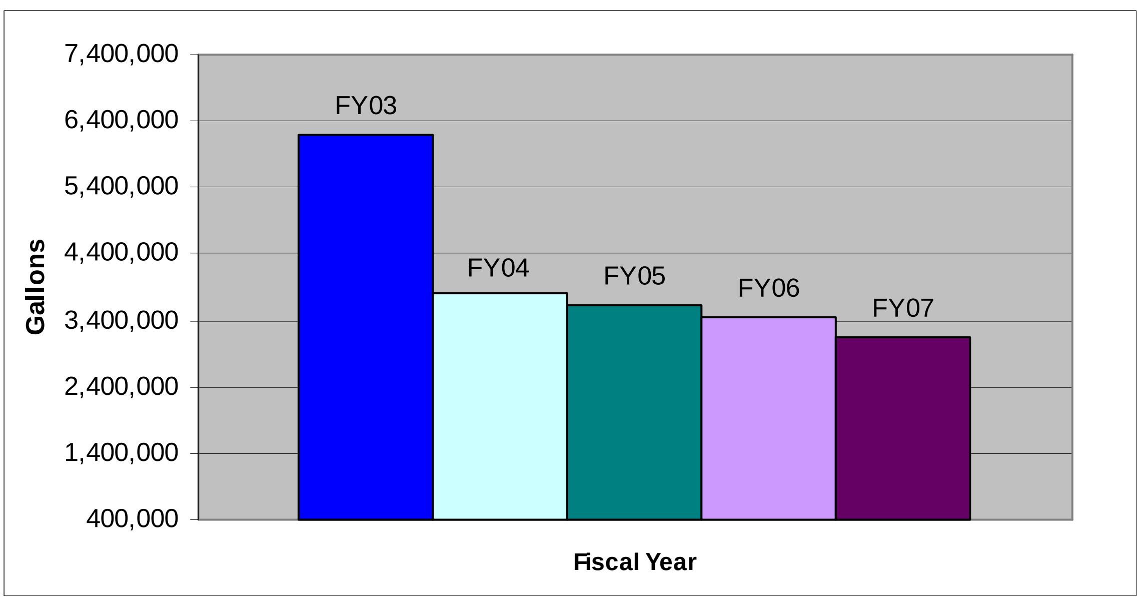

Figure 3.3 - Yearly Fresh Water Usage at WIPP

The WIPP site has experienced expected increases in energy use as waste emplacement activities and associated mining activities have increased. However, as a result of implementing prudent conservation practices and continued supply of over 7 percent of the WIPP site energy needs from wind-generated electricity, increases have been limited and carbon emissions associated with energy use at the WIPP site have remained fairly consistent over the past five years. Figure 3.4 demonstrates the carbon emissions associated with operating the WIPP. These represent the carbon emissions associated with generation of the energy purchased for WIPP operation. Carbon emissions were calculated using Federal Energy Management Program conversion factors.

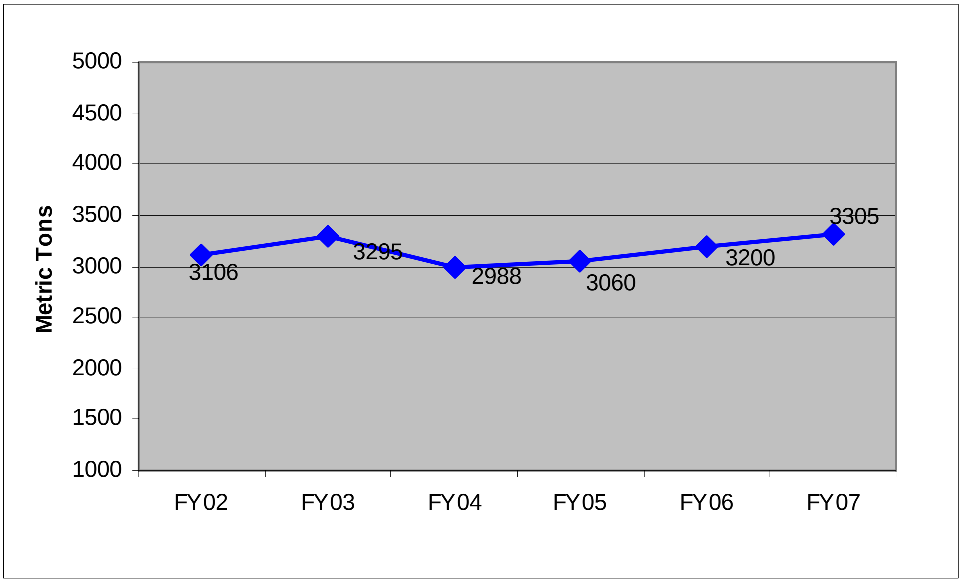

Figure 3.4 - WIPP Carbon Emissions - Estimated

Monitoring for Compliance

Compliance with requirements for WIPP is monitored through a multi-tiered evaluation system. Monitoring is conducted through the inspections, assessments, surveillances, and audits whose scope includes one or more facets of compliance. These include those performed internally (self-assessments) and those performed by external entities (independent). Internal assessments are performed by various WTS departments and Washington Regulatory and Environmental Services. External assessments are performed by the CBFO QA Department and the Carlsbad Technical Assistance Contractor, DOE Headquarters, the NMED, and the EPA. Assessments are summarized in each fiscal year WIPP Integrated Evaluation Plan.

This system continues to be comprehensive and effective, as indicated by the 192 evaluations conducted in FY 2007 that incorporated some level of environmental compliance or performance check. An average of 70 percent of all evaluations performed over the last three years (over 200 per year) had a component of environmental performance checks. Theses results were reported to management in the *WIPP Environmental Management System Annual Report for FY 2007* (DOE/WIPP-08-3333).

Evaluations examine implementation of WIPP policies, programs, procedures, and controls that assure compliance with applicable requirements. Findings identified through these evaluations are incorporated into the WIPP issues management program and corrective action is tracked through completion.

Monitoring for Continual Improvement

The progress toward continual improvement in environmental performance is demonstrated by the following.

- Three of the four recommendations from the 2006 EMS Annual Report were implemented. The remaining recommendation will be completed in FY 2008.
- Five of seven FY 2007 environmental goals were achieved. Five goals were fully completed and two of the goals were 50 percent complete and will be carried over for completion into FY 2008. The goals were linked to DOE Order 450.1 goal areas of waste prevention, environmentally preferred purchasing, and environmental stewardship through resource conservation and efficiency.

Monitoring EMS Effectiveness

In addition to the extensive, ongoing monitoring that is performed as a result of the monitoring plan, indicators are also used to provide a summary of system effectiveness for the annual management review of the EMS. There are eight EMS effectiveness indicators that were used for FY 2007 and summarized in Table 3.2.

Table 3.2 - EMS Effectiveness Indicators
Environmental Stewardship, Compliance, Continual Improvement

Performance Indicator	FY 2007	FY 2006	FY 2005
Aspects and Impacts - Business milestones related to significant aspects and impacts management	88% (144 of 164)	77% (217 of 283)	78% (265 of 338)
Revisions to Significant Aspects and Impacts (does not include administrative revisions)	0	2	0
Environmental goals accomplished	86% (6 of 7)	83% (6.7 of 8)	78% (7 of 9)
Reportable unauthorized contaminant releases	0	0	0
External agency compliance findings/violations	1	1	0
Evaluations (number and percentage of total) that review topics supporting environmental compliance and/or performance	192/62%	250/76%	275/72%
Corrective action process – percent of issues self-discovered	68%	62%	N/A*
Recommendations from Annual EMS Report implemented	75% 3 of 4	92% 5.5 of 6.0	89% 8 of 9

*Not Applicable

Indicator 1. This indicator demonstrates the depth of integration of environmental stewardship into the daily course of activities at WIPP, with 88 percent of business milestones being related to managing a significant environmental impact in FY 2007.

Indicator 2. This indicator shows whether changes were necessary to assure that significant aspects associated with the WIPP mission and potential impacts are identified. There were no changes to significant aspects and impacts.

Indicator 3. This indicator demonstrates WIPP has integrated P2 into the EMS and is actively working to minimize its environmental footprint through resource conservation and waste minimization. Progress continues to be communicated to the organization on a quarterly basis through the P2 website and posting with other business performance measures on the operations conference room performance measures board.

Of note from the FY 2007 goals accomplished was the completion of the resource conservation goal to apply clean storm water from the storm water ponds onto the soil capped surface of the mined tailings pile instead of using water from WIPP's domestic water system. The purpose of this project was to establish vegetation atop the mound for dust suppression, erosion control and reclamation of the area. In addition, WIPP completed the goal to test biodiesel in the commuter buses which transport employees to and from the WIPP site. One bus successfully used biodiesel for three months. Completion of this goal was a notable achievement for WIPP because it demonstrated the technical feasibility of using biodiesel and there is no alternative fuel infrastructure within 170 miles of the WIPP site.

Indicator 4. This indicator demonstrates that WIPP had zero reportable, unauthorized contaminant releases in FY 2007, as has been the case for at least the prior seven years.

Indicator 5. This system indicator demonstrates the WIPP compliance performance and includes any findings, issues, and NOVs from any external agency including the NMED, the EPA, and the U.S. Nuclear Regulatory Commission. During FY 2007, the WIPP facility received one NOV from the NMED related to the domestic water system, which was promptly corrected. Section 2.1.7 provides more detail regarding this instance.

Indicator 6. This indicator demonstrates the WIPP system for checking environmental performance and compliance continues to be healthy, with 62 percent of all evaluations performed in FY 2007 containing varying levels of environmental checks.

Indicator 7. This indicator illustrates that the WIPP corrective and preventive action process is thorough, with WIPP having self-discovered 68 percent of the total issues identified, corrected, and tracked through the WIPP issues management program. Issues self-discovered are those issues which WIPP departments identify versus issues that are identified from an assessment, surveillance, or audit external to the department.

Indicator 8. WIPP continues to improve the EMS with three of four recommendations for system improvements identified in the annual management review completed at the end of FY 2007 and the fourth nearing completion.

3.2.14 Corrective and Preventive Action

WIPP employees have institutionalized a thorough process for managing corrective and preventive action through the issues management program. The Issues Management Committee reviews and verifies concerns, and requires appropriate corrective/ preventive action plans be developed and implemented. Completion of action plans is tracked through the commitment tracking system and monitored by the Issues Management Committee through closure. Issues that are managed through this process include environmental issues that may be raised by employees or identified through evaluations, as well as actions identified through the WIPP incident investigation process. For example, several compliance improvement areas were identified in the fourth quarter of 2007 with corrective and preventive actions in these areas becoming the focus for EMS improvements in 2008. The areas for improvement were related to the Compliance Orders and NOV issued by the NMED and the discharge of approximately 150 gallons of brine water into the H-19 evaporation pond without securing authorizations required in the technical procedure controlling these discharges. Many actions were initiated in the fourth quarter of 2007, and those not already completed by the end of year were continued into 2008 in accordance with plans formalized through the WIPP issues management program and tracked through the commitment tracking system.

3.2.15 EMS Audit

ISMS reviews are performed each year. WTS and CBFO FY 2007 ISMS annual reviews were conducted during August and September 2007. These confirmed the EMS to be effectively integrated into the WIPP ISMS and implemented at WIPP. There were no EMS areas for improvement in the FY 2007 reviews.

3.2.16 Management Review

Senior management reviews the effectiveness of the system through the EMS Annual Report, which is prepared by the CBFO and WTS EMS Coordinators. Management directs improvements to the system for the upcoming fiscal year as a result of this review. The annual report is based on analyzing the environmental performance indicator data described in the measuring and monitoring element in this report. The FY 2007 annual report concluded that the EMS remains suitable and effective for achieving policy, and the policy continues to reflect the organization's commitment to environmental performance.

While the system is recognized as being suitable and effective, compliance issues identified in the fourth quarter of 2007 were also reviewed to identify opportunities for improvement. As a result, the following areas will be the focus for improvement during 2008.

- Strengthen assurance of regulatory compliance through conduct of operations.
- Implement sustainability requirements established in recently issued Executive and DOE orders.
- Complete preparation for an audit of the EMS by an independent party to confirm conformance with revised DOE Order 450.1.

3.2.17 Status of EMS Implementation

WIPP's EMS continues to be effectively implemented. The 2007 annual ISMS and EMS review and the WIPP EMS annual report for FY 2007 confirmed the EMS suitability and effectiveness for achieving WIPP's environmental policy commitments. WIPP's EMS scorecard as reported to DOE rates the WIPP EMS as being in the continuous improvement stage of implementation.

In addition, the scorecard provides a summary of the results of implementing the system in relation to 22 programmatic and performance criteria. Rankings for each criteria use a five-point scale ranging from one (not at all) to five (a great deal) and also allow for items that "do not apply" to a site. These criteria include areas such as reduced risk to facility mission, greater understanding of environmental issues, improved community relations, improved P2, and improved water and energy conservation. Overall, the rankings indicated the EMS has resulted in a ranking of four for the majority of these criteria.

Benefits, successes, and best practices associated with implementing and maintaining the system during FY 2007 are highlighted as follows:

- WIPP's EMS provides a flexible and efficient system to incorporate new requirements into operations. The WIPP EMS was chosen by DOE to use as a complex-wide EMS template for incorporating new EO 13423 requirements.
- The internet site developed to communicate with WIPP stakeholders.
- Use of clean storm water rather than potable water for reclamation of the mined materials pile.
- Testing of biodiesel in the commuter bus.
- A 44 percent increase in the amount of paper recycled between FY 2006 and FY 2007.
- The permit, secured from the USFWS, which allows WIPP to more quickly perform proper handling of migratory birds that are found nesting on site.

These birds can inhibit operations if WIPP is unable to quickly relocate the birds. WIPP continues to work closely with the USFWS and a state-licensed bird rehabilitator before taking action related to migratory birds.

- The routine EMS focus on minimizing hazardous material use and storage resulted in the authorization and successful handling and shipment of five lead sheets, two lead source housing pigs, and several lead blocks for reuse at another DOE site.

WIPP's geographical location continues to present challenges in the implementation of P2. Availability of reliable sources of biodiesel and ethanol, and WIPP's distance from recyclers of common materials such as toner cartridges, galvanized fencing, concrete, and wood create recurring challenges.

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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 and to the population; and evaluate the potential impacts to biota in the vicinity of the DOE activity."

Radionuclides present in the environment, whether naturally occurring or anthropogenic (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.

WIPP personnel monitor air, groundwater, surface water, soils, sediments and biota to characterize the radiological environment around the WIPP facility. This monitoring is carried out in accordance with the WIPP Environmental Monitoring Plan. The radiological monitoring portion of this plan meets the requirements contained in DOE/EH-00173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring*.

WIPP is regulated by the EPA under 40 CFR §191.03, Subpart A, which applies to management and storage of radioactive waste at disposal facilities operated by the DOE. The standards in 40 CFR §191.03(b) state that management and storage of transuranic waste at the DOE facilities shall be conducted in such a manner as to provide reasonable assurance that the annual radiation to any member of the public in the general environmental resulting from discharges of radioactive material and direct radiation from such management and storage shall not exceed specified limits. Based on numerous analyses of radioactive waste disposal facilities in general, and of WIPP in particular, the DOE has identified air emissions as the major pathway of concern. For that reason, the EPA concluded that the only plausible pathway for radionuclide transport during receipt and emplacement of waste at WIPP is by air emissions through the underground exhaust shaft.

The regulatory limits for the WIPP Effluent Monitoring Program can be found in 40 CFR Part 191, Subpart A. Radionuclides being released from WIPP operations, including the underground TRU waste disposal areas and the Waste Handling Building, are monitored through the WIPP effluent monitoring program. 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 (MOU) between the EPA and the DOE, the DOE agreed that the WIPP facility would comply with 40 CFR Part 61, "National Emissions Standards for Hazardous Air Pollutants" (NESHAP), Subpart H, "National Emissions Standards for Hazardous Air Pollutants Other than Radon from Department of Energy Facilities." The NESHAP standard (40 CFR §61.92) 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 effective dose equivalent (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 is located 9 km (5.4 mi) southwest of the WIPP site. The Project Gnome detonation 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 monitoring 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.

The environmental monitoring program sample media 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 facility operations.

Radionuclides are considered "detected" in a sample if the measured concentration or activity is greater than the total propagated uncertainty (TPU) at the 2 sigma level, 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 is 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 spectrometry software. In accordance with the statement of work (SOW) 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 in Appendix D.

WIPP Laboratories performed the analyses for the 10 target radionuclides in all radiological samples. Highly sensitive radiochemical analysis and detection techniques are used 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 WIPP Laboratories were below the recommended MDCs specified in American National Standards Institute (ANSI) Standard N13.30, *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, 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 ventilation fan 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. Filter samples from all three effluent air monitoring stations were analyzed for ^{238}Pu, $^{239+240}Pu$, ^{241}Am, and ^{90}Sr.

The 2007 *Annual Periodic Confirmatory Measurement Compliance Report*, as required by 40 CFR Part 61, Subpart H (NESHAP), will provide the details on the RH TRU and TRU mixed waste receipt and emplacement, as well as the ongoing CH TRU waste process activities. The 2007 report will include analysis of both CH and RH radionuclides, and updates of both existing and newly created RH TRU operating procedures. This expanded report will satisfy the established MOU between the EPA and the DOE (April 5, 1995) regarding the application of the provisions of NESHAP standard. The CAP88-PC dose assessment computer model will continue to be used to estimate the dose(s) and to calculate the EDEs to members of the public.

<u>Environmental Monitoring</u>

The purpose of radiological environmental monitoring is to 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). Radiological monitoring at the WIPP site includes sampling and analysis of air, groundwater, surface water, sediment, soil and biota for ten radionuclides. For each sampling event, chain-of-custody forms were 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. Internal chain of custody forms are used by the laboratory to track and maintain custody while samples are being analyzed.

The radionuclides analyzed were ^{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 were 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.

4.1 Effluent Monitoring

4.1.1 Sample Collection

Stations A, B, and C were monitored with one or more fixed air samplers. The volume of air sampled at each location varied 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-hour) filter samples were collected from Station A from the unfiltered underground exhaust stream. Each day at Station A, approximately 81 m^3 (2,846 cubic feet [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 560 m^3 (19,781 ft^3) of air were 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 228 m^3 (8,065 ft^3) of air were filtered through the Versapor® filter. Based on the specified sampling periods, these air volumes were within ±10 percent of the volume derived using the flow rate set point of 0.057m^3/min (2 ft^3/min) for Stations A and B. The air volume for Station C was within ±10 percent of the volume derived using the flow rate required for isokinetic sampling conditions and the specified sampling period. The sample flow rate for Station C varied according to the exhaust air flow in the Waste Handling Building in order to maintain isokinetic sampling conditions.

The filter samples for Stations B and C were composited each quarter. Because of the large number of samples from Station A, these samples were composited monthly. All filter samples were analyzed radiochemically for ^{241}Am, ^{238}Pu, $^{239+240}$Pu, and ^{90}Sr, $^{233/234}$U, ^{238}U, and ^{137}Cs.

4.1.2 Sample Preparation

The monthly and quarterly filter samples were composited. The composites are 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 of heating at 375°C (707°F) and six hours of heating at 525°C (977°F).

The filters were ashed and cooled, and then transferred into Teflon beakers 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 milliliters (mL) (0.845 fluid ounce [oz]) of concentrated nitric acid and one gram (0.0353 oz) of boric acid were added, and the samples were heated and evaporated to dryness. The sample residues were dissolved in 8 molar nitric acid for gamma spectrometry and measurement of ^{90}Sr and the 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 measured by sequential separation and counting. Strontium-90 was counted on a gas proportional counter. The actinides were co-precipitated, separated on an anion exchange column, and analyzed by alpha spectrometry.

4.1.4 Results and Discussion

For 2007, out of 20 total composite samples, there were 140 analytes as shown in Table 4.1. These analytes comprised of the following radionuclides: ^{241}Am, ^{238}Pu,

$^{239+240}$Pu, ^{90}Sr, $^{233/234}$U, ^{238}U and ^{137}Cs. Fifteen out of 140 analytes had measured concentration or activity greater than the 2 sigma TPU values, and greater than the MDC. Forty-seven out of 140 analytes had 2 sigma TPU values greater than the measured concentration and the MDC. The remaining 78 analytes had MDC values greater than the 2 sigma TPU values, and measured concentration or activity. For the CAP88-PC model used to calculate the EDEs to members of the public (see Section 4.8), detected concentrations are used. When the concentrations are not detected at greater than 2 TPU or the MDC, the 2TPU or MDC value is used, whichever is greater.

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, as specified in 40 CFR §61.92, and the 0.1 mrem per year limit for periodic confirmatory sampling required by 40 CFR §61.93(b)(4)(i), 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 2007

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				8.25E-05	4.00E-04	4.66E-04	-6.22E-05	2.02E-04	6.22E-04
^{238}Pu				7.81E-05	5.00E-04	3.85E-04	-4.29E-05	6.25E-04	5.96E-04
$^{239+240}$Pu				-1.84E-04	3.12E-04	3.81E-04	6.44E-05	5.48E-04	5.92E-04
^{90}Sr		See below [c]		-4.29E-03	2.59E-02	3.56E-03	3.46E-04	3.28E-02	4.03E-03
$^{233+234}$U				1.66E-03	2.42E-03	2.28E-03	3.81E-04	5.66E-04	1.32E-03
^{238}U				-1.20E-04	4.70E-04	1.59E-03	1.18E-04	4.37E-04	6.88E-04
^{137}Cs				3.26E-02	2.08E-01	2.48E-01	-4.33E-03	2.02E-01	2.36E-01
				2nd Quarter					
^{241}Am				2.73E-04	4.48E-04	5.51E-04	2.11E-04	3.89E-04	4.85E-04
^{238}Pu				2.88E-04	4.22E-04	3.26E-04	3.27E-04	4.63E-04	2.93E-04
$^{239+240}$Pu				4.96E-04	5.37E-04	3.63E-04	4.59E-05	2.60E-04	3.58E-04
^{90}Sr		See below		5.25E-03	3.92E-02	3.53E-03	-1.44E-02	3.96E-02	3.63E-03
$^{233+234}$U				1.68E-03	1.18E-03	1.30E-03	9.99E-04	6.88E-04	1.11E-03
^{238}U				7.92E-04	8.47E-04	9.03E-04	5.14E-04	5.25E-04	7.18E-04
^{137}Cs				7.18E-02	2.04E-01	2.45E-01	2.16E-01	2.05E-01	2.57E-01
				3rd Quarter					
^{241}Am				-9.66E-05	2.32E-04	5.29E-04	2.86E-04	6.85E-04	6.07E-04
^{238}Pu				1.63E-03	8.44E-04	3.00E-04	5.88E-05	3.05E-04	3.45E-04
$^{239+240}$Pu				2.67E-04	3.85E-04	3.37E-04	4.26E-04	5.25E-04	4.14E-04
^{90}Sr		See below		-2.71E-03	3.96E-02	3.61E-03	-3.68E-02	4.37E-02	3.92E-03
$^{233+234}$U				1.14E-03	7.73E-04	1.13E-03	1.47E-04	3.96E-04	1.10E-03
^{238}U				4.07E-04	5.11E-04	7.36E-04	4.29E-05	3.03E-04	7.10E-04
^{137}Cs				3.07E-01	1.95E-01	2.53E-01	-1.07E-02	2.17E-01	2.54E-01

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2007

Nuclide	Activity	2 × TPU [a]	MDC[b]	Activity	2 × TPU	MDC	Activity	2 × TPU	MDC
					4th Quarter				
^{241}Am				4.29E-05	3.27E-04	5.37E-04	3.00E-04	4.74E-04	5.29E-04
^{238}Pu				-1.65E-04	4.44E-04	5.25E-04	1.39E-04	3.44E-04	3.42E-04
$^{239+240}$Pu				2.47E-04	3.43E-04	3.49E-04	7.10E-05	2.41E-04	3.02E-04
^{90}Sr		See below		-1.66E-02	4.11E-02	4.07E-03	-1.64E-02	4.03E-02	3.96E-03
$^{233+234}$U				8.92E-04	7.99E-04	1.15E-03	4.92E-04	4.77E-04	1.07E-03
^{238}U				8.88E-05	3.01E-04	6.85E-04	4.96E-04	4.74E-04	6.07E-04
^{137}Cs				-1.41E+00	6.18E-01	5.40E-01	1.02E-01	2.05E-01	2.49E-01
			Station A	1st Quarter		Monthly[c]			
	January			February			March		
^{241}Am	-5.92E-05	1.57E-04	4.51E-04	4.48E-04	5.81E-04	5.25E-04	7.51E-05	3.12E-04	5.22E-04
^{238}Pu	3.48E-04	5.25E-04	4.03E-04	4.63E-04	1.85E-03	1.46E-03	4.77E-04	7.40E-04	5.51E-04
$^{239+240}$Pu	3.74E-04	5.11E-04	5.07E-04	3.70E-04	1.19E-03	1.45E-03	-7.29E-05	2.35E-04	5.48E-04
^{90}Sr	1.35E-03	3.12E-02	4.74E-03	4.48E-03	3.33E-02	4.07E-03	-7.55E-03	3.23E-02	4.03E-03
$^{233+234}$U	1.33E-03	8.99E-04	1.66E-03	1.20E-03	9.92E-04	1.41E-03	1.25E-03	1.22E-03	1.52E-03
^{238}U	8.99E-05	2.76E-04	9.07E-04	-7.36E-05	2.13E-04	7.73E-04	8.95E-04	9.95E-04	8.88E-04
^{137}Cs	3.37E-02	2.06E-01	2.45E-01	1.99E-01	1.97E-01	2.47E-01	-5.55E-01	5.40E-02	5.66E-01
			Station A	2nd Quarter		Monthly			
	April			May			June		
^{241}Am	-1.29E-04	3.11E-04	7.10E-04	8.70E-05	4.18E-04	5.59E-04	7.96E-05	3.81E-04	5.29E-04
^{238}Pu	-9.10E-05	2.61E-04	5.37E-04	-7.92E-05	2.20E-04	4.63E-04	3.03E-04	7.44E-04	5.22E-04
$^{239+240}$Pu	9.73E-05	4.66E-04	5.33E-04	4.74E-05	4.03E-04	4.51E-04	2.24E-04	5.92E-04	5.07E-04
^{90}Sr	-1.27E-02	3.26E-02	3.42E-03	1.85E-03	3.37E-02	3.03E-03	-1.07E-02	3.81E-02	3.18E-03
$^{233+234}$U	2.43E-03	1.35E-03	1.29E-03	2.96E-04	6.62E-04	1.26E-03	1.32E-03	1.07E-03	1.23E-03
^{238}U	3.11E-04	5.00E-04	5.70E-04	1.45E-03	1.08E-03	8.44E-04	8.25E-04	8.44E-04	8.70E-04
^{137}Cs	1.15E-01	1.98E-01	2.43E-01	6.40E-02	2.00E-01	2.42E-01	5.92E-02	2.10E-01	2.53E-01
			Station A	3rd Quarter		Monthly			
	July			August			September		
^{241}Am	2.39E-04	3.96E-04	4.66E-04	5.55E-04	7.18E-04	5.44E-04	2.06E-04	5.29E-04	5.88E-04
^{238}Pu	3.22E-04	5.40E-04	4.14E-04	2.72E-05	3.03E-04	3.21E-04	1.08E-04	2.98E-04	3.77E-04
$^{239+240}$Pu	2.36E-04	4.26E-04	4.00E-04	4.07E-04	4.85E-04	3.92E-04	1.71E-03	9.99E-04	4.40E-04
^{90}Sr	-2.11E-02	3.69E-02	3.10E-03	-3.05E-02	4.59E-02	4.18E-04	-1.75E-02	4.59E-02	4.14E-03
$^{233+234}$U	1.27E-03	9.18E-04	1.17E-03	2.44E-03	1.13E-03	1.12E-03	1.11E-03	8.58E-04	1.17E-03
^{238}U	9.14E-04	8.03E-04	8.10E-04	1.37E-03	8.66E-04	7.36E-04	5.00E-04	6.29E-04	7.88E-04
^{137}Cs	2.62E-01	1.86E-01	2.41E-01	-7.66E-02	2.04E-01	2.31E-01	7.66E-02	2.11E-01	2.54E-01
			Station A	4th Quarter		Monthly			
	October			November			December		
^{241}Am	1.64E-04	4.07E-04	4.66E-04	1.80E-04	4.18E-04	5.44E-04	2.00E-04	4.66E-04	5.81E-04
^{238}Pu	6.55E-05	2.53E-04	3.05E-04	1.24E-04	4.22E-04	4.29E-04	4.70E-05	3.56E-04	4.44E-04
$^{239+240}$Pu	2.68E-04	4.00E-04	3.00E-04	1.65E-04	3.96E-04	3.89E-04	1.97E-04	4.44E-04	3.85E-04
^{90}Sr	-3.45E-02	4.18E-02	3.77E-03	-2.32E-04	4.18E-02	4.03E-03	-1.05E-02	3.25E-02	3.58E-03

Table 4.1 - Activity (Bq) of Quarterly Composite Air Samples from the WIPP Effluent Monitoring Stations A, B, and C for 2007

Nuclide	Activity	2 × TPU [a]	MDC[b]	Activity	2 × TPU	MDC	Activity	2 × TPU	MDC
$^{233+234}U$	1.02E-03	8.14E-04	1.20E-03	1.36E-03	8.92E-04	1.19E-03	-6.11E-05	2.07E-04	1.28E-03
^{238}U	6.14E-04	6.48E-04	7.99E-04	1.51E-03	1.02E-03	7.44E-04	-6.70E-05	2.17E-04	8.18E-04
^{137}Cs	-3.28E-03	2.16E-01	2.55E-01	-1.38E+00	6.18E-01	5.44E-01	4.74E-02	2.01E-01	2.41E-01

[a] Total propagated uncertainty
[b] Minimum detectable concentration
[c] Station A - composited monthly due to the large number of samples

4.2 Airborne Particulates

4.2.1 Sample Collection

Weekly airborne particulate samples are collected from seven locations around WIPP (Figure 4.1) using low-volume air samplers. 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 are filtered through a 4.7-centimeter (cm) (1.85-inch [in.]) diameter glass microfiber filter using a low-volume continuous air sampler.

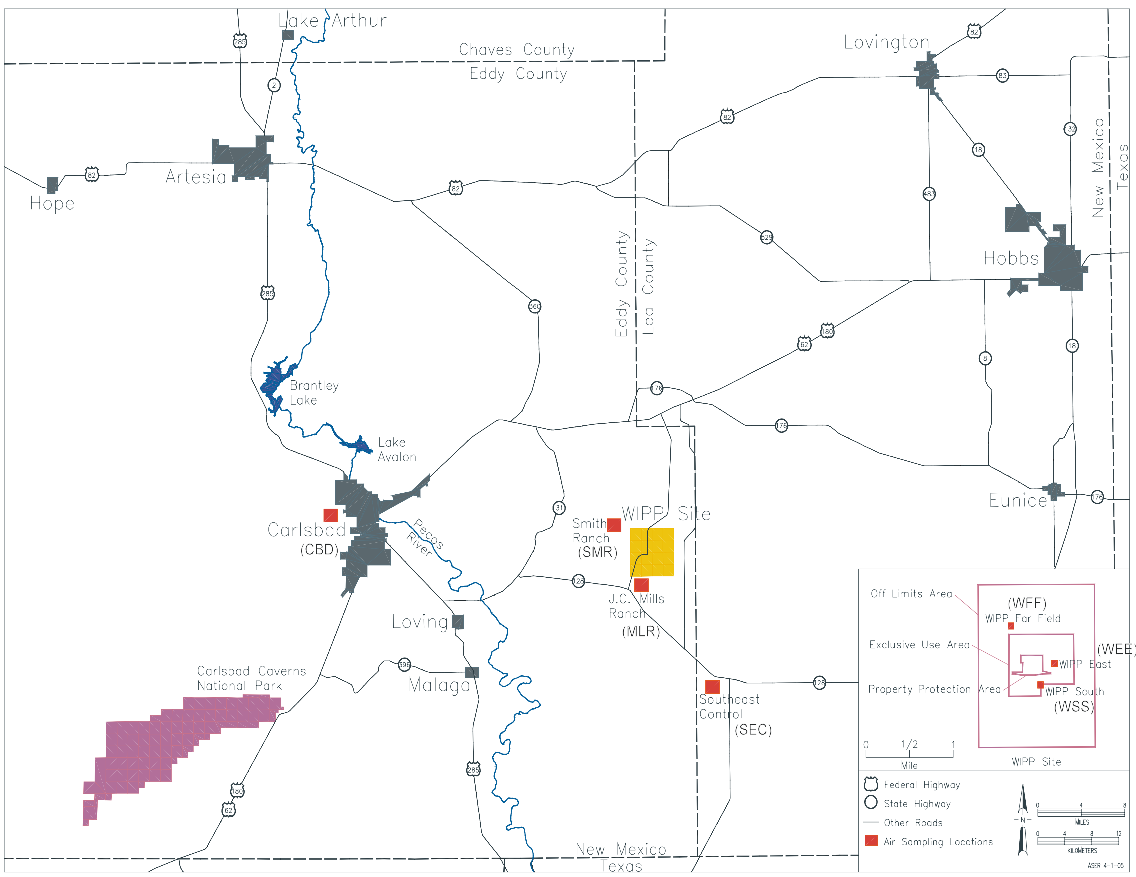

Figure 4.1 - Air Sampling Locations on and Near the WIPP Facility

4.2.2 Sample Preparation

Weekly air particulate samples were composited for each quarter. The composite samples 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 heating for two hours at 375°C (707°F), and heating for six hours at 525°C (977°F).

The filters were ashed and cooled, and then transferred into Teflon beakers 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 (0.845 oz) of concentrated nitric acid and one gram (0.0353 oz) of boric acid were added, and the samples were heated, and finally evaporated to dryness. The residues were dissolved in 8 M nitric acid for gamma spectrometry and for determinations of ^{90}Sr and alpha-emitting radionuclides.

4.2.3 Determination of Individual Radionuclides

Gamma-emitting radionuclides were measured in the air filter samples by gamma spectrometry. Strontium-90 and alpha-emitting radionuclides were measured by sequential separation and counting. Strontium-90 was counted with a gas proportional counter. Actinides were measured by alpha spectrometry following the necessary separation steps involving co-precipitation and ion exchange.

4.2.4 Results and Discussion

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

Natural uranium isotopes were not detected in the composite samples (Table G.1). Whenever the word "sample" is used in this section, it should be taken to mean "composite sample" and does not include blanks. Uranium-234, ^{235}U, and ^{238}U were not detected at any of the sampling locations. None of these isotopes were detected so ANOVA comparisons between years and among locations were not performed.

Plutonium-238, $^{239+240}$Pu, and ^{241}Am were not detected in any low-volume air samples in 2007. Since these isotopes were not detected, ANOVA comparisons between years and among locations were not performed.

Measurable concentrations of ^{40}K (Table G.1) were detected in only two of the air monitoring samples. Most of the gamma spectroscopy values for ^{40}K yield confidence levels less than 90 percent and thus were not considered "detects." Only one of ^{40}K concentrations corresponds to a location with a detected concentration in 2006, and thus no ANOVA comparisons could be performed. The highest concentration of ^{40}K detected (3.89E-04 Bq/m^3) was slightly higher than the baseline value (upper 99th percentile: 3.20E-04 Bq/m^3).

Cesium-137, ^{90}Sr, ^{60}Co and were not detected in any samples in 2007. Since none of these isotopes were detected, ANOVA comparisons between years or among locations were not performed.

Table 4.2 - Minimum, Maximum, and Average Radionuclide Concentrations (Bq/m³) in Air Filter Composites from Stations Surrounding the WIPP Site. See Appendix G for supporting data.

Radionuclide		[RN][a]	2 X TPU[b]	MDC[c]
^{241}Am	Minimum[d]	-1.09E-08	6.74E-08	1.36E-04
	Maximum[d]	1.31E-07	1.27E-07	1.61E-04
	Average[e]	2.52E-08	7.31E-08	1.52E-04
^{238}Pu	Minimum	-2.61E-08	6.12E-08	1.00E-05
	Maximum	5.85E-08	1.09E-07	9.96E-06
	Average	7.40E-09	5.22E-08	1.71E-05
$^{239+240}Pu$	Minimum	-1.88E-08	4.12E-08	4.71E-05
	Maximum	4.79E-08	6.78E-08	9.95E-06
	Average	8.80E-10	3.92E-08	2.14E-05
^{234}U	Minimum	3.72E-07	2.11E-07	7.80E-04
	Maximum	2.30E-06	5.91E-07	7.92E-04
	Average	1.30E-06	3.72E-07	8.48E-04
^{235}U	Minimum	-3.62E-09	1.66E-08	9.90E-05
	Maximum	2.28E-07	2.13E-07	3.73E-05
	Average	7.14E-08	8.74E-08	6.81E-05
^{238}U	Minimum	1.33E-08	6.40E-08	3.96E-04
	Maximum	2.36E-06	5.99E-07	3.22E-04
	Average	1.18E-06	3.42E-07	3.68E-04
^{40}K	Minimum	-1.32E-04*	5.27E-04	5.55E-04
	Maximum	3.89e-04	2.20E-04	3.06E-04
	Average	4.92E-04	4.29E-04	5.44E-04
^{60}Co	Minimum	-3.20E-05*	7.10E-05	7.66E-05
	Maximum	1.64E-04*	7.29E-05	8.56E-05
	Average	2.40E-05	4.99E-05	5.80E-05
^{90}Sr	Minimum	-3.86E-06	4.39E-06	1.40E-03
	Maximum	5.86E-07	4.38E-06	9.90E-04
	Average	-1.22E-06	3.96E-06	1.32E-03
^{137}Cs	Minimum	-1.21E-04*	8.45E-05	8.07E-05
	Maximum	4.00E-05*	4.10E-05	4.98E-05
	Average	-2.20E-05	4.62E-05	4.98E-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, 2 X TPU, and MDC.
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

During 2007, duplicate samples were taken from four locations. There were no instances in which both the sample and its duplicate contained a detectable concentration of a radionuclide. Therefore, relative error ratios (RERs) were not calculated and are not shown for 2007 air filter composite samples.

4.3 Groundwater

4.3.1 Sample Collection

Groundwater samples were collected twice in 2007 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 of water were pumped out of each well before collecting approximately 38 liters (L) (10 gallons) of water samples. The water samples were collected from depths ranging from 180-270 m (591-886 ft) from the six wells (WQSP-1 to WQSP-6), and from a depth of 69 m (226 ft) from WQSP-6A. Approximately 8 L (2 gallons) of water were sent to the laboratory for the measurement of the target radionuclides. The remaining portions of the samples were used to analyze for nonradiological parameters or were placed in storage. The radiological samples were filtered during collection and acidified to pH $\leq$ 2 with concentrated nitric acid.

4.3.2 Sample Preparation

The groundwater sample containers were shaken to distribute any suspended material evenly, and sample aliquots were measured into glass beakers. Tracers (^{232}U, ^{243}Am, and ^{242}Pu) and carriers (strontium nitrate and barium nitrate) were added, and the samples were then digested using concentrated nitric acid and hydrofluoric acid. The samples were then heated to dryness and wet-ashed using concentrated nitric acid and hydrogen peroxide. Finally, the samples were 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 L (16.9 oz) was used for the determination of ^{90}Sr using a gas proportional counter. Another aliquot of the samples was used for the sequential analyses 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 all the groundwater well samples in 2007, as shown in Table 4.3. The concentrations were compared with concentrations at the same locations in 2006 using ANOVA.

The concentrations of the uranium isotopes measured in the WQSP wells in 2007 did not vary significantly from the concentrations measured in the same wells in 2006 as demonstrated by the combined ANOVA of all the wells (ANOVA, ^{234}U p = 0.281; ^{235}U p = 0.185; and ^{238}U p = 0.213).

The concentrations of the uranium isotopes measured in 2007 are not significantly different from well to well (e.g., comparing the concentrations of the different wells with each other) from 2006 to 2007 as shown by the combined well ANOVA for 2007 (ANOVA, ^{234}U p = 0.0550; ^{235}U p = 0.208; and ^{238}U p = 0.0890).

Concentrations of uranium isotopes were also compared with baseline levels observed between 1985 and 1989 (baseline values: ^{234}U = 1.30 Bq/L, ^{235}U = 3.10E-02 Bq/L, ^{238}U = 3.20E-01 Bq/L). For 2007, the concentrations of ^{234}U,^{235}U, and ^{238}U were within the 99 percent confidence interval ranges of baseline levels (DOE/WIPP- 92-037). 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 for in the groundwater samples (Table 4.3). These isotopes were not detected in any of the groundwater samples, so ANOVA comparisons between years and among locations were not performed.

Cesium-137, ^{90}Sr and ^{60}Co were also not detected in any of the groundwater samples. Since none of these isotopes were detected, there was insufficient data for ANOVA comparisons between years or among locations.

Potassium-40 was detected in both well samples from WQSP-1 and WQSP-3 as shown in Table 4-3. It was only detected in one of the two samples from WQSP-2, WQSP-4, and WQSP-5 and was not detected in WQSP-6 or 6A. The gamma spectra did not meet the 90 percent confidence level to confirm ^{40}K presence in the non-detect samples.

ANOVA calculations were performed using the single or average concentrations from the groundwater samples where the ^{40}K was detected. There was a significant difference in ^{40}K concentrations among sampling locations (ANOVA p = 7.22E-05), but not between 2006 and 2007 (ANOVA p=0.819). The differences in ^{40}K concentrations at the various wells (locations) are due to the differences in the abundance of this naturally occurring isotope in the earth's crust. The concentrations of ^{40}K confirmed during 2007 fall within the 99 percent confidence interval range of the baseline concentrations (baseline concentration: 6.30E+01 Bq/L).

Table 4.3 -Radionuclide Concentrations (Bq/L) in Groundwater from Wells at the WIPP Site. See Chapter 6 for the sampling locations.

Location	Sampling Round	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
		^{241}Am			^{238}Pu			$^{239+240}$Pu		
WQSP-1	24	4.15E-04	4.98E-04	4.82E-04	7.43E-05	3.07E-04	3.69E-04	-1.00E-04	2.25E-04	3.60E-04
	25	1.19E-04	6.15E-04	1.05E-03	-7.24E-05	1.78E-04	3.29E-04	4.20E-05	2.86E-04	3.15E-04
WQSP-2	24	4.80E-04	5.61E-04	5.38E-04	-1.16E-05	3.29E-04	3.27E-04	5.01E-05	2.84E-04	3.27E-04
	25	4.66E-04	6.08E-04	5.47E-04	5.22E-04	9.03E-04	1.17E-03	1.74E-04	3.41E-04	5.18E-04
WQSP-3	24	2.45E-04	5.14E-04	5.11E-04	7.75E-06	6.46E-04	6.55E-04	1.17E-04	5.64E-04	6.55E-04
	25	-1.95E-04	3.64E-04	6.16E-04	1.93E-04	7.39E-04	5.86E-04	-1.21E-04	3.16E-04	6.56E-04
WQSP-4	24	1.03E-04	3.94E-04	4.82E-04	6.80E-04	1.13E-03	6.08E-04	5.11E-05	5.71E-04	5.99E-04
	25	3.34E-04	6.69E-04	5.12E-04	-9.92E-05	8.15E-04	7.38E-04	-7.22E-05	7.98E-04	7.71E-04
WQSP-5	24	4.24E-04	5.76E-04	4.38E-04	8.19E-05	2.96E-04	3.55E-04	-9.91E-05	2.22E-04	3.60E-04
	25	1.93E-04	3.23E-04	5.06E-04	-5.01E-05	4.11E-04	3.98E-04	-3.64E-05	4.02E-04	3.83E-04
WQSP-6	24	-1.11E-04	2.68E-04	5.75E-04	-4.36E-05	1.41E-04	3.36E-04	2.77E-05	3.10E-04	3.84E-04
	25	-1.86E-04	3.19E-04	5.23E-04	-1.89E-04	3.13E-04	4.04E-04	-1.48E-04	2.77E-04	3.79E-04
WQSP-6A	24	-1.27E-04	2.42E-04	4.70E-04	7.29E-05	2.47E-04	3.06E-04	-8.01E-05	1.83E-04	4.20E-04
	25	-1.12E-04	2.50E-04	5.31E-04	-7.84E-05	1.93E-04	3.54E-04	5.78E-05	3.01E-04	3.54E-04
		^{234}U			^{235}U			^{238}U		
WQSP-1	24	6.30E-01	1.61E-01	1.28E-03	1.24E-02	4.15E-03	5.02E-04	1.07E-01	2.83E-02	6.85E-04
	25	6.94E-01	3.16E-02	1.19E-03	1.38E-02	3.05E-03	5.32E-04	1.10E-01	8.59E-03	8.03E-04
WQSP-2	24	6.35E-01	1.99E-01	1.35E-03	9.78E-03	4.04E-03	5.94E-04	1.04E-01	3.32E-02	7.58E-04
	25	4.99E-01	2.56E-02	1.24E-03	4.80E-03	1.92E-03	5.88E-04	8.49E-02	7.84E-03	8.46E-04
WQSP-3	24	2.39E-01	6.67E-02	1.45E-03	3.78E-03	1.86E-03	5.44E-04	3.72E-02	1.11E-02	8.07E-04
	25	3.24E-01	1.88E-02	1.26E-03	3.95E-03	1.78E-03	6.05E-04	5.62E-02	6.29E-03	8.72E-04
WQSP-4	24	5.32E-01	2.39E-01	1.61E-03	1.05E-02	5.73E-03	8.01E-04	8.99E-02	4.07E-02	9.38E-04
	25	2.81E-01	1.58E-02	1.10E-03	4.78E-03	1.77E-03	5.01E-04	5.02E-02	5.41E-03	7.35E-04
WQSP-5	24	5.33E-01	1.77E-01	1.67E-03	6.47E-03	3.08E-03	6.82E-04	8.34E-02	2.85E-02	9.40E-04
	25	3.59E-01	2.08E-02	1.19E-03	4.24E-03	1.93E-03	6.49E-04	4.78E-02	5.97E-03	8.46E-04
WQSP-6	24	5.24E-01	1.77E-01	1.66E-03	6.69E-03	3.19E-03	6.84E-04	7.40E-02	2.58E-02	9.30E-04
	25	2.49E-01	1.41E-02	1.07E-03	2.09E-03	1.15E-03	4.80E-04	3.25E-02	4.12E-03	6.96E-04
WQSP-6A	24	2.01E-01	5.55E-02	1.68E-03	1.09E-02	3.92E-03	5.61E-04	1.13E-01	3.16E-02	9.25E-04
	25	1.13E-01	9.42E-03	1.17E-03	4.97E-03	1.98E-03	6.30E-04	6.44E-02	6.77E-03	7.98E-04
		^{40}K			^{60}Co			^{137}Cs		
WQSP-1	24	1.97E+01	5.63E+00	6.86E+00	8.13E-01*	5.42E-01	6.29E-01	-9.35E-01*	5.56E-01	5.21E-01
	25	1.62E+01	3.46E+00	3.26E+00	-5.86E-02*	2.88E-01	3.19E-01	-3.46E-02*	2.24E-01	2.60E-01
WQSP-2	24	1.92E+01*	4.70E+00	6.14E+00	-4.01E-02*	3.56E-01	3.92E-01	-1.84E-01*	3.23E-01	3.38E-01
	25	1.91E+01	4.89E+00	5.98E+00	2.88E-01*	4.86E-01	5.58E-01	-8.30E-01*	5.39E-01	5.48E-01
WQSP-3	24	4.75E+01	7.78E+00	4.72E+00	1.28E-01*	1.39E-01	2.20E-01	1.15E-01*	3.54E-01	4.14E-01
	25	4.99E+01	8.19E+00	6.26E+00	3.67E-01*	4.99E-01	5.75E-01	-4.23E-01*	5.40E-01	5.86E-01
WQSP-4	24	2.56E+01*	5.02E+00	6.13E+00	1.52E-01*	2.38E-01	3.38E-01	-8.21E-02*	2.38E-01	2.69E-01
	25	2.10E+01	5.17E+00	6.21E+00	3.22E-01*	4.96E-01	5.70E-01	-5.23E-01*	5.87E-01	5.88E-01
WQSP-5	24	8.14E+00	3.02E+00	3.94E+00	3.38E-01*	3.58E-01	4.33E-01	2.87E-01*	3.18E-01	3.83E-01
	25	1.14E+01*	3.81E+00	4.61E+00	1.69E-01*	3.53E-01	4.17E-01	-1.49E-01*	2.98E-01	3.34E-01
WQSP-6	24	6.80E+00*	3.79E+00	5.06E+00	7.69E-01*	3.18E-01	4.44E-01	1.33E-01*	3.16E-01	3.71E-01
	25	4.07E+00	3.84E+00	6.09E+00	1.34E-01*	4.90E-01	5.55E-01	1.44E-01*	4.65E-01	5.67E-01
WQSP-6A	24	8.45E-01	2.61E+00	3.09E+00	2.27E-01	2.64E-01	3.23E-01	2.06E-01	2.07E-01	2.59E-01
	25	3.23E+00*	3.28E+00	4.05E+00	3.37E-01*	3.06E-01	3.88E-01	1.43E-01*	2.74E-01	3.15E-01

Table 4.3 -Radionuclide Concentrations (Bq/L) in Groundwater from Wells at the WIPP Site. See Chapter 6 for the sampling locations.

Location	Sampling Round	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
			^{90}Sr							
WQSP-1	24	-5.79E-03	4.78E-02	4.94E-03						
	25	-9.61E-03	3.07E-02	3.05E-03						
WQSP-2	24	-1.41E-02	3.66E-02	4.09E-03						
	25	2.35E-03	5.00E-02	4.44E-03						
WQSP-3	24	-1.04E-02	2.94E-02	4.23E-03						
	25	-1.49E-02	3.34E-02	3.47E-03						
WQSP-4	24	-9.21E-03	4.45E-02	5.48E-03						
	25	2.53E-02	4.86E-02	4.12E-03						
WQSP-5	24	-5.09E-03	2.98E-02	4.75E-03						
	25	-4.42E-02	5.91E-02	4.90E-03						
WQSP-6	24	2.40E-03	2.99E-02	4.75E-03						
	25	1.02E-03	4.16E-02	3.45E-03						
WQSP-6A	24	-7.91E-03	2.67E-02	4.67E-03						
	25	1.70E-02	4.80E-02	4.26E-03						

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects"

Duplicate samples for all radionuclides analyzed were collected from each of the wells as a check on the reproducibility of the radiochemical 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 4.4 for Sampling Round 24 and in Table 4.5 for Sampling Round 25. All 24 of the RER values for Sampling Round 24 were less than one, indicating that the precision objective was met and demonstrating good reproducibility for the sample preparation and analysis procedures.

Six of the 25 RER values from Round 25 yielded values greater than 1. Three of the values were for ^{234}U analysis, one for ^{235}U analysis, and two for ^{238}U analysis. Since the duplicate samples should be identical to each other, these results show that the precision objective was not met for some of the analysis procedures, especially for the alpha spectrometry analysis of the samples from WQSP-5. The alpha spec sample preparation requires many different laboratory procedures, and all the steps can contribute to lack of precision.

Table 4.4 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 24. Units are Bq/L. See Chapter 6 for sampling locations.

Location		Sample			Duplicate			
		[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	RER[d]
WQSP-1	^{234}U	6.30E-01	1.61E-01	1.28E-03	6.09E-01	1.61E-01	1.29E-03	0.09
	^{235}U	1.24E-02	4.15E-03	5.02E-04	1.46E-02	4.84E-03	5.13E-04	0.35
	^{238}U	1.07E-01	2.83E-02	6.85E-04	1.08E-01	2.92E-02	6.93E-04	0.02
	^{40}K	1.97E+01	5.63E+00	6.86E+00	1.84E+01	4.19E+00	4.10E+00	0.19
WQSP-2	^{234}U	6.35E-01	1.99E-01	1.35E-03	6.99E-01	1.83E-01	1.29E-03	0.24
	^{235}U	9.78E-03	4.04E-03	5.94E-04	5.73E-03	2.36E-03	5.09E-04	0.87
	^{238}U	1.04E-01	3.32E-02	7.58E-04	1.10E-01	2.95E-02	6.90E-04	0.14
WQSP-3	^{234}U	2.39E-01	6.67E-02	1.45E-03	2.46E-01	7.01E-02	1.47E-03	0.07
	^{235}U	3.78E-03	1.86E-03	5.44E-04	4.67E-03	2.18E-03	5.65E-04	0.31
	^{238}U	3.72E-02	1.11E-02	8.07E-04	3.64E-02	1.11E-02	8.24E-04	0.05
	^{40}K	4.75E+01	7.78E+00	4.72E+00	5.00E+01	7.86E+00	4.10E+00	0.23
WQSP-4	^{234}U	5.32E-01	2.39E-01	1.61E-03	5.17E-01	1.55E-01	1.43E-03	0.05
	^{235}U	1.05E-02	5.73E-03	8.01E-04	9.33E-03	3.75E-03	5.77E-04	0.17
	^{238}U	8.99E-02	4.07E-02	9.38E-04	8.54E-02	2.63E-02	7.57E-04	0.09
WQSP-5	^{234}U	5.33E-01	1.77E-01	1.67E-03	5.23E-01	1.68E-01	1.68E-03	0.04
	^{235}U	6.47E-03	3.08E-03	6.82E-04	9.21E-03	3.95E-03	6.93E-04	0.55
	^{238}U	8.34E-02	2.85E-02	9.40E-04	7.46E-02	2.48E-02	9.49E-04	0.23
	^{40}K	8.14E+00	3.02E+00	3.94E+00	8.69E+00	2.52E+00	2.78E+00	0.14
WQSP-6	^{234}U	5.24E-01	1.77E-01	1.66E-03	5.74E-01	1.53E-01	1.58E-03	0.21
	^{235}U	6.69E-03	3.19E-03	6.84E-04	5.32E-03	2.29E-03	5.87E-04	0.35
	^{238}U	7.40E-02	2.58E-02	9.30E-04	7.30E-02	2.02E-02	8.52E-04	0.03
WQSP-6A	^{234}U	2.01E-01	5.55E-02	1.68E-03	1.99E-01	4.77E-02	1.69E-03	0.03
	^{235}U	1.09E-02	3.92E-03	5.61E-04	9.22E-03	3.14E-03	5.17E-04	0.33
	^{238}U	1.13E-01	3.16E-02	9.25E-04	9.90E-02	2.41E-02	9.24E-04	0.35

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

Table 4.5 - Results of Duplicate Groundwater Sample Analysis for Sampling Round 25. Units are Bq/L. See Chapter 6 for sampling locations.

Location	Nuclide	Sample			Duplicate			
		[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	RER[d]
WQSP-1	^{234}U	6.94E-01	3.16E-02	1.19E-03	6.38E-01	2.87E-02	1.15E-03	1.31
	^{235}U	1.38E-02	3.05E-03	5.32E-04	1.29E-02	2.87E-03	4.92E-04	0.21
	^{238}U	1.10E-01	8.59E-03	8.03E-04	1.13E-01	8.38E-03	7.70E-04	0.25
	^{40}K	1.62E+01	3.46E+00	3.26E+00	1.23E+01	4.52E+00	6.35E+00	0.69
WQSP-2	^{234}U	4.99E-01	2.56E-02	1.24E-03	5.03E-01	2.52E-02	1.22E-03	0.11
	^{235}U	4.80E-03	1.92E-03	5.88E-04	6.40E-03	2.27E-03	5.62E-04	0.54
	^{238}U	8.49E-02	7.84E-03	8.46E-04	7.42E-02	7.13E-02	8.24E-04	0.15
	^{40}K	1.91E+01	4.89E+00	5.98E+00	1.57E+01	3.38E+00	3.20E+00	0.57
WQSP-3	^{234}U	3.24E-01	1.88E-02	1.26E-03	8.93E-02	7.61E-03	1.19E-03	11.57
	^{235}U	3.95E-03	1.78E-03	6.05E-04	1.81E-03	1.29E-03	5.19E-04	0.97
	^{238}U	5.62E-02	6.29E-03	8.72E-04	1.26E-02	2.70E-03	8.02E-04	6.37
	^{40}K	4.99E+01	8.19E+00	6.26E+00	4.99E+01	8.26E+00	6.47E+00	0.00
WQSP-4	^{234}U	2.81E-01	1.58E-02	1.10E-03	2.96E-01	1.67E-02	1.14E-03	0.65
	^{235}U	4.78E-03	1.77E-03	5.01E-04	3.48E-03	1.60E-03	5.52E-04	0.54
	^{238}U	5.02E-02	5.41E-03	7.35E-04	5.17E-02	5.78E-03	7.77E-04	0.19
	^{40}K	2.10E+01	5.17E+00	6.21E+00	2.47E+01	5.55E+00	6.31E+00	0.49
WQSP-5	^{234}U	3.59E-01	2.08E-02	1.19E-03	2.74E-01	1.60E-02	1.13E-03	3.24
	^{235}U	4.24E-03	1.93E-03	6.49E-04	1.69E-03	1.11E-03	5.73E-04	1.15
	^{238}U	4.78E-02	5.97E-03	8.46E-04	3.64E-02	4.80E-03	7.84E-04	1.49
WQSP-6	^{234}U	2.49E-01	1.41E-02	1.07E-03	2.65E-01	1.43E-02	1.06E-03	0.80
	^{235}U	2.09E-03	1.15E-03	4.80E-04	2.69E-03	1.25E-03	4.67E-04	0.35
	^{238}U	3.25E-02	4.12E-03	6.96E-04	3.33E-02	4.09E-03	6.86E-04	0.14
WQSP-6A	^{234}U	1.13E-01	9.42E-03	1.17E-03	1.13E-01	8.95E-03	1.13E-03	0.00
	^{235}U	4.97E-03	1.98E-03	6.30E-04	3.25E-03	1.53E-03	5.82E-04	0.69
	^{238}U	6.44E-02	6.77E-03	7.98E-04	5.63E-02	6.00E-03	7.59E-04	0.90

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

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 sample analysis results are provided in Section 4.5.

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

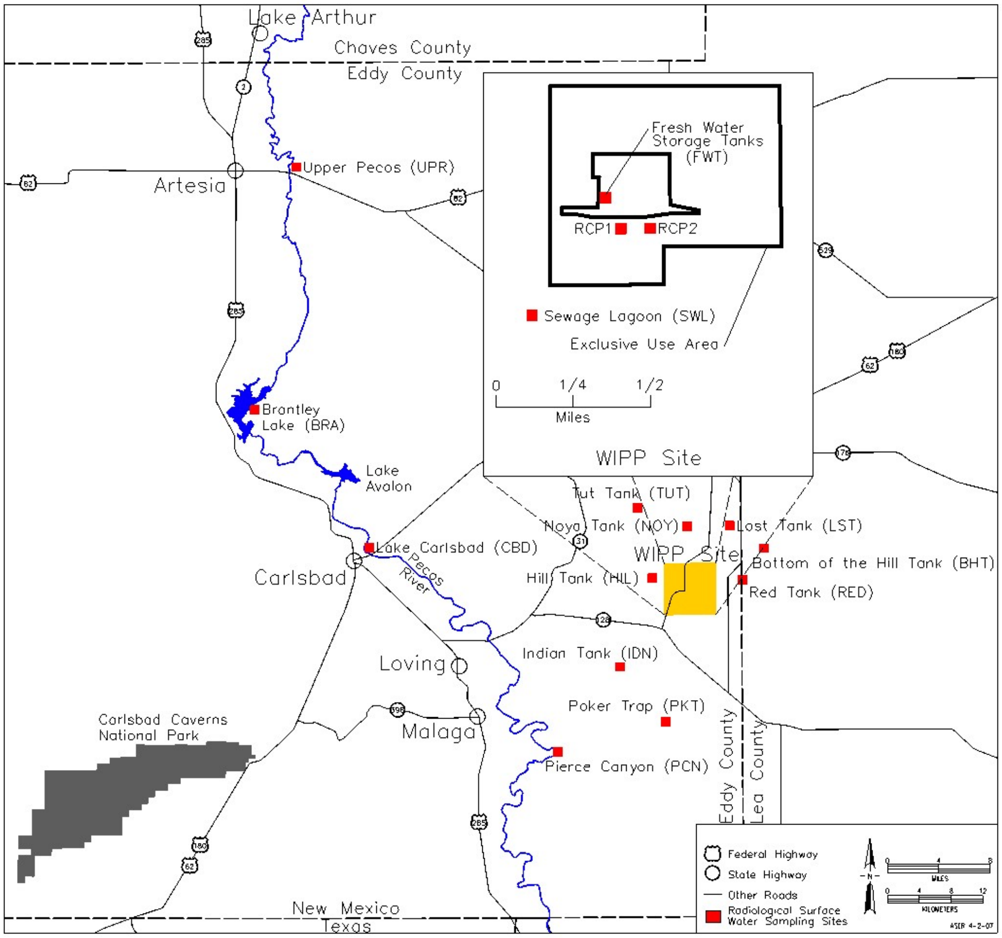

Figure 4.2 - Routine Surface Water Sampling Locations

4.4.2 Sample Preparation

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

4.4.3 Determination of Individual Radionuclides

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

4.4.4 Results and Discussion

Uranium isotopes were detected in most of the surface water samples, which included 14 samples, two duplicate samples, and a distilled water blank (COW). U-234 was detected in all of the samples; ^{235}U was detected in nine of the samples; and ^{238}U was also detected in all of the samples (Table 4.6).

The concentrations of uranium isotopes were compared between 2006 and 2007 and also among sampling locations using ANOVA for those locations where the uranium isotopes were detected both years, and using the average of duplicate samples when available. There was no significant difference in the concentrations of uranium isotopes between 2006 and 2007 (ANOVA, ^{234}U p=0.382, ^{235}U p = 0.435, and ^{238}U p = 0.444).

Significant variability was observed among sampling locations for ^{234}U and ^{238}U but not for ^{235}U (ANOVA, ^{234}U p=3.09E-04, ^{235}U p = 0.222, and ^{238}U p = 8.27E-06). Some variability among sampling locations is expected since natural concentrations of uranium varies widely in the earth's crust, and this variation is reflected in the amounts of uranium dissolved in surface water.

Table 4.6 - Uranium Concentrations (Bq/L) in Surface Water Near the WIPP Site. See Appendix C for sampling location codes.

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	^{234}U			^{235}U			^{238}U		
BRA	2.02E-01	5.29E-02	1.58E-03	6.01E-03	2.45E-03	5.81E-04	7.93E-02	2.14E-02	8.71E-04
BHT	3.06E-03	1.44E-03	1.31E-03	2.85E-04	4.42E-04	5.12E-04	2.90E-03	1.39E-03	7.05E-04
CBD	1.05E-01	2.72E-02	1.55E-03	2.39E-03	1.31E-03	5.49E-04	4.73E-02	1.27E-02	8.45E-04
COW	3.71E-03	1.53E-03	1.52E-03	2.38E-04	4.04E-04	5.43E-04	1.16E-03	7.79E-04	8.30E-04
FWT	4.99E-02	1.30E-02	1.53E-03	1.48E-03	9.88E-04	5.51E-04	1.68E-02	4.89E-03	8.37E-04
HIL	7.40E-03	2.91E-03	1.59E-03	4.42E-04	6.19E-04	6.30E-04	5.68E-03	2.37E-03	9.00E-04
IDN	2.26E-02	7.37E-03	1.60E-03	6.38E-04	7.16E-04	6.37E-04	2.06E-02	6.79E-03	9.06E-04
IDN DUP	2.34E-02	6.39E-03	1.53E-03	6.55E-04	6.36E-04	5.46E-04	1.75E-02	4.98E-03	8.33E-04
LST	2.00E-03	1.03E-03	1.27E-03	9.23E-05	2.95E-04	4.56E-04	1.34E-03	8.25E-04	6.60E-04
NOY	8.68E-03	3.13E-03	1.56E-03	4.27E-04	5.48E-04	5.87E-04	6.23E-03	2.42E-03	8.66E-04
PCN	2.19E-01	5.98E-02	1.57E-03	6.07E-03	2.51E-03	5.75E-04	1.02E-01	2.84E-02	8.66E-04
PCN DUP	2.38E-01	6.24E-02	1.56E-03	7.07E-03	2.71E-03	5.54E-04	1.08E-01	2.89E-02	8.50E-04
PKT	1.36E-02	4.91E-03	1.61E-03	6.18E-04	7.38E-04	6.43E-04	7.89E-03	3.15E-03	9.11E-04
RED	9.81E-03	3.08E-03	1.53E-03	1.97E-04	4.33E-04	5.45E-04	6.15E-03	2.17E-03	8.32E-04
SLW	8.75E-02	2.26E-02	1.56E-03	2.33E-03	1.29E-03	5.59E-04	2.39E-02	6.79E-03	8.53E-04

Table 4.6 - Uranium Concentrations (Bq/L) in Surface Water Near the WIPP Site. See Appendix C for sampling location codes.

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	^{234}U			^{235}U			^{238}U		
TUT	1.43E-02	4.28E-03	1.56E-03	6.86E-04	6.76E-04	5.55E-04	1.21E-02	3.74E-03	8.51E-04
UPR	1.22E-01	3.02E-02	1.54E-03	4.27E-03	1.85E-03	5.33E-04	6.01E-02	1.54E-02	8.32E-04

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

The 2007 uranium isotope surface water concentrations were also compared with baseline levels observed between 1985 and 1989 (DOE/WIPP-92-037). The highest concentrations detected for ^{234}U, ^{235}U, and ^{238}U in the Pecos River and associated bodies of water were within the 99 percent confidence interval ranges of baseline levels (baseline levels: ^{234}U = 3.30E-01 Bq/L, ^{235}U = 1.40E-02 Bq/L, and ^{238}U = 1.10E-01 Bq/L). Likewise, the highest concentrations of all three uranium isotopes for samples taken from tanks and tank-like structures fell within the 99 percent confidence interval ranges of baseline levels (baseline levels: ^{234}U = 1.00E-01 Bq/L, ^{235}U = 5.20E-03 Bq/L, and ^{238}U = 3.20E-02 Bq/L).

The surface water samples were also analyzed for ^{238}Pu, $^{239+240}Pu$, and ^{241}Am (Table 4.7). Plutonium-238 and $^{239+240}Pu$ were not detected in any of the samples. Americium-241 was detected in one sample at location TUT. Americium-241 was not detected in 2006, so no ANOVA comparisons between years and among locations were performed. Also, there were no baseline data relative to ^{241}Am in surface water so no comparison to the baseline could be made.

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

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}Pu$		
BRA	3.25E-04	4.63E-04	4.79E-04	4.07E-05	3.93E-04	4.36E-04	-2.54E-05	1.22E-04	4.74E-04
BHT	1.69E-04	3.81E-04	4.87E-04	1.27E-04	6.08E-04	7.14E-04	1.69E-04	5.72E-04	7.09E-04
CBD	2.22E-04	3.91E-04	4.91E-04	1.66E-04	3.44E-04	3.24E-04	1.59E-04	3.48E-04	3.62E-04
COW	6.55E-05	3.15E-04	4.91E-04	-7.42E-05	2.06E-04	4.12E-04	4.45E-04	6.50E-04	5.26E-04
FWT	1.09E-04	2.59E-04	4.73E-04	1.89E-04	4.48E-04	5.94E-04	1.08E-04	5.17E-04	7.08E-04
HIL	4.23E-04	5.07E-04	4.64E-04	9.17E-05	4.40E-04	5.07E-04	4.81E-04	6.60E-04	6.20E-04
IDN	1.85E-04	3.93E-04	4.77E-04	-5.54E-05	4.08E-04	3.68E-04	-1.75E-04	3.00E-04	4.09E-04
IDN DUP	1.63E-04	3.29E-04	4.25E-04	-1.68E-04	4.65E-04	9.20E-04	-1.90E-04	4.95E-04	1.03E-03
LST	2.91E-04	4.46E-04	4.33E-04	5.55E-05	2.30E-04	2.94E-04	1.21E-04	3.19E-04	2.88E-04
NOY	1.97E-04	3.37E-04	4.44E-04	-6.55E-05	2.34E-04	6.02E-04	1.09E-04	5.24E-04	7.15E-04
PCN	5.82E-05	3.03E-04	4.74E-04	-4.94E-05	1.37E-04	2.91E-04	-5.60E-05	1.46E-04	3.29E-04
PCN DUP	4.38E-04	5.19E-04	4.72E-04	-6.58E-05	1.82E-04	3.80E-04	-7.88E-05	2.00E-04	4.18E-04
PKT	7.13E-05	2.58E-04	4.42E-04	-1.87E-04	6.07E-04	1.39E-03	-3.91E-04	8.78E-04	1.51E-03
RED	6.62E-05	2.74E-04	4.52E-04	9.00E-05	4.01E-04	4.68E-04	2.76E-04	5.09E-04	5.81E-04
SLW	5.52E-04	7.43E-04	6.91E-04	-6.07E-05	1.96E-04	4.53E-04	-1.27E-04	2.84E-04	4.71E-04
TUT	1.14E-03	8.32E-04	4.99E-04	-3.51E-05	1.26E-04	3.41E-04	1.44E-04	3.81E-04	3.79E-04
UPR	1.61E-04	3.99E-04	4.71E-04	7.36E-05	2.35E-04	3.08E-04	-5.60E-05	1.50E-04	3.46E-04

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

Cesium-137, ^{90}Sr, ^{60}Co were not detected in any of the surface water samples (Table 4.8). Since these isotopes were not detected, ANOVA comparisons between years and among locations were not performed.

Potassium-40 was detected in just two of the surface water samples, BHT and SLW, as well as the distilled water blank COW as shown in Table 4.8. Again, most of the gamma spectroscopy samples did not meet the 90 percent confidence levels and were not considered detects. Potassium is ubiquitous throughout the earth's crust, so it would be expected to be found in some surface water samples due to leaching from sediments.

Comparison of the maximum detected ^{40}K (1.48E+02 Bq/L in Sample SWL) with the baseline data (baseline value: 7.60E+01 Bq/L) shows that the concentration in this particular sample was higher than the 99 percent confidence interval ranges of the baseline concentrations (DOE/WIPP- 92-037). The reason for this higher detected concentration is unknown. Since there was only one detected concentration in the same samples in 2006 and 2007, there were insufficient data for ANOVA comparisons between years or among locations.

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

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
		^{137}Cs			^{60}Co	
BRA	-3.59E-01*	5.31E-01	5.49E-01	5.63E-01*	5.32E-01	6.15E-01
BHT	5.82E-02*	2.87E-01	3.44E-01	1.31E-01*	3.45E-01	4.05E-01
CBD	1.16E-01*	2.94E-01	3.35E-01	-1.11E-01*	3.69E-01	3.95E-01
COW	-5.52E-01	6.64E-01	6.82E-01	1.12E+00*	5.99E-01	7.03E-01
FWT	-7.73E-02*	3.17E-01	3.57E-01	1.56E-01*	3.71E-01	4.25E-01
HIL	-1.20E-01*	3.62E-01	3.85E-01	-1.20E-01*	3.62E-01	3.85E-01
IDN	1.25E-01*	2.88E-01	3.30E-01	-4.01E-02*	3.56E-01	3.92E-01
IDN DUP	-4.25E-01*	5.93E-01	6.78E-01	1.18E+00*	5.82E-01	6.86E-01
LST	-1.48E-01*	3.96E-01	5.11E-01	5.84E-01*	5.41E-01	6.22E-01
NOY	1.04E-01*	3.07E-01	3.61E-01	3.22E-01*	3.51E-01	4.25E-01
PCN	2.35E-02*	2.85E-01	3.19E-01	1.94E-01*	3.57E-01	4.20E-01
PCN DUP	-8.97E-02*	3.06E-01	3.43E-01	2.59E-01*	3.61E-01	4.28E-01
PKT	3.79E-02*	3.07E-01	3.57E-01	2.37E-01*	3.52E-01	4.17E-01
RED	1.55E-01*	2.79E-01	3.23E-01	1.44E-02*	3.46E-01	3.89E-01
SWL	-6.45E-01*	5.30E-01	6.04E-01	2.20E-01*	5.47E-01	6.12E-01
TUT	-1.30E-01*	3.26E-01	3.62E-01	3.99E-01*	3.55E-01	4.38E-01
UPR	1.71E-01*	2.98E-01	3.43E-01	2.20E-01*	3.52E-01	4.17E-01
		^{90}Sr			^{40}K	
BRA	5.16E-03	4.55E-02	6.08E-03	4.89E+00	4.61E+00	7.31E+00
BHT	-1.61E-02	3.67E-02	4.27E-03	3.02E+00	1.86E+00	2.70E+00
CBD	-2.25E-02	3.95E-02	5.64E-03	-1.09E+00*	3.68E+00	3.85E+00
COW	-2.42E-03	2.59E-02	4.40E-03	6.60E+00	3.14E+00	4.56E+00
FWT	-4.94E-03	2.59E-02	4.46E-03	1.04E+00*	3.64E+00	4.30E+00
HIL	1.06E-02	2.65E-02	4.46E-03	2.82E+00*	3.42E+00	4.08E+00
IDN	2.20E-02	3.95E-02	5.77E-03	3.33E+00*	3.24E+00	3.97E+00
IDN DUP	1.52E-03	2.45E-02	4.25E-03	1.18E+01*	5.57E+00	6.52E+00

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

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
LST	-6.94E-03	3.78E-02	4.33E-03	1.95E-02*	1.87E+00	6.30E+00
NOY	1.93E-03	2.66E-02	4.48E-03	1.11E+00*	3.52E+00	4.28E+00
PCN	-1.32E-02	4.40E-02	6.00E-03	3.65E+00*	3.35E+00	4.10E+00
PCN DUP	-6.92E-03	4.57E-02	6.23E-03	5.22E+00*	3.31E+00	4.45E+00
PKT	1.67E-02	2.87E-02	4.64E-03	2.77E+00*	3.37E+00	4.28E+00
RED	-1.84E-03	2.59E-02	4.44E-03	2.74E+00*	3.25E+00	3.90E+00
SWL	-1.77E-02	4.31E-02	5.97E-03	1.48E+02	2.02E+01	6.56E+00
TUT	-1.41E-03	3.86E-02	5.36E-03	4.98E+00*	2.79E+00	3.96E+00
UPR	-1.66E-02	4.26E-02	5.95E-03	4.06E+00*	3.30E+00	4.09E+00

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

The reproducibility of the sampling and analysis procedures was assessed by collecting and analyzing duplicate samples from two locations (PCN and IDN). RERs were calculated for the isotopes in which measurable concentrations of the target radionuclides were detected in both the original and duplicate samples. The RERs for the analysis results are presented in Table 4.9. All the RERs were well below the precision objective of 1, confirming good reproducibility for the analysis procedures.

Table 4.9 - Results of Duplicate Surface Water Sample Analysis. Results are Bq/L. See Appendix C for sampling location codes.

Location		Sample			Duplicate			
		[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	RER[d]
PCN	^{234}U	2.19E-01	5.98E-02	1.57E-03	2.38E-01	6.24E-02	1.56E-03	0.22
PCN	^{235}U	6.07E-03	2.51E-03	5.75E-04	7.07E-03	2.71E-03	5.54E-04	0.27
PCN	^{238}U	1.02E-01	2.84E-02	8.66E-04	1.08E-01	2.89E-02	8.50E-04	0.15
IDN	^{234}U	2.26E-02	7.37E-03	1.60E-03	2.34E-02	6.39E-03	1.53E-03	0.08
IDN	^{238}U	2.06E-02	6.79E-03	9.06E-04	1.75E-02	4.98E-03	8.33E-04	0.37

[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 WIPP Laboratories for 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 into smaller particle sizes. A 2-g (0.08-oz) aliquot of each of the dried and homogenized sediment samples was dissolved by heating with a mixture of nitric, hydrochloric, and hydrofluoric acids. The sample residues were heated with nitric and boric acids to remove hydrofluoric acid. Finally, the residues were dissolved in hydrochloric acid for the measurement of the individual radionuclide concentrations.

4.5.3 Determination of Individual Radionuclides

Approximately 100-g (4-oz) portions of the dried and homogenized sediment samples were counted by gamma-spectrometry for analysis of ^{40}K, ^{60}Co, and ^{137}Cs. Strontium-90 was analyzed in an aliquot of dissolved sediment by chemical separation, followed by beta gas proportional counting. Uranium, plutonium, and americium were analyzed by alpha spectrometry after chemical separation, micro-precipitation, and filtration onto micro-filter papers.

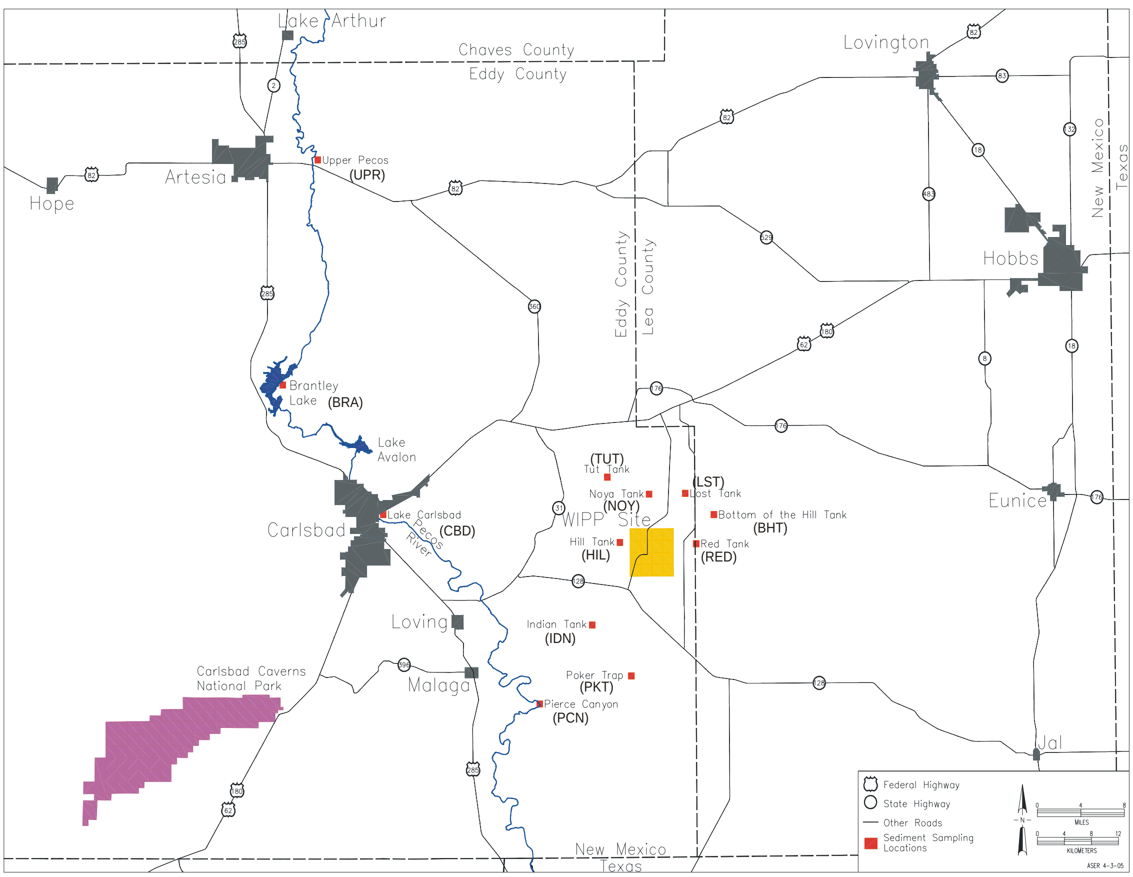

Figure 4.3 - Sediment Sampling Sites

4.5.4 Results and Discussion

Uranium-234, ^{235}U,and ^{238}U were detected in every sediment sample with the exception of ^{235}U, which was not detected at the CBD location (Table 4.10).

The concentrations of the uranium isotopes were compared between 2006 and 2007 and also among sampling locations using ANOVA using the average of duplicate samples when available. There was no statistical difference in the concentrations of uranium isotopes between 2006 and 2007 (ANOVA, ^{234}U p=0.817, ^{235}U p = 0.219, and ^{238}U p = 0.820).

There was also no significant variation in uranium isotope concentrations among sampling locations (ANOVA ^{234}U p = 0.516, ^{235}U p = 0.399, ^{238}U p = 0.411).

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). Baseline values for the Pecos and associated bodies of water, and tanks and tank-like structures were the same.

Table 4.10 - Uranium Concentrations (Bq/g) in Sediment Near the WIPP Site. See Appendix C for sampling location codes.

Location	[RN][a]	TPU[b]	MDC[c]	[RN]	TPU	MDC	[RN]	TPU	MDC
	^{234}U			^{235}U			^{238}U		
BRA	1.49E-02	5.50E-03	1.19E-03	1.06E-03	5.98E-04	2.43E-04	1.59E-02	5.83E-03	5.99E-04
BHT	1.13E-02	4.25E-03	1.19E-03	4.54E-04	3.45E-04	2.38E-04	1.06E-02	3.98E-03	5.95E-04
CBD	1.42E-02	1.10E-02	1.34E-03	8.91E-04	9.48E-04	4.18E-04	1.11E-02	8.57E-03	7.40E-04
HIL	1.23E-02	3.95E-03	1.21E-03	8.44E-04	4.57E-04	2.03E-04	1.31E-02	4.18E-03	6.01E-04
IDN	1.92E-02	7.20E-03	1.23E-03	9.66E-04	5.75E-04	2.34E-04	2.04E-02	7.62E-03	6.26E-04
IDN DUP	2.05E-02	8.70E-03	1.24E-03	1.61E-03	9.05E-04	2.42E-04	2.02E-02	8.58E-03	6.32E-04
LST	2.15E-02	1.35E-02	1.28E-03	1.74E-03	1.34E-03	3.48E-04	2.16E-02	1.36E-02	6.84E-04
NOY	1.21E-02	5.35E-03	1.25E-03	6.15E-04	4.76E-04	2.58E-04	1.24E-02	5.50E-03	6.46E-04
PCN	2.76E-02	6.35E-03	1.19E-03	7.76E-04	3.57E-04	1.75E-04	1.70E-02	3.99E-03	5.78E-04
PCN DUP	2.80E-02	1.11E-02	1.20E-03	1.15E-03	6.74E-04	2.45E-04	2.05E-02	8.17E-03	6.01E-04
PKT	2.18E-02	8.05E-03	1.22E-03	7.91E-04	4.90E-04	2.23E-04	2.18E-02	8.07E-03	6.17E-04
RED	8.28E-03	2.47E-03	1.20E-03	2.52E-04	2.10E-04	1.88E-04	7.47E-03	2.25E-03	5.89E-04
TUT	1.73E-02	8.68E-03	1.23E-03	1.35E-03	9.00E-04	2.92E-04	2.25E-02	1.12E-02	6.39E-04
UPR	2.20E-02	9.61E-03	1.21E-03	1.67E-03	9.54E-04	2.63E-04	2.19E-02	9.57E-03	6.15E-04

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

Sediment samples were also analyzed for ^{241}Am, ^{238}Pu, and $^{239+240}$Pu, with the results reported in Table 4.11. Plutonium-238 was not detected in any of the samples. Americium-241 was not detected in any of the samples in 2007. Plutonium-239+240 was detected in three samples, including IDN, LST, and PKT, but it was not detected in the IDN duplicate sample.

In comparing the 2006 and 2007 data for these radionuclides, only $^{239+240}Pu$ was detected in both samples (LST and PKT). There was no significant difference in the concentrations between years (ANOVA, $p = 0.476$) or by location (ANOVA, $p = 0.938$).

The $^{239+240}Pu$ concentrations that were detected fell within the 99 percent confidence interval ranges of the baseline concentrations (baseline concentration for all locations: 1.90E-03Bq/g) (DOE/WIPP- 92-037). Since there were insufficient detections of ^{241}Am and $^{239+240}Pu$, ANOVA comparisons between years and among locations were not performed.

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

Location	[RN][a]	TPU[b]	MDC[c]	[RN]	TPU	MDC	[RN]	TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}Pu$		
BRA	1.58E-04	1.45E-04	2.15E-04	5.49E-05	1.54E-04	1.14E-04	2.04E-05	8.73E-05	1.19E-04
BHT	4.78E-05	1.18E-04	2.36E-04	7.66E-05	1.66E-04	1.57E-04	-2.00E-05	6.38E-05	1.62E-04
CBD	8.11E-05	1.07E-04	2.17E-04	-6.08E-05	1.06E-04	1.43E-04	2.09E-04	2.22E-04	1.48E-04
HIL	7.37E-05	1.09E-04	2.04E-04	9.54E-05	1.77E-04	1.23E-04	1.36E-04	1.59E-04	1.91E-04
IDN	3.49E-04	2.29E-04	2.14E-04	-5.34E-06	1.47E-04	1.59E-04	2.48E-04	2.32E-04	2.27E-04
IDN DUP	9.06E-05	1.10E-04	2.09E-04	1.09E-04	3.69E-04	3.13E-04	1.50E-04	3.45E-04	3.81E-04
LST	2.03E-04	1.74E-04	2.23E-04	0.00E+00	1.86E-04	1.95E-04	4.94E-04	3.87E-04	2.00E-04
NOY	2.06E-05	6.21E-05	2.00E-04	-4.52E-05	7.85E-05	1.15E-04	1.34E-05	8.83E-05	1.83E-04
PCN	8.93E-05	1.08E-04	1.94E-04	3.66E-05	7.92E-05	8.71E-05	1.57E-05	5.82E-05	1.55E-04
PCN DUP	9.31E-05	1.20E-04	2.13E-04	7.07E-05	1.39E-04	1.09E-04	5.24E-05	1.10E-04	1.14E-04
PKT	1.10E-04	1.26E-04	2.06E-04	2.06E-04	2.48E-04	1.58E-04	3.85E-04	2.95E-04	2.26E-04
RED	7.21E-05	1.02E-04	2.00E-04	-7.63E-06	9.29E-05	1.04E-04	8.73E-05	1.42E-04	1.72E-04
TUT	2.68E-05	8.56E-05	2.40E-04	1.38E-04	3.16E-04	2.26E-04	-9.71E-05	1.71E-04	2.31E-04
UPR	9.72E-05	1.30E-04	2.35E-04	-4.75E-06	1.31E-04	1.39E-04	3.65E-05	9.93E-05	1.43E-04

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

Cesium-137 was detected in 12 of 14 samples including two duplicate samples (Table 4.12). It was not detected in at locations LST and PCN, but was detected in the duplicate of sample from the PCN location.

For locations where ^{137}Cs was detected in the primary samples, there was no significant difference in the concentrations between 2006 and 2007 (ANOVA, $p = 0.818$), or among sampling locations (ANOVA, $p = 0.132$). All the measured ^{137}Cs concentrations for tanks and tank-like structures were within the 99 percent confidence interval range of the baseline concentration (3.50E-02 Bq/g). The detected concentration of ^{137}Cs at sample location BRA exceeded the 99 percent confidence interval range of the baseline concentration for the Pecos River and associated bodies of water (baseline concentration: 5.00E-03 Bq/g). Although ^{137}Cs is a fission product, it is ubiquitous in sediment and soil because of global fallout from atmospheric nuclear weapons testing (Beck and Bennett, 2002; and UNSCEAR [United Nations Scientific Committee on the Effects of Atomic Radiation], 2000).

Strontium-90 and ^{60}Co were not detected in any of the sediment samples. Thus, no ANOVA among sampling locations or between years could be calculated.

Potassium-40 was detected in all sediment samples except sample BHT, as shown in Table 4.12. When data from 2006 and 2007 were compared for all locations with ^{40}K detections, there was no significant statistical difference between years (ANOVA, $p = 0.117$). There was only slightly more variation between locations (ANOVA, $p = 0.0992$).

All detected concentrations of ^{40}K observed in the samples from tank and tank-like structures were within the 99 percent confidence interval range of baseline concentrations (baseline concentration: 1.20E+00 Bq/g). Detected concentrations of ^{40}K at locations BRA, CBD, and UPR exceeded the 99 percent confidence interval range of the baseline concentration for the Pecos River and associated bodies of water (baseline concentration: 4.00E-01 Bq/g). Potassium is ubiquitous throughout the earth's crust and therefore would be expected to be present at varying concentrations in the sediment samples.

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

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
	^{137}Cs			^{60}Co		
BRA	5.46E-03	9.99E-04	8.64E-04	1.75E-03*	1.52E-03	1.73E-03
BHT	3.15E-03	4.99E-04	3.93E-04	4.29E-04*	7.70E-04	8.71E-04
CBD	1.47E-03	5.81E-04	8.24E-04	5.13E-04*	1.23E-03	1.36E-03
HIL	1.10E-03	3.99E-04	5.42E-04	1.62E-03*	1.11E-03	1.28E-03
IDN	4.96E-03	8.40E-04	6.68E-04	5.82E-04*	1.03E-03	1.17E-03
IDN DUP	5.76E-03	7.63E-04	3.32E-04	6.61E-04*	5.79E-04	6.51E-04
LST	3.63E-04*	5.77E-04	6.71E-04	5.35E-04*	7.56E-04	8.54E-04
NOY	1.63E-03	2.48E-04	2.29E-04	5.57E-04*	4.36E-04	4.91E-04
PCN	3.82E-04*	5.36E-04	6.27E-04	6.73E-04*	6.71E-04	7.80E-04
PCN DUP	1.49E-04	8.44E-05	5.00E-04	1.24E-04*	4.80E-04	5.41E-04
PKT	8.73E-03	1.43E-03	1.08E-03	1.02E-03*	1.37E-03	1.54E-03
RED	7.21E-04	2.87E-04	4.05E-04	2.16E-04*	6.20E-04	7.01E-04
TUT	1.37E-03	2.33E-04	3.02E-04	7.37E-04*	5.27E-04	5.91E-04
UPR	9.37E-04	2.52E-04	4.62E-04	3.52E-04*	8.04E-04	9.05E-04
	^{90}Sr			^{40}K		
BRA	-4.43E-03	6.90E-03	2.94E-03	8.53E-01	1.24E-01	1.38E-02
BHT	-8.82E-04	5.90E-03	2.82E-03	4.96E-01*	6.97E-02	3.04E-02
CBD	-2.43E-03	5.99E-03	2.83E-03	5.80E-01	8.49E-02	1.11E-02
HIL	-2.45E-03	6.49E-03	2.86E-03	7.66E-01	1.11E-01	9.60E-03
IDN	3.65E-03	6.80E-03	2.88E-03	6.97E-01	9.78E-02	1.09E-02
IDN DUP	1.21E-03	6.75E-03	2.88E-03	7.27E-01	9.53E-02	6.53E-03
LST	-3.54E-04	6.01E-03	2.85E-03	2.46E-01	3.68E-02	7.78E-03
NOY	-3.81E-03	6.37E-03	2.86E-03	6.57E-01	8.60E-02	4.76E-03
PCN	-3.89E-03	7.01E-03	2.94E-03	1.88E-01	2.86E-02	8.03E-03
PCN DUP	-5.04E-04	7.29E-03	2.98E-03	1.78E-01	2.56E-02	5.07E-03
PKT	-1.73E-04	6.88E-03	2.91E-03	8.06E-01	1.17E-01	1.37E-02
RED	-2.16E-04	6.81E-03	2.89E-03	2.70E-01	3.85E-02	5.70E-03

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

Location	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
TUT	-1.80E-03	6.34E-03	2.89E-03	8.34E-01	1.09E-01	5.82E-03
UPR	-3.13E-03	6.36E-03	2.89E-03	5.39E-01	7.56E-02	9.74E-03

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

Duplicate analyses were performed for all the radionuclides in sediment samples from sampling locations IDN and PCN, as shown in Table 4.13. RERs were calculated for the isotopes for which measurable concentrations of the target radionuclides were detected in both the original and duplicate samples. The RERs were less than one for all isotopes detected in the duplicate samples, indicating that the precision objective was met for the reproducibility of the sample analysis procedures.

Table 4.13 - Results of Duplicate Sediment Sampling Analysis. Units are Bq/g. See Appendix C for sampling location codes.

Location		Sample			Duplicate			
		[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	RER[d]
IDN	^{234}U	1.92E-02	7.20E-03	1.23E-03	2.05E-02	8.70E-03	1.24E-03	0.12
	^{235}U	9.66E-04	5.75E-04	2.34E-04	1.61E-03	9.05E-04	2.42E-04	0.60
	^{238}U	2.04E-02	7.62E-03	6.26E-04	2.02E-02	8.58E-03	6.32E-04	0.02
	^{40}K	6.97E-01	9.78E-02	1.09E-02	7.27E-01	9.53E-02	6.53E-03	0.22
	^{137}Cs	4.96E-03	8.40E-04	6.68E-04	5.76E-03	7.63E-04	3.32E-04	0.70
PCN	^{234}U	2.76E-02	6.35E-03	1.19E-03	2.80E-02	1.11E-02	1.20E-03	0.03
	^{235}U	7.76E-04	3.57E-04	1.75E-04	1.15E-03	6.74E-04	2.45E-04	0.49
	^{238}U	1.70E-02	3.99E-03	5.78E-04	2.05E-02	8.17E-03	6.01E-04	0.38
	^{40}K	1.88E-01	2.86E-02	8.03E-03	1.78E-01	2.56E-02	5.07E-03	0.26

[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 six of the locations where the low-volume air samplers are stationed 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 (0-2 cm [0-0.8 in.]), intermediate soil (2-5 cm [0.8-2 in.]), and deep soil (5-10 cm [2-4 in.]). Measurements of radionuclides in depth profiles may provide information about their vertical movements in the soil systems.

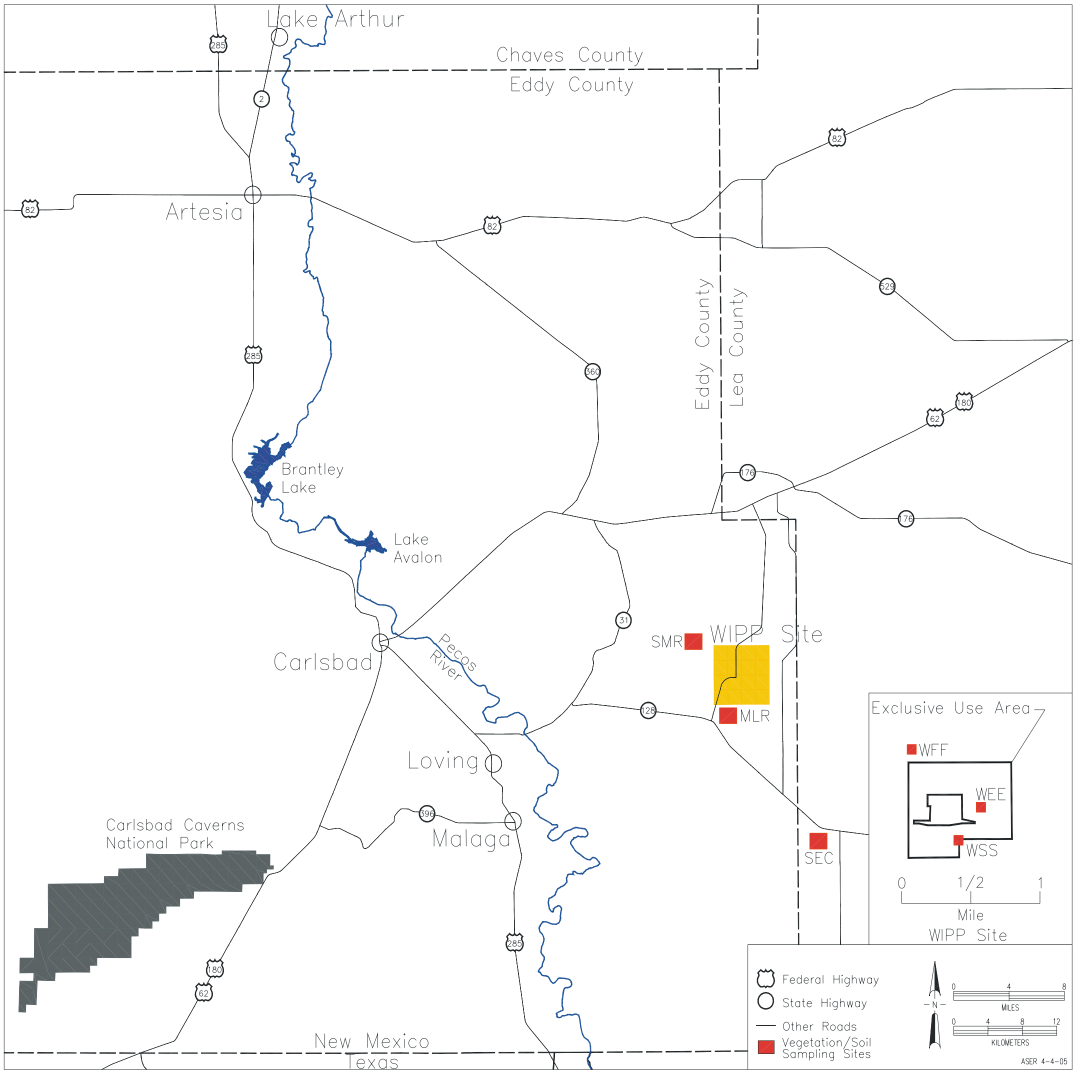

Figure 4.4 - Routine Soil and Vegetation Sampling Areas

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 the soil samples were dissolved by heating with a mixture of nitric, hydrochloric, and hydrofluoric acids. Finally, the samples were heated with nitric and boric acids, and the residues were dissolved in hydrochloric acid for the analysis of individual radionuclides.

4.6.3 Determination of Individual Radionuclides

Gamma-emitting radionuclides (^{40}K, ^{60}Co, and ^{137}Cs) were analyzed by counting an aliquot of the ground and well-homogenized soil samples by gamma spectrometry. Strontium-90 was analyzed in an aliquot of the soil digestate sample solution by separating it from other stable and radioactive species using chemical separation techniques and beta counting using a gas 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 by alpha spectrometry.

4.6.4 Results and Discussion

Uranium-234, ^{235}U, and ^{238}U were detected in most but not every soil sample in 2007. Uranium-234 was detected in all samples except the 5-10 cm depth of WEE. Uranium-235 was not detected at the 2-5 cm depth of MLR; the 0-2 cm depth of SEC; any of the three depths of WEE; and the 2-5 cm and 5-10 cm depths of WFF. Uranium-238 was not detected in the 5-10 cm depth of MLR and the 5-10 cm depth of WEE.

There was no significant difference between detected uranium isotope concentrations between 2006 and 2007 (ANOVA, ^{234}U $p = 0.459$.; ^{235}U $p = 0.102$; ^{238}U $p = 0.400$). There was also no significant variation in uranium isotope concentrations among sampling locations using the combined analysis results from all the depths to yield a single ANOVA for each isotope (ANOVA, ^{234}U $p = 0.226$; ^{235}U $p = 0.594$;and ^{238}U $p = 0.229$).

The highest concentrations of ^{234}U measured in 2007 (1.64E-02 Bq/g) fell within the 99 percent confidence interval range of baseline concentrations (baseline = 2.20E-02 Bq/g) while the highest concentrations of ^{235}U (3.26E-03 Bq/g) and ^{238}U (1.75E-02 Bq/g) were slightly above the 99 percent confidence interval range of baseline concentrations (^{235}U baseline concentration = 1.70E-03 Bq/g; and ^{238}U baseline concentration =1.30E-02 Bq/g) (DOE/WIPP-92-037).

These detected concentrations were similar to the range of natural concentrations of uranium found in soils throughout the world. The average concentration of ^{238}U in soil (upper crust) is 3.60E-02 Bq/g (NCRP Report No. 94, 1987a). The consistency of the measured uranium concentrations with natural uranium in soils throughout the world, 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.

Table 4.14 - Uranium Concentrations (Bq/g) in Soil Near the WIPP Site. See Appendix C for sampling location codes.

Location	Depth (cm)	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
		^{234}U			^{235}U			^{238}U		
MLR	0-2	7.91E-03	2.88E-03	1.47E-03	5.58E-04	3.82E-04	2.79E-04	7.37E-03	2.70E-03	7.61E-04
MLR	2-5	7.65E-03	2.66E-03	1.46E-03	2.07E-04	2.16E-04	2.71E-04	7.59E-03	2.64E-03	7.54E-04
MLR	5-10	6.31E-03	2.46E-03	1.47E-03	3.08E-04	2.94E-04	2.83E-04	4.44E-04	1.79E-03	7.65E-04
SEC	0-2	2.68E-03	1.27E-03	1.49E-03	1.59E-04	2.13E-04	3.05E-04	2.49E-03	1.19E-03	7.82E-04
SEC	2-5	9.32E-03	2.50E-03	1.45E-03	4.96E-04	2.91E-04	2.29E-04	8.79E-03	2.37E-03	7.06E-04
SEC	5-10	9.81E-03	2.46E-03	1.45E-03	6.04E-04	3.15E-04	2.25E-04	8.41E-03	2.14E-03	7.03E-04

Table 4.14 - Uranium Concentrations (Bq/g) in Soil Near the WIPP Site. See Appendix C for sampling location codes.

Location	Depth (cm)	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
SMR	0-2	1.48E-02	8.28E-03	1.53E-03	2.26E-03	1.47E-03	3.35E-04	1.75E-02	9.78E-03	7.92E-04
SMR	2-5	1.64E-02	1.24E-02	1.62E-03	3.26E-03	2.69E-03	4.34E-04	1.70E-02	1.29E-02	8.72E-04
SMR	5-10	1.55E-02	4.26E-03	1.46E-03	8.18E-04	4.10E-04	2.38E-04	1.61E-02	4.41E-03	7.14E-04
WEE	0-2	7.28E-03	2.75E-03	1.47E-03	2.97E-04	2.85E-04	3.06E-04	7.18E-03	2.71E-03	7.98E-04
WEE	2-5	5.28E-03	2.18E-03	1.48E-03	2.51E-04	2.52E-04	2.90E-04	4.97E-03	2.06E-03	7.70E-04
WEE	5-10	1.02E-03	1.12E-03	1.64E-03	-5.14E-05	1.66E-04	4.97E-04	1.02E-03	1.12E-03	9.37E-04
WFF	0-2	4.84E-03	2.08E-03	1.47E-03	6.42E-04	4.55E-04	3.11E-04	4.86E-03	2.09E-03	8.02E-04
WFF	2-5	5.23E-03	1.62E-03	1.43E-03	2.55E-04	2.17E-04	2.66E-04	5.30E-03	1.64E-03	7.65E-04
WFF	5-10	5.10E-03	1.85E-03	1.45E-03	2.59E-04	2.44E-04	2.86E-04	4.45E-03	1.64E-03	7.82E-04
WSS	0-2	6.58E-03	2.15E-03	1.44E-03	3.78E-04	2.80E-04	2.78E-04	5.72E-03	1.89E-03	7.75E-04
WSS	2-5	6.92E-03	2.36E-03	1.44E-03	5.33E-04	3.59E-04	2.79E-04	6.34E-03	2.18E-03	7.76E-04
WSS	5-10	5.60E-03	1.84E-03	1.44E-03	3.72E-04	2.71E-04	2.75E-04	6.52E-03	2.11E-03	7.72E-04

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

Plutonium-238, $^{239+240}$Pu, and ^{241}Am were analyzed for in all the soil samples (Table 4.15). Americium-241 and Pu-238 were not detected in any of the soil samples.

Plutonium-239+240 was detected in three samples, including the 0-2 cm depth at MLR; the 2-5 cm depth at SEC; and the 2-5 cm depth at WEE. The detected concentrations of $^{239+240}$Pu were low and relatively close to the respective MDCs.

There were insufficient detections of ^{238}Pu, $^{239+240}$Pu, and ^{241}Am to permit ANOVA among sampling locations or between years. The detected concentrations of $^{239+240}$Pu fell within the 99 percent confidence interval range of the baseline concentration of 1.90E-03 Bq/g (DOE/WIPP-92-037).

Table 4.15 - 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 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
			^{241}Am			^{238}Pu			$^{239+240}$Pu	
MLR	0-2	1.17E-04	1.65E-04	2.99E-04	8.60E-05	1.84E-04	1.15E-04	3.96E-04	2.63E-04	2.15E-04
MLR	2-5	1.79E-04	1.53E-04	2.80E-04	-6.38E-06	8.98E-05	9.30E-05	1.08E-04	1.28E-04	1.93E-04
MLR	5-10	7.93E-05	1.18E-04	2.83E-04	2.85E-05	1.56E-04	1.27E-04	7.94E-05	1.74E-04	2.27E-04
SEC	0-2	1.02E-04	1.24E-04	2.90E-04	1.11E-04	1.55E-04	1.06E-04	1.28E-04	1.47E-04	2.06E-04
SEC	2-5	9.11E-05	1.28E-04	2.53E-04	8.17E-06	1.07E-04	1.16E-04	3.59E-04	2.43E-04	2.22E-04
SEC	5-10	1.37E-04	1.46E-04	2.49E-04	5.66E-05	9.90E-05	9.52E-05	8.09E-05	1.23E-04	2.02E-04
SMR	0-2	5.33E-05	1.14E-04	2.51E-04	2.15E-05	7.77E-05	9.68E-05	8.47E-05	1.24E-04	2.03E-04
SMR	2-5	4.71E-05	1.11E-04	2.47E-04	-1.88E-05	4.89E-05	9.47E-05	8.60E-05	1.20E-04	2.01E-04
SMR	5-10	1.33E-04	1.58E-04	2.53E-04	-1.68E-05	5.01E-05	1.10E-04	1.37E-04	1.61E-04	2.17E-04
WEE	0-2	1.49E-05	7.47E-05	2.94E-04	6.95E-05	1.40E-04	1.60E-04	-2.41E-05	6.48E-05	2.34E-04
WEE	2-5	-3.11E-05	5.73E-05	2.84E-04	7.43E-05	1.94E-04	1.18E-04	3.82E-04	2.53E-04	2.17E-04
WEE	5-10	-7.76E-06	8.31E-05	2.87E-04	4.10E-05	1.80E-04	1.21E-04	1.41E-05	1.03E-04	2.20E-04
WFF	0-2	3.15E-05	1.16E-04	3.02E-04	3.42E-05	1.09E-04	1.70E-04	-3.09E-05	7.62E-05	2.44E-04
WFF	2-5	-4.13E-06	8.58E-05	2.91E-04	1.85E-05	7.67E-05	1.26E-04	-1.20E-05	3.88E-05	2.00E-04
WFF	5-10	-9.08E-06	9.73E-05	3.00E-04	1.58E-04	1.76E-04	1.54E-04	1.43E-05	1.09E-04	2.28E-04

Table 4.15 - 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 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
WSS	0-2	7.07E-05	1.27E-04	2.85E-04	-2.37E-05	6.58E-05	1.66E-04	-3.95E-05	8.48E-05	2.40E-04
WSS	2-5	2.17E-04	1.87E-04	2.95E-04	3.26E-05	8.30E-05	1.43E-04	3.26E-05	8.29E-05	2.17E-04
WSS	5-10	8.80E-05	1.31E-04	2.91E-04	2.84E-05	1.48E-04	2.02E-04	4.26E-05	1.36E-04	2.76E-04

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

The sample data in Table 4.16 show that ^{137}Cs and ^{40}K were detected in all of the soil samples, while ^{60}Co and ^{90}Sr were not detected in any of the soil samples.

Statistical analysis of ^{137}Cs data show that there was a slight statistical difference between the concentrations in 2006 and 2007 (ANOVA, $p = 0.0172$) and no statistical difference in the concentrations between locations (ANOVA, $p = 0.595$). All ^{137}Cs concentrations fell within the 99 percent confidence interval range of baseline values (4.00E-02 Bq/g). Cesium-137 is a fission product and is ubiquitous in soils because of global fallout from atmospheric nuclear weapons testing (Beck and Bennett, 2002; and UNSCEAR, 2000).

Potassium-40 is a naturally occurring gamma-emitting radionuclide that is ubiquitous in soils. There was a significant difference in the concentrations between 2006 and 2007 (ANOVA, $p = 0.00327$). This value is a result of higher ^{40}K concentrations in 2007 than in 2006 at all locations. However, there was no statistical difference in concentration by location (ANOVA, $p = 0.562$). The highest ^{40}K concentration of 6.88E-01 Bq/g at the 0-2 cm depth at location SMR was higher than the 99 percent confidence interval range of baseline levels (3.40E-01 Bq/g) (DOE/WIPP-92-037). The ^{40}K concentrations at the 2-5 cm depth (6.10E-01 Bq/g) and at the 5-10 cm depth (4.86E-01 Bq/g) at location SMR were also higher than the 99 percent confidence interval range from the baseline.

Since ^{90}Sr and ^{60}Co were not detected at any sampling locations (Table 4.16), there are insufficient data to permit any kind of variance analysis between years or among sampling locations.

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

Location	Depth (cm)	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
		^{137}Cs			^{60}Co		
MLR	0-2	7.37E-03	9.60E-04	3.35E-04	3.58E-04*	3.56E-04	3.98E-04
MLR	2-5	1.97E-03	3.44E-04	3.32E-04	1.99E-04*	5.53E-04	6.37E-04
MLR	5-10	4.92E-04	1.26E-04	2.39E-04	-6.42E-05*	3.85E-04	4.18E-04
SEC	0-2	3.16E-03	4.44E-04	2.49E-04	1.70E-04*	3.04E-04	3.38E-04
SEC	2-5	3.37E-03	6.74E-04	6.85E-04	3.10E-04*	8.22E-04	9.16E-04
SEC	5-10	2.17E-03	4.28E-04	4.06E-04	4.35E-04*	5.80E-04	6.72E-04
SMR	0-2	1.60E-03	5.41E-04	7.44E-04	1.39E-04*	1.05E-03	1.14E-03
SMR	2-5	3.74E-03	6.02E-04	5.52E-04	1.76E-04*	9.41E-04	1.03E-03
SMR	5-10	5.14E-03	9.06E-04	8.42E-04	1.66E-04*	7.26E-04	8.06E-04

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

Location	Depth (cm)	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC
WEE	0-2	2.79E-03	4.81E-04	3.86E-04	1.16E-04*	4.68E-04	5.39E-04
WEE	2-5	3.30E-03	4.40E-04	1.98E-04	7.96E-05*	3.13E-04	3.46E-04
WEE	5-10	2.63E-03	5.36E-04	5.75E-04	3.52E-04*	4.33E-04	5.19E-04
WFF	0-2	1.18E-03	3.38E-04	4.33E-04	-1.07E-04*	4.22E-04	4.64E-04
WFF	2-5	1.63E-03	3.40E-04	3.98E-04	4.21E-05*	2.87E-04	3.17E-04
WFF	5-10	1.39E-03	2.35E-04	2.06E-04	1.28E-04*	2.86E-04	3.18E-04
WSS	0-2	2.04E-03	3.91E-04	3.67E-04	3.37E-04*	4.26E-04	5.09E-04
WSS	2-5	1.49E-03	3.10E-04	3.05E-04	-8.00E-05*	4.68E-04	5.19E-04
WSS	5-10	2.20E-03	3.54E-04	3.00E-04	-4.17E-06*	3.21E-04	3.52E-04
		^{90}Sr			^{40}K		
MLR	0-2	9.44E-04	7.96E-03	3.25E-03	3.54E-01	4.51E-02	3.87E-03
MLR	2-5	-2.41E-04	7.68E-03	3.22E-03	3.49E-01	4.83E-02	5.75E-03
MLR	5-10	1.86E-03	8.74E-03	3.34E-03	3.60E-01	4.60E-02	4.19E-03
SEC	0-2	-1.48E-04	7.80E-03	3.24E-03	2.34E-01	3.00E-02	3.20E-03
SEC	2-5	7.00E-03	1.05E-02	3.32E-03	2.53E-01	3.77E-02	8.55E-03
SEC	5-10	6.62E-03	1.02E-02	3.30E-03	2.32E-01	4.12E-02	5.21E-03
SMR	0-2	7.03E-04	1.01E-02	3.31E-03	6.88E-01	9.86E-02	1.05E-02
SMR	2-5	2.36E-03	1.03E-02	3.33E-03	6.10E-01	8.76E-02	9.95E-03
SMR	5-10	-4.19E-03	1.00E-02	3.32E-03	4.86E-01	8.49E-02	6.82E-03
WEE	0-2	-3.57E-04	6.12E-03	3.02E-03	2.29E-01	3.21E-02	4.83E-03
WEE	2-5	1.42E-03	8.06E-03	3.26E-03	2.41E-01	3.09E-02	3.37E-03
WEE	5-10	1.77E-03	7.99E-03	3.26E-03	2.20E-01	3.09E-02	5.03E-03
WFF	0-2	2.20E-03	7.17E-03	3.12E-03	1.79E-01	2.54E-02	4.48E-03
WFF	2-5	-6.51E-04	6.40E-03	3.04E-03	1.81E-01	2.33E-02	3.27E-03
WFF	5-10	4.12E-04	6.79E-03	3.10E-03	1.74E-01	2.24E-02	3.00E-03
WSS	0-2	-4.11E-03	6.35E-03	3.04E-03	2.06E-01	2.90E-02	4.85E-03
WSS	2-5	1.08E-03	6.60E-03	3.06E-03	1.97E-01	2.78E-02	4.78E-03
WSS	5-10	1.55E-03	6.47E-03	3.04E-03	2.26E-01	2.91E-02	3.49E-03

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

Soil samples collected from one location (WEE) were divided into two parts and analyzed separately (Table 4.17). RERs were calculated for those duplicate pairs for which the target radionuclides were detected. Two of ten RERs were just barely above the precision objective of RER=1, while the other eight RERs met the precision objective and demonstrated good reproducibility for the analysis procedures. The two RERs that did not meet the objective were 1.09 for ^{40}K at the 2-5 cm depth, and 1.05 for ^{137}Cs at the 0-2 cm depth. The higher RERs may reflect some inhomogeneity in the prepared samples or the variability inherit in radioanalytical techniques.

Table 4.17 - Results of Duplicate Soil Sampling Analysis in Soil Near the WIPP Site. Units are Bq/g. See Appendix C for sampling locations.

Location	Depth (cm)		Sample [RN][a]	Sample 2 X TPU[b]	Sample MDC[c]	Duplicate [RN]	Duplicate 2 X TPU	Duplicate MDC	RER[d]
WEE	0-2	^{234}U	7.28E-03	2.75E-03	1.47E-03	6.15E-03	1.63E-03	1.45E-03	0.35
WEE	2-5		5.28E-03	2.18E-03	1.48E-03	6.24E-03	1.60E-03	1.44E-03	0.36
WEE	0-2	^{238}U	7.18E-03	2.71E-03	7.98E-04	5.99E-03	1.59E-03	7.03E-04	0.38
WEE	2-5		4.97E-03	2.06E-03	7.70E-04	5.36E-03	1.40E-03	7.02E-04	0.16
WEE	0-2	^{40}K	2.29E-01	3.21E-02	4.83E-03	2.27E-01	3.37E-02	7.50E-03	0.04
WEE	2-5		2.41E-01	3.09E-02	3.37E-03	1.91E-01	3.40E-02	5.38E-03	1.09
WEE	5-10		2.20E-01	3.09E-02	5.03E-03	2.61E-01	3.44E-02	3.76E-03	0.89
WEE	0-2	^{137}Cs	2.79E-03	4.81E-04	3.86E-04	2.04E-03	5.25E-04	6.48E-04	1.05
WEE	2-5		3.30E-03	4.40E-04	1.98E-04	2.88E-03	5.00E-04	4.11E-04	0.63
WEE	5-10		2.63E-03	5.36E-04	5.75E-04	2.93E-03	4.26E-04	2.75E-04	0.44

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

4.7 Biota

4.7.1 Sample Collection

Rangeland vegetation samples were collected from the same six locations from which the soil samples were collected (Figure 4.4). Fauna samples were also collected when available. All biota samples were analyzed for the target radionuclides.

4.7.2 Sample Preparation

<u>Vegetation</u>

The vegetation samples were chopped into 2.5-to-5-cm (1-to-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 measurements of ^{40}K, ^{60}Co, and ^{137}Cs were performed directly on 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 for isotopic separation and alpha spectrometric analysis of ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239+240}Pu$, and ^{241}Am and gas proportional counting for ^{90}Sr.

<u>Animals</u>

The tissue samples were placed in digestion beakers and concentrated nitric acid was added to cover the samples. The samples were heated until nearly dry. The samples were then wet-ashed using nitric acid and hydrogen peroxide until the residues were lightly colored. The residues were dissolved in nitric acid and transferred to a Teflon beaker. Concentrated hydrofluoric acid was added, and the samples were heated to dryness. Concentrated nitric acid and boric acid were added and the samples again heated to dryness. The samples were then dissolved in nitric acid, transferred into their original glass beakers, and heated in a Muffle furnace at 350-375°C (652-707°F) for eight to twelve hours. When gamma spectroscopy analyses were required, 0.5 M nitric acid was added to until the volume reached 500 mL (16.9 oz). Following gamma spectroscopic analysis, the samples were heated to dryness and subjected to another wet-ashing procedure in preparation for isotopic separations and gas proportional counter and alpha spectroscopic analyses.

4.7.3 Results and Discussion

Vegetation

Table 4.18 shows that ^{238}U, ^{234}U, and ^{235}U were not detected in any of the vegetation samples. This compares to one detection of U-238 in 2006. Thus, no ANOVA comparisons were able to be performed. Americium-241, ^{238}Pu, and $^{239+240}$Pu were not detected in any of the vegetation samples. Cesium-137, ^{60}Co, and ^{90}Sr were also not detected in any vegetation samples and no statistical comparisons between years or locations could be performed on any of these radionuclides in vegetation.

Potassium-40 was detected in each vegetation sample analyzed (Table 4.18). There was little statistical difference in ^{40}K vegetation concentrations between 2006 and 2007 (ANOVA, p = 0.209). However, the detected concentrations varied significantly at the different locations where the vegetation was collected (ANOVA, p = 0.0443) due to the natural variability of this naturally occurring radionuclide in the earth's crust.

Table 4.18 - Radionuclide Concentrations (Bq/g Wet Mass) in Vegetation Near the WIPP Site. See Appendix C for sampling location codes.

Location	RN	2 X TPU	MDC	RN	2 X TPU	MDC	RN	2 X TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}$Pu		
MLR	1.94E-05	4.83E-05	2.01E-04	-7.06E-06	1.74E-05	3.52E-05	-7.06E-06	1.74E-05	4.01E-05
SEC	4.98E-05	5.42E-05	1.92E-04	1.95E-05	5.93E-05	5.80E-05	-1.60E-05	3.30E-05	6.17E-05
SMR	5.61E-05	5.87E-05	1.95E-04	-1.05E-05	2.59E-05	5.50E-05	-1.05E-05	2.59E-05	5.87E-05
WEE	8.36E-05	7.85E-05	1.99E-04	6.48E-05	2.12E-04	1.45E-04	1.49E-05	1.88E-04	1.49E-04
WFF	1.16E-04	8.69E-05	1.98E-04	6.53E-05	9.10E-05	7.80E-05	1.51E-05	5.82E-05	8.17E-05
WSS	3.63E-05	5.11E-05	1.93E-04	3.20E-05	6.61E-05	6.77E-05	3.20E-05	6.61E-05	7.14E-05
	^{234}U			^{235}U			^{238}U		
MLR	1.76E-04	1.21E-04	9.57E-04	-1.08E-05	2.82E-05	1.75E-04	1.45E-04	1.08E-04	4.00E-04
SEC	5.06E-05	6.46E-05	9.56E-04	7.34E-06	4.55E-05	1.73E-04	5.04E-05	6.44E-05	3.99E-04
SMR	1.53E-04	1.01E-04	9.50E-04	0.00E+00	4.35E-05	1.66E-04	-1.27E-05	2.50E-05	3.93E-04
WEE	1.43E-04	1.00E-04	9.53E-04	6.76E-06	4.20E-05	1.70E-04	7.37E-05	7.19E-05	3.96E-04
WFF	1.94E-04	1.21E-04	9.53E-04	-1.35E-05	2.98E-05	1.69E-04	1.52E-04	1.06E-04	3.69E-04
WSS	9.28E-05	9.43E-05	9.63E-04	-1.43E-05	3.47E-05	1.82E-04	2.31E-05	5.61E-05	4.06E-04

Table 4.18 - Radionuclide Concentrations (Bq/g Wet Mass) in Vegetation Near the WIPP Site. See Appendix C for sampling location codes.

Location	RN	2 X TPU	MDC	RN	2 X TPU	MDC	RN	2 X TPU	MDC
	^{137}Cs			^{60}Co			^{90}Sr		
MLR	-3.07E-03*	2.97E-03	2.94E-03	2.20E-03*	2.56E-03	2.95E-03	3.08E-04	3.88E-03	1.52E-03
SEC	-4.36E-03*	2.98E-03	2.84E-03	1.87E-03*	2.56E-03	2.94E-03	-6.35E-04	3.40E-03	1.47E-03
SMR	-5.75E-03*	3.16E-03	2.92E-03	-4.68E-04*	2.74E-03	3.03E-03	-4.90E-04	3.12E-03	1.43E-03
WEE	-4.42E-03*	2.99E-03	2.85E-03	1.82E-03*	2.58E-03	2.97E-03	2.03E-03	4.13E-03	1.54E-03
WFF	-3.15E-04*	1.14E-03	1.30E-03	-5.80E-05*	1.44E-03	1.61E-03	2.58E-03	3.46E-03	1.46E-03
WSS	-1.46E-05*	1.16E-03	1.36E-03	6.87E-04*	1.54E-03	1.82E-03	3.35E-03	3.98E-03	1.51E-03
	^{40}K								
MLR	8.77E-01	1.18E-01	3.53E-02						
SEC	8.80E-01	1.19E-01	3.58E-02						
SMR	1.20E+00	1.59E-01	3.52E-02						
WEE	6.88E-01	9.49E-02	3.57E-02						
WFF	3.19E-01	4.64E-02	1.77E-02						
WSS	6.38E-01	8.66E-02	1.73E-02						

[a] Radionuclide concentration
[b] Total propagated uncertainty
[c] Minimum detectable concentration
* Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

A duplicate analysis of the vegetation sample from sampling location SEC was performed for all the radionuclides of interest. An RER was calculated for the detection of ^{40}K, the only target radionuclide detected. The RER was less one indicating that the precision objective was met for the duplicate analysis.

Table 4.19 - Results of Duplicate Vegetation Sample Analysis. Units are Bq/g. See Appendix C for sampling location codes.

Location		Sample			Duplicate			
		[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	RER[d]
SEC	K-40	8.80E-01	1.19E-01	3.58E-02	1.05E+00	1.39E-01	1.48E-02	0.93

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

Animals

Table 4.20 shows that ^{238}U, ^{234}U, and ^{235}U were not detected in any of the animal tissue samples. Americium-241, ^{238}Pu, and $^{239+240}$Pu, as well as ^{137}Cs, ^{60}Co, and ^{90}Sr, were also not detected in any of the animal samples (Table 4.18). No statistical comparisons between locations or years could be performed for any of these radionuclides.

K-40 was detected in the deer, quail, and fish samples, but not the rabbit sample (Table 4.20). Although there were too few samples to allow statistical comparison between years, the detected ^{40}K concentrations were lower than the concentrations for the same animals measured in 2006 and are within the baseline analysis results (DOE/WIPP-92-037).

These results can only be used as a gross indication of uptakes, since the sample sizes are too small to provide a thorough analysis. However, the data do not suggest any contribution to animal uptake of the radionuclides of interest due to WIPP facility operations. Due to the limited sample sizes of only one or two samples per animal type, duplicate analyses were not performed.

Table 4.20 - Radionuclide Concentrations (Bq/g Wet Mass) in Deer, Quail, Rabbit, and Fish Near the WIPP Site. See Appendix C for sampling location codes.

	[RN][a]	2 X TPU[b]	MDC[c]	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	^{241}Am			^{238}Pu			$^{239+240}$Pu		
Deer (SOO)	1.14E-07	8.67E-07	1.12E-04	1.16E-06	1.42E-06	1.08E-05	1.35E-07	8.38E-07	1.45E-05
Quail (WEE)	-7.31E-08	2.82E-06	1.88E-04	8.59E-08	1.13E-06	3.46E-05	2.06E-06	1.92E-06	1.11E-05
Rabbit (SOO)	2.31E-06	3.66E-06	1.63E-04	7.99E-07	1.90E-06	1.15E-05	-2.05E-07	6.84E-07	1.38E-04
Fish (PCN)	-2.74E-08	1.70E-07	1.74E-04	2.27E-07	9.38E-07	1.10E-05	2.00E-07	9.59E-07	1.10E-05
Fish (BRA)	9.36E-07	1.22E-06	1.49E-04	2.95E-07	7.55E-07	5.58E-06	1.55E-07	5.27E-07	7.12E-05
	^{234}U			^{235}U			^{238}U		
Deer (SOO)	-8.53E-08	3.46E-07	8.30E-04	2.11E-07	1.10E-06	8.78E-05	-1.34E-07	4.33E-07	3.72E-04
Quail (WEE)	4.60E-05	1.61E-05	1.37E-03	2.55E-06	2.71E-06	1.38E-04	3.27E-05	1.21E-05	6.20E-04
Rabbit (SOO)	2.38E-05	9.77E-06	1.39E-03	6.53E-07	1.67E-06	1.38E-04	1.49E-05	7.18E-06	6.20E-04
Fish (PCN)	-3.42E-07	6.99E-07	1.00E-03	2.62E-07	1.02E-06	1.00E-04	5.05E-07	1.13E-06	3.85E-04
Fish (BRA)	1.08E-05	3.42E-06	8.30E-04	5.67E-07	9.81E-07	6.28E-05	3.84E-06	2.08E-06	4.09E-04
	^{137}Cs			^{60}Co			^{90}Sr		
Deer (SOO)	-2.82E-05*	2.28E-04	2.65E-04	-2.31E-04*	3.21E-04	3.29E-04	-1.17E-05	4.55E-05	9.43E-04
Quail (WEE)	-1.00E-03*	6.47E-04	7.17E-04	3.44E-04*	6.13E-04	6.91E-04	8.33E-05	9.57E-05	2.73E-03
Rabbit (SOO)	1.30E-04*	2.97E-04	3.58E-04	-5.65E-06*	3.78E-04	4.28E-04	7.96E-04	3.22E-04	2.80E-03
Fish (PCN)	-1.12E-03*	9.38E-04	9.70E-04	-8.01E-04*	8.97E-04	9.13E-04	4.06E-06	3.51E-05	1.61E-03
Fish (BRA)	-6.88E-04*	1.23E-03	1.26E-03	-1.55E-04*	1.11E-03	1.23E-03	-3.36E-05	8.97E-05	1.02E-03
	^{40}K								
Deer (SOO)	3.70E-02	5.87E-03	2.90E-03						
Quail (WEE)	4.80E-02	8.51E-03	7.33E-03						
Rabbit (SOO)	1.31E-01*	1.81E-02	1.39E-02						
Fish (PCN)	7.91E-02	1.33E-02	1.09E-02						
Fish (BRA)	3.94E-02	1.09E-02	1.39E-02						

[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 limits can be found in 40 CFR Part 191, Subpart A. 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 MOU 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 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.

Compliance with applicable regulatory requirements is determined by monitoring, extracting, and calculating the EDE. 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, which 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.

The Safe Drinking Water Act (40 CFR §141.66, "Maximum Contaminant Levels for Radionuclides") states that average annual concentrations for beta- and gamma-emitting human-made radionuclides in drinking water shall not result in an annual dose equivalent greater than 0.04 millisieverts (mSv) (4 mrem). It is important to note that all of these dose equivalent limits are set for radionuclides released to the environment from DOE operations. They do not include, but are limits in addition to, doses from natural background radiation or from medical procedures.

4.8.2 Background Radiation

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.

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 routes of intake of radionuclides for members of the public are ingestion and inhalation. Ingestion includes eating and drinking food or drink containing radionuclides. Inhalation includes the intake of radionuclides through breathing radioactive particulates. External dose can occur from immersion 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 4.21).

Table 4.21 - Annual Estimated Average Radiation Dose Received by a Member of the Population of the United States from Naturally Occurring Radiation Sources (adapted from NCRP, 1987a)

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

4.8.3 Dose from Air Emissions

The 40 CFR Part 191, Subpart A, standard limits radiation doses to members of the public in the general environment. The DOE has identified air emissions as the major pathway of concern for the WIPP facility.

Compliance with Subpart A (40 CFR §191.03[b]) and the NESHAP standard (40 CFR §61.92) is determined by comparing annual radiation doses to the maximally exposed individual (MEI) to the regulatory standards. As recommended by the EPA, the DOE uses 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 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, ^{90}Sr, $^{233/234}$U, ^{238}U, and ^{137}Cs because these radionuclides constitute over 98 percent of the dose potential from CH and RH waste. A combination of measured concentration or activity results, the 2 sigma TPU values, and the MDC values were used as input nuclide data in the CAP88-PC computer model to calculate the EDEs to members of the public (see Section 4.1.4 for more information on the results and discussion of the effluent monitoring data).

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 radionuclides emitted via the air pathway from the WIPP facility.

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 4.8.4.3 discusses 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 the WIPP facility during 2007.

4.8.4.1 Potential Dose from Water Ingestion Pathway

The potential dose to individuals from the ingestion of WIPP facility-related radionuclides transported in water is determined to be zero for several reasons. Drinking water for communities near the WIPP facility comes from groundwater sources that are not expected to be affected by WIPP facility contaminants based on current radionuclide transport scenarios summarized in DOE/WIPP-95-2065. The only credible pathway for contaminants from the WIPP facility 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 milligrams per liter (mg/L). Groundwater samples collected around the WIPP facility during 2007 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 2007 were mule deer, rabbit, fish, and quail. The only radionuclides detected were not different from baseline levels measured prior to commencement of waste shipments to the WIPP facility. Therefore, no dose from WIPP facility-related radionuclides could have been received by any individual from this pathway during 2007.

4.8.4.3 Total Potential Dose from All Pathways

The only credible pathway from the WIPP facility to humans is through air emissions and, therefore, this is the only pathway for which a dose is calculated. The total radiological dose and atmospheric release at WIPP in 2007 is summarized in Table 4.22 for the regulations in both 40 CFR §61.92 and 40 CFR §191.03(b).

In compliance with 40 CFR Part 191, Subpart A, the receptor selected is assumed to reside year-round at the fence line in the northwest sector. For 2007, the dose to this receptor was estimated to be less than 1.52E-06 mSv (1.52E-04 mrem) per year for the whole body and less than 1.46E-05 mSv (1.46E-03 mrem) per year to the critical organ. These values are in compliance with the requirements specified in 40 CFR §191.03(b).

For the NESHAP standard (40 CFR §61.92), the EDE potentially received by the MEI in 2007 assumed to be residing 7.5 km (4.66 mi) west-northwest of WIPP is calculated to be less than 7.01E-08 mSv (7.01E-06 mrem) per year for the whole body. This value is in compliance with 40 CFR §61.92 requirements.

As required by DOE Order 5400.5, Chapter II, Section 6.b, the collective dose to the public within 80 km (50 mi) of the WIPP facility has been evaluated, and is 2.17E-07 person Sv (2.17E-05 person rem) in 2007. The collective dose to the public is a factor considered in developing the field program for the ALARA process, as required by DOE Order 5400.5, Chapter II, Section 2.a(2).

Table 4.22 - WIPP Radiological Dose and Release Summary

WIPP Radiological Atmospheric Releases [a] During 2007			
^{238}Pu	**$^{239+240}$Pu**	**^{241}Am**	**^{90}Sr**
4.77E-08 Ci[b] 1.77E+03 Bq[c]	5.04E-08 Ci 1.87E+03 Bq	4.45E-08 Ci 1.65E+03 Bq	2.97E-06 Ci 1.10E+05 Bq
$^{233/234}$U	**^{238}U**	**^{137}Cs**	
1.19E-07 Ci[b]	7.70E-08 Ci	2.40E-05 Ci	
4.40E+03 Bq[c]	2.85E+03 Bq	8.88E+05 Bq	

WIPP Radiological Dose Reporting Table in 2007							
Pathway	EDE to the Maximally Exposed Individual at 7,500 Meters WNW		Percent of EPA 10-mrem/ Year Limit to Member of the Public	Estimated Population Dose Within 50 Miles		Estimated Population Within 50 Miles[b]	Estimated Natural Radiation Population Dose[c]
	(mrem/year)	*(mSv/year)*		*(person-rem/year)*	*(person-Sv/ year)*		*(person-rem)*
Air	7.01E-06	7.01E-08	7.01E-05	2.17E-05	2.17E-07	101,017	30,305
Water	N/A[f]	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

Table 4.22 - WIPP Radiological Dose and Release Summary

WIPP Radiological Dose Reporting Table in 2007							
Pathway	Dose equivalent to the whole body of the receptor who resides year-round at WIPP fence line 350 meters NW		Percent of EPA 25-mrem/year Whole Body Limit	Dose equivalent to the critical organ of the receptor who resides year-round at WIPP fence line 350 meters NW		Percent of EPA 75-mrem/year Critical Organ Limit
	(mrem/year)	*(mSv/year)*		*(mrem/year)*	*(mSv/year)*	
Air	1.52E-04	1.52E-06	6.08E-04	1.46E-03	1.46E-05	1.95E-03
Water	N/A[d]	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 either the 2 Sigma TPU or MDC values, whichever are greater (where activities were less than the 2 Sigma TPU and MDC values) and multiplied by the ratio of flow to stack flow volumes.
[b] Source: 2000 Census Data
[c] Estimated natural radiation populations dose = (Estimated population within 50 mi) x (300 mrem/year)
[d] Not applicable at WIPP

4.8.5 Dose to Nonhuman Biota

Dose limits for populations of aquatic and terrestrial organisms are 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*, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*. 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 ASER 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 2007 using the maximum radionuclide concentrations listed in Table 4.23, and the sum of fractions was less than one for all media. The element ^{40}K is not included in Table 4.23 since it is a natural component of the earth's crust and is not part of TRU-waste-related radionuclides.

Table 4.23 - 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 2007

Medium	Radionuclide	Maximum Detected Concentration	BCG[a]	Concentration/BCG
		Aquatic System Evaluation		
Sediment (Bq/g)	^{60}Co	ND[c]	5.00E+01	N/A[d]
	^{90}Sr	ND	2.00E+01	N/A
	^{137}Cs	8.73E-03	1.00E+02	8.37E-05
	^{234}U	2.80E-02	2.00E+02	1.40E-04
	^{235}U	1.74E-03	1.00E+02	1.74E-05
	^{238}U	2.25E-02	9.00E+01	2.50E-04
	^{238}Pu	ND	2.00E+02	N/A
	$^{239+240}$Pu	4.94E-04	2.00E+02	2.47E-06
	^{241}Am	ND	2.00E+02	N/A
Water[b] (Bq/L)	^{60}Co	ND	1.00E+02	N/A
	^{90}Sr	ND	1.00E+01	N/A
	^{137}Cs	ND	2.00E+00	N/A
	^{234}U	2.38E-01	7.00E+00	3.40E-02
	^{235}U	7.07E-03	8.00E+00	8.84E-04
	^{238}U	1.08E-01	8.00E+00	1.35E-02
	^{238}Pu	ND	7.00E+00	N/A
	$^{239+240}$Pu	ND	7.00E+00	N/A
	^{241}Am	ND	2.00E+01	N/A
			SUM OF FRACTIONS	4.89E-02
		Terrestrial System Evaluation		
Soil (Bq/g)	^{60}Co	ND	3.00E+01	N/A
	^{90}Sr	ND	8.00E-01	N/A
	^{137}Cs	7.37E-03	8.00E-01	9.21E-03
	^{234}U	1.64E-02	2.00E+02	8.20E-05
	^{235}U	3.26E-03	1.00E+02	3.26E-05
	^{238}U	1.75E-02	6.00E+01	2.92E-04
	^{238}Pu	ND	2.00E+02	N/A
	$^{239+240}$Pu	3.96E-04	2.00E+02	1.98E-06
	^{241}Am	ND	1.00E+02	N/A
Water (Bq/L)	^{60}Co	ND	4.00E+04	N/A
	^{90}Sr	ND	2.00E+04	N/A
	^{137}Cs	ND	2.00E+04	N/A
	^{234}U	2.38E-01	1.00E+04	2.38E-05
	^{235}U	7.07E-03	2.00E+04	3.54E-07
	^{238}U	1.08E-01	2.00E+04	5.40E-06

Table 4.23 - 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 2007

Medium	Radionuclide	Maximum Detected Concentration	BCG[a]	Concentration/BCG
	^{238}Pu	ND	7.00E+03	N/A
	$^{239+240}Pu$	ND	7.00E+03	N/A
	^{241}Am	ND	7.00E+03	N/A
			SUM OF FRACTIONS	9.65E-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 sample 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 values to assess potential dose to biota. As long as the sum of the ratios between detected 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 from the WIPP facility in 2007. The criteria utilized for release of potentially radioactive materials are specified in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Figure IV-1, Allowable Total Residual Surface Contamination. The primary isotopes of concern for unrestricted release of potentially contaminated materials are transuranic. The values for transuranic isotopes are very low and close to minimum detectable activity for instruments used for the assessments of removable and total contamination levels on items being released. The values in 5400.5 for transuranics are less than 20% of the values in ANSI/HPS [Health Physics Society] N13.12-1999, *Surface and Volume Radioactivity Standards for Clearance*.

4.9 Radiological Program Conclusions

Effluent Monitoring

For 2007, the EDE to the receptor (hypothetical MEI) who resides year-round at the fence line is less than 1.52E-06 mSv (1.52E-04 mrem) per year for the whole body, and is less than 1.46E-05 mSv (1.46E-03 mrem) per year for the critical organ. For the WIPP Effluent Monitoring Program, Figure 4.5 and Table 4.24 show the dose to the whole body for the hypothetical MEI for CY 1999 to CY 2007. In addition, Figure 4.6 and Table 4.26 show the dose to the critical organ for the hypothetical MEI for CY 1999 to CY 2007. 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).

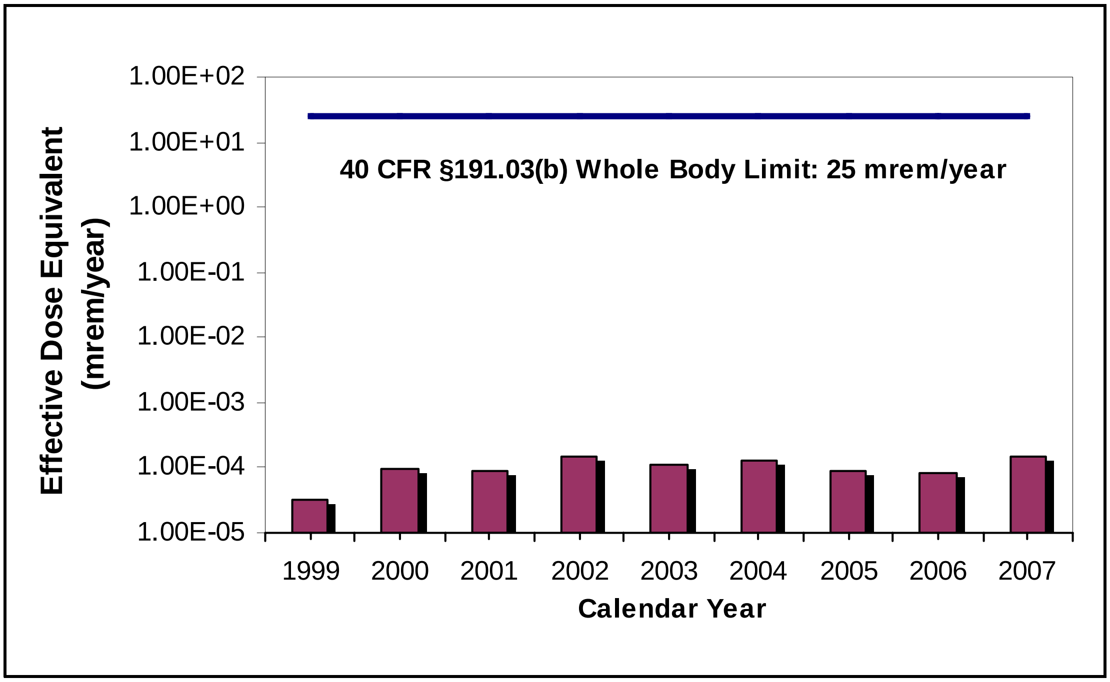

Figure 4.5 - Dose to the Whole Body for the Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.24 - Comparison of Dose to the Whole Body to EPA Limit of 25 mrem/year per 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
2005	8.86E-05	354 millionth
2006	8.16E-05	326 millionth
2007	1.52E-04	608 millionth
40 CFR §191.03(b) Whole Body Limit	25	

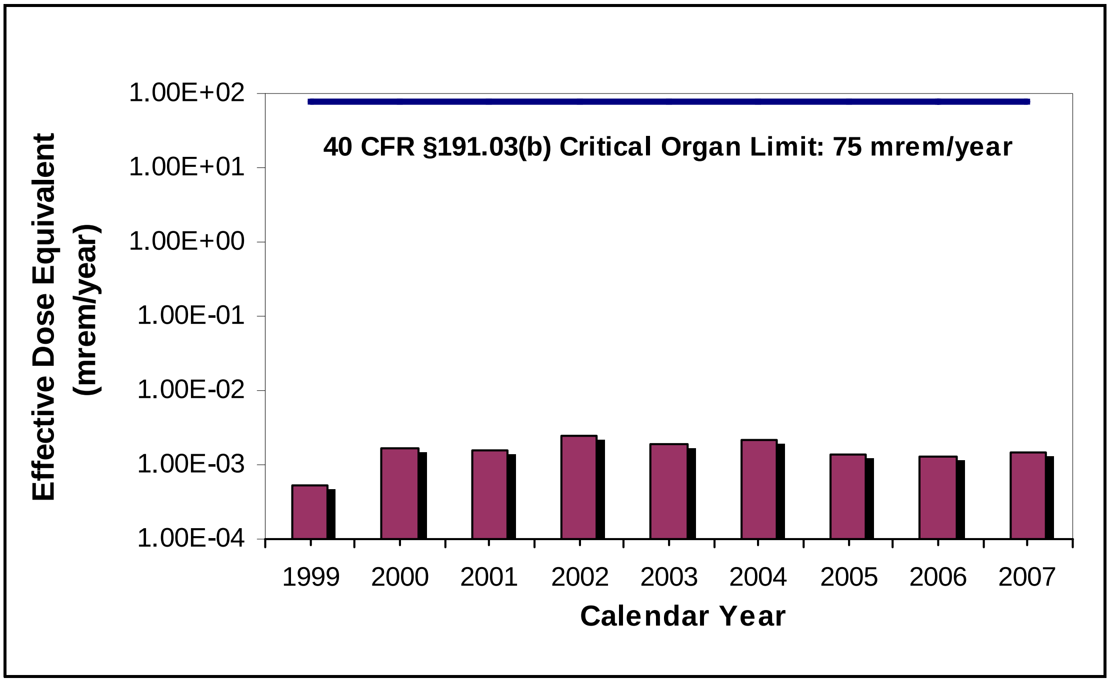

Figure 4.6 - Dose to the Critical Organ for Hypothetical Maximally Exposed Individual at the WIPP Fence Line

Table 4.25 - Comparison of Dose to the Critical Organ to EPA Limit of 75 mrem/year per 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
2005	1.41E-03	1880 millionth
2006	1.30E-03	1730 millionth
2007	1.46E-03	1947 millionth
40 CFR §191.03(b) Critical Organ Limit	75	

In addition, for 2007, the EDE to the MEI from normal operations conducted at the WIPP facility is less than 7.01E-08 mSv (7.01E-06 mrem) per year. For the WIPP Effluent Monitoring Program, Figure 4.7 and Table 4.26 show the EDE to the MEI for CY 1999 to CY 2007. 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.

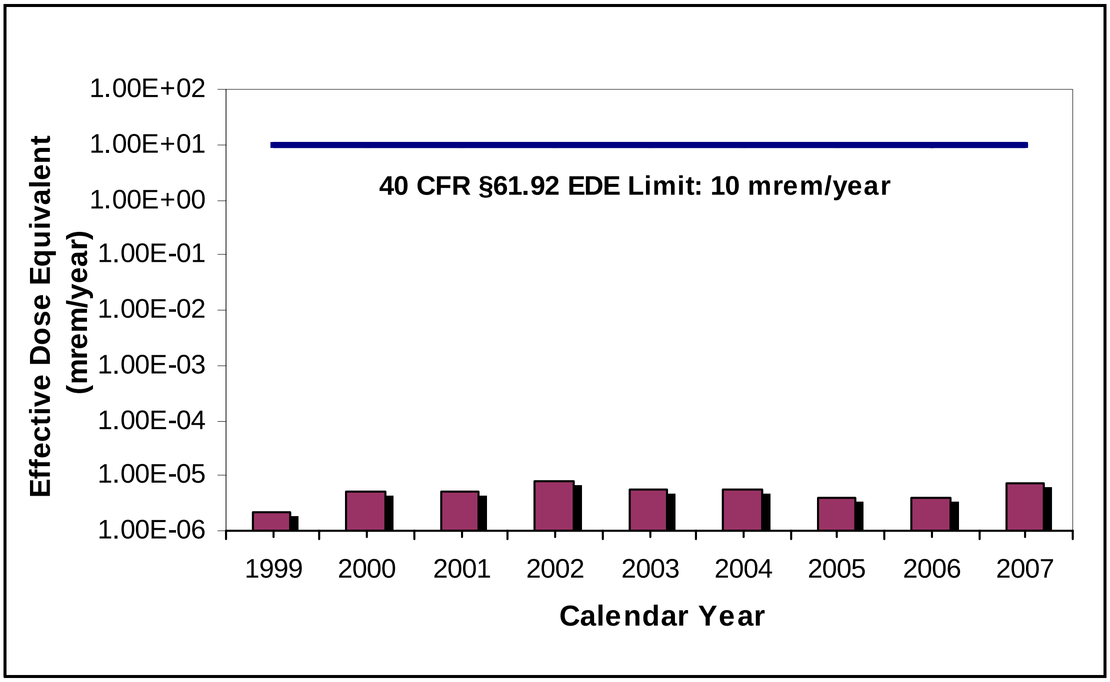

Figure 4.7 - WIPP EDE to the Off-Site MEI

Table 4.26 - Comparison of EDEs to EPA Limit of 10 mrem/year per 40 CFR §61.92

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
2005	3.85E-06	38.5 millionth
2006	3.93E-06	39.3 millionth
2007	7.01E-06	70.1 millionth

Environmental Monitoring

Radionuclide concentrations observed in environmental monitoring were extremely small and comparable to radiological baseline levels. Appendix H contains graphs comparing 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, and they are so far below the regulatory limit as to be nonimpactive.

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CHAPTER 5 - ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

Nonradiological programs at WIPP include land management, meteorological monitoring, VOC monitoring, seismic monitoring, certain aspects of liquid effluent, and groundwater monitoring. VOC monitoring is performed to comply with the provisions of the WIPP HWFP. Surface water monitoring is performed in accordance with DP-831. Radiological and nonradiological groundwater monitoring is discussed in Chapters 4 and 6, respectively.

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;
- 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 Memorandum of Understanding and Interagency Agreements).

5.2 Land Management Programs

On October 30, 1992, the WIPP LWA was approved by Congress. This act transferred the responsibility for the management of the WIPP Land Withdrawal Area 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 . . . for the construction, experimentation, operation, repair and maintenance, disposal, shutdown, monitoring, decommissioning, and other authorized activities associated with the purposes of WIPP as set forth in Section 213 of the Department of Energy National Security and Military Application of the Nuclear Energy Authorization 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. The LMP was developed in consultation and cooperation with the BLM and the state of New Mexico.

The LMP sets forth cooperative arrangements and protocols for addressing WIPP-related land management actions. Commitments contained in current permits, agreements, or concurrent Memoranda of Understanding with other agencies will be respected when addressing and evaluating land use management activities and future amendments that affect the management of WIPP lands.

5.2.1 Land Use Requests

Parties who wish to conduct activities that may impact lands under the jurisdiction of WIPP, but outside the Property Protection Area, are required by the LMP to prepare a land use request. A land use request consists of a narrative description of the project, a completed environmental review, and a map depicting the location of the proposed activity. This documentation is used to determine if applicable regulatory requirements have been met prior to the approval of a proposed project. A land use request 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 Land Withdrawal Area or on lands used in the operation of the WIPP facility, under the jurisdiction of the DOE. During 2007, ten requests were submitted for review and approval; all met applicable criteria and were approved.

5.2.2 Wildlife Population Monitoring

In 1995, the 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 SEIS-II (*Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement,* DOE/EIS-0026-S-2) was conducted in 1996 to determine the presence or absence of threatened or endangered species in the vicinity of the WIPP site 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 employees continue 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." An example this is protection of the Lesser Prairie Chicken (a candidate for listing under the Endangered Species Act) and its habitat in accordance with BLM guidance. Favorable habitat for the Lesser Prairie Chicken has been observed within the WIPP Land Withdrawal Area and areas affected by WIPP operational activities.

5.2.3 Reclamation of Disturbed Lands

Reclamation 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 needed for WIPP operations. Reclamation activities are intended to reduce soil erosion, increase the rate of plant colonization and succession, and provide habitat for wildlife in disturbed areas.

The WIPP facility 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. Additionally, special seed mixes identified by the BLM are used where necessary to preserve the habitat of the Lesser Prairie Chicken.

5.2.4 Oil and Gas Surveillance

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:

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

During 2007, WIPP surveillance teams conducted 74 scheduled surveillances and approximately 214 field inspections. Field personnel inspected 74 well locations for conditions that may compromise WIPP properties. During 2007, no major leaks or occurrences were observed.

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 Land Withdrawal Area, the driller is required to submit daily deviation surveys to the WIPP Land Use Coordinator to assess the horizontal drift of the well bore during drilling. During 2007, daily logs were transmitted to WIPP for 18 new wells. Deviation calculations showed that there were no trespass conditions.

5.3 Meteorological Monitoring

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

5.3.1 Climatic Data

The precipitation at the WIPP site for 2007 was 435 mm (17.13 in.). Figure 5.1 displays the monthly precipitation at WIPP. Snow at WIPP was minimal in 2007 and did not exceed the safety basis snow load of 27 lbs/square foot.

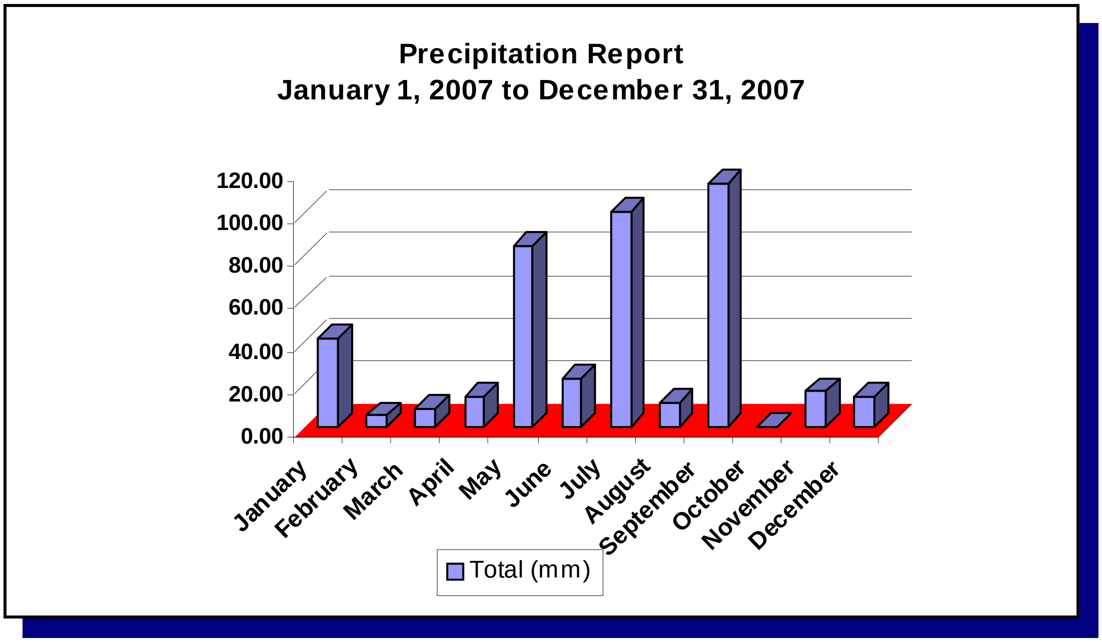

Figure 5.1 - WIPP Precipitation Report for 2007

January 1, 2007, to December 31, 2007

Month	Total (mm)
Jan	41.4
Feb	5.33
Mar	8.64
Apr	13.97
May	85.09
Jun	22.61
Jul	100.84
Aug	11.68
Sep	114.04
Oct	0
Nov	16.76
Dec	14.48

The maximum recorded temperature was 38.8°C (101.9°F) in August (Figure 5.2). Monthly temperatures are illustrated in Figures 5.2, 5.3, and 5.4. The mean temperature at the WIPP site in 2007 was 17.0°C (62.6°F). The mean monthly temperatures for the WIPP area ranged from 26.4°C (79.5°F) during August to 4.0°C (39.2°F) in January (Figure 5.3). The lowest recorded temperature was -6.9°C (19.6°F) in January.

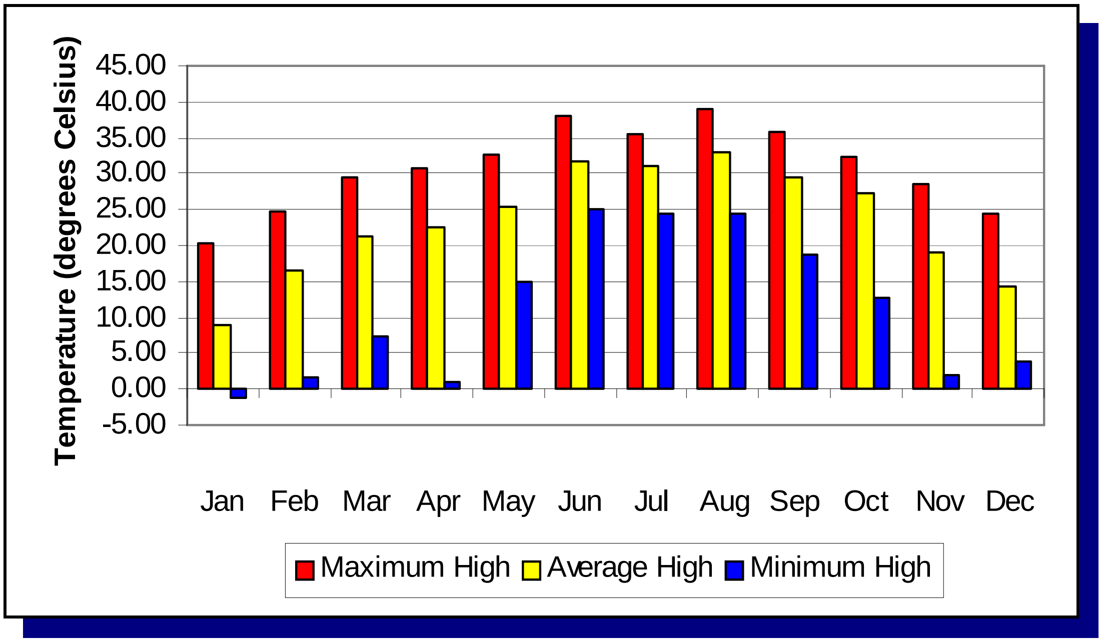

Figure 5.2 - WIPP High Temperatures for 2007

Temperature Report - Highs
January 1, 2007, to December 31, 2007, Elevation 10.0 Meters

Month	Maximum High	Average High	Minimum High
Jan	20.47°C	8.98°C	-1.05°C
Feb	24.69°C	16.42°C	1.64°C
Mar	29.42°C	21.32°C	7.39°C
Apr	30.81°C	22.50°C	0.97°C
May	32.65°C	25.29°C	15.06°C
Jun	37.96°C	31.67°C	24.91°C
Jul	35.65°C	30.97°C	24.50°C
Aug	38.84°C	32.82°C	24.49°C
Sep	35.97°C	29.43°C	18.62°C
Oct	32.43°C	27.26°C	12.60°C
Nov	28.43°C	19.10°C	1.82°C
Dec	24.49°C	14.31°C	3.73°C

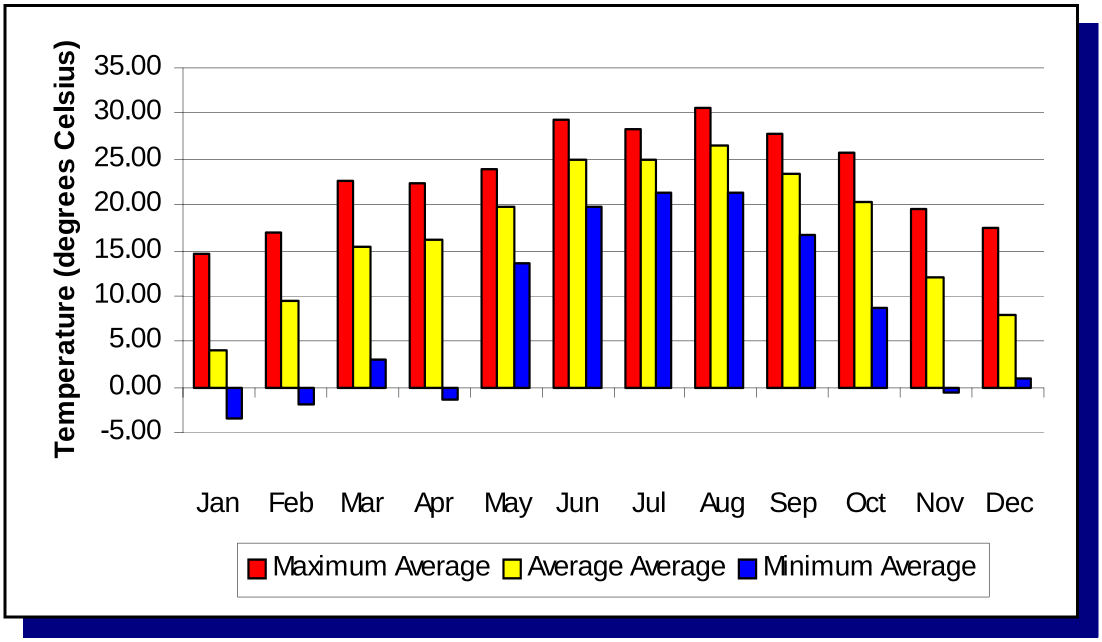

Figure 5.3 - WIPP Average Temperatures for 2007

Temperature Report - Averages
January 1, 2007, to December 31, 2007, Elevation 10.0 Meters

Month	Maximum Average	Average Average	Minimum Average
Jan	14.51°C	3.96°C	-3.54°C
Feb	16.99°C	9.45°C	-1.90°C
Mar	22.73°C	15.32°C	3.05°C
Apr	22.47°C	16.05°C	-1.38°C
May	23.93°C	19.70°C	13.47°C
Jun	29.23°C	24.84°C	19.65°C
Jul	28.27°C	24.93°C	21.25°C
Aug	30.52°C	26.45°C	21.31°C
Sep	27.77°C	23.46°C	16.69°C
Oct	25.75°C	20.37°C	8.55°C
Nov	19.58°C	11.96°C	-0.70°C
Dec	17.39°C	7.89°C	1.05°C

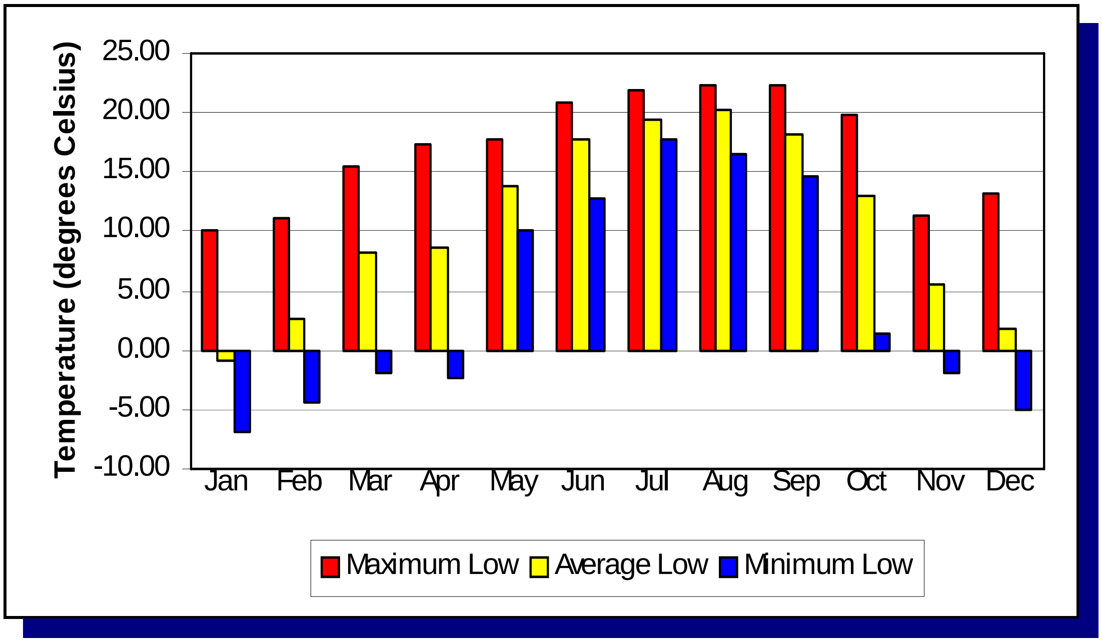

Figure 5.4 - WIPP Low Temperatures for 2007

Temperature Report - Lows
January 1, 2007, to December 31, 2007, Elevation 10.0 Meters

Month	Maximum Low	Average Low	Minimum Low
Jan	10.04°C	-0.91°C	-6.91°C
Feb	11.19°C	2.54°C	-4.44°C
Mar	15.38°C	8.22°C	-1.87°C
Apr	17.33°C	8.74°C	-2.28°C
May	17.69°C	13.89°C	10.08°C
Jun	20.87°C	17.77°C	12.87°C
Jul	21.92°C	19.40°C	17.66°C
Aug	22.24°C	20.24°C	16.57°C
Sep	22.26°C	18.23°C	14.73°C
Oct	19.92°C	13.07°C	1.44°C
Nov	11.27°C	5.52°C	-1.88°C
Dec	13.28°C	1.81°C	-4.93°C

5.3.2 Wind Direction and Wind Speed

Winds in the WIPP area are predominantly from the southeast. In 2007, 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]) approximately 0.6 percent of the time. Winds of 3.71 to 6.30 m/s (8.30 to 14.09 mph) were the most prevalent over 2007, occurring approximately 36 percent of the time. There were no tornadoes at WIPP in 2007 and straight line winds did not exceed 130 mph; the strongest wind recorded at WIPP was 17.7 m/s (39.5 mph). Figure 5.5 displays the annual wind data at WIPP for 2007.

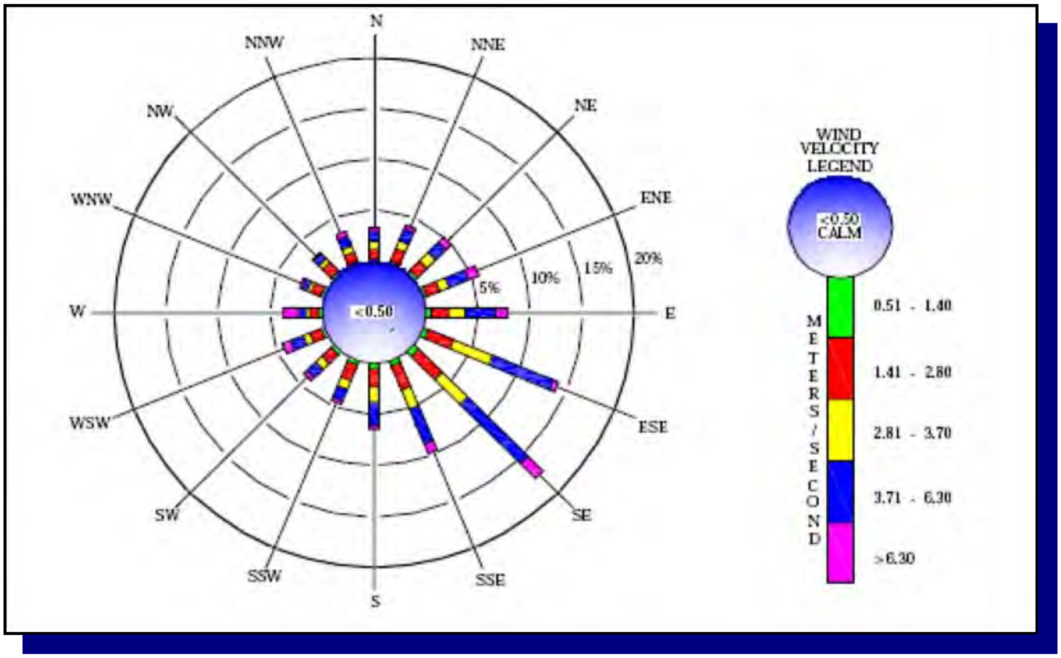

Figure 5.5 - Wind Speed Report for 2007

Wind Speed Report (Meters/Second)
January 1, 2007, to December 31, 2007 - Elevation 10.0 Meters

Wind Direction	0.0 - 0.50	0.51 - 1.40	1.41 - 2.80	2.81 - 3.70	3.71 - 6.30	>6.30	Total Percent Occurrence by Direction
E	0.05	0.45	1.78	1.56	2.88	1.20	7.92
ENE	0.02	0.38	1.31	0.95	2.01	1.05	5.72
NE	0.04	0.38	1.31	1.16	1.42	0.70	5.00
NNE	0.03	0.33	1.31	0.84	1.26	0.40	4.16
N	0.03	0.32	0.98	0.69	1.01	0.40	3.44
NNW	0.03	0.26	1.02	0.60	1.06	0.51	3.49
NW	0.03	0.33	1.18	0.52	0.72	0.14	2.91
WNW	0.05	0.40	0.99	0.39	0.53	0.29	2.65
W	0.05	0.33	0.85	0.36	0.78	1.44	3.82
WSW	0.03	0.29	1.19	0.70	1.31	0.83	4.34
SW	0.02	0.31	1.30	0.76	1.18	0.48	4.05
SSW	0.05	0.39	1.65	0.91	1.25	0.35	4.61
S	0.05	0.45	1.87	1.41	2.34	0.34	6.46
SSE	0.04	0.53	2.52	1.98	3.76	0.99	9.82
SE	0.05	0.60	3.18	3.49	8.12	2.11	17.54
ESE	0.03	0.50	2.55	4.16	6.27	0.57	14.08
	0.61%	6.24%	24.98%	20.48%	35.89%	11.80%	100.00%

5.4 Volatile Organic Compound Monitoring

VOC monitoring was implemented on April 21, 1997, in accordance with WP 12-VC.01, Confirmatory Volatile Organic Compound Monitoring Program. This program is a requirement of the HWFP. VOC monitoring is performed to verify that 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 shown in Table 5.1.

On November 16, 2006, additional HWFP conditions were implemented requiring the addition of disposal room VOC monitoring to the program. This new requirement included the addition of sampling locations within active hazardous waste facility units. Within each active unit, two sampling locations are required for each closed room, one at the exhaust side of the room and one at the inlet side of the room. In addition, each room actively receiving waste is required to be sampled at the exhaust side of the room. The sampling frequency for disposal room sampling is biweekly. Disposal room sampling terminates in each unit upon initiation of panel closure activities. Typical disposal room VOC sampling locations are shown in Figure 5.6.

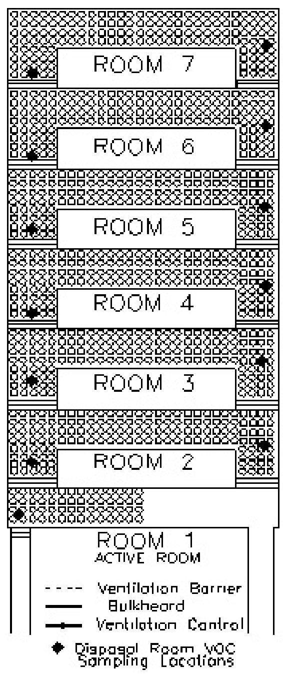

Figure 5.6 - Typical Disposal Room VOC Sampling Locations

Disposal room VOC monitoring included sampling in Panel 3 when the permit condition became effective in November 2006. Active sampling locations were two locations in each closed room (Rooms 7 through 2) and one location at the exhaust side of Room 1.

Repository VOC sampling for target compounds is performed semiweekly at two ambient 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 the active panel. VOC-B was moved from Drift S3080, upstream from Panel 3 when waste emplacement began in Panel 4. 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 VOCs entering the mine through the air intake shaft and VOCs 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 the HWFP (Table 5.1).

Table 5.1 - Concentrations of Concern for Volatile Organic Compounds, from Module IV of the HWFP (No. NM4890139088-TSDF)

Compound	Concentration of Concern ppbv[a]	Room Based Limits ppmv[b]
1,1,1-Trichloroethane	590	33700
1,1,2,2-Tetrachloroethane	50	2960
1,1-Dichloroethylene	100	5490
1,2-Dichloroethane	45	2400
Carbon tetrachloride	165	9625
Chlorobenzene	220	13000
Chloroform	180	9930
Methylene chloride	1930	100000
Toluene	190	11000

[a] Parts per billion by volume
[b] Parts per million by volume

VOC sampling reported in this section was performed using guidance included in Compendium Method TO-15, *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analysis By Gas Chromatography/ Mass Spectrometry (GC/MS)* (EPA, 1999), as a basis. 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-15 and the draft EPA *Contract Laboratory Program Volatile Organics Analysis of Ambient Air in Canisters* (EPA, 1994).

For repository VOC sampling, the routine method reporting limits (MRLs) and maximum concentrations detected (MCDs) 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 between 20 times and 386 times lower than the respective concentrations of concern for the nine target compounds.

The results of 2007 repository VOC monitoring, compared to 2006, indicated an increase in the maximum and average concentration of each detected target compound in air downstream of Panel 1. Although the sample results for 2007 showed an overall increase in the concentration of detections, repository VOC sample results were well below the concentrations of concern listed in Table 5.1.

Table 5.2 - Repository Air VOC MRLs and MCDs

Compound	MRL (ppbv)*	MCD (ppbv)*
1,1,1-Trichloroethane	5	30.01
1,1,2,2-Tetrachloroethane	2	< MRL
1,1-Dichloroethylene	5	< MRL
1,2-Dichloroethane	2	< MRL
Carbon Tetrachloride	2	37.65
Chlorobenzene	2	< MRL
Chloroform	2	< MRL
Methylene chloride	5	< MRL
Toluene	5	< MRL

* ppbv = parts per billion by volume

For disposal room VOC monitoring, 458 samples were collected during 2007 (including field duplicates). The routine MRLs and MCDs are shown in Table 5.3. Three of the nine target compounds were detected above the MRL. The sample results indicated an overall increase in concentrations detected in disposal rooms. The most substantial results were carbon tetrachloride at 17.7ppmv (0.18 percent of room based limits [RBL] shown in Table 5.1), methylene chloride at 12.13 ppmv (0.01 percent of RBL), and 1,1,1-trichloroethane at 31.38 ppmv (0.09 percent of RBL).

Table 5.3 - Disposal Room VOC MRLs and MCDs

Compound	MRL (ppmv)*	MCD (ppmv)*
1,1,1-Trichloroethane	.5	31.3
1,1,2,2-Tetrachloroethane	.5	< MRL
1,1-Dichloroethylene	.5	< MRL
1,2-Dichloroethane	.5	< MRL
Carbon Tetrachloride	.5	17.7
Chlorobenzene	.5	< MRL
Chloroform	.5	< MRL
Methylene chloride	.5	12.1
Toluene	.5	< MRL

* ppbv = parts per million by volume

5.5 Seismic Activity

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 a nine-station network approximately centered on the site (Figure 5.7). 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 2007 was approximately 89.6 percent. From January 1 through December 31, 2007, locations for 45 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 2.2) occurred on April 3, 2007, and was located approximately 72 km (45 mi) east of the site. The closest event to the site was located approximately 34 km (21 mi) west and had a magnitude of 1.5. These events had no effect on WIPP structures.

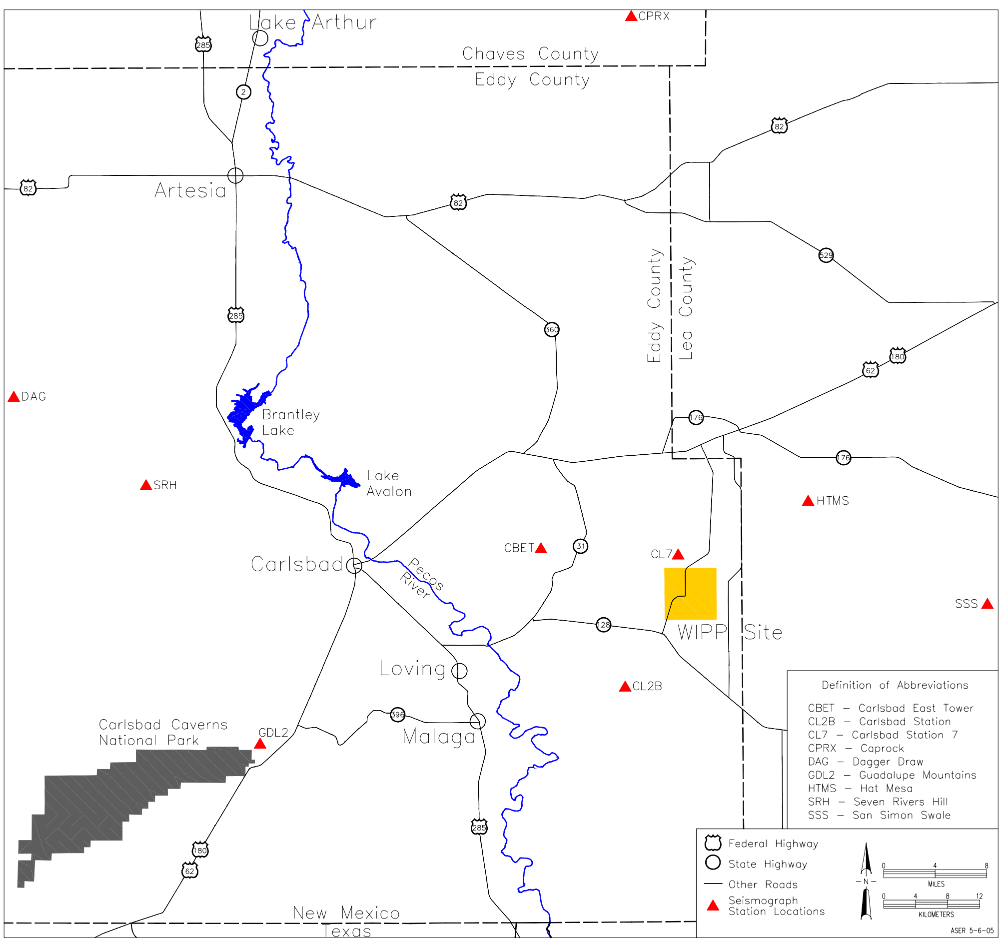

Figure 5.7 - WIPP Seismograph Station Locations

5.6 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 2, Section 2.1.6. The WIPP site has no discharges that could impact surface water. The WIPP facility does have DP-831 (a discharge permit) for discharges to the sewage lagoons and the H-19 Evaporation Pond, and for the control of subsurface infiltration from active and inactive salt piles.

The WIPP sewage system consists of lined ponds that allow for the evaporation of liquids. The sewage treatment facility is permitted for the disposal of up to 87,064 L (23,000 gallons) per day of sewage effluent and up to 7,570 L (2,000 gallons) of nonhazardous brine water to the north evaporation pond.

The H-19 Evaporation Pond is permitted for the treatment of up to 30,283 L (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 L (100 gallons) of neutralized acid waste; however, neutralized acid waste is no longer generated at the WIPP facility.

A DP-831 modification approved on December 22, 2003, addressed infiltration of storm water containing high total dissolved solids to the subsurface from a 16-acre tailings pile accumulated from mining activities. In accordance with the DP-831 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 storm water runoff. Additionally, the tailings 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 infiltration. Another discharge permit modification was approved on December 29, 2006, which incorporated the SPDV material pile into the discharge permit. Three groundwater monitoring wells around the pile were installed in 2007 as required by the discharge permit. Additionally, the permit modification incorporated a more detailed closure plan into the permit.

Discharge monitoring reports are submitted semiannually to the NMED to demonstrate compliance with the inspection, monitoring, and reporting requirements identified in DP-831. The permit requires semiannual sampling of the sewage lagoons and the H-19 Evaporation Pond and annual sampling of the storm water infiltration control ponds. There are no regulatory limits associated with the analytes. Detection limits vary with each analytical event based on the required sample dilutions. Analytical data from the discharge monitoring reports are summarized in Tables 5.4, 5.5, and 5.6. Subsurface shallow water monitoring results are outlined in Chapter 6.

Table 5.4 - Sewage Lagoon and H-19 Semiannual Analytical Results for January 1 through June 30, 2007

Analyte	Influent to Facultative Lagoon System		Evaporation Pond B		Evaporation Pond C		H-19 Evaporation Pond	
Nitrate (mg/L)	0.670		N/A		N/A[a]		N/A	
TKN[b] (mg/L)	9.24		N/A		N/A		N/A	
TDS[c] (mg/L)	358.0		7,700		24,800		364,500	
	Activity	**TPU 2 σ[d]**	**Activity**	**TPU 2 σ**	**Activity**	**TPU 2 σ**	**Activity**	**TPU 2 σ**
$U^{233/234}$ (Bq/L)[e]	2.27E-02	7.40E-03	8.56E-03	4.15E-03	8.15E-03	4.00E-03	1.06E-03	1.12E-03
U^{235} (Bq/L)	7.67E-04	7.85E-04	6.21E-04	8.34E-04	6.29E-04	8.44E-04	4.40E-04	7.53E-04
U^{238} (Bq/L)	1.30E-02	4.56E-03	4.13E-03	2.36E-03	2.28E-03	1.68E-03	7.39E-05	5.05E-04
Pu^{238} (Bq/L)	1.24E-05	1.04E-03	2.36E-04	5.79E-04	-2.37E-04	3.83E-04	-1.41E-04	2.72E-04
$Pu^{239+240}$ (Bq/L)	1.88E-04	9.04E-04	4.72E-05	3.59E-04	9.15E-05	3.78E-04	-8.17E-05	2.07E-04
Am^{241} (Bq/L)	3.64E-04	5.35E-04	2.25E-04	5.28E-04	-5.41E-05	3.82E-04	-3.60E-06	3.05E-04
Sr^{90} (Bq/L)	-6.52E-04	3.62E-02	-2.82E-02	3.84E-02	-1.19E-02	3.25E-02	5.23E-03	3.93E-02

[a] N/A: The analytical parameter is not required.
[b] Total Kjeldahl Nitrogen (as N)
[c] Total dissolved solids
[d] TPU 2 σ = total propagated uncertainty at 2-sigma (95 percent confidence interval)
[e] Becquerel per liter.

Table 5.5 - Sewage Lagoon and H-19 Semiannual Analytical Results for July 1 through December 31, 2007

Analyte	Influent to Facultative Lagoon System		Evaporation Pond B		Evaporation Pond C		H-19 Evaporation Pond	
Nitrate (mg/L)	1.0		N/A		N/A		N/A	
TKN[b] (mg/L)	70.28		N//A		N/A		N/A	
TDS[c] (mg/L)	520		15,500		17,050		355,000	
	Activity	**TPU 2 σ[d]**	**Activity**	**TPU 2 σ**	**Activity**	**TPU 2 σ**	**Activity**	**TPU 2 σ**
$U^{233/234}$ (Bq/L)[e]	8.00E-03	1.96E-03	3.56E-03	1.80E-03	3.51E-03	1.83E-03	1.12E-03	8.92E-04
U^{235} (Bq/L)	2.52E-04	4.35E-04	1.60E-04	6.55E-04	-5.80E-05	2.46E-04	-5.69E-05	2.04E-04
U^{238} (Bq/L)	1.46E-03	8.60E-04	5.64E-04	8.27E-04	8.75E-04	1.21E-03	5.10E-05	3.88E-04
Pu^{238} (Bq/L)	-1.54E-04	2.88E-04	-4.45E-05	4.00E-04	-1.41E-04	2.47E-04	1.92E-04	4.48E-04
$Pu^{239+240}$ (Bq/L)	-7.93E-05	2.06E-04	2.67E-05	3.51E-04	2.90E-04	4.09E-04	-8.49E-05	1.90E-04
Am^{241} (Bq/L)	5.18E-04	5.30E-04	6.19E-05	3.22E-04	1.77E-04	3.87E-04	4.28E-04	5.75E-04
Sr^{90} (Bq/L)	2.00E-02	4.71E-02	5.90E-03	5.42E-02	-1.41E-02	5.50E-02	1.48E-02	4.80E-02

[a] N/A: The analytical parameter is not required.
[b] Total Kjeldahl Nitrogen (as N).
[c] Total dissolved solids.
[d] TPU 2 σ = total propagated uncertainty at 2-sigma (95% confidence interval).
[e] Becquerel per liter.

Table 5.6 - Infiltration Control Evaporation Ponds Annual Analytical Results for January 1 through December 31, 2007

Evaporation Pond	Chloride mg/L	Nitrate-N mg/L	Sulfate mg/L	TDS mg/L	Selenium mg/L	Chromium mg/L
Salt Pile Evaporation Pond	12,600	<1.00	75.9	14,780	< 0.02	< 0.005
Salt Storage Extension Evaporation Basin	260,000	<20.0	16,900	339,500	< 0.02	< 0.005
Pond 1	92.9	<1.00	22.0	201.0	< 0.02	< 0.005
Pond 2	304	<1.00	12.1	426.0	< 0.02	< 0.005
Pond A	197	<1.00	20.6	256.0	< 0.02	< 0.005

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

Current groundwater monitoring activities for the WIPP facility are outlined in the WIPP Groundwater Monitoring Program Plan (WP 02-1). In addition, the WIPP facility 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 included in the Environmental Monitoring Plan.

6.1 Site Hydrology

The hydrology at and surrounding the WIPP site has been studied extensively over the last 30 years. A summary of the hydrology in this area is contained in the following sections. Figure 6.1 presents the WIPP stratigraphy.

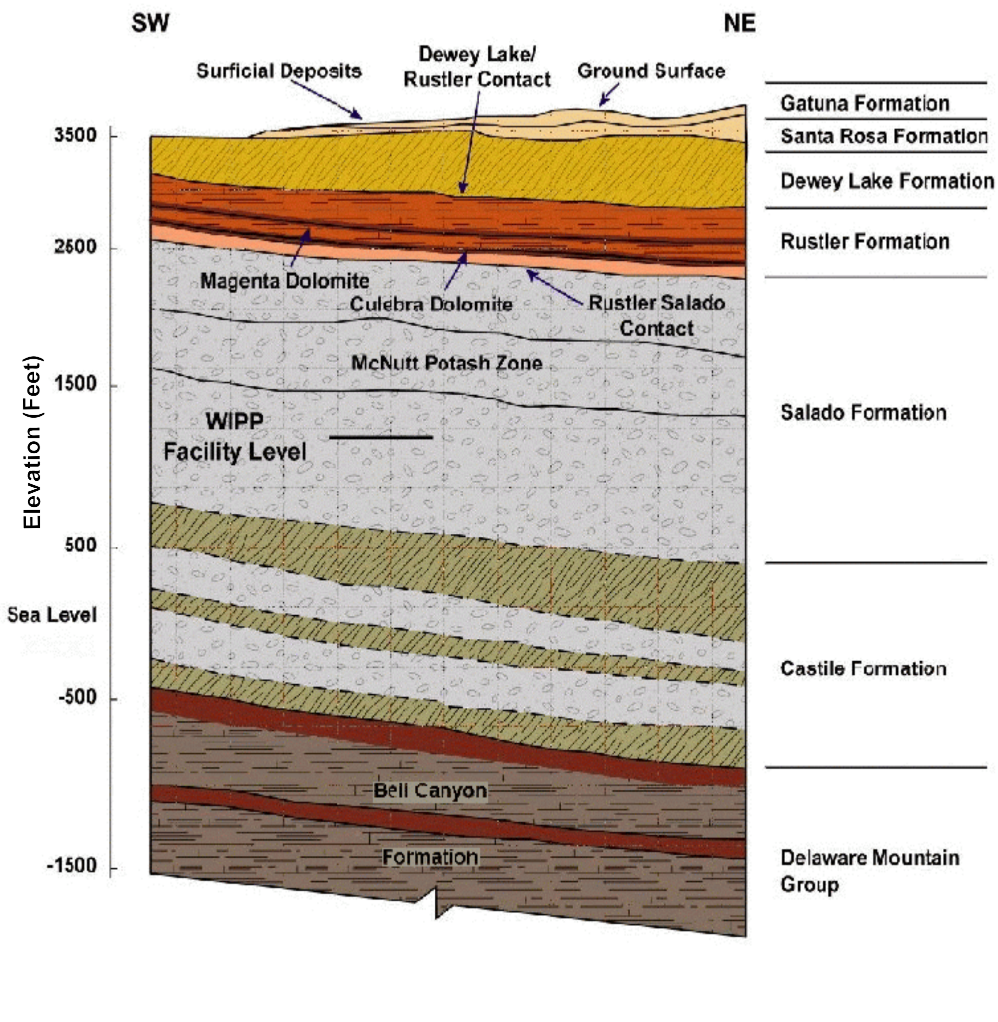

Figure 6.1 - WIPP Stratigraphy

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 13 km (8 mi) west-southwest of the center of the WIPP site in Nash Draw, where shallow brine ponds occur. Small, manmade livestock watering 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 Formation and the overlying Triassic Dockum group in the southern part of the WIPP Land Withdrawal Area. 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 appears to be present in the Castile Formation in the vicinity of WIPP. The only significant water present in the formation occurs in isolated brine reservoirs in fractured anhydrite. Wells have encountered pressurized brine reservoirs in the upper anhydrite unit of the Castile Formation in the vicinity of the WIPP site. Two such encounters have been made by the boreholes: (1) Borehole ERDA-6, located northeast of the current WIPP site, encountered a pressurized brine reservoir in 1975; and Borehole WIPP-12 encountered another brine reservoir one mile north of the center of the WIPP site in 1981. Both encounters were hydrologically and chemically tested in 1981 and were found to be not connected with each other.

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 hydraulic conductivity of the undisturbed salt mass of less than 6.5E-09 m per day (m/d) (2.1E-08 ft/d), with the more pure (less argillaceous) halites having even lower permeability. Anhydrite interbeds typically have hydraulic conductivities ranging from 6.5E-09 m/d to 6.5E-07 m/d (2.1E-08 to 2.1E-06 ft/d) (Beauheim and Roberts, 2002). The only significant variation to these extremely low permeabilities occurs in the immediate vicinity of the underground workings (Stormont et al., 1991). This increase is believed to be a result of near-field fracturing due to the excavation.

Small quantities of brine have been observed to collect in boreholes drilled into Marker Bed 139 a few feet below the floor of the WIPP rooms and have also been observed to seep out of the excavated walls. The long-term performance assessment for the WIPP site assumes that small quantities of brine will be present in the WIPP repository.

6.1.2.3 Hydrology of the Rustler-Salado Contact

In Nash Draw and areas immediately west of the site, the Rustler-Salado 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 (Mercer, 1983). Small quantities of brine were found in this zone at the WIPP site in the WIPP test holes (Mercer and Orr, 1977).

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 8.4E-03 to approximately 6.4 m^2/d (9.0E-02 to approximately 69 ft^2/d); the majority of the values are less than 9.3E-02 m^2/d (1 ft^2/d) (Beauheim, 1987). Transmissivities generally decrease from west to east across the site area. The regional flow direction of groundwater in the Culebra Dolomite is generally south.

6.1.2.5 Hydrology of the Magenta Member

The Magenta Dolomite is situated above the Culebra and, though not the water-bearing zone of interest for monitoring of a facility release, is of interest in understanding water-level changes that occur in the Culebra. The Magenta has been tested in 18 cased and open holes at and around the WIPP site. Transmissivities within the WIPP site range from 2.0E-04 to 3.5E-02 m^2/d (2.1E-03 to 3.8E-01 ft^2/d) (Beauheim et al., 1991; Beauheim and Ruskauff, 1998).

6.1.2.6 Hydrology of the Dewey Lake Redbeds Formation

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 since 1995. This is described in Section 6.6. The lower Dewey Lake is below the sulfate cementation change, with much lower permeabilities.

WIPP monitoring well WQSP-6A (see Figure 6.2) intersects natural water in the Dewey Lake. At this location, the saturated horizon is within the middle portion of the formation. The saturated zone at well WQSP-6A is both vertically and laterally distinct from the water at C-2811 (see Figure 6.2), which is located approximately one mile (1.61 km) to the northeast on the C-2737 well pad (see Figure 6.2). Approximately one mile south of the WIPP site, domestic and stock supply wells produce water from the middle Dewey Lake (Cooper and Glanzman, 1971).

6.1.2.7 Hydrology of the Santa Rosa and Gatuña Formations

Within the WIPP site boundary, the Santa Rosa is relatively thin to absent. At the Air Intake Shaft, 0.6 m (2 ft) of rock is attributed to the Santa Rosa. The Santa Rosa is a maximum of 78 m (255 ft) thick in exploratory potash holes drilled for WIPP, east of the site boundary. The Santa Rosa is thicker to the east. The geologic data from design studies have been incorporated with data from drilling to investigate SSW in the Santa Rosa to provide structure and thickness maps of the Santa Rosa in the vicinity of the WIPP surface structures area. These results are consistent with the broader regional distribution of the Santa Rosa (DOE/WIPP-04-3231).

Water in the Santa Rosa has been found in the center part of the WIPP site since 1995 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, wells C-2505, C-2506, and C-2507 were drilled and tested in 1996 and 1997 (*Exhaust Shaft Hydraulic Assessment Data Report*, DOE/WIPP-97-2219). These wells are shown in Figure 6.12 of this report. During October 2007, three additional piezometers were installed around the SPDV tailings pile to evaluate the nature and extent of SSW around this area (see Section 6.6) (DOE/WIPP-08-3375).

The Gatuña Formation unconformably overlies the Santa Rosa Formation at the WIPP site. This formation ranges in thickness from approximately 6 to 9 m (19 to 31 ft) at the WIPP site and consists of silt, sand, and clay, with deposits formed 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).

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 surrounding the WIPP facility throughout the operational lifetime of the facility; and
- Document and identify effects, if any, of WIPP operations on groundwater parameters throughout the operational lifetime (including closure) and post-closure of the facility.

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) and five-year recertification applications.

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 are compared to water quality data collected semiannually at DMP wells.

6.2.2 Summary of 2007 Activities

Routine groundwater monitoring activities include groundwater quality sampling, groundwater level monitoring, and the pressure density survey, as described in this section. These annual programs are required by the HWFP. Supporting activities during 2007 included hydraulic testing and non-HWFP groundwater quality sampling (Section 6.4), and well maintenance (Section 6.5). Table 6.1 presents a summary of WIPP groundwater monitoring activities at the end of 2007. Wells are classified as environmental surveillance wells. WIPP does not have wells required for remediation, waste management, or other requirements. Appendix F, Table F.8, lists active groundwater monitoring wells at WIPP at the end of 2007.

Radiological data from 2007 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 2007 DOE WIPP Region Groundwater Monitoring Program

	Environmental Surveillance
Number of Active Wells	84
Number of Samples Taken	28*
Number of Water Level Measurements	769
Number of Analyses Performed	1,708
% of Analyses that are Non-Detects	79%**

* Primary and duplicate samples taken from seven wells, twice per year. Sixty-one constituents analyzed per sample.

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

Regular monthly groundwater level data were gathered from 77 wells across the WIPP region (Figure 6.2), four of which were equipped with production-injection packers (PIPs) to allow groundwater level surveillance of more than one zone through the same well. Table F.9 shows the water level data. Water levels were not taken where access was poor, or in certain wells whenever testing equipment was present.

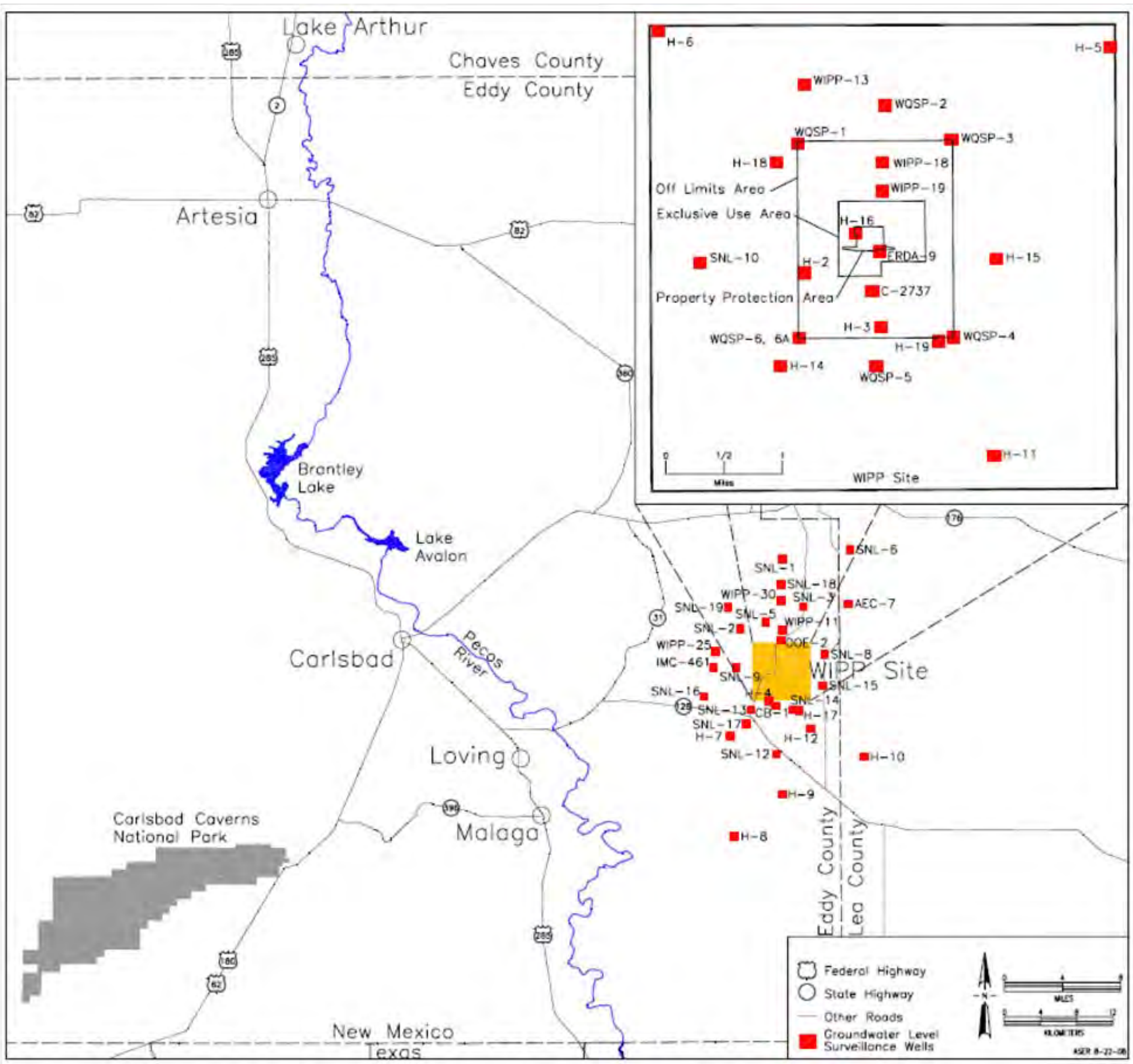

Figure 6.2 - Groundwater Level Surveillance Wells (insert represents the groundwater surveillance wells in WIPP Land Withdrawal Area)

6.2.3 Groundwater Quality Sampling

The HWFP Module V requires groundwater quality sampling twice a year, from March through May (Round 24 for 2007), and again from September through November (Round 25 for 2007). Sampling for groundwater quality was performed at seven DMP well sites during 2007 (Figure 6.3). Field analyses for oxygen-reduction potential, specific gravity, specific conductance, acidity or alkalinity, chloride, divalent cations, and total iron were performed periodically during the sampling.

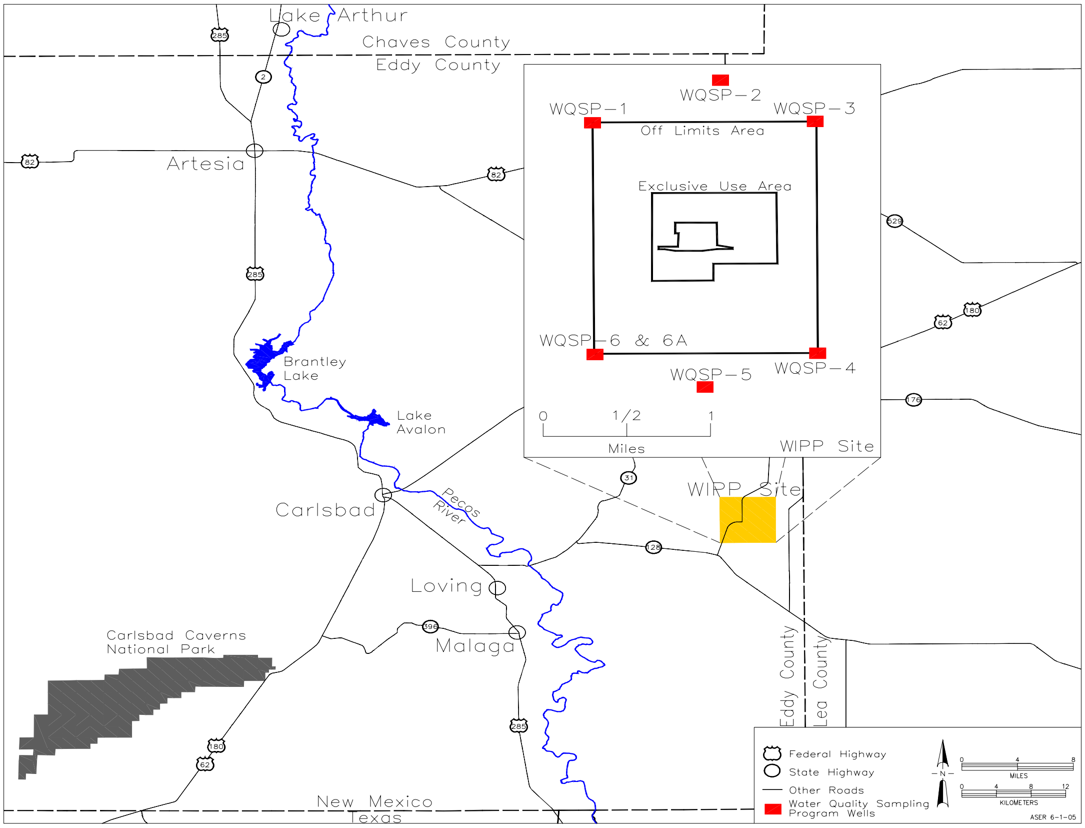

Figure 6.3 - Water Quality Sampling Program Wells

Primary and duplicate samples for groundwater quality were taken in each of the seven DMP wells: six wells completed in the Culebra (WQSP-1 through WQSP-6) and one well completed in the Dewey Lake (WQSP-6A), for a total of 14 samples analyzed per sampling round.

Wells WQSP-1, WQSP-2, and WQSP-3 are located upgradient of the WIPP shaft area. The locations of the three upgradient wells were selected to be representative of the groundwater moving downgradient onto the WIPP site. WQSP-4, WQSP-5, and WQSP-6 were located downgradient of the WIPP shaft area. WQSP-4 was also specifically located to monitor a zone of higher transmissivity. WQSP-6a was installed in the Dewey Lake at the WQSP-6 well pad to assess shallower groundwater conditions at this location.

The difference between the depth of the WIPP repository and the depth of the DMP wells completed in the Culebra 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 a release along the pathway from the repository to the Culebra is highly unlikely. In order for contaminated liquid to move from the repository into the Culebra, three conditions must be met. First, sufficient water has to accumulate in the waste disposal areas to leach contaminants from the disposed waste. Second, sufficient pressure would have to build up in the disposal region to overcome the hydrostatic head between the repository and the Culebra, assuming that any pathway exists after the shafts and boreholes are sealed. Third, the pathway must remain open. Current plans call for sealing the shafts and boreholes that would create such a pathway at the time of closure of the facility, which is long before the first two conditions could be met. Furthermore, the movement of brine into the sealed repository will decrease and eventually stop as pressure builds up from creep closure and gas generation, making it unlikely that the first condition will ever be met.

Table 6.2 lists the analytical parameters included in the 2007 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)	300/353.3
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	160.1
108-90-7	Chlorobenzene	8260B		Total organic carbon	415.1
67-66-3	Chloroform	8260B		Total organic halogen	9020B
540-59-0	*cis*-1,2-Dichloroethylene	8260B		Total suspended solids	160.2
540-59-0	*trans*-1, 2-Dichloroethylene	8260B			
78-93-3	Methyl ethyl ketone	8260B			
75-09-2	Methylene chloride	8260B			
127-18-4	Tetrachloroethylene	8260B	7440-36-0	Alkalinity	310.1
108-88-3	Toluene	8260B	7440-38-2	Antimony	6010B
79-01-6	Trichloroethylene	8260B	7440-39-3	Arsenic	6010B
75-69-4	Trichlorofluoromethane	8260B	7440-41-7	Barium	6010B
75-01-4	Vinyl chloride	8260B	7440-43-9	Beryllium	6010B
1330-20-7	Xylene	8260B	7440-70-2	Cadmium	6010B
95-50-1	1,2-Dichlorobenzene	8270C	7440-47-3	Calcium	6010B
106-46-7	1,4-Dichlorobenzene	8270C	7439-89-6	Chromium	6010B
51-28-5	2,4-Dinitrophenol	8270C	7439-92-1	Iron	6010B
121-14-2	2,4-Dinitrotoluene	8270C	7439-95-4	Lead	6010B
95-48-7	2-Methylphenol	8270C	7439-97-6	Magnesium	6010B
108-39-4/ 106-44-5	3-Methylphenol/ 4-Methylphenol	8270C	2023473	Mercury	7470A
			2023692	Nickel	6010B
118-74-1	Hexachlorobenzene	8270C	7782-49-2	Potassium	6010B
67-72-1	Hexachloroethane	8270C	7440-22-4	Selenium	6010B
98-95-3	Nitrobenzene	8270C	7440-23-5	Silver	6010B
87-86-5	Pentachlorophenol	8270C	7440-28-0	Sodium	6010B
110-86-1	Pyridine	8270C	7440-62-2	Thallium	6010B
78-83-1	Isobutanol	8260B	7440-66-6	Vanadium	6010B

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

6.2.4 Evaluation of Groundwater Quality

The quality of the Culebra water sampled at the WIPP site is naturally poor and not suitable for human consumption or for agricultural purposes, because the TDS concentrations are generally above 10,000 mg/L. In 2007, average TDS concentrations in the Culebra (as measured in WQSP wells) varied from a low of 14,800 mg/L (WQSP-6) to a high of 232,750 mg/L (WQSP-3). The groundwater of the Culebra is considered to be Class III water (non-potable) by EPA guidelines.

Water quality measurements performed in the Dewey Lake indicate that the water is considerably better quality than that from the Culebra. In 2007, the TDS values in water from the well WQSP-6A, obtained from the Dewey Lake, averaged 3,370 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 SSW has been encountered in the upper Dewey Lake at the Santa Rosa contact (see Section 6.6).

Because of the highly variable 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 (Appendix E, Figures E.1 through E.98). The results of analyses for each parameter or constituent for the two sampling sessions in 2007 (Rounds 24 and 25) 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 (i.e., 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 24 and 25 to evaluate potential contamination of the local groundwater.

In some of the WQSP wells during 2007, reported concentrations of some parameters, such as alkalinity, calcium, chloride, magnesium, sodium, sulfate, and TDS slightly exceeded the calculated 95th percentile or the 95th UTLV. Such exceedences do not indicate the presence of contamination because none of the parameters that exceeded the 95th percentile or the 95th UTLV are regulated constituents of the TRU mixed waste that is authorized to be disposed of under the WIPP HWFP. 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 chloride, magnesium, sodium and sulfate exhibit the most variability during Rounds 19 to 25.

6.2.5 Groundwater Level Surveillance

Well bores were used to perform surveillance of the groundwater surface elevation of five water-bearing zones in the WIPP area:

- SSW (Santa Rosa/Dewey Lake Interface)
- Dewey Lake
- Magenta
- Culebra
- Bell Canyon

The two zones of most interest are the Culebra and Magenta (see Figure 6.1). Throughout 2007, water levels in up to 48 Culebra wells were measured (includes the Culebra zone of dual completion wells) and 14 wells in the Magenta (includes the Magenta zone of dual completion wells). One Dewey Lake well and two Bell Canyon wells were monitored. Sixteen wells in the shallow zone of the Santa Rosa/Dewey Lake interface were monitored. Groundwater level measurements were taken monthly in at least one accessible well bore at each well site for each available formation (Figure 6.2). Water levels in 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.9).

A breakout of the groundwater zone(s) intercepted by each well measured at least once in 2007 is given in Appendix F, Table F.8. Note that five existing wells (WIPP-30, Culebra/Magenta; C-2737, Culebra/Magenta; WIPP-25, Culebra/Magenta; H-9c, Culebra/Magenta; and H-15, Culebra/Magenta) are completed at multiple depths. By using PIPs, these wells monitor more than one formation.

Water elevation trend analysis was performed for 35 of 50 wells completed or isolated in the Culebra. The subset of wells analyzed were those which had a sufficient period of record to analyze through CY 2007, did not display anomalous levels or trends, and were representative of more than one well at a given well pad (Appendix F, Table F.8). Excluded from trend analysis were AEC-7 (water level rising through the bottom seal and not representative of Culebra water) and SNL-15 (water level depressed from projected equilibrium). Also excluded were SNL-6 and WIPP-25 (inaccessible throughout the year), and other wells for reasons shown on the table.

The dominant trend through 2007 was a spatially uniform, rising freshwater equivalent level in the Culebra, with a slight plateau in the last three months of the year. By "dominant," it is meant that (1) water levels rose in 32 of 35 wells from January through December (or shorter periods in wells that still had a discernable trend), (2) the average water level rise was 1.6 feet (0.49 m), and (3) the general water level rise is best indicated by over two-thirds of measured water level rising in the 1.0- to 2.0-foot range.

Water levels in the Culebra Dolomite Member of the Rustler Formation, and to a lesser extent in the Magenta Member, have generally been rising throughout the history of WIPP. The rise was not recognized as having a regional extent for many years because of well drilling and testing, shaft sinking, and other human activities that disturbed water levels. Since the major activities associated with WIPP site characterization were completed in the early 1990's, and other activities that disturbed groundwater levels were minimal, the rise in water levels over the entire area monitored by WIPP has become evident.

The water-level rise is not monotonic, but shows variations related to factors both known and hypothesized. Water levels in the Culebra in Nash Draw, west of the WIPP site, respond to major rainfall events within a few days (Hillesheim et al., 2007). It is hypothesized that the change in head in Nash Draw then propagates under Livingston Ridge to the WIPP site in the succeeding weeks or months. It is also hypothesized that the Culebra may be receiving leakage through poorly plugged and abandoned drillholes, or through fractures in Nash Draw, from higher hydrologic units and/or potash tailings piles north of the WIPP site. For example, the observed long-term rise in water levels might be caused by the leakage into the Culebra of approximately 74 acre-ft/yr of the approximately 2,200 acre-ft/yr of brine discharged onto the Intrepid East tailings pile north of the WIPP site, and/or by the leakage of a similar volume through 26 potash exploration holes north, west, and south of the WIPP site that may not have been properly plugged through the Culebra (Lowry and Beauheim, 2004; 2005). Likewise, a number of plugged and abandoned oil or gas wells have been identified, mostly to the east and south of the WIPP site, that may not be plugged through the Culebra with cement and could, hypothetically, be sources of leakage that affects the head in the Culebra (Powers, 2004).

Because of the wide areal distribution of the rise, it is not resulting in significant changes in the hydraulic gradient in the Culebra, which is what controls the rate and direction of groundwater flow. The DOE uses updated heads in calculating potential radionuclide releases through the Culebra in the performance assessments that are part of each Compliance Recertification Application.

Figures 6.4 through 6.10 provide hydrographs of the DMP wells for CY 2007. The six Culebra wells (Figures 6.4 through 6.9; WQSP-6A is Dewey Lake) are typical of the hydrographs of the 35 wells analyzed for Culebra water level trends. Temporary declines from spring and fall water quality sampling are evident in some wells such as WQSP-3. The HWFP requires that the NMED be notified if a cumulative groundwater surface elevation change of more than two feet is detected in any DMP well over the course of one year which is not attributable to site tests or natural stabilization of the site hydrologic system. All of the DMP wells trended in line with the hydrologic system. There was no abnormal or unexplained rise in the DMP wells outside the regional trend, and no DMP wells had a cumulative change from January to December of more than two feet (WQSP-1 registered a 1.74-ft rise).

Figure 6.4 - Hydrograph of WQSP-1

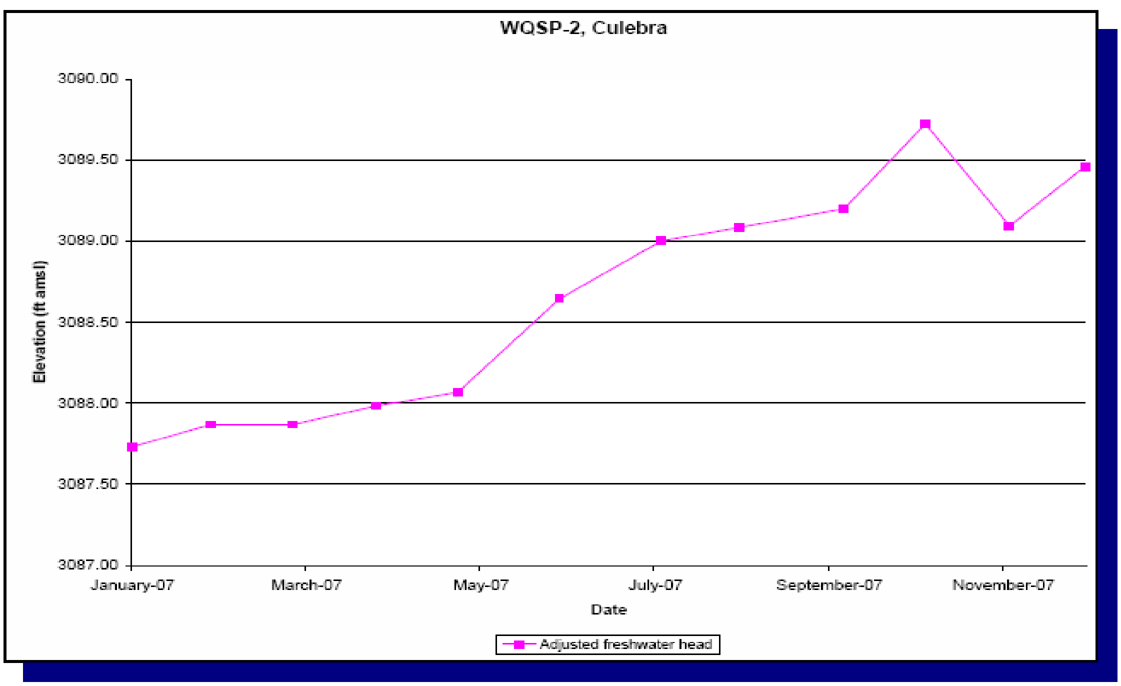

Figure 6.5 - Hydrograph of WQSP-2

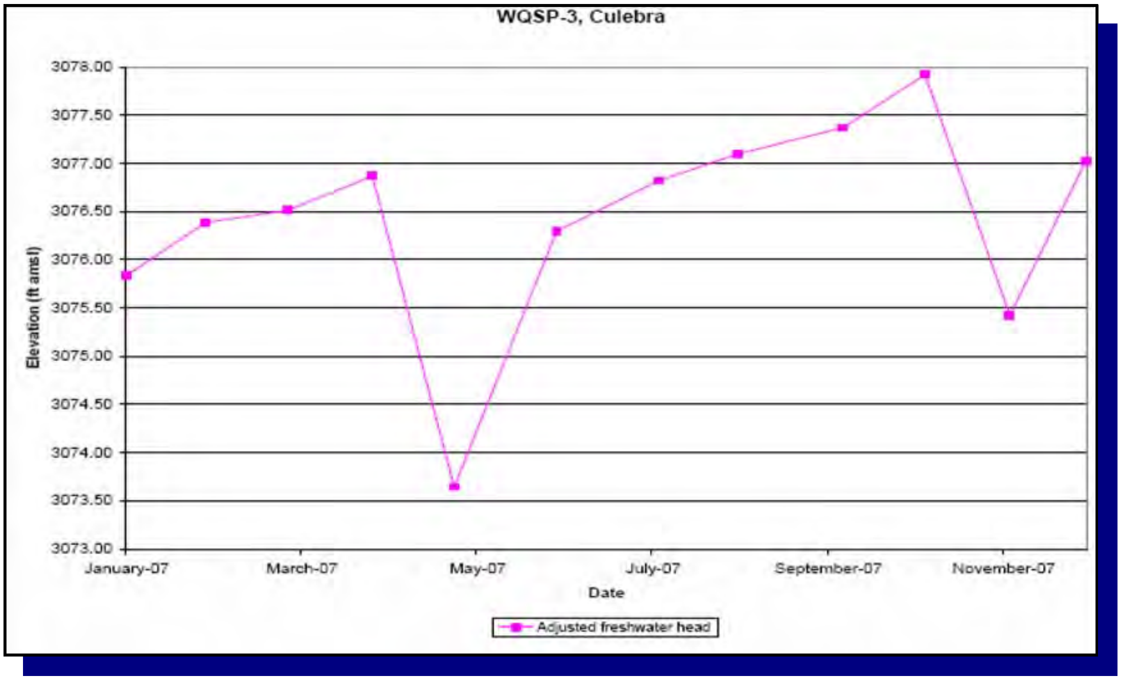

Figure 6.6 - Hydrograph of WQSP-3

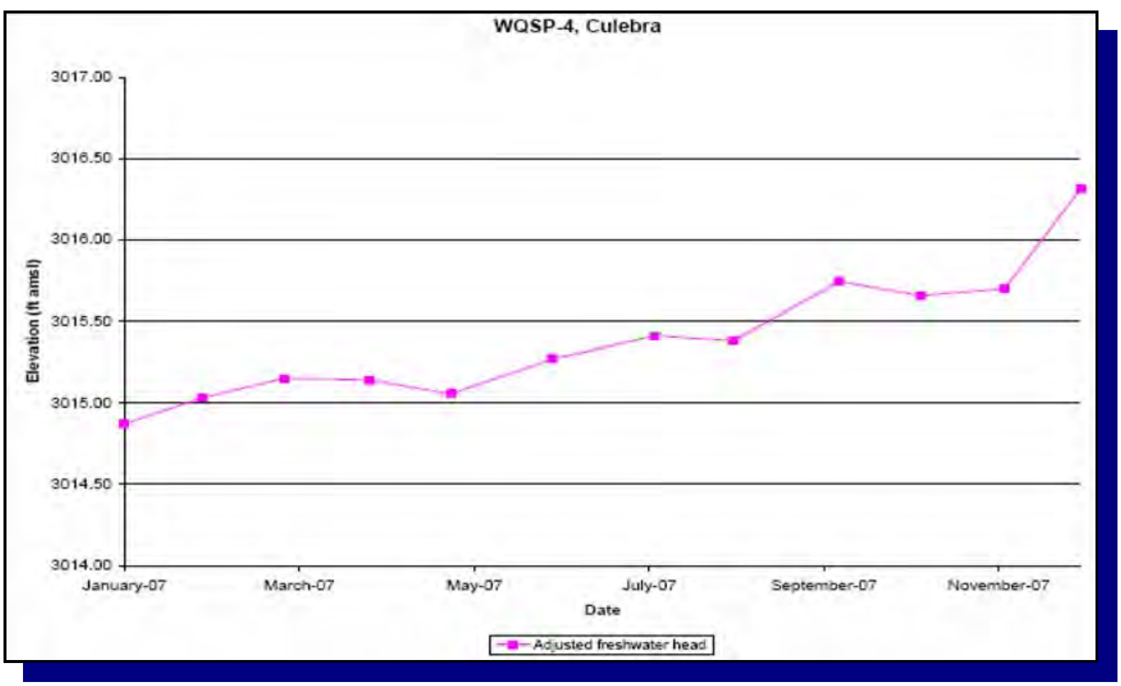

Figure 6.7 - Hydrograph of WQSP-4

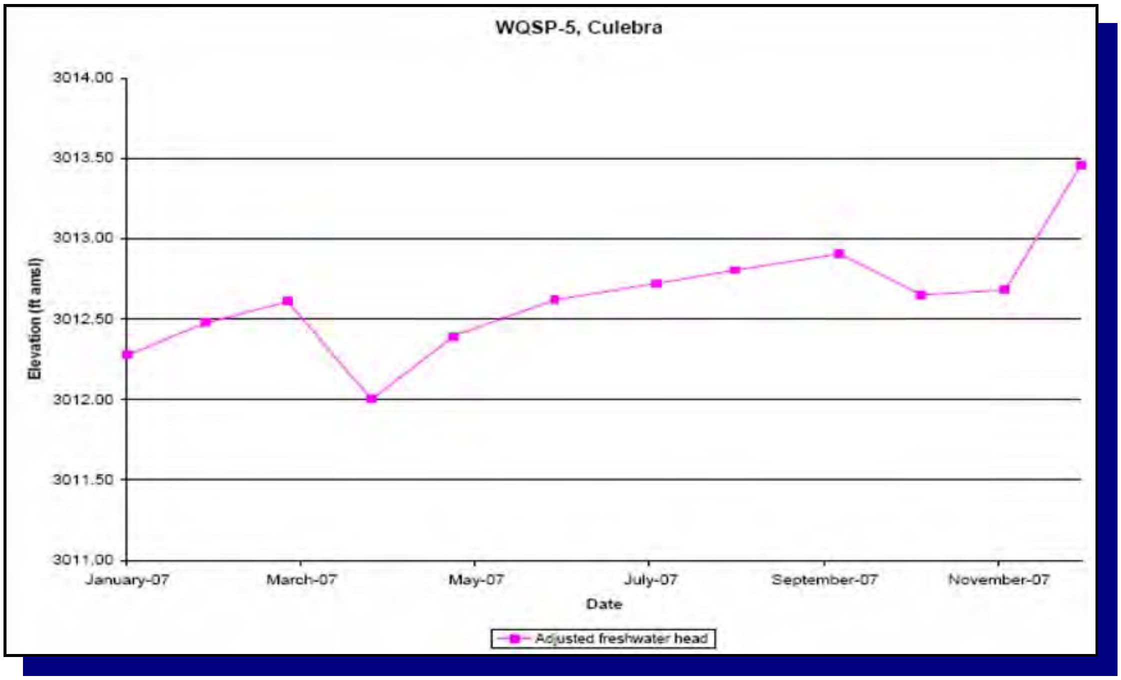

Figure 6.8 - Hydrograph of WQSP-5

Figure 6.9 - Hydrograph of WQSP-6

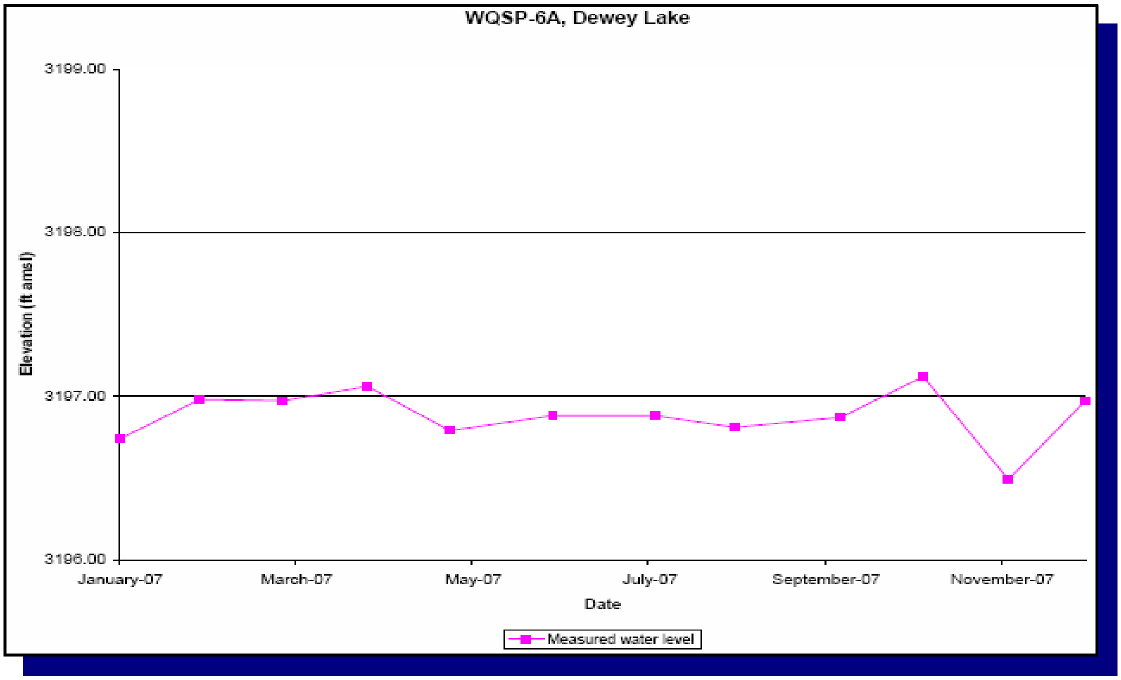

Figure 6.10 - Hydrograph of WQSP-6A

Groundwater level data were transmitted on a monthly basis to the NMED, Sandia National Laboratories (SNL), and the CBFO Technical Assistance Contractor. Appendix F, Table F.9 incorporates errata that were noted and corrected during the year. A copy of the data was placed in the operating record for inspection.

Regional Culebra flow is documented in the WIPP body of literature to be generally south. For the WIPP site, equivalent freshwater heads for December 2007 were used to contour the potentiometric surface map. This month was judged to have a large number of Culebra water levels available, few wells affected by pumping events, and all wells in quasi-steady state with few individual wells contrary to the general water level trend. Table 6.3 shows the water level data set.

Notable is that December 2007 was the first month that CY 2007 density information was used to adjust measured water levels to the adjusted freshwater head as shown. This single adjustment factored into the CY 2007 Culebra hydrographs and trend analysis already discussed. Section 6.2.6 shows the slight differences in density between CY 2007 and the CY 2006 survey or data sets used. Different pressure density surveys may provide slightly different densities simply because of measurement error. Groundwater density is susceptible to change when stresses are induced such as well development, extended pumping, water injection for slug tests, or when natural recharge to the system occurs. The density data set used to adjust measured water levels to adjusted freshwater heads will be updated each January based on the most recent density measurements. Adjusted freshwater heads are typically accurate to $\pm$ 1.5 feet given the density measurement error.

Table 6.3 - Water Level Elevations for the December 2007 Potentiometric Surface, Culebra Hydraulic Unit

Well I.D.	Date of Measurement	Adjusted Freshwater Head (feet, msl)	Density Used (grams/cc)	Notes
AEC-7	12/10/07	3,239.22	1.211	Freshwater head not representative of Culebra water due to leakage from Salado. No surrogate used.
C-2737 (PIP)	12/11/07	3,021.78	1.010	Do not use. Freshwater in tubing.
ERDA-9	12/11/07	3,028.38	1.047	
H-02b2	12/11/07	3,050.47	1.014	
H-03b2	12/11/07	3,013.37	1.042	
H-04b	12/11/07	3,006.63	1.015	
H-05b	12/10/07	3,083.43	1.091	
H-06b	12/07/07	3,074.32	1.034	
H-07b1	12/10/07	3,000.48	1.002	
H-09c (PIP)	12/10/07	2,997.58	1.001	
H-10c	12/10/07	3,030.53	1.008	
H-11b4	12/11/07	3,008.28	1.070	
H-12	12/10/07	3,001.92	1.097	
H-15 (PIP)	12/11/07	3,018.55	1.053	Do not use. Freshwater in tubing.
H-17	12/11/07	3,008.22	1.133	
H-19b0	12/11/07	3,015.41	1.068	H-19B2, H-19B3, H-19B4, H-19B5, H-19B6, H-19B7 are redundant.
I-461	12/07/07	3,048.00	1.005	
SNL-01	12/07/07	3,089.90	1.033	
SNL-02	12/07/07	3,077.69	1.012	
SNL-03	12/07/07	3,084.57	1.023	
SNL-05	12/07/07	3,081.27	1.010	
SNL-06			1.246	No access through 2007. Depressed and recovering from pumping.
SNL-08	12/10/07	3,038.29	1.103	Depressed from pumping Jul - Aug 2007.
SNL-09	12/07/07	3,058.84	1.024	
SNL-10	12/11/07	3,054.57	1.011	
SNL-12	12/10/07	3,003.61	1.005	
SNL-13	12/10/07	3,016.00	1.027	
SNL-14	12/11/07	3,006.51	1.048	
SNL-15	12/10/07	2,874.96	1.228	Abnormally depressed from projected steady Culebra head at this location, no good for potentiometric surface.
SNL-16	12/10/07	3,014.00	1.010	
SNL-17	12/10/07	3,007.46	1.006	
SNL-18	12/07/07	3,081.55	1.028	
SNL-19	12/07/07	3,077.98	1.003	
WIPP-11	12/07/07	3,087.68	1.038	
WIPP-13	12/11/07	3,083.49	1.053	
WIPP-19	12/11/07	3,070.67	1.044	
WIPP-25 (PIP)			1.011	No access until after December 2007 water level round. Freshwater in tubing December 2007

Table 6.3 - Water Level Elevations for the December 2007 Potentiometric Surface, Culebra Hydraulic Unit

Well I.D.	Date of Measurement	Adjusted Freshwater Head (feet, msl)	Density Used (grams/cc)	Notes
WIPP-30 (PIP)	09/17/07	3,090.87	1.000	Do not use. Leaky packer through 2007. Density rounded from 2007 field measurement of 0.994
WQSP-1	12/11/07	3,080.88	1.048	Density from DMP Round 25, field hydrometer
WQSP-2	12/11/07	3,089.46	1.048	Density from DMP Round 25, field hydrometer
WQSP-3	12/11/07	3,077.03	1.146	Density from DMP Round 25, field hydrometer
WQSP-4	12/11/07	3,016.31	1.075	Density from DMP Round 25, field hydrometer
WQSP-5	12/11/07	3,013.46	1.025	Density from DMP Round 25, field hydrometer
WQSP-6	12/11/07	3,025.12	1.014	Density from DMP Round 25, field hydrometer

Adjusted freshwater level contours of the Culebra for December 2007 are shown on Figure 6.11. These were created using SURFER version 8.06.39 surface mapping software by Golden Software. Thirty-six water level elevation data points (Z) from Table 6.3 were used. The method used to generate the data grid was kriging with 100 rows and 73 columns (7,300 nodes). After kriging and contouring the 36 wells, the contour map was excised to that seen in Figure 6.11. Although this figure is visually scaled down to focus on the site, the contours represent the entire network of data points used in the kriging and contouring process. The shaping of the contours at the LWA boundary thus represents far-range control afforded by wells not seen on the figure.

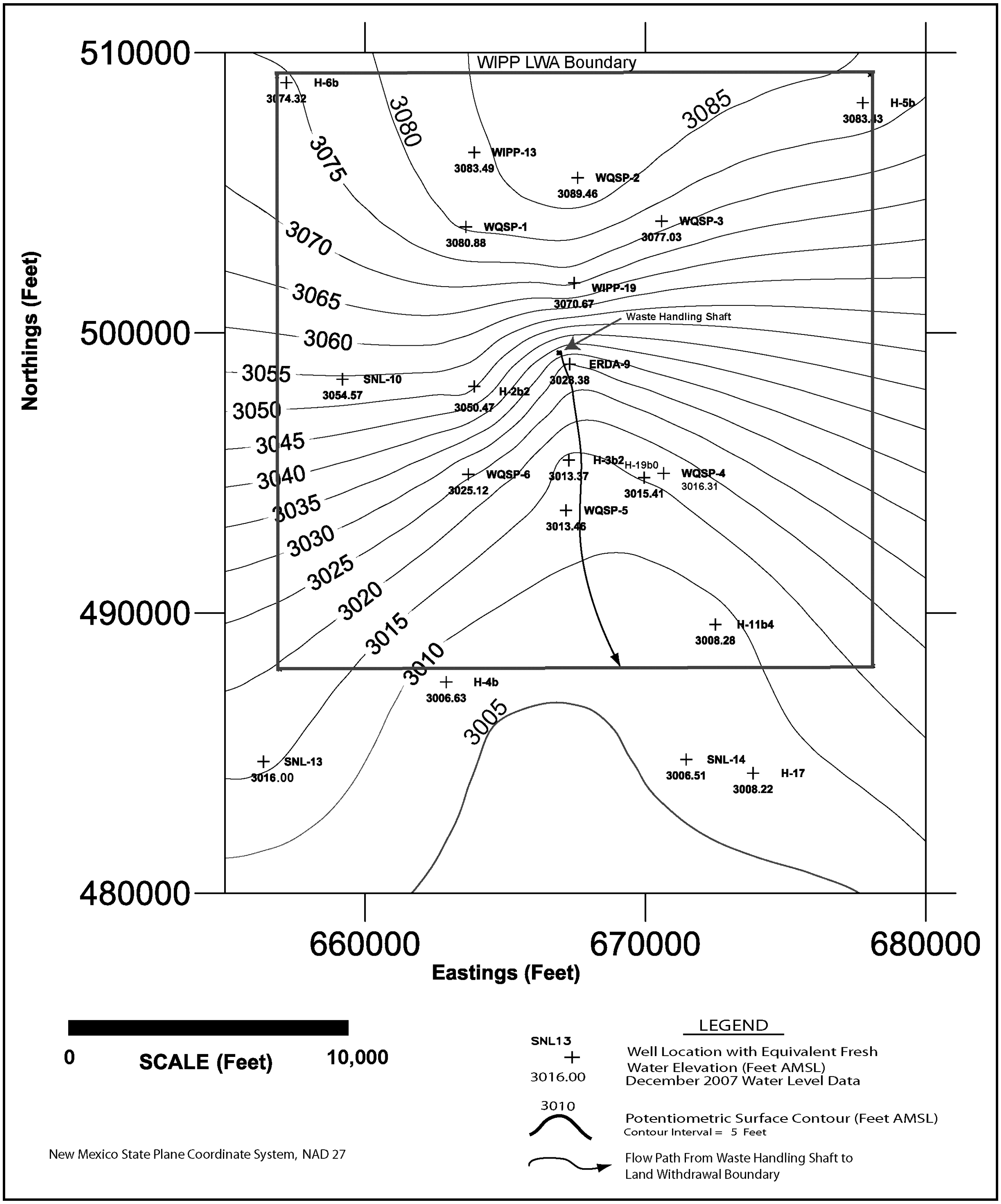

Figure 6.11 - Culebra Potentionmetric Surface Map

The Culebra flow rate was determined for a flow path between the waste handling shaft and the LWA boundary, and the discharge velocity was calculated using the following equation.

$q = Ki$

Where:

K = hydraulic conductivity at WQSP-4, which had been placed in a high transmissivity zone (0.52 ft/day)

i = hydraulic gradient across the flow path

The discharge velocity thus calculated is 1.5E-03 ft/day (4.6E-04 m/d). The overall gradient on the flow path was 0.003 (dimensionless).

6.2.6 Pressure Density Surveys

At the WIPP site, variable TDS concentrations result in variability in groundwater density. WIPP measures the density of well-bore fluids in water level monitoring wells to adjust water levels to their equivalent freshwater head values. This allows more accurate determination of relative heads between wells.

In 2007, density measurements were derived from 44 wells, as shown in Table 6.4, from Mini Trolls installed by Sandia National Laboratories, the Scientific Advisor. This approach employed several calibrated pressure-measuring transducers dedicated to given wells at times during the year, whereas in 2006, a single calibrated transducer was moved among all the wells to perform the work. For the WQSP wells, field hydrometer measurements are always used. For comparison, 2006 density data are shown.

As to application, the 2006 ASER employed density values that were considered most representative of each well based on a body of historical data for each well, setting aside the 2006 Pressure Density results. The 2006 ASER also employed field hydrometer readings to two decimals. Future ASERs will use the most recent density measurements.

Table 6.4 - Pressure Density Survey for 2007

Well I.D.	Last Reported in 2006 ASER, and used in 2006 Potentiometric Map if Applicable	2006 Pressure Density Survey Result	2007 Pressure Density Survey Result - used for 2007 ASER Potentiometric Map (Table 6.3)	Notes for 2007 Pressure Density Survey
	Density (grams/cc)	Density (grams/cc)	Density (grams/cc)	
AEC-7	1.089	1.211	1.211	Not representative of Culebra water; water leaking from Salado
C-2737	1.010	1.027	1.010	Freshwater used to inflate packer; not representative of Culebra water
ERDA-9	1.067	Obstructed	1.047	
H-02B2	1.013	1.000	1.014	
H-03B2	1.036	1.009	1.042	
H-04B	1.011	1.021	1.015	
H-05B	1.099	1.099	1.091	
H-06B	1.041	1.043	1.034	
H-07B1	1.002	1.006	1.002	
H-09C	1.005	1.007	1.001	
H-10C	1.009	1.005	1.008	
H-11B4	1.064	1.071	1.070	
H-12	1.083	1.108	1.097	
H-15	1.097	Testing in progress	1.053	Freshwater used to inflate packer; not representative of Culebra water
H-17	1.136	1.134	1.133	
H-19B0	1.067	1.071	1.068	
I-461	1.004	1.017	1.005	
SNL-01	1.028	1.027	1.033	
SNL-02	1.010	1.017	1.012	
SNL-03	1.035	1.028	1.023	
SNL-05	1.011	1.010	1.010	
SNL-06	No meas.	No meas.	1.246	
SNL-08	1.056	1.051	1.103	
SNL-09	1.022	1.024	1.024	
SNL-10	1.001	1.004	1.011	
SNL-12	1.004	1.006	1.005	
SNL-13	1.054	1.008	1.027	
SNL-14	1.062	1.038	1.048	
SNL-15	1.230	1.221	1.228	
SNL-16	1.014	1.000	1.010	
SNL-17	1.001	Testing in progress	1.006	
SNL-18	1.015	Testing in progress	1.028	
SNL-19	1.007	Testing in progress	1.003	
WIPP-11	1.038	1.039	1.038	

Table 6.4 - Pressure Density Survey for 2007

Well I.D.	Last Reported in 2006 ASER, and used in 2006 Potentiometric Map if Applicable	2006 Pressure Density Survey Result	2007 Pressure Density Survey Result - used for 2007 ASER Potentiometric Map (Table 6.3)	Notes for 2007 Pressure Density Survey
	Density (grams/cc)	Density (grams/cc)	Density (grams/cc)	
WIPP-13	1.050	1.041	1.053	
WIPP-19	1.060	1.055	1.044	
WIPP-25	1.022	Testing in progress	1.011	Freshwater used to inflate packer in Dec 2007; not representative of Culebra water
WIPP-30	1.025	1.007	1.000	Leaky packer; not representative of Culebra water
WQSP-1	1.040	1.048	1.048	Round 25, field hydrometer
WQSP-2	1.040	1.047	1.048	Round 25, field hydrometer
WQSP-3	1.140	1.145	1.146	Round 25, field hydrometer
WQSP-4	1.060	1.074	1.075	Round 25, field hydrometer
WQSP-5	1.020	1.025	1.025	Round 25, field hydrometer
WQSP-6	1.010	1.014	1.014	Round 25, field hydrometer

6.3 Drilling Activities

Three shallow piezometers were drilled around the SPDV tailings pile during 2007. These were installed as a requirement of the DP-831 permit (see Section 6.6).

6.4 Hydraulic Testing and Other Water Quality Sampling

Hydrologic testing was performed throughout 2007. In January, slug tests of the Culebra were conducted at C-2737. In late July, a slug test of the Culebra was performed on SNL-8. Both wells had been drilled and completed prior to 2007.

In addition to pumping tests primarily for hydraulic characterization, SNL performed sampling to obtain basic water chemistry data and age-dating at selected wells. Water sampling for general chemistry parameters was performed at SNL-15 in April, SNL-8 in July, and SNL-14 in August. Age dating sampling was performed at SNL-8 and SNL-14.

6.5 Well Maintenance

Well maintenance activities for 2007 included resetting packers in wells C-2737 and WIPP-25, and an attempted removal of a packer in WIPP-30. In addition, the damaged well, SNL-16, was repaired. Its new top of casing elevation was unchanged.

After testing at well C-2737, the PIP was reset in this well during February to allow monitoring of both the Magenta and Culebra. Also following testing at well WIPP-25, the PIP was reset in this well in December to allow dual monitoring of the Magenta and Culebra Members of the Rustler Formation. In December, leakage of the packer separating the Magenta and Culebra of WIPP-30 was suspected due to water level behavior in the Magenta. Removal of this well's packer was attempted in December; however, during the process it got stuck in the well casing. It has been scheduled to be plugged and abandoned in 2008.

6.6 Shallow Subsurface Water Monitoring Program

SSW occurs beneath the WIPP site at a depth of less than 100 ft below ground level at the contact between the Santa Rosa and the Dewey Lake (Figure 6.1). The formations containing shallow water, specifically at the site, yield generally less than one gallon per minute in monitoring wells and piezometers and the water contains high concentrations of TDS (968 mg/L to 245,500 mg/L) and chloride (186 mg/L to 150,000 mg/L); to the south, yields are greater. The origin of the high TDS in this water is believed to be primarily from anthropogenic sources, with some contribution from natural sources. The SSW 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 6.12). Additionally, drilling in 2007 around the SPDV tailings pile revealed shallow water in three piezometers (PZ-13, PZ-14, and PZ-15, shown in Figure 6.12). Natural shallow groundwater occurs in the middle part of the Dewey Lake at the southern portion of the WIPP site (WQSP-6A) and to the south of the WIPP site (J. C. Mills Ranch). To date, there is no indication that the anthropogenic SSW has affected the naturally occurring groundwater in the Dewey Lake.

Since discovery of the SSW in 1995 and through most of 2007, 12 piezometers (PZ-1 to PZ-12) 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 SSW levels and water quality. SSW monitoring activities during 2007 included SSW level surveillance primarily at these 16 locations (Figure 6.12).

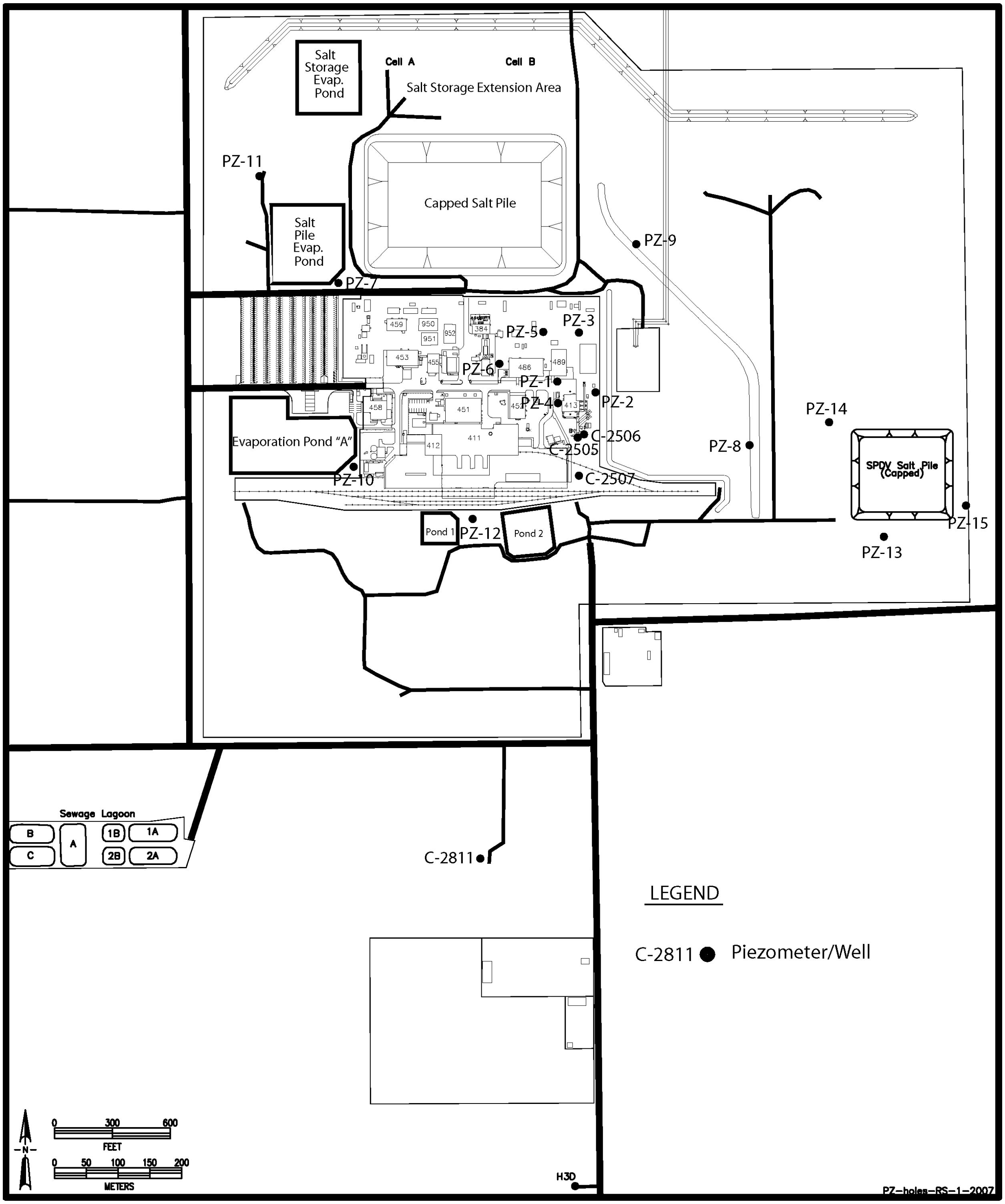

Figure 6-12 - Location of SSW Wells (Piezometers PZ-01 through 15, C-2811, C-2505, C-2506, C-2507, H-3D)

On December 29, 2006, the NMED GWQB issued a DP-831 modification with a condition that the SPDV salt pile be investigated as a possible source of shallow groundwater. The modification indicated that WIPP should install three monitoring wells adjacent to the SPDV tailings pile. Piezometers PZ-13, PZ-14, and PZ-15 were drilled during August 2007 around the SPDV tailings pile to investigate the possibility of SSW beneath the subsurface (DOE/WIPP-08-3375).

Piezometers PZ-13, PZ-14, and PZ-15 indicated saturated sections in all three locations at differing horizons and, in one case, a different formation. Based on the geologic data obtained the SSW appears to be isolated in different and variable zones around the SPDV tailings pile based on examination of split spoon samples obtained during drilling. Structural features of the Santa Rosa/Dewey Lake contact play an important role in accumulation and movement of SSW and the stratigraphy overlying the Santa Rosa/ Dewey Lake contact is heterogeneous and tortuous. The heterogeneity and tortuosity leads to preferential flow and a vertical dampening effect. The heterogeneity, small saturated lenses, and tortuous flow affects the ability for flow to readily occur in the unsaturated zone around the SPDV tailings pile (DOE/WIPP-08-3375).

Piezometers PZ-13, PZ-14, and PZ-15 have been added to the quarterly water level monitoring and semiannual sampling programs as part of DP-831.

6.6.1 Shallow Subsurface Water Quality Sampling

DP-831, as modified, requires ten SSW wells to be sampled on a semiannual 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. These wells were sampled in May and October 2007 and laboratory analyzed for the parameters presented in the previous section. The new piezometers installed around the SPDV tailings pile were sampled once during October 2007. Results are indicated in Table 6.5.

Table 6.5 - 2007 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	5/9/07	2.70	2220	63000	107000	<0.0500	<0.0250
PZ-1	10/9/07	<1.00	2820	83200	99500	<0.1000	<0.0250
PZ-5	5/9/07	4.60	1640	17300	32400	<0.0500	<0.0250
PZ-5	10/9/07	<1.00	1880	19400	28700	0.0710	<0.005
PZ-6	5/9/07	6.65	2840	73500	122500	<0.0500	<0.0250
PZ-6	10/9/07	<1.00	3080	81000	105000	<0.1000	<0.0250
PZ-7	5/7/07	5.15	3190	6480	119000	<0.0200	0.0200
PZ-7	10/8/07	<1.00	2660	45600	65000	0.0640	<0.00500
PZ-8	10/15/07	0.677	500	7440	15000	0.039	<0.00500
PZ-9	5/9/07	3.28	4320	89600	164000	<0.0500	<0.0250
PZ-9	10/9/07	<200	4720	116000	144000	<0.0200	<0.0050

Table 6.5 - 2007 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-10	5/7/07	14.8	407	274	1504	<0.0200	0.0200
PZ-10	10/8/07	<1.00	211	186	968	0.0260	<0.0050
PZ-11	5/7/07	3.84	2620	68700	135000	<0.0200	<0.0100
PZ-11	10/8/07	<1.00	2970	94400	108000	<0.0200	<0.0050
PZ-12	5/7/07	10.8	831	3780	7010	<0.0200	0.0240
PZ-12	10/8/07	<1.00	958	4310	6200	0.0260	<0.0050
PZ-13	10/10/07	12.4	2670	150000	245500	<0.01000	<0.00500
PZ-14	10/15/07	1.41	2140	71500	106000	<0.0100	<0.00500
PZ-15	10/15/07	2.97	169	764	2060	0.022	<0.00500
C-2811	5/7/07	5.31	516	1760	4205	<0.0200	0.0310
C-2811	10/8/07	<1.00	635	2980	3860	0.0510	<0.0050
C-2507	5/9/07	6.62	1110	3060	5485	<0.0500	<0.0250
C-2507	10/9/07	<1.00	1220	3500	5540	0.0550	0.007

6.6.2 Shallow Subsurface Water Level Surveillance

Sixteen wells were primarily used to perform surveillance of the SSW-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 6.12, with the exception of PZ-13, PZ-14, and PZ-15, which only had two rounds of measurements during 2007 (Appendix F, Table F.8). Well PZ-8 was dry since its drilling in 1996 through October 2007.

The potentiometric surface for the SSW using December 2007 data is presented in Figure 6.13. The contours were generated using SURFER version 8.06.39 surface mapping software by Golden Software. All 19 data points were used in the contour development. The potentiometric surface was then overlain on top of a shaded relief map of the Dewey Lake Surface.

Groundwater elevation measurements in the SSW indicate that flow moves east and south away from a potentiometric high located near PZ-7 adjacent to the Salt Pile Evaporation Pond (Figure 6.13). At this time, it appears that the water identified in PZ-13 and PZ-14 is separate and distinct from the SSW in the other wells on the WIPP site. Water detected in PZ-15 is a separate and distinct body to all the SSW wells.

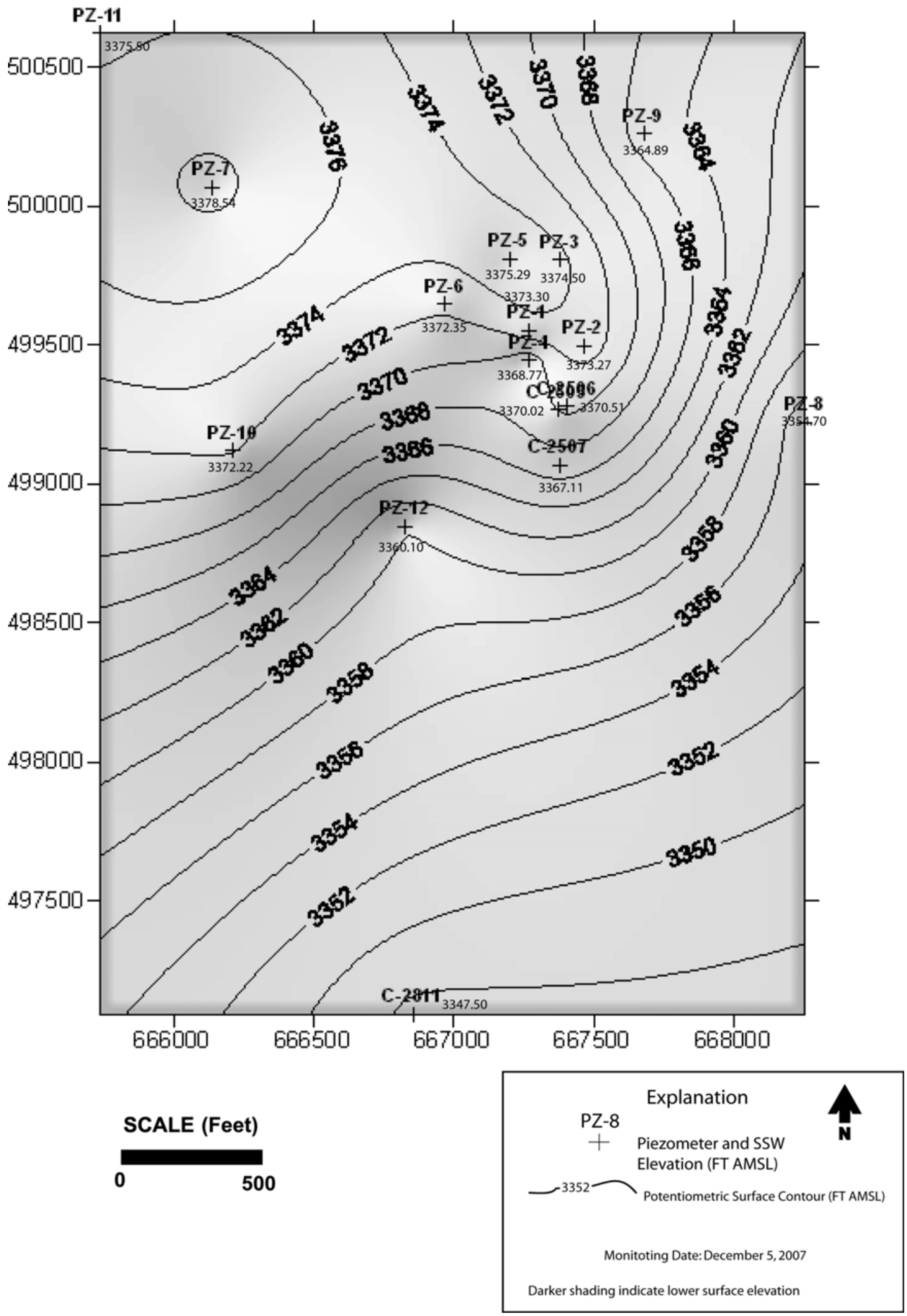

Figure 6.13 - SSW Potentiometric Surface Superimposed on Dewey Lake Surface

6.7 Public Drinking Water Protection

The water wells nearest the WIPP site that use the natural shallow groundwater for domestic use are the Barn Well and Ranch Well located on the J. C. Mills Ranch. These wells are located approximately 3 mi south-southwest of the WIPP surface facilities, and about 1.75 mi south of WQSP-6A (see Figure 6.3 for location of WQSP-6A). 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 SSW at the site, a water budget analysis of the SSW was performed by Daniel B. Stephens & Associates (Daniel B. Stephens and Associates, Inc., 2003). The analysis was performed to evaluate important hydrologic processes controlling the SSW 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 SSW saturated lens and that the lens is expected to spread.

The potential extent for long-term SSW 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.

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 2007, WIPP Laboratories performed the radiological analyses of WIPP environmental samples, while contract laboratories, Carlsbad Environmental Monitoring and Research Center (CEMRC), in Carlsbad, New Mexico; and TraceAnalysis, Inc., in Lubbock, Texas, performed the nonradiological analyses. These laboratories were required contractually to have documented QA programs, including standard procedures to perform the work. The WIPP Laboratories and TraceAnalysis, Inc., were required to participate in intercomparison programs with such entities as the National Institute of Standards and Technology Radiochemistry Intercomparison Program (NRIP), the Mixed Analyte Performance Evaluation Program (MAPEP), the Environmental Resource Associates® interlaboratory assessment, and/or other reputable intercomparison programs. Laboratories used by the WIPP program are required to meet the applicable requirements of the CBFO *Quality Assurance Program Document* (DOE/CBFO-94-1012), as flowed down through the Washington TRU Solutions LLC Quality Assurance Program Description (WP 13-1).

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

- American Society of Mechanical Engineers [ASME] NQA [Nuclear Quality Assurance] -1-1989; ASME NQA-2a-1990 Addenda, Part 2.7, to ASME NQA-2-1989 edition; and ASME NQA-3-1989 edition (excluding Section 2.1[b] and [c], and Section 17.1)

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

- EPA/600 4-83-004, *Interim Guidelines and Specification for Preparing Quality Assurance Project Plans*

- U.S. Nuclear Regulatory Commission Regulatory Guide 4.15, Rev. 1, *Quality Assurance for Radiological Monitoring Program-Effluent Streams and the Environment*

- ANSI N13.30, *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 sampling program and its analytical laboratories operate in accordance with Quality Assurance Plans and Quality Assurance Project Plans that incorporate QA requirements for sampling from the WTS Quality Assurance Program Description. These plans contain such elements as:

- Management and Organization
- Quality System and Description
- Personnel Qualification and Training
- Procurement of Products and Services
- Documents and Records
- Computer Hardware and Software
- Planning
- Management of Work Process (Standard Operating Procedures)
- Assessment and Response
- Quality Improvement

To ensure that the quality of the systems, processes, and deliverables are maintained or improved, three layers of assessments and audits are performed:

- DOE/CBFO performs assessments and audits of the WTS QA program.
- WTS performs internal assessments and audits of their own QA program.
- WTS performs assessments and audits of subcontractor QA programs as applied to WTS contract work.

Along with protocols listed above, WIPP personnel must also implement DOE Order 414.1C. The data quality objectives for the sampling program 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 that the samples are 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 are representative of the baseline information for radionuclides of interest at the WIPP facility.

Sections 7.1, 7.2, and 7.3 discuss the quality control results for the WIPP Laboratories, CEMRC, and TraceAnalysis, Inc., respectively, in terms of how they met the performance evaluation parameters.

7.1 WIPP Laboratories

7.1.1 Completeness

The 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 2007.

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 moved from location to location in each quarter, and was operated along with routine stationary air particulate samplers. There were no results of these duplicate comparisons shown for 2007 as there were no instances in which both the sample and the duplicate met the detection criteria. The duplicate samples for other environmental media were collected at the same time, same place, and under similar conditions as routine samples. Tables 4.4 and 4.5, 4.9, 4.13, 4.17, and 4.19 show duplicate analysis results for groundwater, surface water, sediment, soil, and vegetation samples, respectively.

The measure of precision for radionuclide sample analyses 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

The quality assurance objective for the RER results is a value less than or equal to one. Values less than one are acceptable and demonstrate adequate reproducibility. RERs for most of the duplicate samples analyzed for multiple radiological parameters were less than one, indicating good reproducibility for the combination of the sampling and analysis procedures. Some duplicate pairs for groundwater, sediments, soil, and vegetation yielded RERs greater than one, indicating that the precision objective was not met (Tables 4.4 and 4.5, 4.9, 4.13, 4.17, and 4.19). The cause is unclear but may be due to either the sampling or analysis procedures and may reflect actual differences in the composition of the duplicate samples due to a non-homogeneous distribution of radionuclides in the samples.

Laboratory precision was verified through analysis of replicate samples. Replicate analyses were performed on 10 percent of samples when sample volume allowed. A second aliquot of the selected sample was taken and prepared and analyzed with the sample batch. If the sample replicates did not meet the RER acceptance criterion, the entire batch was re-aliquoted and analyzed again. If the RER acceptance criterion was not met the second time, this was a good indication that the original sample was inhomogeneous. All laboratory replicates passed the RER acceptance criterion, indicating acceptable laboratory precision.

7.1.3 Accuracy

The SOW requires accuracy (as evaluated through analysis of spiked samples) 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) traceable standards for instrument calibration. Overall analytical accuracy was checked through the use of NIST-traceable, spiked, laboratory control samples (LCSs). Analysis of LCSs containing the isotopes of interest was performed on a 10-percent basis (one per every batch of ten or fewer samples). The data quality objective for the results was that the measured concentration be within ± 20 percent of the known values. If this criterion was not met, the entire batch of samples was reanalyzed. LCS results for each isotope were tracked on a running basis using control charts. All radiological LCS results fell within the acceptable ranges, indicating good accuracy.

Accuracy was also ensured through participation by the laboratory in the DOE MAPEP and NRIP interlaboratory comparison programs, as discussed in more detail in Section 7.1.4. Under these programs, analytical results from WIPP Laboratories were compared with the results obtained by the MAPEP and NRIP laboratories. Performance was 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 mission of WIPP Laboratories is to produce high-quality and defensible analytical data in support of the WIPP operations. The SOW requires WIPP Laboratories to ensure consistency through the use of standard analytical methods coupled with specific procedures that govern the handling of samples and the reporting of analytical results. A key element in the WIPP Laboratories quality assurance program is to analyze performance evaluation (PE) samples as part of interlaboratory comparison programs administered by reputable agencies. During the period September 1, 2006, to September 1, 2007, WIPP Laboratories participated in four rounds of the NIST NRIP and two rounds of the DOE MAPEP. In addition, WIPP Laboratories hosted an on-site audit and analyzed numerous PE samples from the DOE Laboratory Accreditation Program (DOELAP), which granted accreditation for in-vitro bioassay analyses on March 21, 2001, and renewed the accreditation in 2004 and 2007 as part of the three-year renewal schedule.

The MAPEP, NRIP, and DOELAP programs involve preparing QC samples containing various alpha-, beta-, and gamma-emitting radionuclides in synthetic urine, synthetic feces, air filter, water, soil, and vegetation media, and distributing the samples to the participating laboratories. The programs are interlaboratory comparisons in that results from the participants are compared with the experimentally measured results of the administering agencies. The programs assess each laboratory's analysis results as acceptable (or passing) or not acceptable (or failing), based on the accuracy of the analyses.

Since bioassay (urine and feces) samples are not analyzed as part of the WIPP environmental program, these NIST program PE analysis results will not be specifically discussed in this report. However, out of a total of 106 NRIP, 96 DOELAP, and 102 MAPEP PE samples analyzed in fiscal year 2007, only six analysis results did not meet the acceptance criteria of the various agencies. Of these six, only four analysis results were for the analysis of WIPP target analytes in environmental samples provided by MAPEP. The four results that did not meet the accuracy criteria are shown in Table 7.1.

Table 7.1 - WIPP Laboratories Only MAPEP PE Sample Analysis Results Not Meeting Accuracy Criteria

Analyte	Matrix	Reported[a]	Acceptable Range[b]	MAPEP Result
^{134}Cs	Soil	218 ± 14 Bq/kg (low)	316 - 588 Bq/kg	452 Bq/kg
^{137}Cs	Soil	264 ± 18 Bq/kg (low)	368 - 683 Bq/kg	526 Bq/kg
^{234}U	Air filter	0.130 ± 0.181 Bq/sample (high)	0.0687 - 0.1275 Bq/sample	0.0981 Bq/sample
^{238}U	Air filter	0.135 ± 0.0187 Bq/sample (high)	0.0715 - 0.1327 Bq/sample	0.102 Bq/sample

[a] Values reported by WIPP Laboratories
[b] Acceptable ranges provided by MAPEP

Cesium-134 and ^{137}Cs concentrations by gamma spectroscopy analysis were lower than the acceptance criteria in soil but did meet the acceptance criteria in the water, air filter, and vegetation matrices. All other radionuclides analyzed by gamma spectroscopy also met the acceptance criteria. Cesium-134 is not a WIPP target radionuclide, but was analyzed concurrently with ^{137}Cs, which is a WIPP analyte. WIPP Laboratories determined that the sample size taken for analysis was not representative of the entire sample, and larger sample sizes subsequently have been used for the gamma counting. Uranium-234 and ^{235}U analysis results by alpha spectrometry were higher than the acceptance criteria in the MAPEP filter sample, but these analytes did meet the criteria in the water, soil, and vegetation matrices. All other alpha spectrometry analysis results were acceptable. The MAPEP PE filter sample (MAPEP-07-RdF17) contained low concentrations of the uranium isotopes, and the ^{234}U and ^{238}U results reported by WIPP Laboratories were slightly higher than the upper range of the acceptance criteria as shown in Tables 7-1 and 7-2. WIPP Laboratories investigated possible reasons for the high results but was not able to determine a specific cause. As shown in Table 7-2, WIPP Laboratories also reported ^{234}U and ^{238}U concentrations in MAPEP water, soil, and vegetation matrices, and these results met the MAPEP acceptance range (-25 percent/+50 percent) for all radionuclides and samples matrices of interest at the WIPP site. Table 7-2 also shows the results of the analysis of another air filter

(MAPEP-06-RdF16, which also contained low concentrations of ^{234}U and ^{238}U and for which the analysis results were within the acceptable range.

Table 7.2 presents the analysis results for MAPEP soil, air filter, vegetation, and water PE samples. All MAPEP bias results met the acceptance criteria (-25 percent/ +50 percent) for all radionuclides and media of interest at the WIPP site, with the exception of those discussed above, and are included in the table.

Table 7.2 - Mixed Analyte Performance Evaluation Program Review for WIPP Laboratories, 2007

	MATRIX: Air Filter (Bq/Filter) MAPEP-06-RdF16				MATRIX: Air Filter (Bq/Filter) MAPEP-07-RdF17			
[RN][a]	Reported Value	MAPEP[b] Value	E[c]	% Bias	Reported Value	MAPEP Value	E	% Bias
^{241}Am	0.134	0.142	A	-5.6	0.0777	0.0977	A	-20.5
^{60}Co	1.62	2.582	A	9.6	2.75	2.8876	A	14.3
^{134}Cs	3.21	3.147	A	2.0	3.74	4.1960	A	-10.9
^{137}Cs	1.87	1.805	A	3.6	2.40	2.5693	A	-6.6
^{238}Pu	0.118	0.118	A	0.0	0.0558	0.0669	A	-16.6
$^{239+240}Pu$	0.00155	ND[d]	N/A[e]	N/A	0.0739	0.0839	A	-11.9
^{90}Sr	0.530	0.62	A	-14.5	0.540	0.6074	A	-11.1
^{234}U	0.145	0.134	A	8.2	0.130	0.0981	N	32.5
^{238}U	0.147	0.139	A	5.8	0.135	0.1021	N	32.2
	MATRIX: Soil (Bq/kg) MAPEP-06-MaS16				**MATRIX: Soil (Bq/kg) MAPEP-07-MaS17**			
[RN]	**Reported Value**	**MAPEP Value**	**E**	**% Bias**	**Reported Value**	**MAPEP Value**	**E**	**% Bias**
^{241}Am	100	105.47	A	-5.2	28.0	34.8	A	-19.5
^{60}Co	714	676.33	A	5.6	486	471.2	A	3.1
^{134}Cs	218	452.13	N	-51.8	330	327.4	A	0.8
^{137}Cs	264	525.73	N	-49.8	755	799.7	A	-5.6
^{238}Pu	78.8	82	A	-3.9	27.5	31.3	A	-12.1
$^{239+240}Pu$	N/A	N/A	N/A	N/A	38.7	44.5	A	-13.0
^{90}Sr	189	223.3	A	-15.4	291	319.0	A	-8.8
^{234}U	150	152.44	A	-1.6	165	185.0	A	-10.8
^{238}U	154	158.73	A	-3.0	168	192.4	A	-12.7

Table 7.2 - Mixed Analyte Performance Evaluation Program Review for WIPP Laboratories, 2007

	MATRIX: Water (Bq/Sample) MAPEP-06-MaW16				MATRIX: Water (Bq/Sample) MAPEP-07-MaW17			
[RN]	Reported Value	MAPEP Value	E	% Bias	Reported Value	MAPEP Value	E	% Bias
^{241}Am	2.26	2.31	A	-2.2	1.65	1.71	A	-3.5
^{60}Co	226	213.08	A	6.1	28.8	26.9	A	7.1
^{134}Cs	109	112.82	A	-3.4	83.1	83.5	A	-0.5
^{137}Cs	197	196.14	A	0.4	168	163.0	A	3.1
^{238}Pu	1.37	1.39	A	-1.4	2.04	2.25	A	-9.3
$^{239+240}Pu$	1.82	1.94	A	-6.2	2.00	2.22	A	-9.9
^{90}Sr	11.4	15.69	A	-27.3	8.09	8.87	A	-8.8
^{234}U	2.23	2.15	A	3.7	2.34	2.49	A	-6.0
^{238}U	2.24	2.22	A	0.9	2.42	2.48	A	-2.4

	MATRIX: Vegetation (Bq/Sample) MAPEP-06-RdV16				MATRIX: Vegetation (Bq/Sample) MAPEP-07-RdV17			
[RN]	Reported Value	MAPEP Value	E	% Bias	Reported Value	MAPEP Value	E	% Bias
^{241}Am	0.160	0.1806	A	-11.4	ND	ND	N/A	N/A
^{60}Co	5.13	5.8215	A	11.9	5.34	5.806	A	-8.0
^{134}Cs	5.27	6.2101	A	-15.1	6.30	7.487	A	-15.9
^{137}Cs	6.08	6.9949	A	-13.1	4.80	5.495	A	-12.6
^{238}Pu	0.142	0.1484	A	-4.3	0.148	0.151	A	-2.0
$^{239+240}Pu$	0.203	0.2135	A	-4.9	0.00274	ND	N/A	N/A
^{90}Sr	1.48	1.5351	A	-3.6	1.05	1.095	A	-4.1
^{234}U	0.281	0.2624	A	7.1	0.250	0.243	A	2.9
^{238}U	0.268	0.2724	A	-1.6	0.249	0.253	A	-1.6

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

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 of radionuclides. 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 integrity.

7.2 CEMRC

CEMRC performed the analyses of VOC samples collected in the WIPP underground during 2007.

7.2.1 Completeness

Completeness is defined in WP 12-VC.01 as being "the percentage of the ratio of the number of valid sample results received versus the total number of samples collected." For 2007, CEMRC was required to maintain a completeness of 90 percent. For 2007, 690 samples (including field duplicates) were submitted to CEMRC for analysis; 689 of these produced valid data. One sample was voided due to a leaky canister valve and did not count against laboratory completeness; therefore, the program completion percentage was 100 percent.

7.2.2 Precision

Precision is evaluated by two means in the VOC monitoring program: comparing both laboratory duplicate samples and 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. 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 2007, a LCS and LCSD were generated and evaluated for all data packages discussed in Section 7.2. The result from the evaluation of the comparison resulted in 100 percent of the data within the acceptable range.

Field duplicate samples are also collected and compared for precision. The acceptable range for the concentrations resulting from analysis is ± 35 percent. For each value reported over the MRL in 2007, each field duplicate met the acceptance criteria.

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, 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 percentage of less than 30 percent for each analyte of the calibration. This is calculated by first calculating the relative response factor as indicated below:

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

$$\text{Relative Standard Deviation} = \frac{\text{Standard Deviation of Relative Response Factor}}{\text{Average Relative Response Factor of Analyte}} \times 100$$

During 2007, 100 percent of instrument calibrations met the ± 30 percent criteria.

LCS recoveries

LCS recoveries are required to have a percent recovery of ± 25 (75-125%R) percent. LCS recoveries are calculated as follows:

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

During 2007, 100 percent of the LCS recoveries met the ± 25 percent criterion.

Internal Standard Area

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

During 2007, 100 percent of all standards met this criterion.

Sensitivity

The method detection limit for each of the nine target compounds must be evaluated before sampling begins to meet sensitivity requirements. The initial and annual method detection limit evaluation is performed in accordance with 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," and with EPA/530-SW-90-021, as revised and retitled, "Quality Assurance and Quality Control" (Chapter 1 of SW-846) (1996). For 2007, CEMRC completed method detection limit studies in March, May, and November.

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 2007, all ion abundance criteria were within tolerance.

7.2.4 Comparability

There is no HWFP requirement for comparability in the VOC monitoring program. However, CEMRC participated in an intercomparison laboratory study conducted by Spectra Gases. CEMRC passed the criteria listed in the comparison study for the analytes that are quantitated in the WIPP VOC SOW. Additionally, CEMRC uses NIST traceable standards for each set of analyses. This practice is driven by Method TO-15 (EPA, 1999) and the contract SOWs.

7.2.5 Representativeness

There is no HWFP requirement for representativeness in the VOC monitoring program.

7.3 TraceAnalysis, Inc.

TraceAnalysis, Inc., of Lubbock, Texas, was subcontracted in 2007 to perform the analyses of groundwater samples collected at the WIPP site.

7.3.1 Completeness

Seven monitoring wells are sampled twice each year for the WIPP Groundwater Detection Monitoring Program. During 2007, all seven wells were sampled twice for all required parameters on schedule. The 14 sets of water samples were submitted to TraceAnalysis, Inc., which completed all required analyses without losing any samples. The completeness objective was met, and analytical results were received for all the samples submitted (100% completeness).

7.3.2 Precision

The groundwater samples contained detects in at least some samples for general parameters and cations including calcium, magnesium, potassium, sodium, chloride, nitrate, sulfate, TOC, TOX, density, TDS, total suspended solids (TSS), pH, conductivity, and alkalinity. For these parameters, precision was based on the analysis results of the sample duplicates as well as the precision of the recoveries of the LCS/LCSD pairs, where appropriate. There were no detects for the trace metals, volatile organics, or semivolatile organics in any of the samples, and thus the precision for these parameters was based on the analysis results of the LCS/LCSD pairs.

The precision objective was an RPD of 20. The precision objective was generally met for all the target analytes in Rounds 24 and 25, although not all sample duplicates and LCS/LCSD pairs met the precision objective. Some specific instances of the sample duplicate data or LCS/LCSD recovery data not meeting the precision objective are provided in Table 7.3. This is a small percentage of the total amount of precision data generated, with >95% of the precision data yielding RPDs less than 20. In some cases where the precision objective was not met, the analysis results were at or near the detection limit where the precision would not be expected to be as good as at higher concentrations.

Table 7.3 - Individual Cases Where Precision Objective Was Not Met for Samples Analyzed by TraceAnalysis, Inc.

Round	Well	Parameter	Sample	Duplicate	RPD
25	WQSP-2	Alkalinity	74 mg/L	130 mg/L	55
25	WQSP-2	Potassium	848 mg/L	626 mg/L	30
25	WQSP-3	Alkalinity	30 mg/L	38 mg/L	24
25	WQSP-3	Chloride	136,000 mg/L	184,000 mg/L	30
25	WQSP-3	TOC	U (1.0 mg/L)	2.99 mg/L	100
25	WQSP-4	TSS	2.5 mg/L	16.5 mg/L	147
25	WQSP-5	TSS	2.0 mg/L	1.0 mg/L	67
25	WQSP-5	2,4-Dinitrophenol	30 µg/L	24 µg/L	22
25	WQSP-6A	Chloride	350 mg/L	516 mg/L	38
25	WQSP-6A	Nitrate	5.47 mg/L	6.98 mg/L	24
24	WQSP-1	Alkalinity	72 mg/L	54 mg/L	29
24	WQSP-1	TSS	1.50 mg/L	U (1.0) mg/L	40
24	WQSP-3	Nitrate	0.158 mg/L	U (1.0) mg/L	45
24	WQSP-3	TSS	3.5 mg/L	5.0 mg/L	35
24	WQSP-6A	Nitrate	5.78 mg/L	9.35 mg/L	47
24	WQSP-6A	K	5.5 mg/L	4.5 mg/L	20

U = undetected

7.3.3 Accuracy

The accuracy of the groundwater-sample analyses was based on the percent recovery of individual chemical parameters from the LCS and LCSD QC samples. The data quality objective for the accuracy of the recoveries was 75-125 percent for the general chemistry parameters and metals and 70-130 percent for the VOCs. The data quality objective for the recoveries of the SVOCs was based on historical recoveries as recorded on control charts. The WIPP Laboratories' control chart range was wide for some SVOC parameters (e.g., from "detected" to 63 percent for pyridine; from 19-91 percent for 2-methylphenol; and from "detected" to 123 percent for pentachlorophenol).

The SVOC compounds were detected in the spiked water samples, and the actual recoveries generally ranged from 20-80 percent. Accuracy was also measured through the recoveries of target analytes spiked into DMP groundwater samples (matrix spike/matrix spike duplicate samples). However, TraceAnalysis, Inc. randomly selected samples to use for the matrix spike samples and did not always use DMP groundwater samples for the MS/MSD samples. In addition, not all of the DMP target VOC and SVOC compounds were used for spiking some of the LCS/LCSD and MS/MSD samples. Although the SVOC recoveries were more variable than for the other target analytes, the analysis method ensured that the compounds would have been detected, if present, in the groundwater samples at concentrations near or above the reporting limit of 5 µg/L for most of the SVOC compounds (20 µg/L for 2.4-dinitrophenol).

The general parameter analyses include alkalinity, density, pH, specific conductance, total dissolved solids, TSS, chloride, sulfate, TOX, and TOC. The accuracy and precision of these analyses generally meet the method accuracy and precision objectives. For most of these parameters, the laboratory analyzes one of the duplicate WQSP samples in duplicate as well.

Two of the parameters did not meet DQOs in all cases. The first is TOX. The samples contain high native chloride, and the TOC in the spiked samples was not adequately trapped on the front carbon column. The accuracy and precision objectives were not met for some of the samples. TOX was not detected in any of the 2007 samples. The other parameter for which the precision objective was not always met was TSS. The TSS levels were near the detection limit of 1 mg/L in most samples. The TSS results could vary among duplicates due to some variable condensation of salts from the high-ionic strength samples.

With respect to metals analysis, the trace metals and the major cations were analyzed separately. For some WQSP sample sets, the matrix spike recoveries were slightly lower than the 75-125 percent recovery objective. However, in the few cases that the recoveries did not meet the objective, the recoveries were still generally within 10 percent of the objective range. The lowest recovery reported was 53 percent for chromium in a matrix spike sample in WQSP-3, the well location with the highest salt concentration. The MSD recovery was higher resulting in the precision objective not being met. Chromium was not detected in any of the WQSP samples.

The only trace metal detections were consistent in the two sampling rounds, Rounds 24 and 25, with barium detected in one of the duplicates from WQSP-3; barium detected in both of the duplicates from WQSP-4; and nickel detected in both duplicates and at the same concentrations in WQSP-6A.

The analysis data for the major cations (calcium, magnesium, potassium, and sodium) were accurate and precise for the laboratory control spikes. The only objective not met was the precision of the potassium analyses for WQSP-2 during Round 25 with an RPD of 30.

The spike concentrations used for the MS/MSD samples were well below the native concentrations. If the native concentration is greater than four times the spike level, EPA guidance indicates matrix spike data are not applicable. The laboratory did report MS/MSD data for the major cations, and the recoveries and precision objectives were generally met for calcium, magnesium, and potassium, but not the high-concentration sodium.

The accuracy and precision data generally met the objectives for the VOC analyses. The primary issues with VOC analyses were with the analysis of isobutanol, methyl ethyl ketone (MEK), trichlorofluoromethane, and tetrachloroethylene. Isobutanol does not purge well but is able to be detected using the Method 8260 purge-trap-desorb technique. Its gas chromatography/mass spectrometry relative response factor (RRF) is less than the 0.05 data review criteria is higher than 0.01, the method criteria. The compound often did not meet the precision criteria for the daily calibration check. MS/MSD recoveries were sometimes higher or lower than the objective as were the recoveries for MEK, another poorly purgeable compound.

The CCV and recovery objectives were not met for tetrachloroethylene in a few occasions and for chloroform on one occasion. The target VOCs were not detected in any of the samples.

7.3.4 Comparability

The HWFP requires that groundwater analytical results be comparable by reporting data in consistent units and collecting and analyzing samples using consistent methodology. These comparability requirements were met through the use of consistent, approved standard operating procedures for sample collection and analyses. The normal reporting units for metals were mg/L, and the normal reporting limits for organics were ug/L.

TraceAnalysis, Inc., participated in an Absolute Grade PT Program interlaboratory assessment running from October to November 2007, and 97 percent of the parameters analyzed met the acceptance criteria.

7.3.5 Representativeness

The groundwater DMP is designed to collect representative groundwater samples from specific monitoring well locations. During the sampling process, serial samples were collected and analyzed to help determine when final samples should be collected. These field analyses were conducted to determine whether the water being pumped from the monitoring wells was stable and representative of the natural groundwater at each well. The final samples for analysis of VOCs, SVOCs, metals and general parameters by TraceAnalysis, Inc., were collected only when it had been determined from serial sampling and analysis of groundwater samples in the mobile laboratory that the water being pumped was representative of the natural groundwater at each location.

Appendix A
References

10 CFR Part 50, Appendix B. "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

10 CFR Part 834. "Radiation Protection of the Public and the Environment"; Proposed Rule. *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

10 CFR Part 1021. "National Environmental Policy Act Implementing Procedures." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 61. "National Emission Standards for Hazardous Air Pollutants." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 61.93. "Emission Monitoring and Test Procedure." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 61, Subpart H. "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 121.1. "Purpose and Scope." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 136. "Guidelines Establishing Test Procedures for the Analysis of Pollutants." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 141. "National Primary Drinking Water Regulations." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 143. "National Secondary Drinking Water Regulations." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Parts 150-189. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Regulations. *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 191. "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 191. Subpart A, "Environmental Standards for Management and Storage." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 191, Subpart B. "Environmental Standards for Disposal." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 191, Subpart C. "Environmental Standards for Ground-Water Protection." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 194. "Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance With the 40 CFR Part 191 Disposal Regulations." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR §194.4. "Conditions of Compliance Certification." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR §194.21. "Inspections." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 261.24. "Toxicity Characteristic." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 262. "Standards Applicable to Generators of Hazardous Waste." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 264. "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 270. "EPA Administered Permit Programs: the Hazardous Waste Permit Program." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 280. "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 300. "National Oil and Hazardous Substances Pollution Contingency Plan." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 302. "Designation, Reportable Quantities, and Notification." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 313. "Toxics Release Inventory." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Part 761. "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

40 CFR Parts 1500-1508. "Council on Environmental Quality." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

50 CFR Part 17. "Endangered and Threatened Plants and Wildlife." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

50 CFR Part 20. "Migratory Bird Hunting." *Code of Federal Regulations*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

70 FR 61107-61111. "Notification of Completeness of the Department of Energy's Compliance Recertification Application for the Waste Isolation Pilot Plant." *Federal Register*. Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

20.2.72 NMAC. "Construction Permits." Title 20, New Mexico Administrative Code. (Air Quality Control Regulation 702). Santa Fe, NM.

20.4.1 NMAC. "Hazardous Waste Management." Title 20, New Mexico Administrative Code. Santa Fe, NM.

20.4.1.500 NMAC. "Adoption of 40 CFR Part 264." Title 20, New Mexico Administrative Code. Santa Fe, NM.

20.5 NMAC. "Petroleum Storage Tanks." Title 20, New Mexico Administrative Code. Sante Fe, NM.

20.6.2 NMAC. "Ground and Surface Water Protection." Title 20, New Mexico Administrative Code. Santa Fe, NM.

20.7.10 NMAC. "Drinking Water." Title 20 New Mexico Administrative Code. Santa Fe, NM.

7 U.S.C. §§136, et seq. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). U.S. Government Printing Office, Washington, D.C.

15 U.S.C. §§2601, et seq. Toxic Substances Control Act. U.S. Government Printing Office, Washington, D.C.

16 U.S.C. §§470, et seq. National Historic Preservation Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

16 U.S.C. §§1531, et seq. Endangered Species Act of 1973. *United States Code*. U.S. Government Printing Office, Washington, D.C.

16 U.S.C. §§703, et seq. Migratory Bird Treaty Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

33 U.S.C. §§1251, et seq. Federal Water Pollution Control Act of 1948 (Clean Water Act), Section 402. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§300f, et seq. Safe Drinking Water Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §2011, et seq. Atomic Energy Act of 1954, as amended. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§4321, et seq. National Environmental Policy Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§6901, et seq. Resource Conservation and Recovery Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §6924, et seq. Treatment Standards for Wastes Subject to Land Disposal. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§6912, 6939c, and 6961. Federal Facilities Compliance Act of 1992. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§7401, et seq. Clean Air Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §§9601, et seq. Comprehensive Environmental Response, Compensation, and Liability Act (including the Superfund Amendments and Reauthorization Act of 1986). *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §10101, et seq. Nuclear Waste Policy Act of 1982. *United States Code*. U.S. Government Printing Office, Washington, D.C.

42 U.S.C. §11101. Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III. *United States Code*. U.S. Government Printing Office, Washington, D.C.

43 U.S.C. §§1701, et seq. Federal Land Policy and Management Act. *United States Code*. U.S. Government Printing Office, Washington, D.C.

ANSI/HPS N13.12-1999, *Surface and Volume Radioactivity Standards for Clearance*.

ANSI N13.30. 1996. *Performance Criteria for Radiobioassay*. Health Physics Society, Washington, D.C.

ASME NQA-1-1989 and Supplementary Requirements, *Quality Assurance Program Requirements for Nuclear Facilities*.

ASME NQA-2a-1990 addenda, Part 2.7, *Quality Assurance Requirements of Computer Software for Nuclear Facility Applications*.

ASME NQA-3-1989 (excluding Section 2.1(b) and (c), and Section 17.1), *Quality Assurance Program Requirements for the Collection of Scientific and Technical Information for Site Characterization of High-Level Nuclear Waste*.

Beauheim, R. L. 1986. *Analysis of Pumping Tests of the Culebra Dolomite Conducted at the H-3 Hydropad at the Waste Isolation Pilot Plant (WIPP) Site*, SAND86-2311, Sandia National Laboratories, Albuquerque, NM.

Beauheim, R. L. 1987. Interpretations of Single-Well Hydraulic Tests Conducted at and Near the Waste Isolation Pilot Plant (WIPP) Site, 1983-1987. SAND 87-0039, Sandia National Laboratories, Albuquerque, NM.

Beauheim, R. L., T. F. Dale, and J. F. Pickens. 1991. *Interpretations of Single-Well Hydraulic Tests of the Rustler Formation Conducted in the Vicinity of the Waste Isolation Pilot Plant Site, 1988-1989*. SAND-890869, Sandia National Laboratories, Albuquerque, NM.

Beauheim, R. L., and G. J. Ruskauff. 1998. *Analysis of Hydraulic Tests of the Culebra and Magenta Dolomites and Dewey Lake Redbeds Conducted at the Waste Isolation Pilot Plant Site*. SAND 98-0049, Sandia National Laboratories, Albuquerque, NM.

Beauheim, R. L., and R. M. Roberts. 2002. "Hydrology and Hydraulic Properties of a Bedded Evaporite Formation." Journal of Hydrology, v. 259, pp. 66-88.

Beck, Harold L. and Burton G. Bennet. 2002. *Historical Overview of Atmospheric Nuclear Weapon Testing and Estimates of Fallout in the Continental United States*. Health Phys 82:591-608.

Cooper, J. B., and V. M. Glanzman. 1971. "Geohydrology of Project Gnome Site, Eddy County, New Mexico." Professional Paper 712-A, U.S. Geological Survey, Washington, D.C.

Daniel B. Stephens & Associates, Inc. 2003. *Water Budget Analysis of the Shallow Subsurface Water at the Waste Isolation Pilot Plant*, Carlsbad, NM.

DOE/EH-0173T. 1991. *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, Department of Environment, Safety, and Health, U.S. Department of Energy, Washington, D.C.

DOE Order 231.1A. 2004. *Environment, Safety, and Health Reporting*. U.S. Department of Energy, Washington, D.C.

DOE Order 414.1C. 2005. *Quality Assurance*. U.S. Department of Energy, Washington, D.C.

DOE Order 435.1. 1999. *Radioactive Waste Management*. U.S. Department of Energy, Washington, D.C.

DOE Order 450.1. 2003. *Environmental Protection Program*. U.S. Department of Energy, Washington D.C.

DOE Order 451.1B. 2001. *National Environmental Compliance Policy Act Compliance Program*. U.S. Department of Energy, Washington, D.C.

DOE Order 5400.5. 1993. *Radiation Protection of the Public and the Environment*. U.S. Department of Energy, Washington, D.C.

DOE/EIS-0026-S-2. 1997. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (SEIS-II). Volumes 1 through 3. U.S. Department of Energy, Washington, D.C.

DOE-STD-1153-2002. 2003. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. National Technical Information Service, Washington, D.C.

DOE/CAO 96-2184. 1996. *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant*. U.S. Department of Energy, Carlsbad Field Office. Carlsbad, NM.

DOE/CBFO-94-1012. 1994. *Quality Assurance Program Document*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/CBFO-98-2276. 2003. *Integrated Safety Management System Description*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-92-037. 1992. *Statistical Summary of the Radiological Baseline for the Waste Isolation Pilot Plant*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-93-004. 2002. *Waste Isolation Pilot Plant Land Management Plan*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-95-2065. 2004. *Waste Isolated Pilot Plant Contact Handled (CH) Documented Safety Analysis*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-97-2219. 1997. *Exhaust Shaft Hydraulic Assessment Data Report*. Waste Isolation Pilot Plant. Carlsbad, NM.

DOE/WIPP-98-2285. 1998. *Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-99-2194. 2004. *Waste Isolation Pilot Plant Environmental Monitoring Plan*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-02-3122. 2006. *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-02-3286. 2006. *Waste Isolation Pilot Plant Contact-Handled Waste Handling Emergency Planning Hazards Assessment*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-04-3231. 2004. *Title 40 CFR Part 191 Subparts B and C Compliance Recertification Application 2004*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-04-3310. 2004. *CBFO/WTS Environmental Policy Statement*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-05-3318. 2005. *Waste Isolation Pilot Plant Environmental Management System Description*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-05-3331. 2005. *Waste Isolation Pilot Plant Remote-Handled Waste Handling Emergency Planning Hazards Assessment*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-07-2225. 2007. *Waste Isolation Pilot Plant Annual Site Environmental Report for 2006*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-07-2293. 2006. *WIPP Subsidence Monument Leveling Survey 2006*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-07-3177-Vol 1. 2007. *Geotechnical Analysis Report for July 2005 – June 2006*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-07-3177-Vol 2. 2007. *Geotechnical Analysis Report for July 2005 – June 2006*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-07-3317. 2007. *Annual Change Report- 2006-2007*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP-08-2171. 2008. *Waste Isolation Pilot Plant Biennial Environmental Compliance Report*. Waste Isolation Pilot Plant, Carlsbad, NM.

DOE/WIPP 08-3333. 2008. *WIPP Environmental Management System Annual Report for Fiscal Year 2007*. Waste Isolation Pilot Plant. Carlsbad, NM.

DP-831. 2003. WIPP Discharge Permit. New Mexico Environment Department, Santa Fe, NM.

EPA/530-SW-90-021. 1996. *Quality Assurance and Quality Control*. U.S. Environmental Protection Agency, Washington, D.C.

EPA/600 4-83-004. 1983. *Interim Guidelines and Specification for Preparing Quality Assurance Project Plans*. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1994. Draft *Contract Laboratory Program Volatile Organics Analysis of Ambient Air in Canisters*

EPA. 2007a. Letter to David Moody (CBFO) from Juan Reyes (EPA) dated February 14, 2007.

EPA. 2007b. Letter to David Moody (CBFO) from Juan Reyes (EPA) dated December 20, 2007.

EPA Compendium Method TO-15. 1999. *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and*

Analysis By Gas Chromatography/Mass Spectrometry (GC/MS). U.S. Environmental Protection Agency, Washington, D.C.

EPA Docket A-98-49, Item II-B3-102.

Executive Order 13101. 1998. *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition.* Office of the President, Washington, D.C.

Executive Order 13148. 1998. *Greening the Government Through Leadership in Environmental Management*. Office of the President, Washington, D.C.

Executive Order 13423. 2007. *Strengthening Federal Environmental, Energy, and Transportation Management*. Office of the President, Washington, D.C.

Hillesheim, M. B., R.L. Beauheim, and R. G. Richardson. 2006. "Overview of the WIPP Groundwater Monitoring Programs with Inferences about Karst in the WIPP Vicinity," in L. Land, V. W. Lueth, W. Raatz, P. Boston, and D. L. Love, eds., *Caves and Karst of Southeastern New Mexico*. New Mexico Geological Society, 57th Annual Fall Field Conference Guidebook. 277-286.

International Atomic Energy Agency. 1992. Technical Report Series No. 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*. Vienna, Austria.

ISO 14001. *Environmental Management Systems - Specification with Guidance for Use*. 2004. International Organizations for Standardization, Geneva, Switzerland.

ISO/IEC 17025. 2006. *General Requirements for the Competence of Testing and Calibration Laboratories*. International Organization for Standardization, Geneva, Switzerland.

IT Corporation. 2000. Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Update Report. Albuquerque, NM.

Lowry, T. S., and R. L. Beauheim. 2004. Analysis Report, Task 2 of AP-110, Evaluation of Water-Level Rise in the Culebra Due to Recharge from Refining Process Water Discharged onto Potash Tailings Piles. ERMS# 536239. Carlsbad, NM: Sandia WIPP Records Center.

Lowry, T. S., and R. L. Beauheim. 2005. Analysis Report, Task 3 of AP-110, Evaluation of Water-Level Rise in the Culebra Due to Leakage Through Poorly Plugged and Abandoned Potash Boreholes. ERMS# 540187. Carlsbad, NM: Sandia WIPP Records Center.

Mercer, J. W. 1983. *Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Los Medaños Area, Southeastern New Mexico*. Water Resources investigations, Report 83-4016, U.S. Geological Survey.

Mercer, J. W. and B. R. Orr. 1977. *Review and Analysis of Geologic Conditions Near the Site of a Potential Nuclear Waste Repository Eddy and Lea Counties, New Mexico*. U.S. Geological Survey Open-File Rept., 77-123.

Minnema, D. M. and L. W. Brewer. 1983. Background Radiation Measurements at Waste Isolation Pilot Plant Site, Carlsbad, New Mexico. SAND83-1296.

MP 1.28, Integrated Safety Management. Washington TRU Solutions LLC, Waste Isolation Pilot Plant, Carlsbad, NM.

NCRP. 1987a. Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*. National Council on Radiation Protection and Measurements. Bethesda, MD.

NCRP. 1987b. Report No. 087, *Use of Bioassay Procedures for Assessment of Internal Radionuclide Deposition*. National Council on Radiation Protection and Measurements. Bethesda, MD.

NCRP. 1991. Report No. 109, *Effects of Ionizing Radiation on Aquatic Organisms*. National Council on Radiation Protection and Measurements. Bethesda, MD.

NM4890139088-TSDF. 1999. Waste Isolation Pilot Plant Hazardous Waste Facility Permit. New Mexico Environment Department, Santa Fe, NM.

NMSA 1978. §74-2. New Mexico Air Quality Control Act. New Mexico Statutes Annotated 1978. State of New Mexico, Santa Fe, NM.

NMSA 1978. §74-4-1. New Mexico Hazardous Waste Act. New Mexico Statutes Annotated 1978. State of New Mexico, Santa Fe, NM.

NMSA 1978. §74-6-1. New Mexico Water Quality Act. New Mexico Statutes Annotated. State of New Mexico, Santa Fe, NM.

Pacific Northwest National Laboratory. 1999. *Hanford Decision Level for Alpha Spectrometry Bioassay Analyses Based on the Sample Specific Total Propagated Uncertainty* (99352). J. A. MacLellan, Radiation and Health Technology. Richland, WA.

Powers, D. W. 2004. Analysis Report, Task 1B of AP-110, Identify Plugged and Abandoned Oil or Gas Wells Not Sealed Through the Culebra with Cement, and Units to Which the Culebra Might Be Connected. ERMS# 538279. Carlsbad, NM: Sandia WIPP Records Center.

Public Law 96-164. National Security and Military Applications of Nuclear Energy Authorization Act of 1980.

Public Law 102-579. Waste Isolation Pilot Plant Land Withdrawal Act. October 1992, as amended October 1996 by Public Law 104-201.

Stormont, J. C., C. L. Howard, and J. J. K. Daemen. 1991. Changes in Rock Salt Permeability Due to Nearby Excavation. In: Roegiers, J. C. (Ed.), Rock Mechanics as a Multidisciplinary Science. Proceedings of the 32nd U.S. Symposium, the University of Oklahoma, Norman, Oklahoma, July 10-12, 1991. A. A. Balkema, Brookfield, VT, pp. 899-907.

U.S. Nuclear Regulatory Commission Docket-71-9218. *TRUPACT-II Safety Analysis Report for Packaging*. Nuclear Regulator Commission, Washington, D.C.

UNSCEAR. 2000. *Sources and Effects of Ionizing Radiation*. 2000 Report, Vol. 1. United Nations Scientific Committee on the Effects of Atomic Radiation.

WP 02-1, WIPP Groundwater Monitoring Program Plan. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 02-EC.07, Waste Isolation Pilot Plant Affirmative Procurement Plan. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 02-EC.11, Waste Isolation Pilot Plant Pollution Prevention Program Plan. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 02-EC.13, Environmental Assessment Plan. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 02-EM3004, Radiological Data Verification and Validation. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 04-CO, Maintenance Operation Instruction Manual. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 09, Engineering Conduct of Operations. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 10-2, Conduct of Operations. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 12-VC.01, Confirmatory Volatile Organic Compound Monitoring Program. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description. Washington TRU Solutions LLC. Waste Isolation Pilot Plant, Carlsbad, NM.

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Appendix B
Active Environmental Permits

Table B.1 - Active Environmental Permits and Rights of Way for the Waste Isolation Pilot Plant - Calendar Year 2007 (Does Not Include Hazardous Waste Facility Permit or DP-831)

	Granting Agency	Type of Permit	Permit Number	Granted	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	NM46092	7/3/90	9/4/11
9	Department of the Interior, Bureau of Land Management	Right-of-Way for Valor Telecon	NM113339	8/9/05	12/31/34
10	Department of the Interior, Bureau of Land Management	Right-of-Way for SPS Powerline	NM43203	2/20/96	10/19/11
11	Department of the Interior, Bureau of Land Management	Right-of-Way for South Access Road	NM46130	8/17/81	8/17/31
12	Department of the Interior, Bureau of Land Management	Right-of-Way for South Access Road Fence	NM94304	3/15/95	none
13	Department of the Interior, Bureau of Land Management	Right-of-Way for Duval telephone line	NM60174	11/6/96	3/8/15
14	Department of the Interior, Bureau of Land Management	Right-of-Way for Wells AEC-7 & AEC-8	NM108365	8/30/02	8/30/32
15	Department of the Interior, Bureau of Land Management	Right-of-Way for ERDA-6	NM108365	8/30/02	8/30/32
16	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
17	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
18	Department of the Interior, Bureau of Land Management	Right-of-Way for Seismic Monitoring Station	NM85426	9/23/91	None
19	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
20	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
21	Department of the Interior, Bureau of Land Management	Right-of-Way for Monitoring Well WIPP-11	NM108365	9/15/04	9/20/34
22	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
23	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

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	Granting Agency	**Type of Permit**	**Permit Number**	**Granted**	**Expiration**
24	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
25	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-1 and access road	109177	6/17/03	6/17/33
26	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-11 and access road	110735	10/16/03	10/16/33
27	Department of the Interior, Bureau of Land Management	Right-of-Way easement for WIPP well bore SNL-5 and access road	110735	10/16/03	10/16/33
28	Department of the Interior, Bureau of Land Management	Right-of-Way grant for SNL-16 and 17	NM108365	12/21/05	8/30/32
29	Department of the Interior, Bureau of Land Management	Right-of-Way grant for SNL-18 and 10	NM115315	3/21/06	12/31/35
30	Department of the Interior, Bureau of Land Management	Right-of-way reservation amendment for SNL-13 and SNL-14	NM108365	1/25/05	8/30/32
31	Department of the Interior, Bureau of Land Management	Right-of-way reservation amendment for SNL-6, SNL-8, and SNL-15	NM108365	3/15/05	8/30/32
32	Department of the Interior, Bureau of Land Management	Right-of-way for 20 radiological stations, 2 aerosol samplers, and 2 weather monitor site.	NM063136	7/3/86	7/2/11
33	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
34	New Mexico Commissioner of Public Lands	Right-of-Way for High Volume Air Sampler	RW-22789	10/3/85	10/3/20
35	New Mexico Commissioner of Public Lands	Monitoring Well SNL-3	RW-28537	7/31/03	7/31/38
36	New Mexico Commissioner of Public Lands	Monitoring Well SNL-1	RW-28535	8/27/03	8/27/38
37	New Mexico Commissioner of Public Lands	Right-of-Way Easement for Accessing State Trust Lands in Eddy & Lea Counties	RW-25430	9/28/04	9/28/14
38	New Mexico Environment Department Air Quality Bureau	Operating Permit for two backup diesel generators	310-M-2	12/7/93	None
39	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
40	New Mexico Environment Department-UST Bureau	Underground Storage Tanks	Facility No. 31539	7/1/07	6/30/08
41	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2801	2/23/01	None
42	New Mexico State Engineer Office	Monitoring Well	C-2811	3/2/02	None
43	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2802	2/23/01	None
44	New Mexico State Engineer Office	Monitoring Well Exhaust Shaft Exploratory Borehole	C-2803	2/23/01	None
45	New Mexico State Engineer Office	Appropriation: WQSP-1 Well	C-2413	10/21/96	None
46	New Mexico State Engineer Office	Appropriation: WQSP-2 Well	C-2414	10/21/96	None
47	New Mexico State Engineer Office	Appropriation: WQSP-3 Well	C-2415	10/21/96	None
48	New Mexico State Engineer Office	Appropriation: WQSP-4 Well	C-2416	10/21/96	None
49	New Mexico State Engineer Office	Appropriation: WQSP-5 Well	C-2417	10/21/96	None
50	New Mexico State Engineer Office	Appropriation: WQSP-6 Well	C-2418	10/21/96	None

Table B.1 - Active Environmental Permits and Rights of Way for the Waste Isolation Pilot Plant - Calendar Year 2007 (Does Not Include Hazardous Waste Facility Permit or DP-831)

	Granting Agency	Type of Permit	Permit Number	Granted	Expiration
51	New Mexico State Engineer Office	Appropriation: WQSP-6a Well	C-2419	10/21/96	None
52	New Mexico State Engineer Office	Monitoring Well AEC-7	C-2742	11/6/00	None
53	New Mexico State Engineer Office	Monitoring Well AEC-8	C-2744	11/6/00	None
54	New Mexico State Engineer Office	Monitoring Well Cabin Baby	C-2664	7/30/99	None
55	New Mexico State Engineer Office	Monitoring Well DOE-1	C-2757	11/6/00	None
56	New Mexico State Engineer Office	Monitoring Well DOE-2	C-2682	4/17/00	None
57	New Mexico State Engineer Office	Monitoring Well ERDA-9	C-2752	11/6/00	None
58	New Mexico State Engineer Office	Monitoring Well H-1	C-2765	11/6/00	None
59	New Mexico State Engineer Office	Monitoring Well H-2A	C-2762	11/6/00	None
60	New Mexico State Engineer Office	Monitoring Well H-2B1	C-2758	11/6/00	None
61	New Mexico State Engineer Office	Monitoring Well H-2B2	C-2763	11/6/00	None
62	New Mexico State Engineer Office	Monitoring Well H-2C	C-2759	11/6/00	None
63	New Mexico State Engineer Office	Monitoring Well H-3B1	C-2764	11/6/00	None
64	New Mexico State Engineer Office	Monitoring Well H-3B2	C-2760	11/6/00	None
65	New Mexico State Engineer Office	Monitoring Well H-3B3	C-2761	11/6/00	None
66	New Mexico State Engineer Office	Monitoring Well H-3D	C-3207	11/6/00	None
67	New Mexico State Engineer Office	Monitoring Well H-4A	C-2725	11/6/00	None
68	New Mexico State Engineer Office	Monitoring Well H-4B	C-2775	11/6/00	None
69	New Mexico State Engineer Office	Monitoring Well H-4C	C-2776	11/6/00	None
70	New Mexico State Engineer Office	Monitoring Well H-5A	C-2746	11/6/00	None
71	New Mexico State Engineer Office	Monitoring Well H-5B	C-2745	11/6/00	None
72	New Mexico State Engineer Office	Monitoring Well H-5C	C-2747	11/6/00	None
73	New Mexico State Engineer Office	Monitoring Well H-6A	C-2751	11/6/00	None
74	New Mexico State Engineer Office	Monitoring Well H-6BR	C-3362	12/27/07	None
75	New Mexico State Engineer Office	Monitoring Well H-6C	C-2750	11/6/00	None
76	New Mexico State Engineer Office	Monitoring Well H-7A	C-2694	4/17/00	None
77	New Mexico State Engineer Office	Monitoring Well H-7B1	C-2770	11/6/00	None
78	New Mexico State Engineer Office	Monitoring Well H-7B2	C-2771	11/6/00	None
79	New Mexico State Engineer Office	Monitoring Well H-7C	C-2772	11/6/00	None
80	New Mexico State Engineer Office	Monitoring Well H-8A	C-2780	11/6/00	None
81	New Mexico State Engineer Office	Monitoring Well H-8B	C-2781	11/6/00	None
82	New Mexico State Engineer Office	Monitoring Well H-8C	C-2782	11/6/00	None
83	New Mexico State Engineer Office	Monitoring Well H-9A	C-2785	11/6/00	None
84	New Mexico State Engineer Office	Monitoring Well H-9B	C-2783	11/6/00	None
85	New Mexico State Engineer Office	Monitoring Well H-9C	C-2784	11/6/00	None
86	New Mexico State Engineer Office	Monitoring Well H-10A	C-2779	11/6/00	None
87	New Mexico State Engineer Office	Monitoring Well H-10B	C-2778	11/6/00	None
88	New Mexico State Engineer Office	Monitoring Well H-10C	C-2695	4/17/00	None
89	New Mexico State Engineer Office	Monitoring Well H-11B1	C-2767	11/6/00	None
90	New Mexico State Engineer Office	Monitoring Well H-11B2	C-2687	4/17/00	None
91	New Mexico State Engineer Office	Monitoring Well H-11B3	C-2768	11/6/00	None
92	New Mexico State Engineer Office	Monitoring Well H-11B4	C-2769	11/6/00	None
93	New Mexico State Engineer Office	Monitoring Well H-12	C-2777	11/6/00	None
94	New Mexico State Engineer Office	Monitoring Well H-14	C-2766	11/6/00	None

Table B.1 - Active Environmental Permits and Rights of Way for the Waste Isolation Pilot Plant - Calendar Year 2007 (Does Not Include Hazardous Waste Facility Permit or DP-831)

	Granting Agency	Type of Permit	Permit Number	Granted	Expiration
95	New Mexico State Engineer Office	Monitoring Well H-15	C-2685	4/17/00	None
96	New Mexico State Engineer Office	Monitoring Well H-15R	C-3361	12/27/07	None
97	New Mexico State Engineer Office	Monitoring Well H-16	C-2753	11/6/00	None
98	New Mexico State Engineer Office	Monitoring Well H-17	C-2773	11/6/00	None
99	New Mexico State Engineer Office	Monitoring Well H-18	C-2683	4/17/00	None
100	New Mexico State Engineer Office	Monitoring Well P-17	C-2774	11/6/00	None
101	New Mexico State Engineer Office	Monitoring Well WIPP-11	C-3365	12/27/07	None
102	New Mexico State Engineer Office	Monitoring Well WIPP-12	C-2639	1/12/99	None
103	New Mexico State Engineer Office	Monitoring Well WIPP-13	C-2748	11/6/00	None
104	New Mexico State Engineer Office	Monitoring Well WIPP-18	C-2684	4/17/00	None
105	New Mexico State Engineer Office	Monitoring Well WIPP-19	C-2755	11/6/00	None
106	New Mexico State Engineer Office	Monitoring Well WIPP-21	C-2754	11/6/00	None
107	New Mexico State Engineer Office	Monitoring Well WIPP-25	C-2723	7/26/00	None
108	New Mexico State Engineer Office	Monitoring Well WIPP-26	C-2724	11/6/00	None
109	New Mexico State Engineer Office	Monitoring Well WIPP-27	C-2722	11/6/00	None
110	New Mexico State Engineer Office	Monitoring Well WIPP-28	C-2636	1/12/99	None
111	New Mexico State Engineer Office	Monitoring Well WIPP-29	C-2743	11/6/00	None
112	New Mexico State Engineer Office	Monitoring Well WIPP-30	C-2727	8/4/00	None
113	New Mexico State Engineer Office	Monitoring Well SNL-2	C-2948	2/14/03	None
114	New Mexico State Engineer Office	Monitoring Well SNL-9	C-2950	2/14/03	None
115	New Mexico State Engineer Office	Monitoring Well SNL-12	C-2954	2/25/03	None
116	New Mexico State Engineer Office	Monitoring Well SNL-1	C-2953	2/25/03	None
117	New Mexico State Engineer Office	Monitoring Well SNL-3	C-2949	2/14/03	None
118	New Mexico State Engineer Office	Monitoring Well WTS-4	C-2960	3/18/03	None
119	New Mexico State Engineer Office	Monitoring Well SNL-5	C-3002	10/1/03	None
120	New Mexico State Engineer Office	Monitoring Well IMC-461	C-3015	11/25/03	None
121	New Mexico State Engineer Office	Monitoring Well SNL-11	C-3003	10/1/03	None
122	New Mexico State Engineer Office	Monitoring Well SNL10	C03221	7/26/05	None
123	New Mexico State Engineer Office	Monitoring Well SNL16	C03220	7/26/05	None
124	New Mexico State Engineer Office	Monitoring Well SNL17	C03222	7/26/05	None
125	New Mexico State Engineer Office	Monitoring Well SNL18	C03233	10/6/05	None
126	New Mexico State Engineer Office	Monitoring Well SNL19	C03234	10/6/05	None
127	U.S. Fish and Wildlife Service	Migratory Bird Special Purpose - Relocate	MB155189-0	7/10/07	3/31/09

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	SOO	Sample of Opportunity*
IDN	Indian Tank	SWL	Sewage Lagoons
LST	Lost Tank	TUT	Tut Tank
MLR	Mills Ranch	UPR	Upper Pecos River
NOY	Noya Tank	WAB	WIPP Air Blank
PCN	Pierce Canyon	WEE	WIPP East
PEC	Pecos River	WFF	WIPP Far Field
PKT	Poker Trap	WQSP	Water Quality Sample Program
		WSS	WIPP South

* Sample taken where found

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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 2 sigma level. For the exceptions noted, these radionuclides are considered detected if they meet the criteria listed above <u>and</u> 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 a radionuclide in a sample that will be detected with a 5 percent probability of nondetection while accepting a 5 percent probability of erroneously deciding that a positive quantity of a radionuclide 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:

$$MDC = \frac{4.66 \sqrt{S}}{K\ T} + \frac{3.00}{K\ T}$$

Where:

S	=	Net method blank counts; when method blank counts = 0, average of the last 30 blanks analyzed are substituted
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 ANSI N13.30, *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 TPU for each data point must be reported at 2σ level. $TPU_{2\sigma}$ is found by multiplying $TPU_{1\sigma}$ by 1.96 after using the following equation:

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

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	=	Radionuclide Decay Constant = ln 2/(half-life) (same units as the half-life used to compute Δt)
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 ANSI N13.30 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, Radiological Data Verification and Validation).

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

Where:

$\overline{X}_A$	=	Mean Activity of Population A
$\overline{X}_B$	=	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.

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

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 the "baseline period" concentrations. Baseline concentrations were measured from 1995 through 2000 for the analytes shown. These plots indicate the sample and duplicate concentration values with respect to sample round, and the baseline period is represented by plotted data for Rounds 1 through 10. Sampling Round 24 occurred March through May 2007 and sampling Round 25 occurred September through November 2007. See Appendix F for specific concentration information on the WQSP groundwater wells.

An example of a time trend analysis is a comparison between the baseline period concentrations and the data collected during subsequent sampling rounds. One illustration is in total suspended solids (TSS) concentrations which, as shown in the time trend graphs in this appendix, exhibit a change from the early sampling rounds to latter rounds in all WQSP wells. 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.

Notable trends and observations include:

Magnesium ion concentrations reported for well WQSP-3 exhibited a moderate increase during Round 24; however, during Round 25 the magnesium ion concentrations for well WQSP-3 were within the normal range of past values. Magnesium ion concentrations reported for wells WQSP-1, -2, -4, -5, -6 and -6A were within the normal range of past values for Rounds 24 and 25.

Potassium ion concentrations reported for wells ion concentrations reported for wells WQSP-1, -2, -3, -4, -5, -6 and -6A were within the normal range of past values for Rounds 24 and 25.

Sodium ion concentrations reported for well WQSP-1 exhibited a moderate increase during Round 24; however, during Round 25, the sodium ion concentrations for well WQSP-1 were within the normal range of past values. The average sodium ion concentration reported for well WQSP-4 exhibited a moderate increase during Round 25; however, during Round 24, the average sodium ion concentration for well WQSP-4 was within the normal range of past values. The average sodium ion concentrations in wells WQSP-2, -3, -5, -6 and -6A were within the normal range of past values during Rounds 24 and 25.

The average chloride ion concentration reported for well WQSP-1 exhibited a moderate increase during Round 24; however, during Round 25, the average chloride ion concentration reported for well WQSP-1 was within the normal range of past values.

The average chloride ion concentrations reported for well WQSP-3 exhibited a moderate increase during Round 25; however, during Round 24 the average chloride ion concentration reported for well WQSP-3 was within the normal range of past values. The average chloride ion concentrations reported for well WQSP-4 exhibited a moderate increase in Round 24, but decreased in Round 25. The average chloride ion concentrations in wells WQSP-2, -5, -6, and -6A were within the normal range of past values during Rounds 24 and 25.

Sulfate ion concentrations reported for well WQSP-3 exhibited a significant increase during Round 19; however, during Rounds 20 and 21, sulfate ion concentrations in well WQSP-3 returned to near normal values, only to exhibit a moderate increase again during Rounds 22 and 23. During Rounds 24 and 25, sulfate ion concentrations in well WQSP-3 returned to near normal values again. The average sulfate ion concentration reported for well WQSP-4 during Round 24 exhibited a moderate increase; however, during Round 25 the average sulfate ion concentration in well WQSP-4 returned to a near normal value. Average sulfate ion concentrations reported for well WQSP-5 exhibited moderate increases during Rounds 21, 23, and 24; however, during Rounds 22 and 25 average sulfate ion concentrations in well WQSP-5 returned to near normal values. The average sulfate ion concentrations in wells WQSP-1, -2, -6, and -6A were close to the normal range of past values during Rounds 24 and 25.

The apparent fluctuations of reported chloride, magnesium, sodium, and sulfate ion concentrations in some of the WQSP wells during Rounds 19 to 25, as described above, may be the result of random or systematic errors as the laboratory reported that interferences were present in the analyses. None of the parameters that exhibited increases in concentration are regulated constituents of the transuranic mixed waste that is authorized to be disposed of under the WIPP HWFP.

Overall, the cation-anion charge balance errors for Round 25 WQSP well samples were significantly lower than the cation-anion charge balance errors for Round 24 WQSP well samples. For Round 25 samples, only well WQSP-3 exhibited a cation-anion charge balance error of greater than 10 percent, and wells WQSP-5, -6 and -6A exhibited cation-anion charge balance errors of less than 1 percent. WIPP groundwater exhibits large variations in total dissolved solids concentration. Wells WQSP-1, -2, -3, and -4 produce brine water samples with extremely high dissolved solids concentrations, whereas wells WQSP-5 and -6 produce brine water samples with moderately high to high dissolved solids concentrations (wells WQSP-1 through -6 are screened in the deep water bearing Culebra Dolomite of the Rustler Formation). Well WQSP-6A produces brackish water samples with much lower dissolved solids concentrations. Therefore, cation-anion charge balance errors that exceed 10 percent are not uncommon, especially for the brine water samples obtained from wells WQSP-3 and -4.

The laboratory reported average total suspended solids concentrations that were unusually high in wells WQSP-1, -2, -3, -4, and -5 in Round 25. The cause is unknown.

Total organic halogens (TOX) had been reported at relatively high and highly variable concentrations during rounds prior to Round 19 in wells WQSP-1, 3, 4, 5, 6, and 6A. A new contract laboratory began performing TOX analyses with Round 19. The previous laboratory reported having great difficulty with TOX analyses for WIPP brines due to the great concentrations of inorganic halogens interfering with the analysis. The new laboratory has reported lower and consistent average concentrations for TOX since Round 19 and through Round 25.

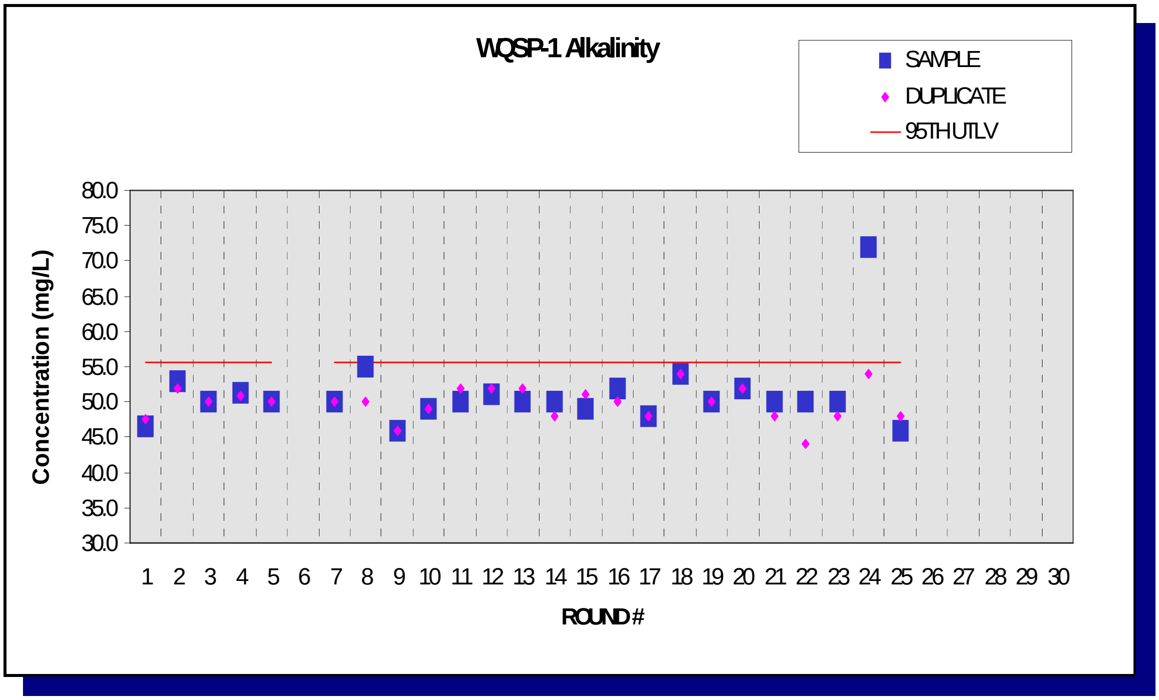

Figure E.1 - Time Trend Plot for Alkalinity at WQSP-1

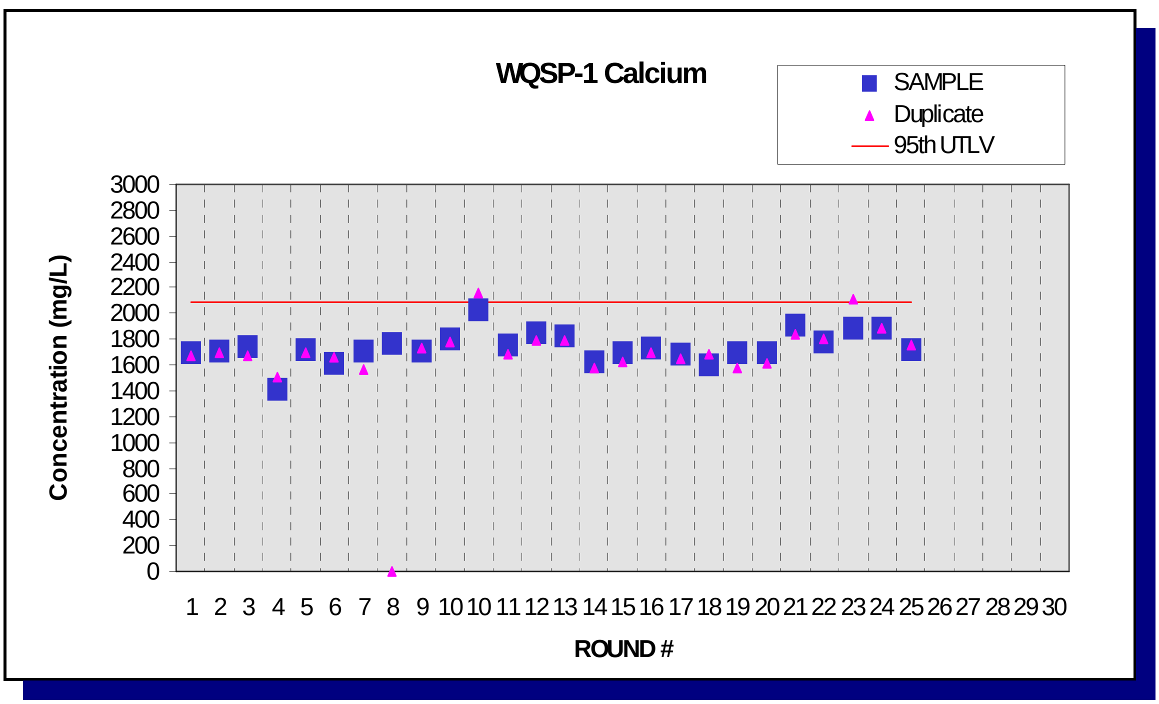

Figure E.2 - Time Trend Plot for Calcium at WQSP-1

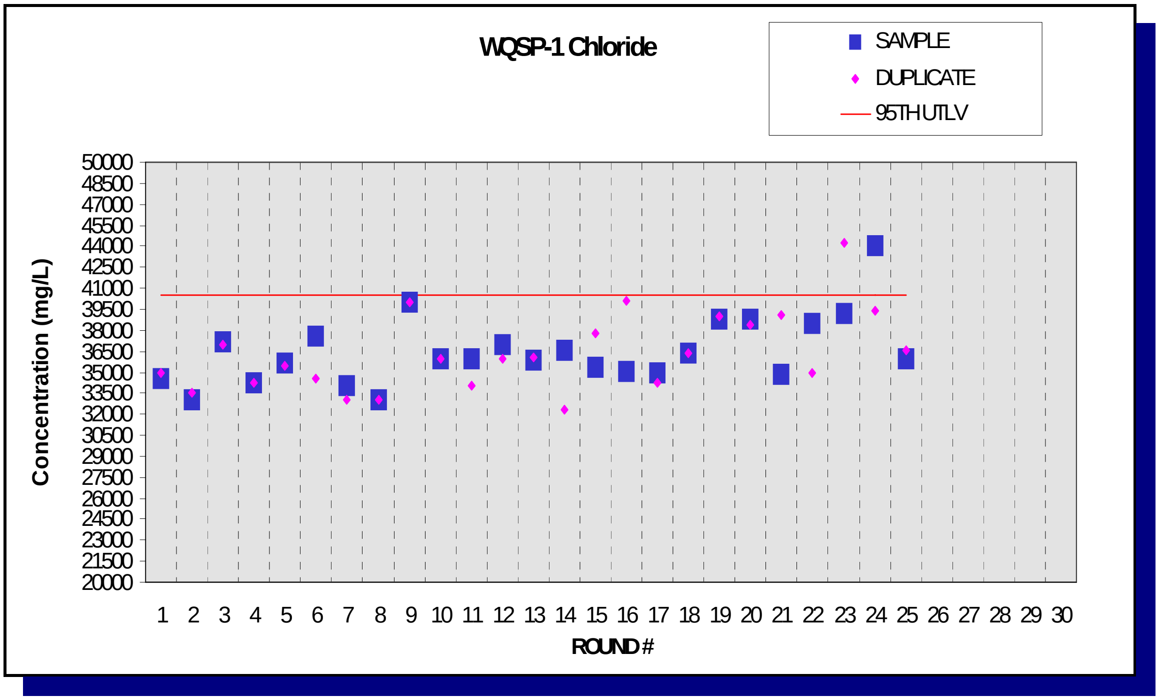

Figure E.3 - Time Trend Plot for Chloride at WQSP-1

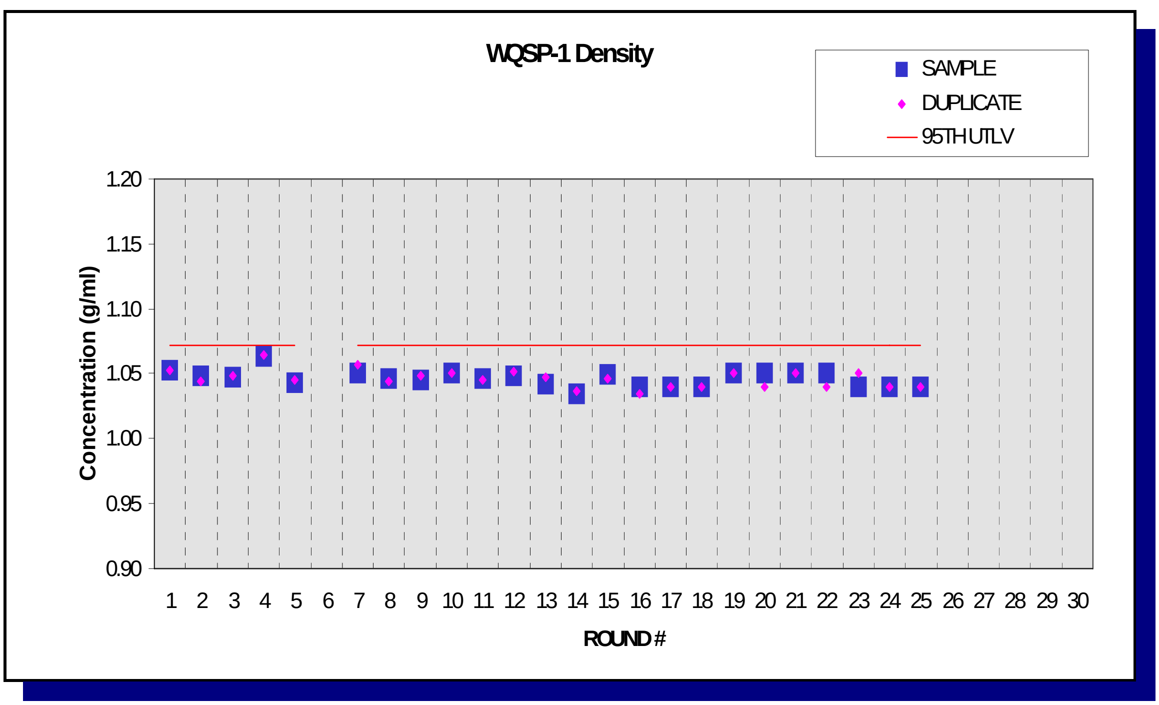

Figure E.4 - Time Trend Plot for Density at WQSP-1

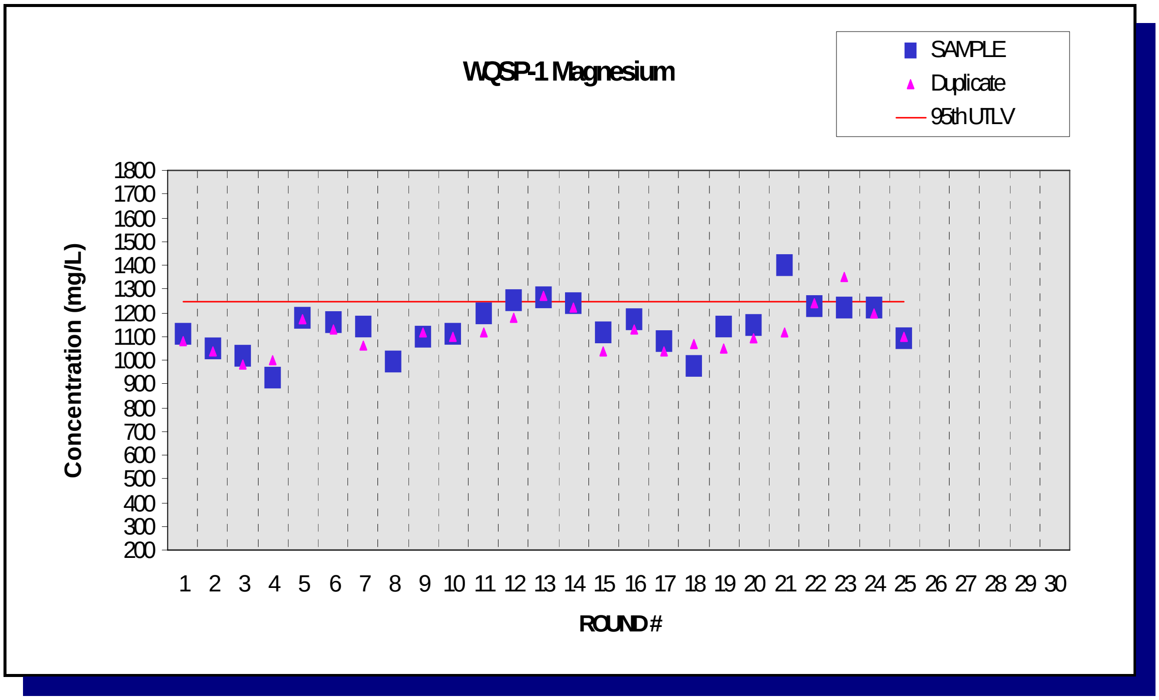

Figure E.5 - Time Trend Plot for Magnesium at WQSP-1

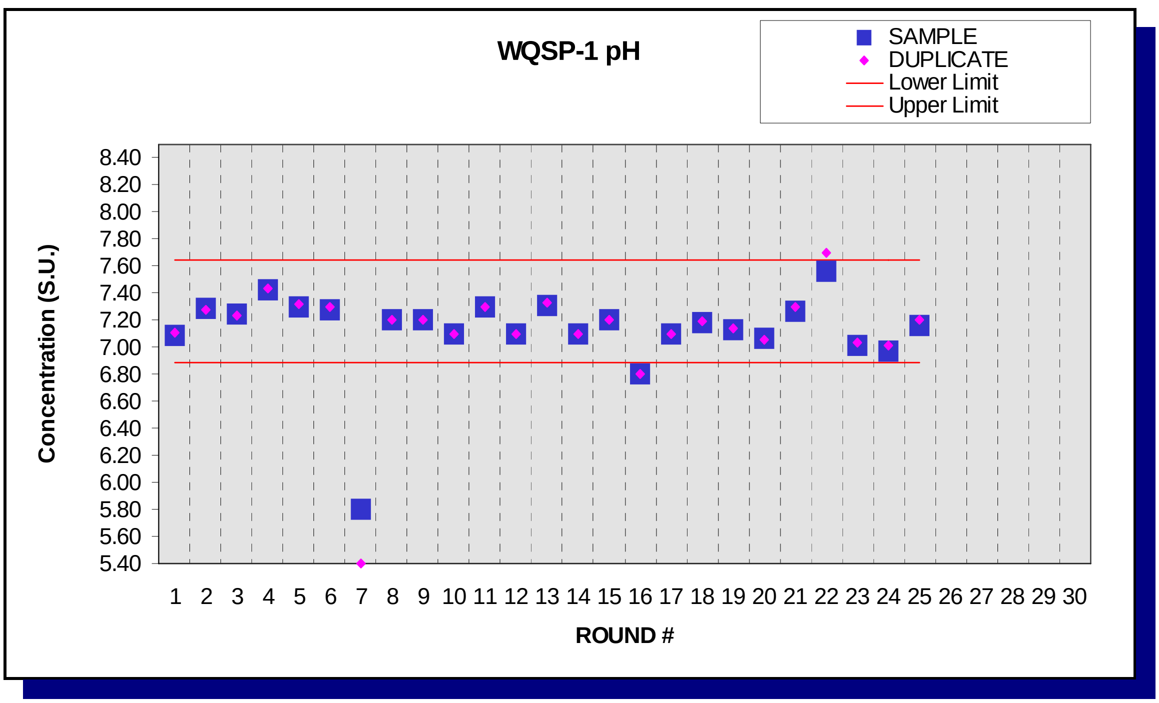

Figure E.6 - Time Trend Plot for pH at WQSP-1

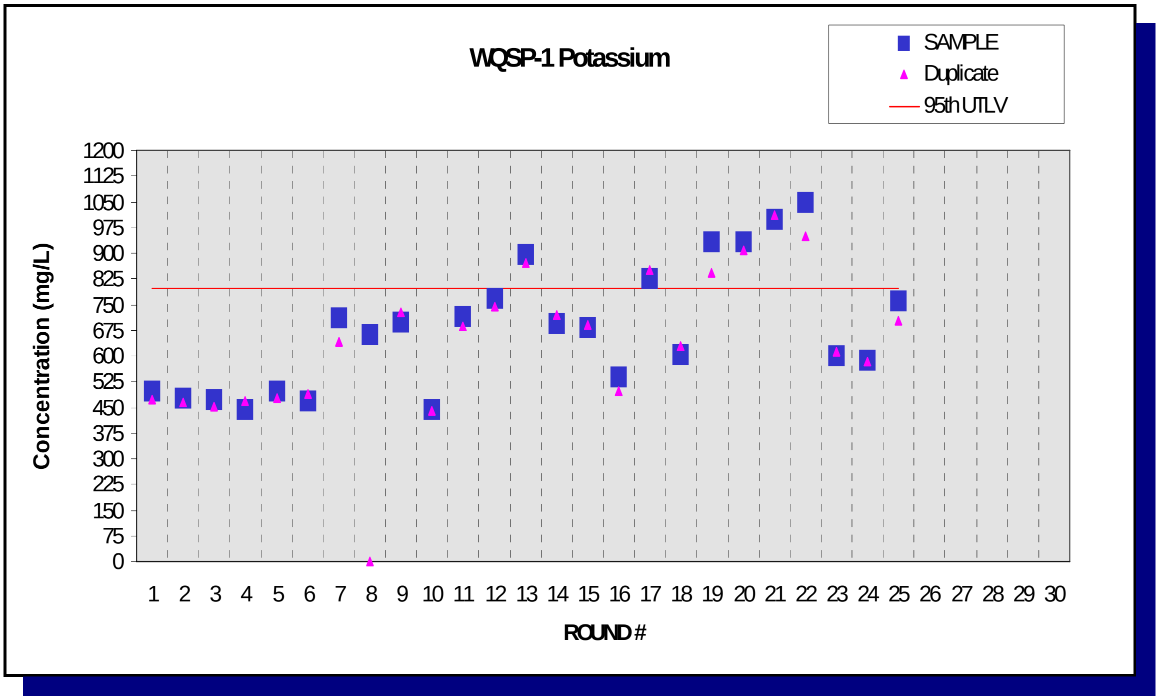

Figure E.7 - Time Trend Plot for Potassium at WQSP-1

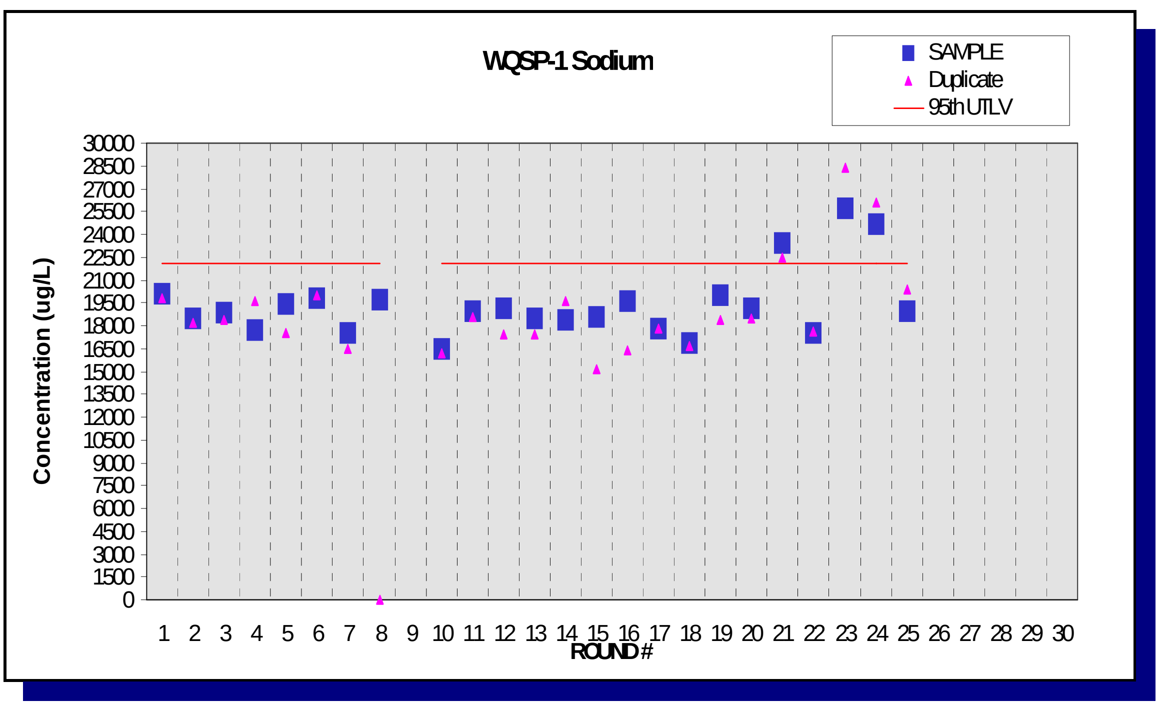

Figure E.8 - Time Trend Plot for Sodium at WQSP-1

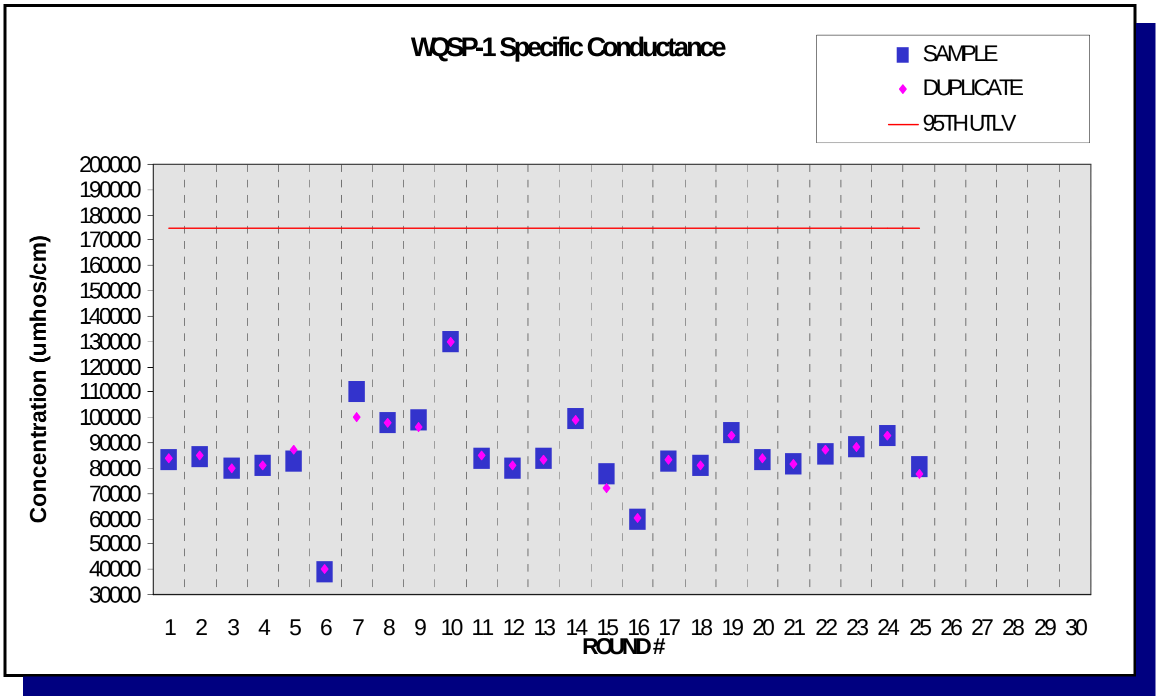

Figure E.9 - Time Trend Plot for Specific Conductance at WQSP-1

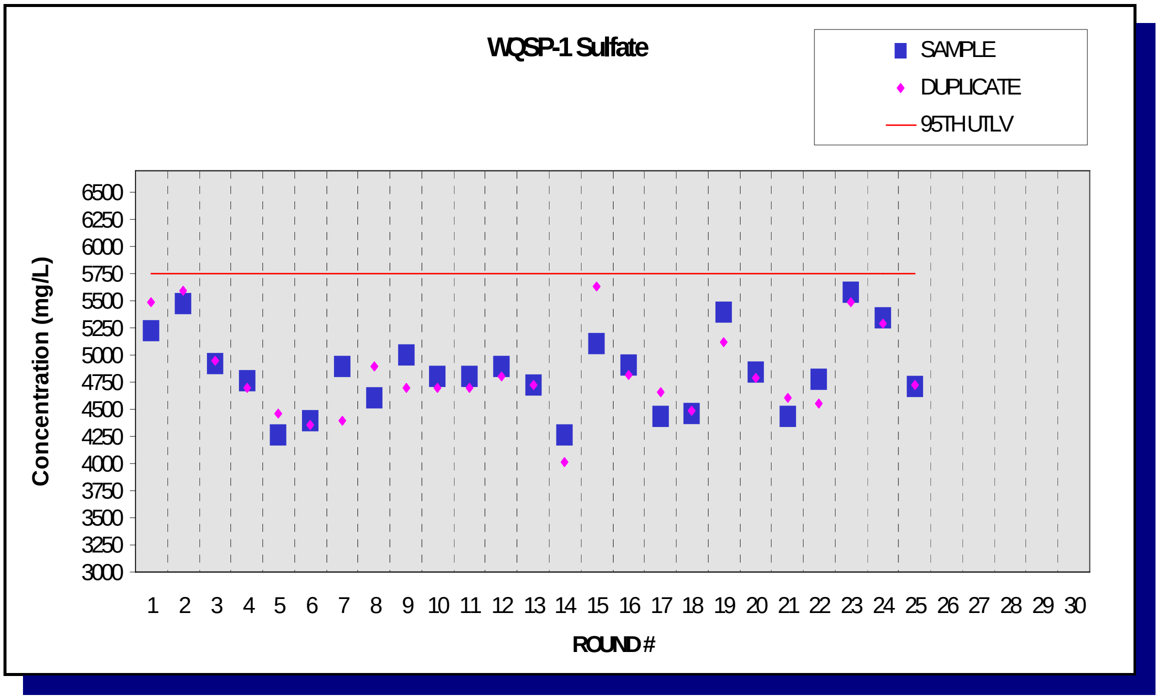

Figure E.10 - Time Trend Plot for Sulfate at WQSP-1

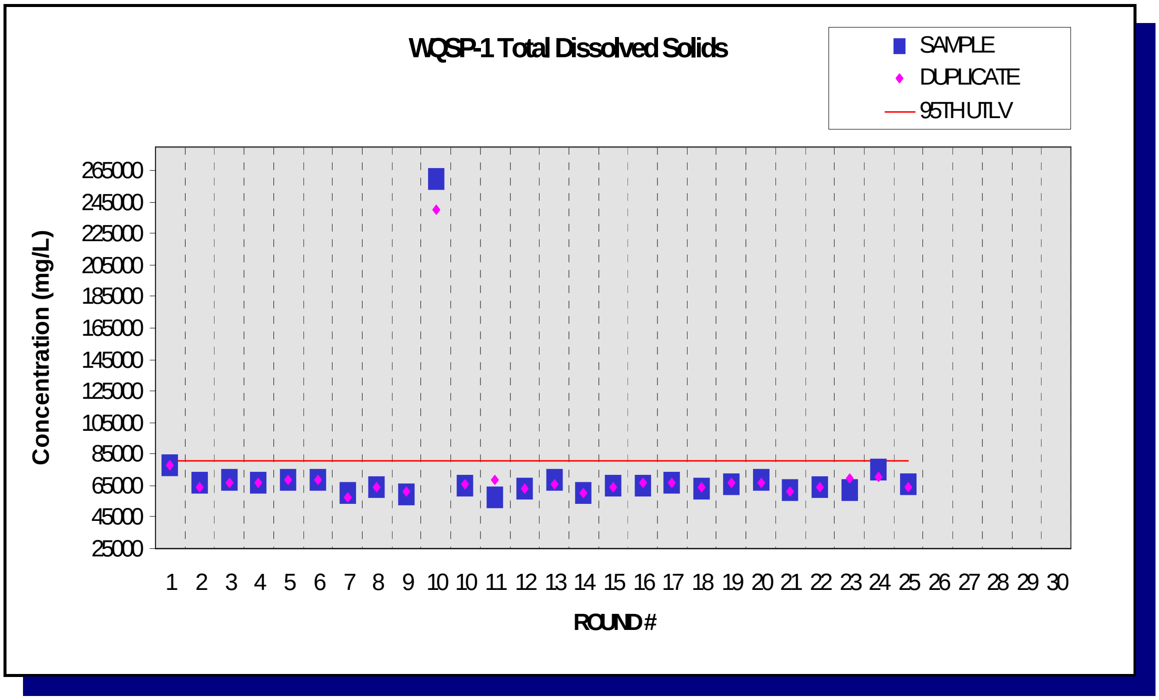

Figure E.11 - Time Trend Plot for Total Dissolved Solids at WQSP-1

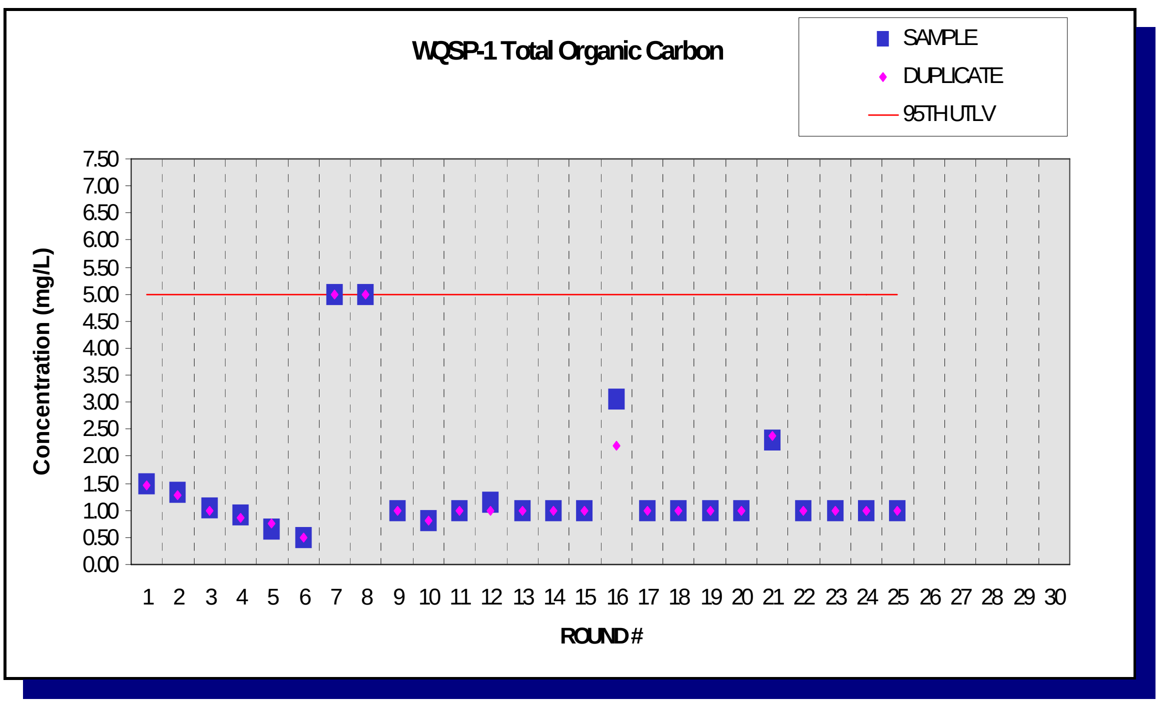

Figure E.12 - Time Trend Plot for Total Organic Carbon at WQSP-1

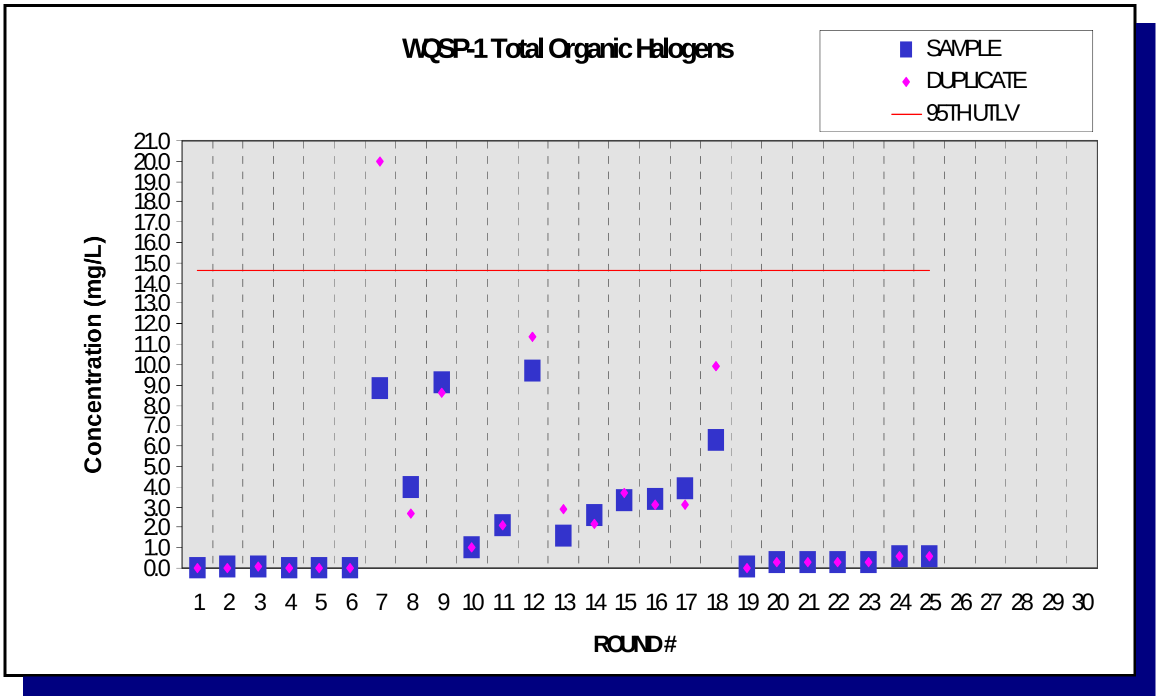

Figure E.13 - Time Trend Plot for Total Organic Halogens at WQSP-1

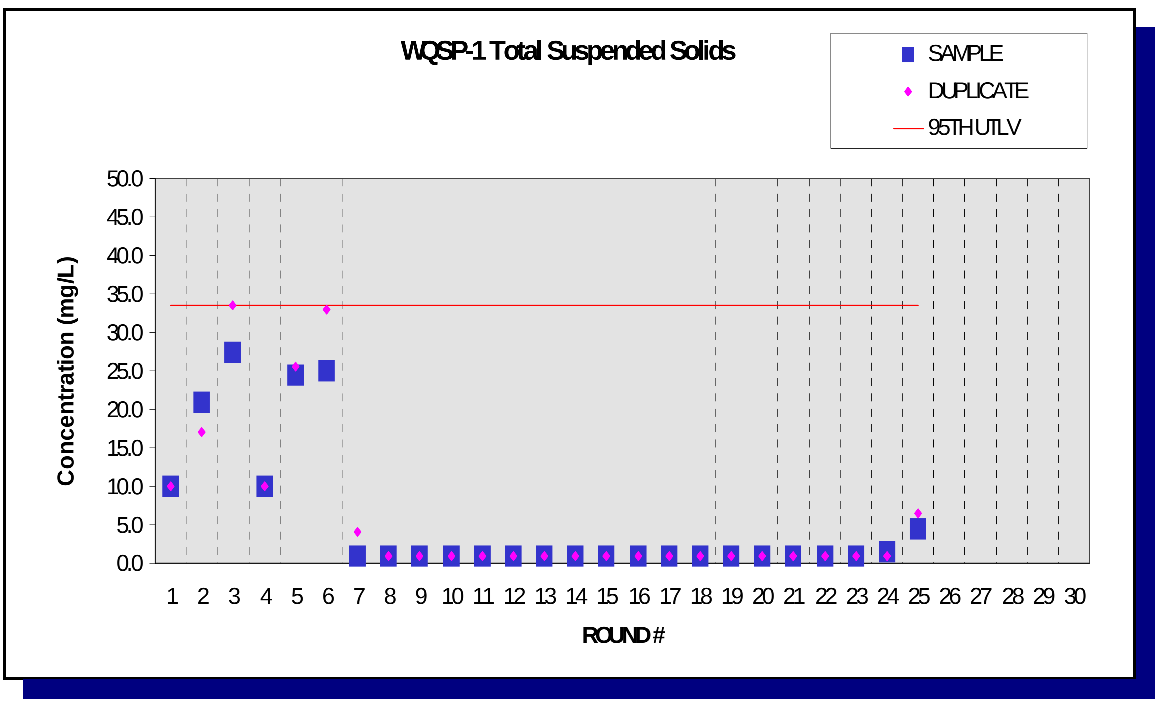

Figure E.14 - Time Trend Plot for Total Suspended Solids at WQSP-1

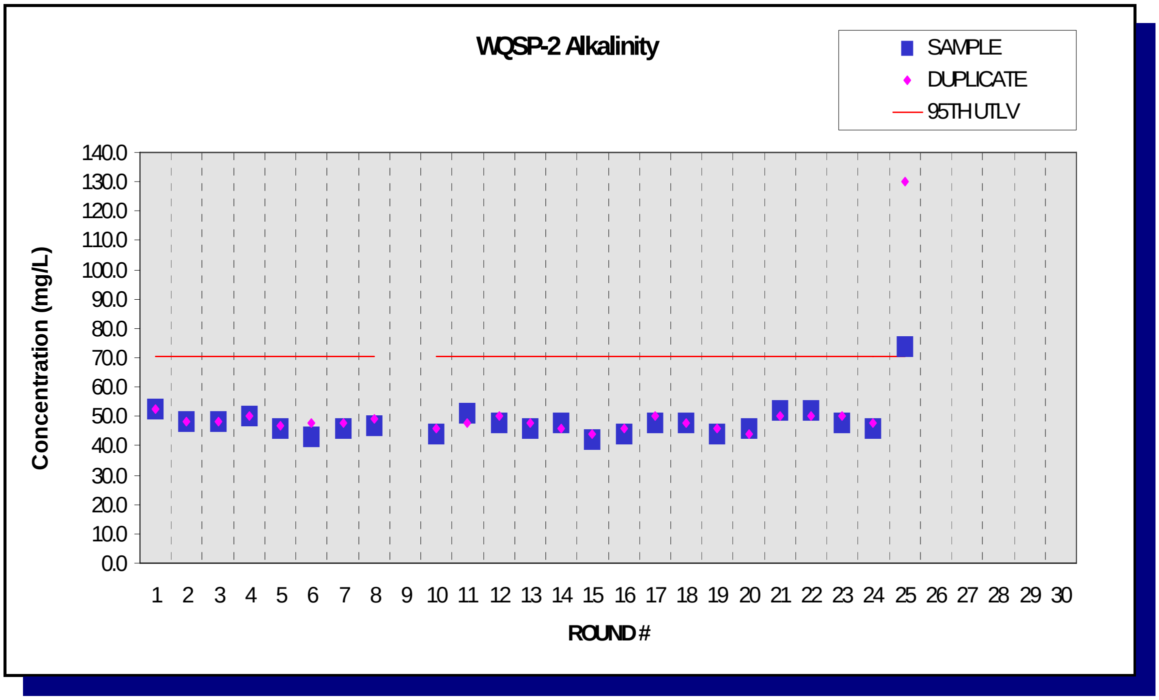

Figure E.15 - Time Trend Plot for Alkalinity at WQSP-2

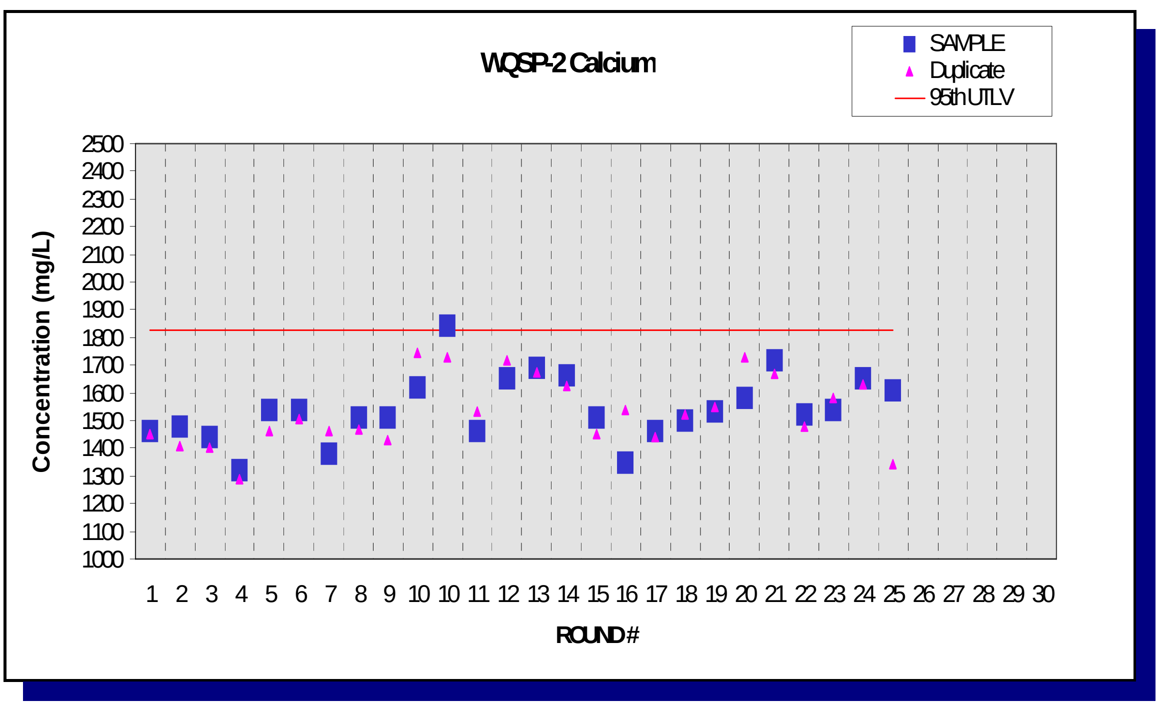

Figure E.16 - Time Trend Plot for Calcium at WQSP-2

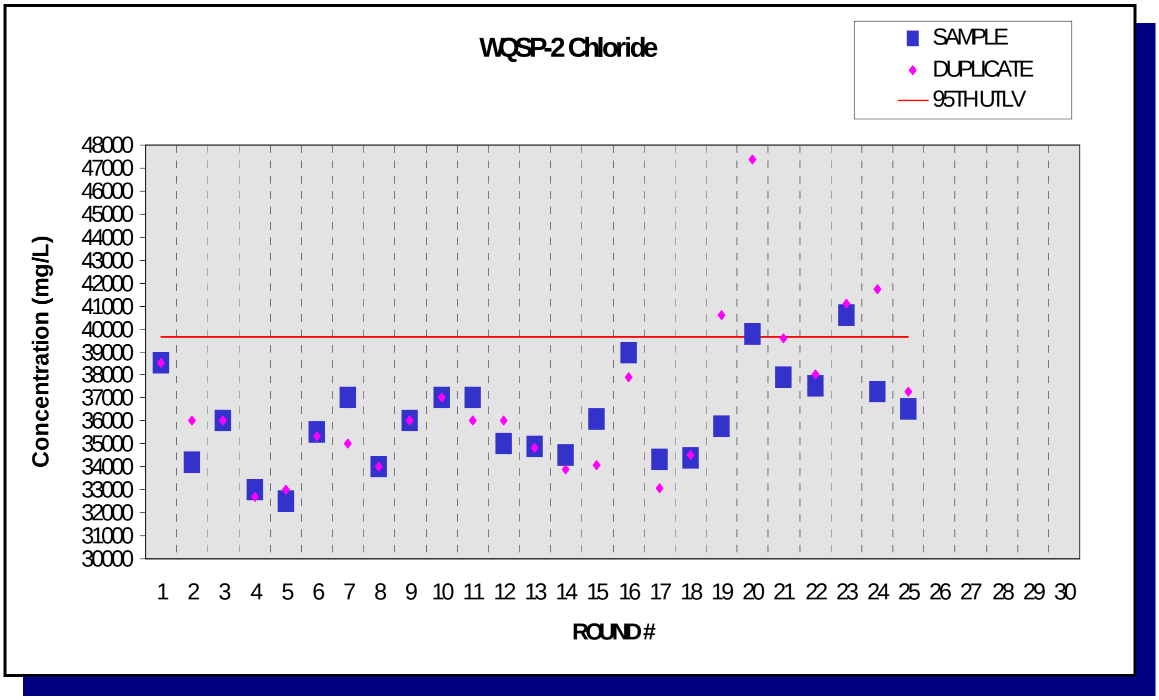

Figure E.17 - Time Trend Plot for Chloride at WQSP-2

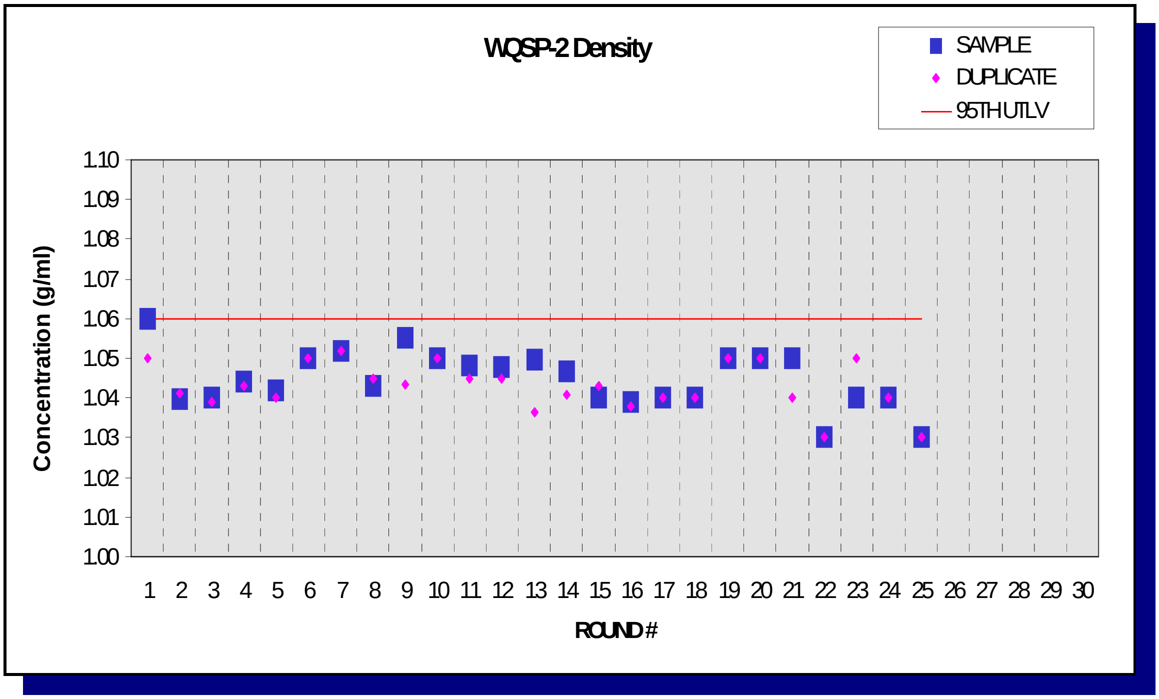

Figure E.18 - Time Trend Plot for Density at WQSP-2

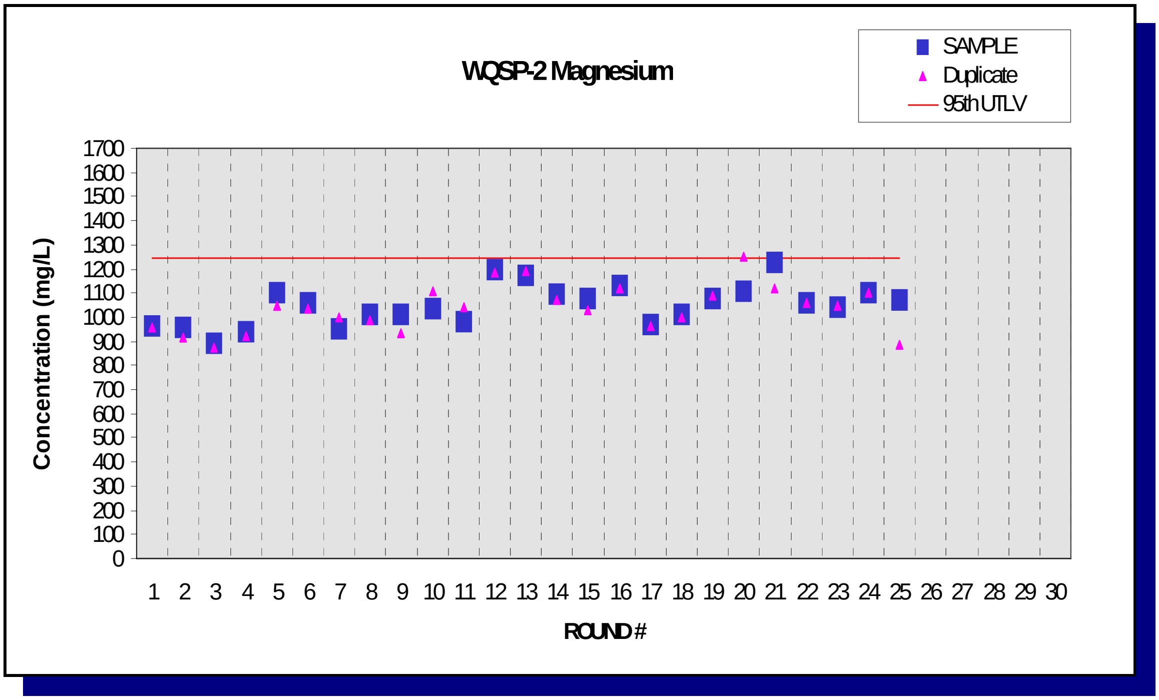

Figure E.19 - Time Trend Plot for Magnesium at WQSP-2

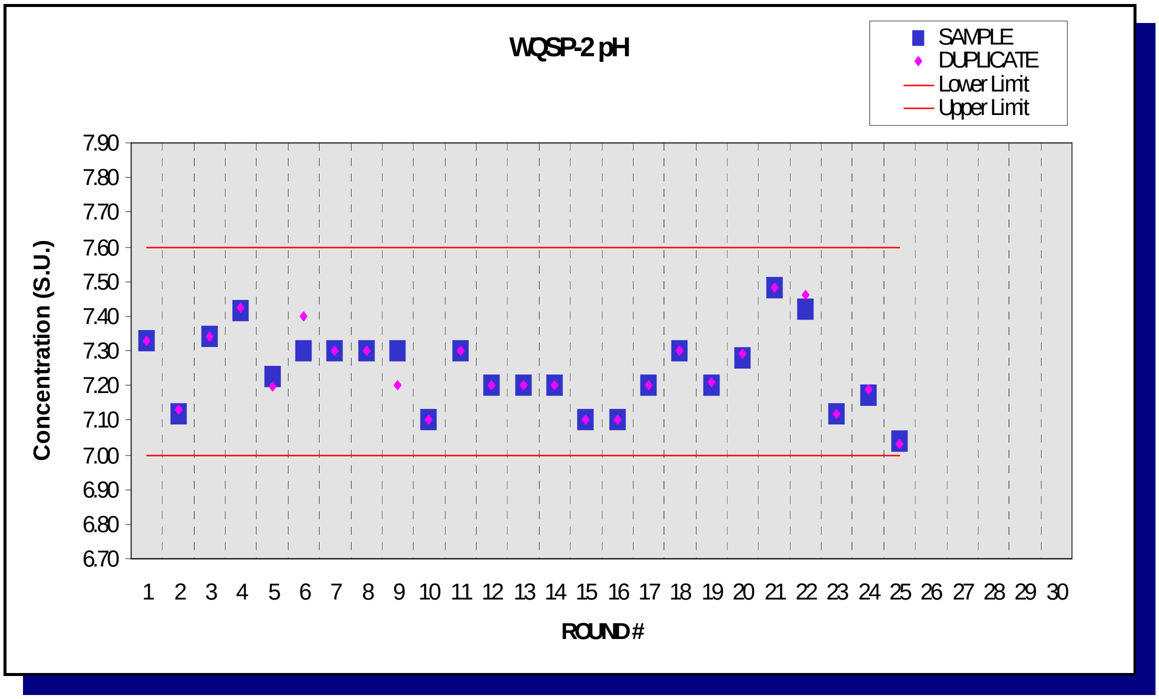

Figure E.20 - Time Trend Plot for pH at WQSP-2

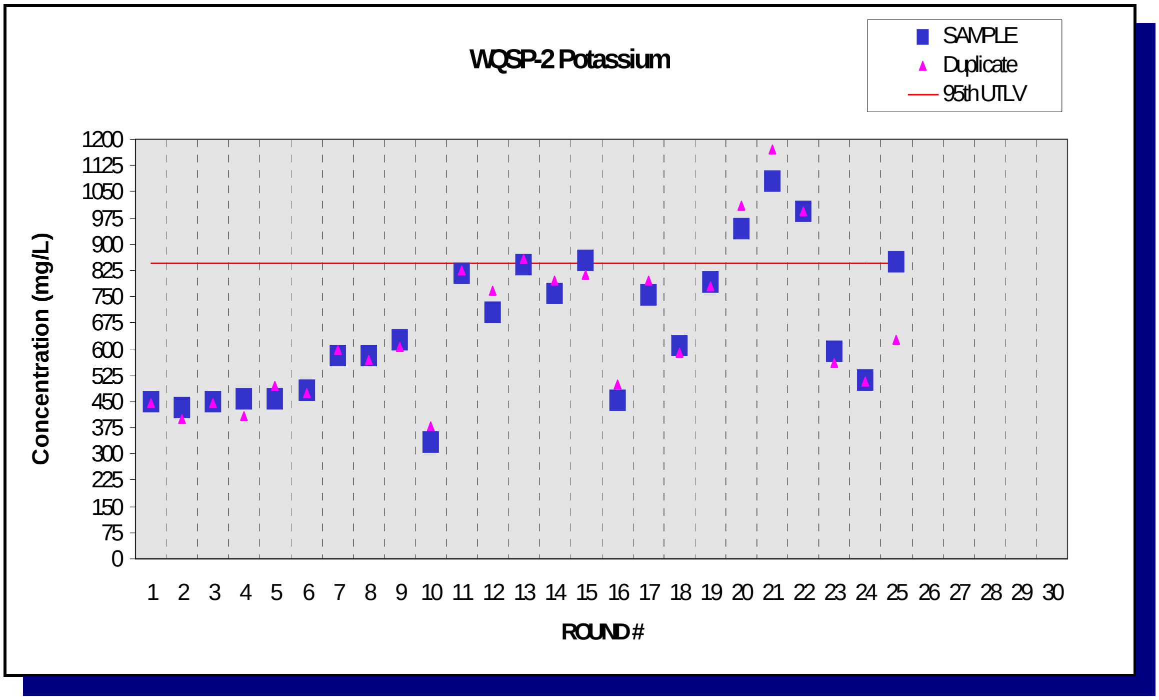

Figure E.21 - Time Trend Plot for Potassium at WQSP-2

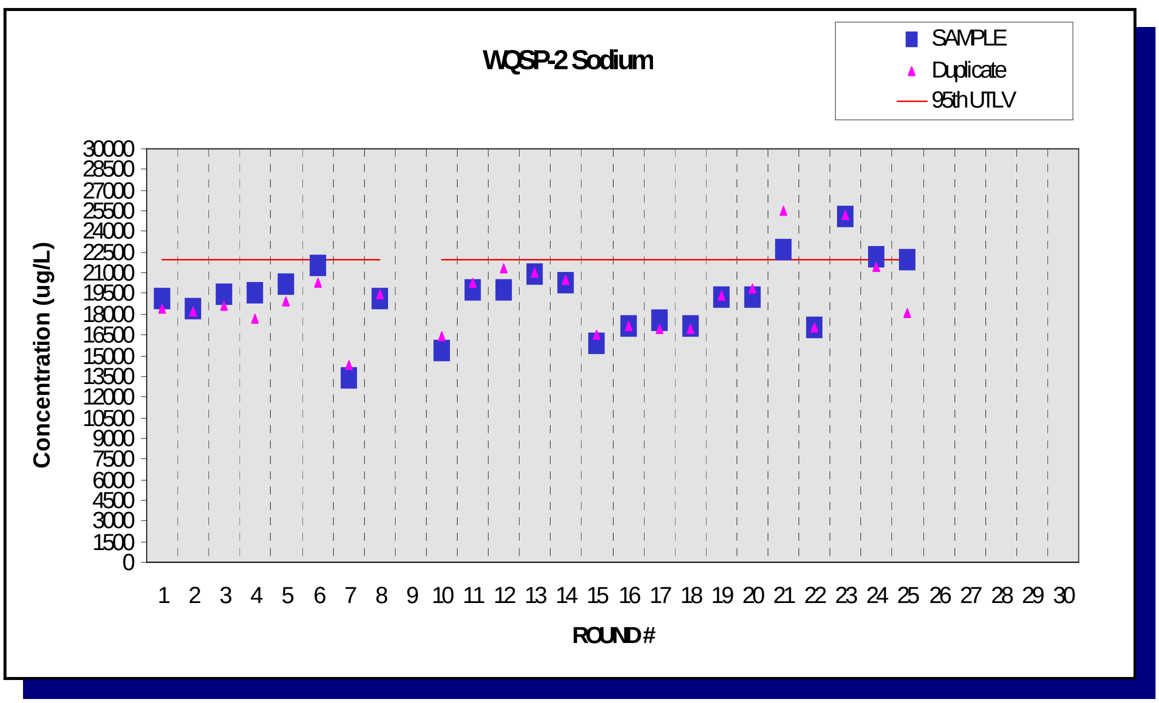

Figure E.22 - Time Trend Plot for Sodium at WQSP-2

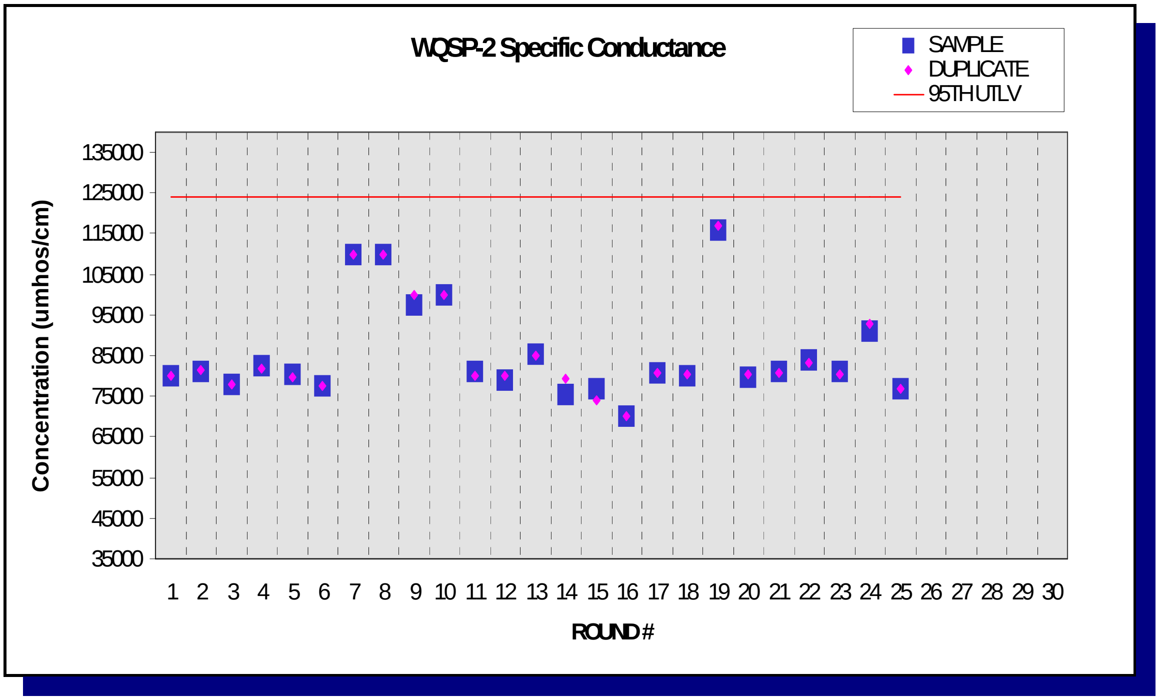

Figure E.23 - Time Trend Plot for Specific Conductance at WQSP-2

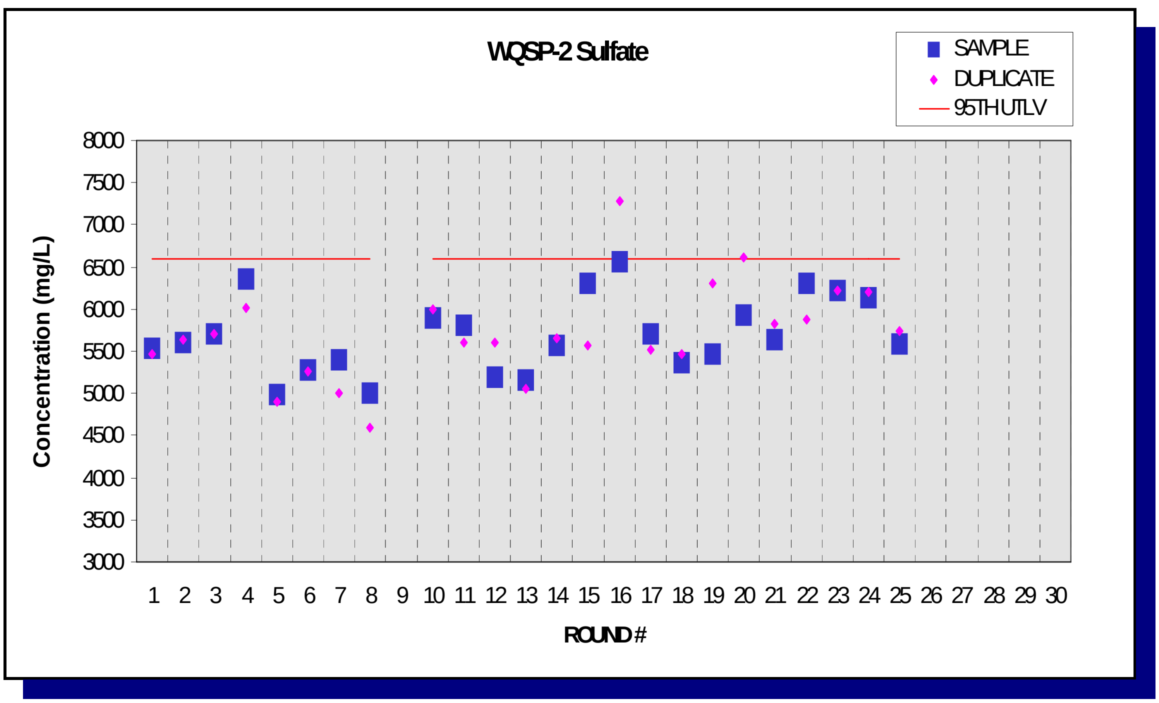

Figure E.24 - Time Trend Plot for Sulfate at WQSP-2

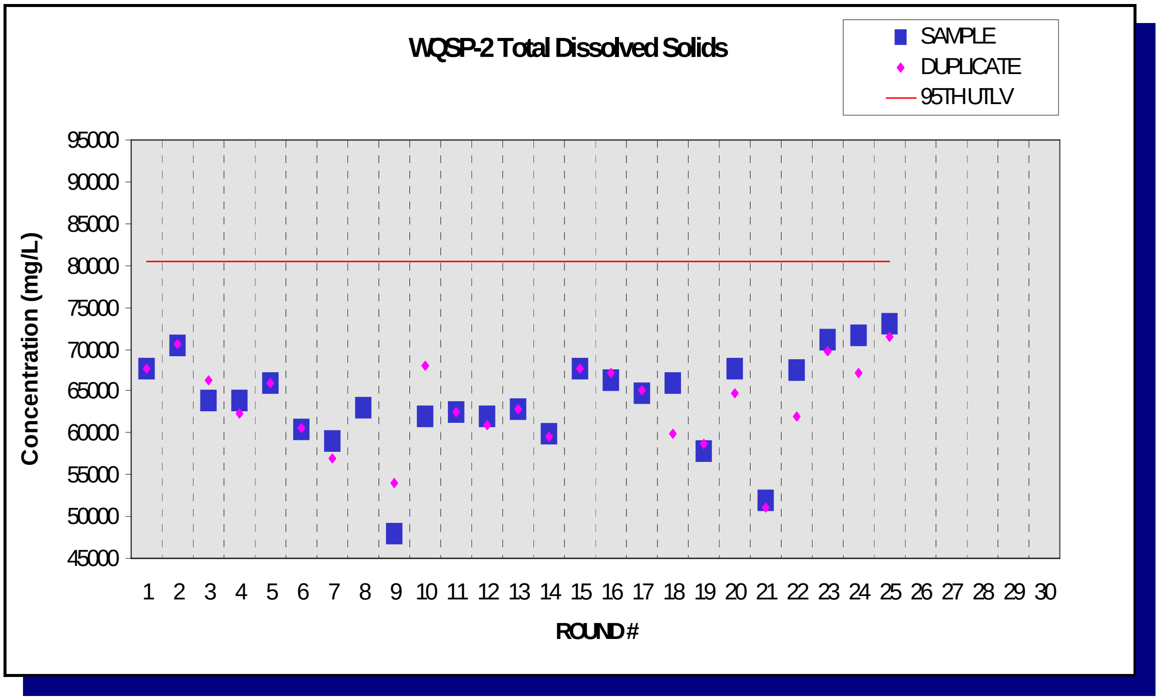

Figure E.25 - Time Trend Plot for Total Dissolved Solids at WQSP-2

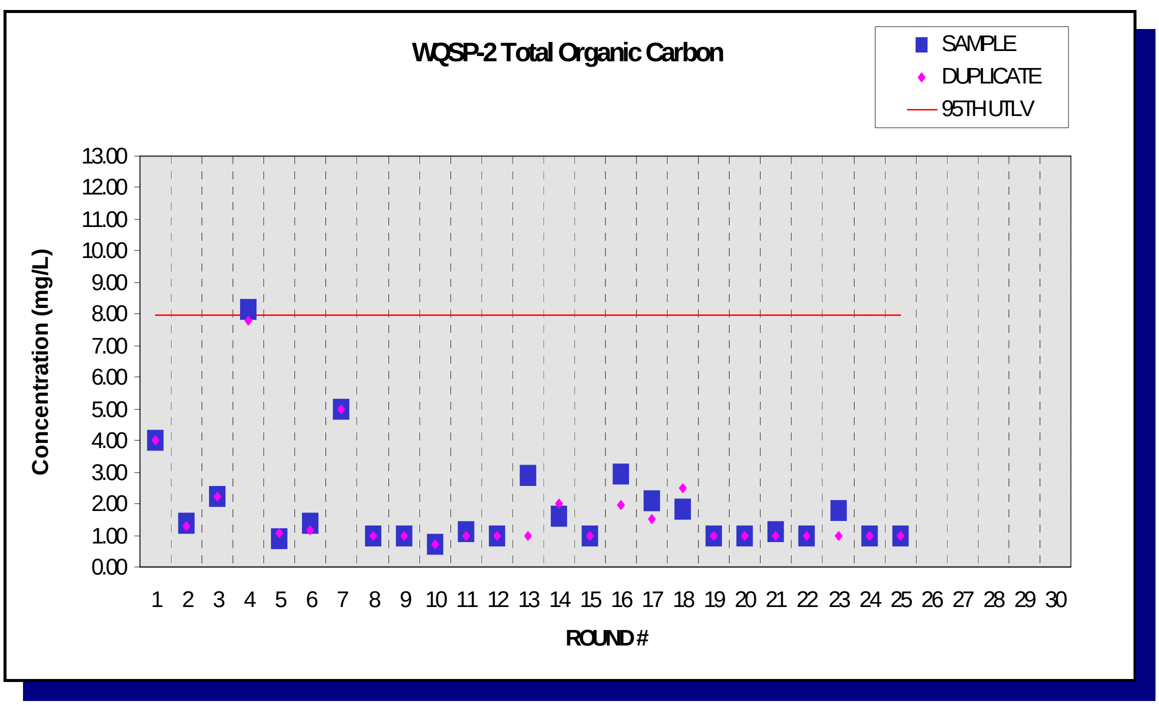

Figure E.26 - Time Trend Plot for Total Organic Carbon at WQSP-2

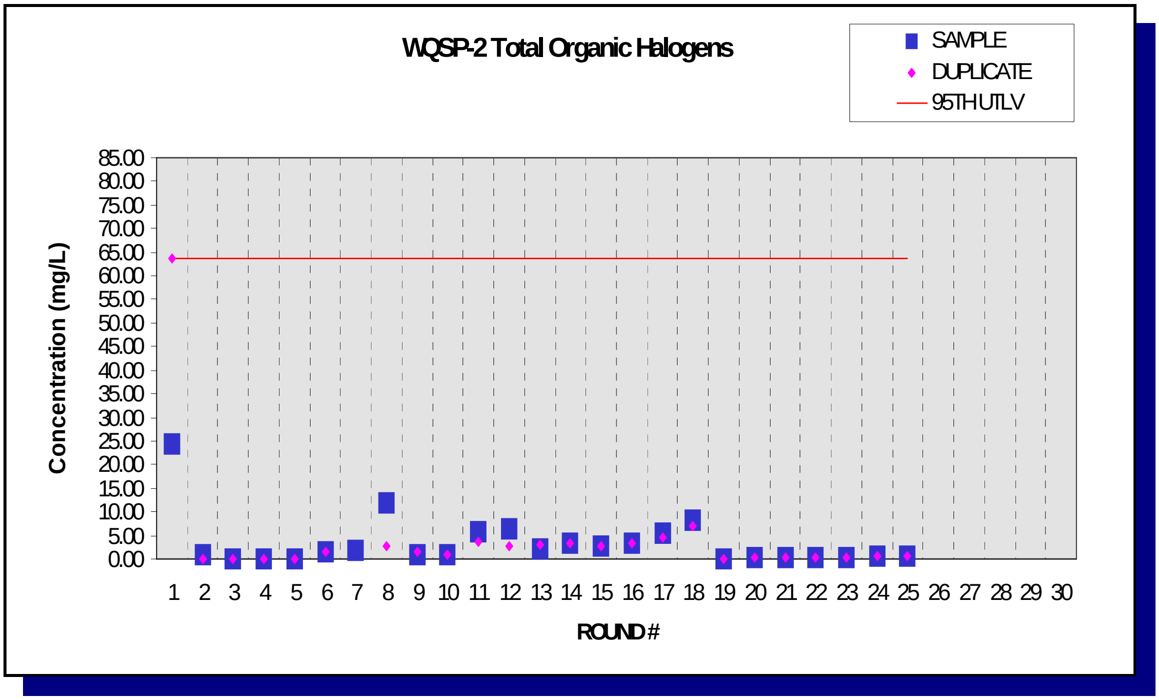

Figure E.27 - Time Trend Plot for Total Organic Halogens at WQSP-2

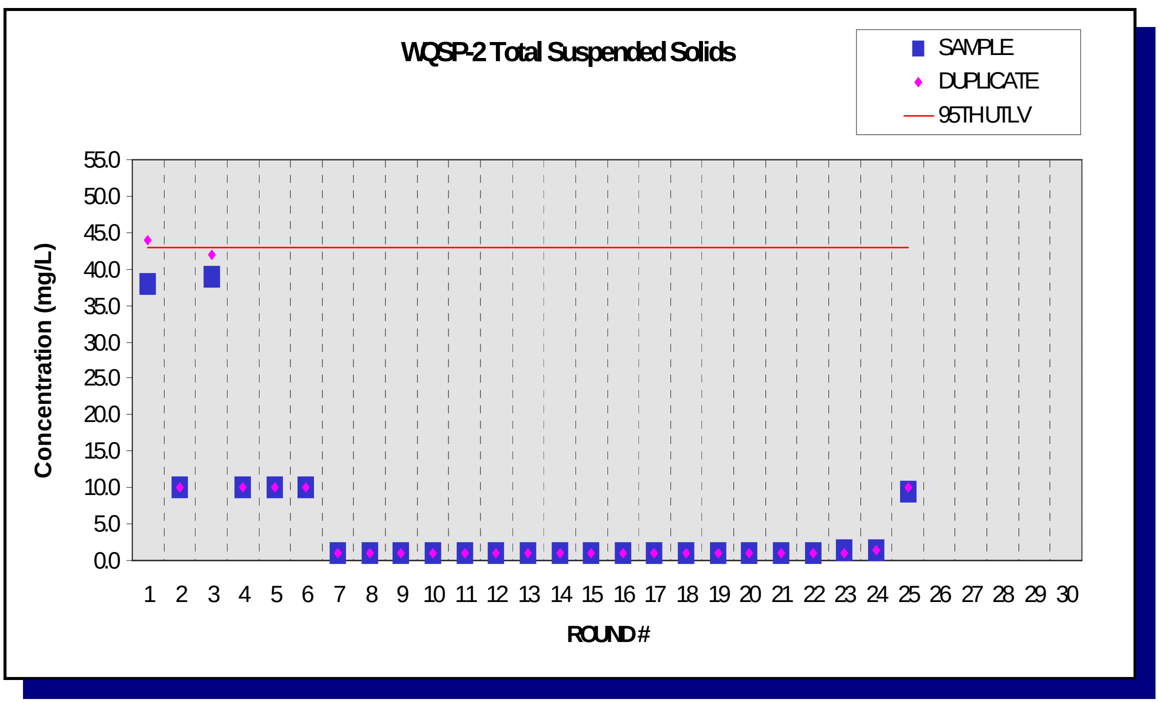

Figure E.28 - Time Trend Plot for Total Suspended Solids at WQSP-2

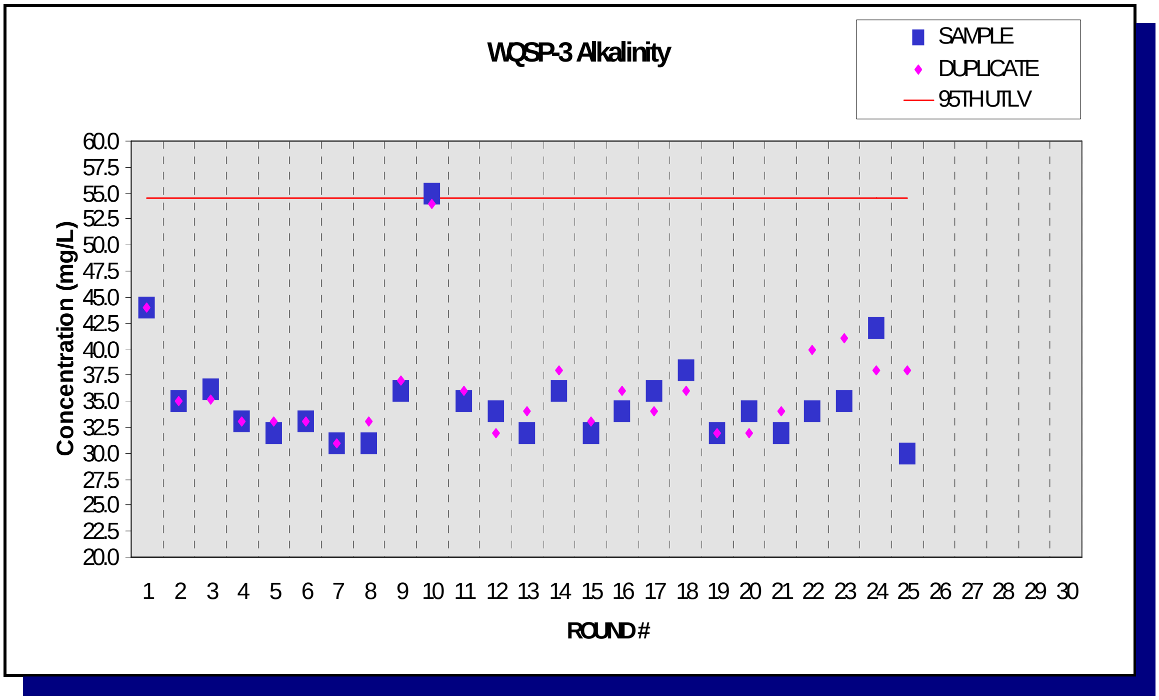

Figure E.29 - Time Trend Plot for Alkalinity at WQSP-3

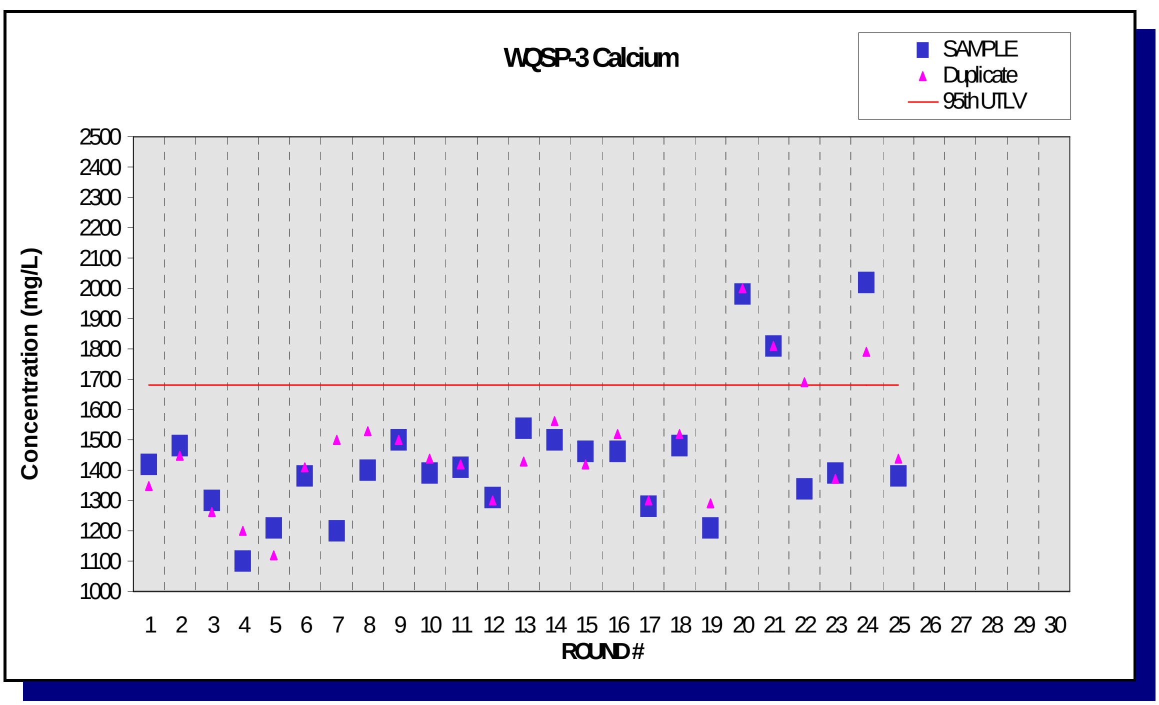

Figure E.30 - Time Trend Plot for Calcium at WQSP-3

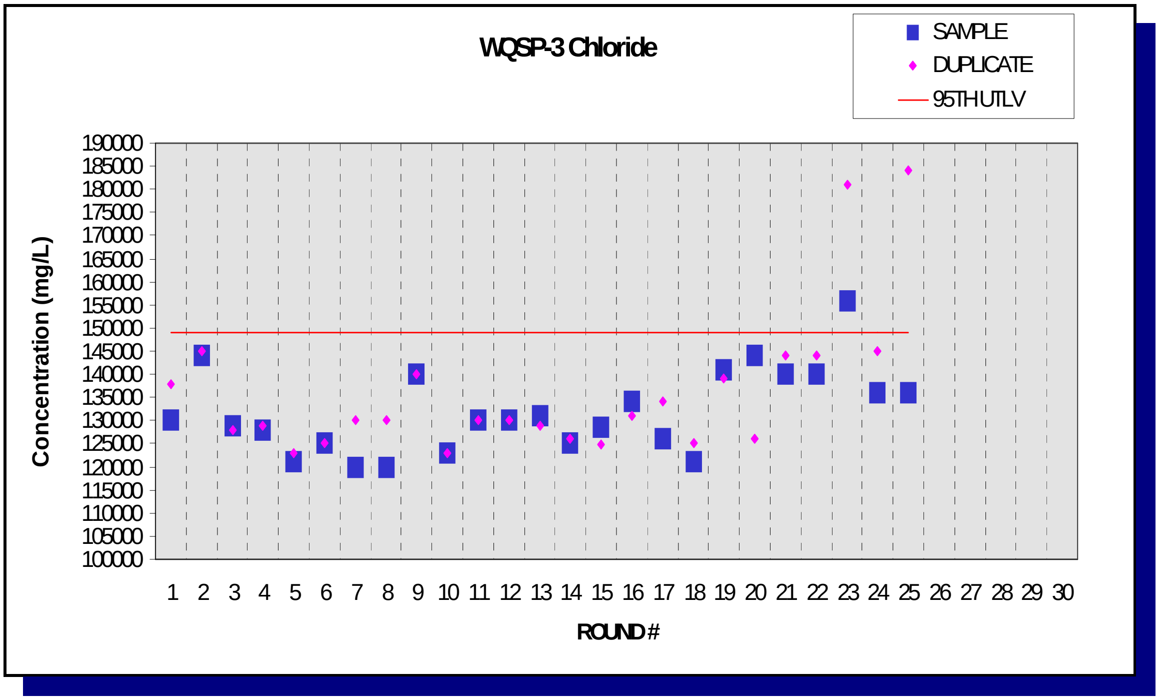

Figure E.31 - Time Trend Plot for Chloride at WQSP-3

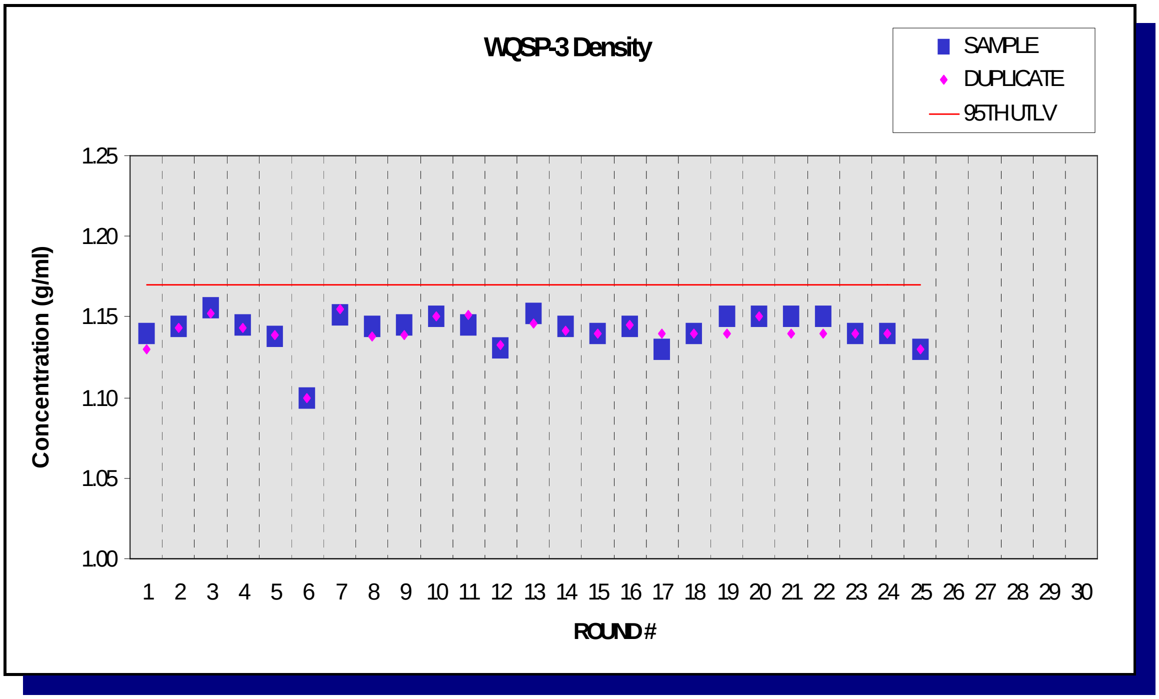

Figure E.32 - Time Trend Plot for Density at WQSP-3

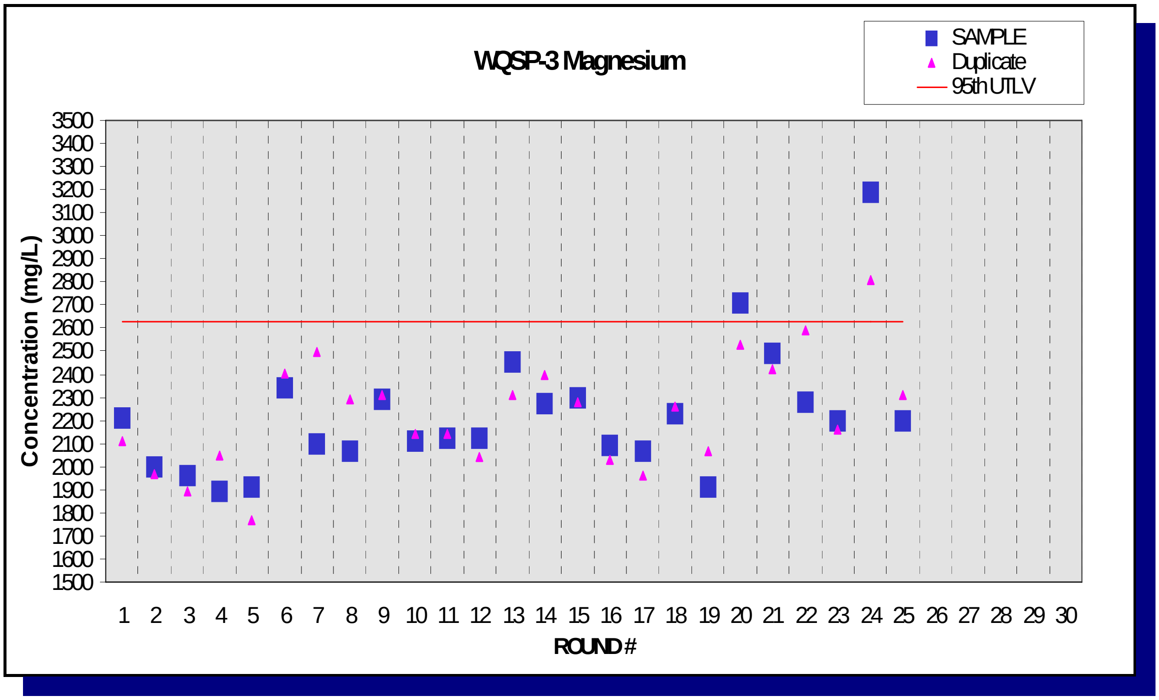

Figure E.33 - Time Trend Plot for Magnesium at WQSP-3

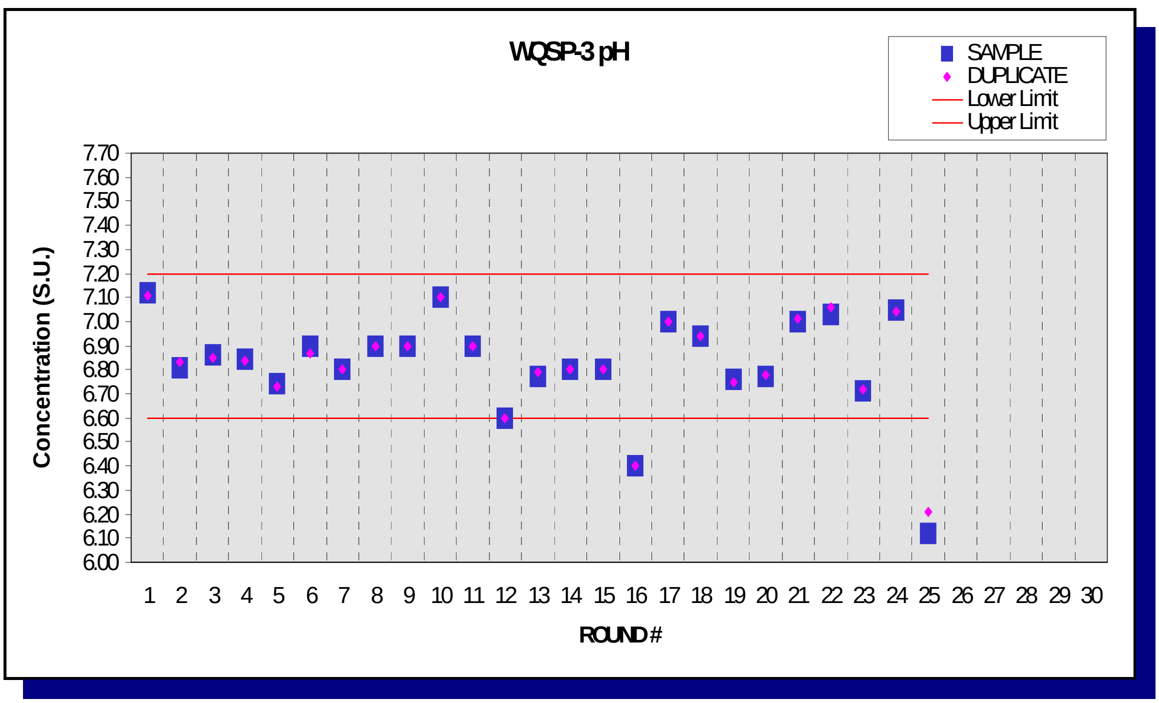

Figure E.34 - Time Trend Plot for pH at WQSP-3

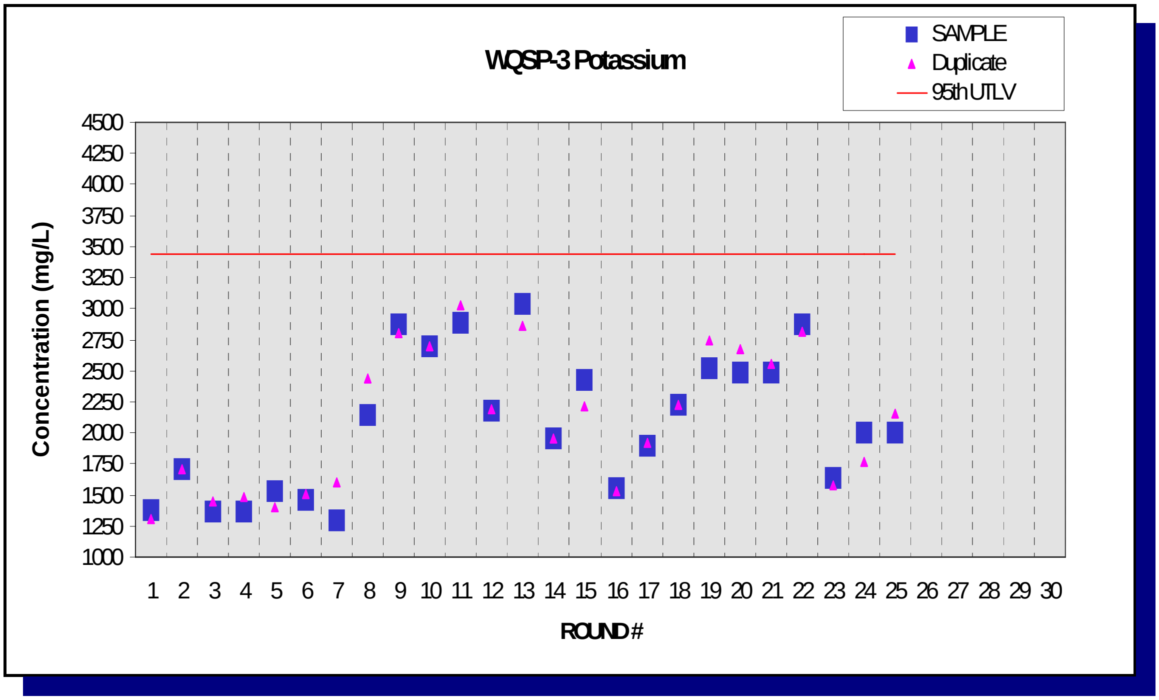

Figure E.35 - Time Trend Plot for Potassium at WQSP-3

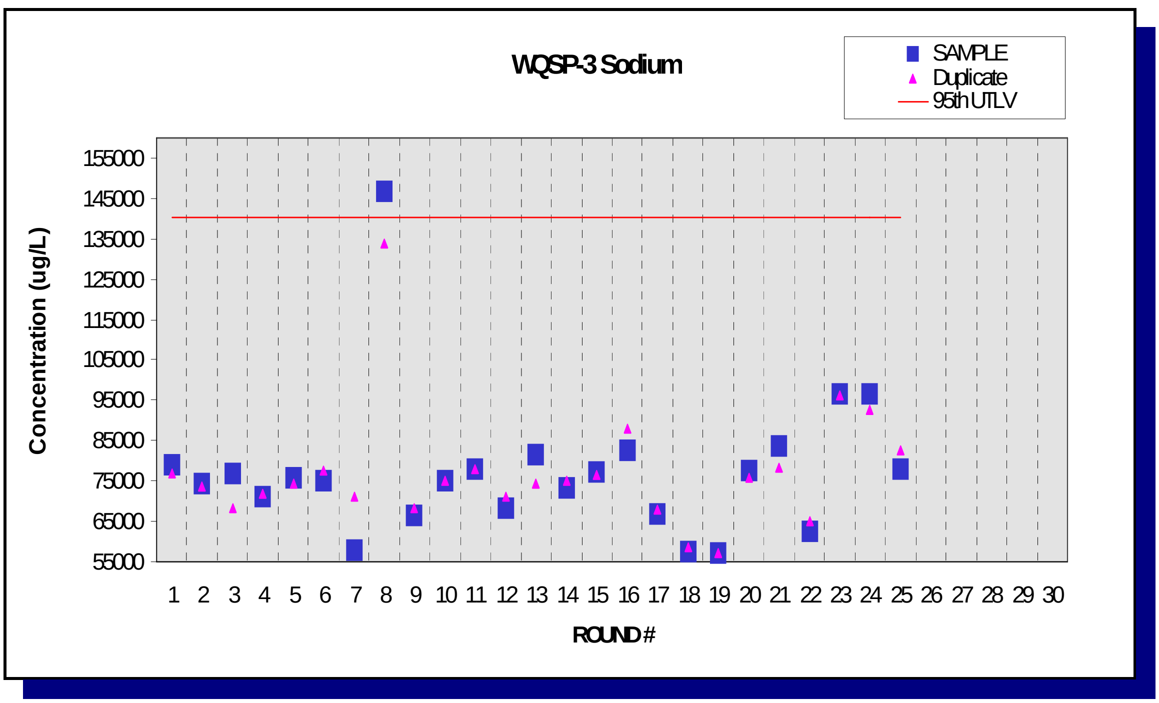

Figure E.36 - Time Trend Plot for Sodium at WQSP-3

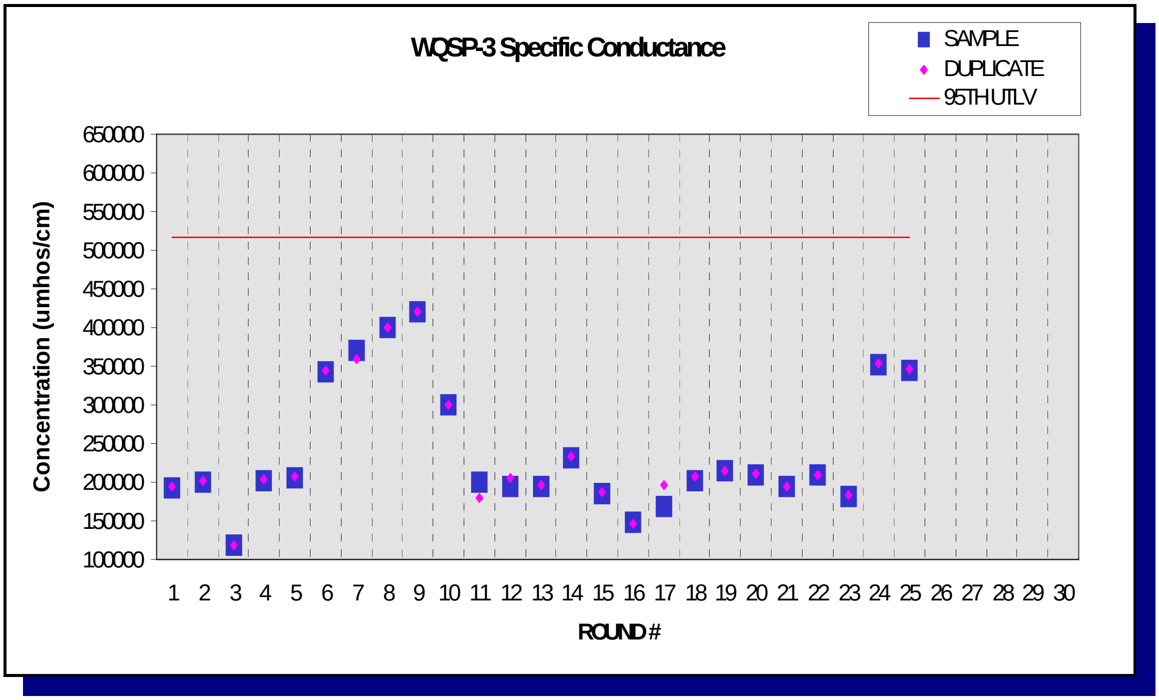

Figure E.37 - Time Trend Plot for Specific Conductance at WQSP-3

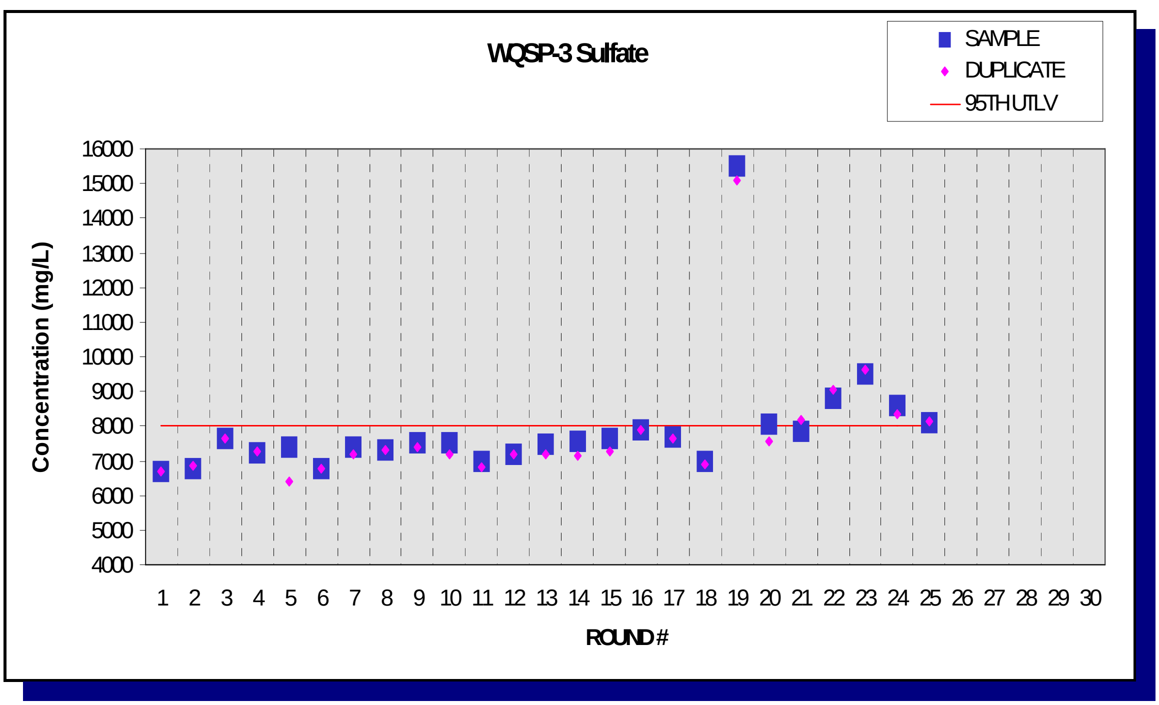

Figure E.38 - Time Trend Plot for Sulfate at WQSP-3

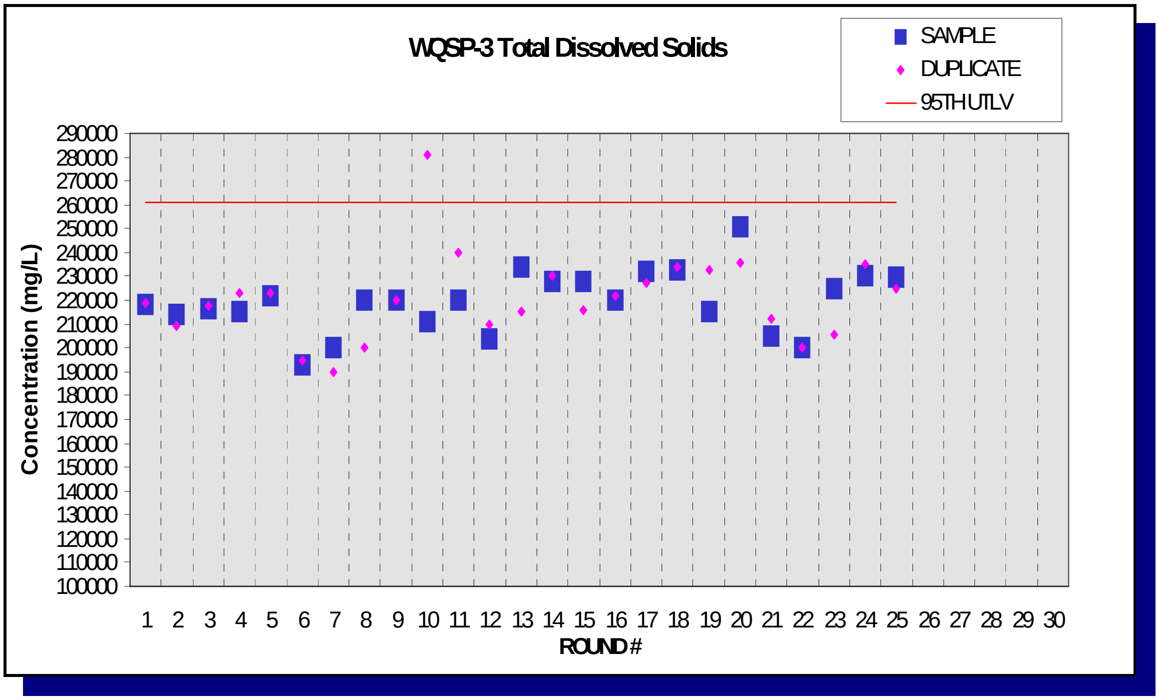

Figure E.39 - Time Trend Plot for Total Dissolved Solids at WQSP-3

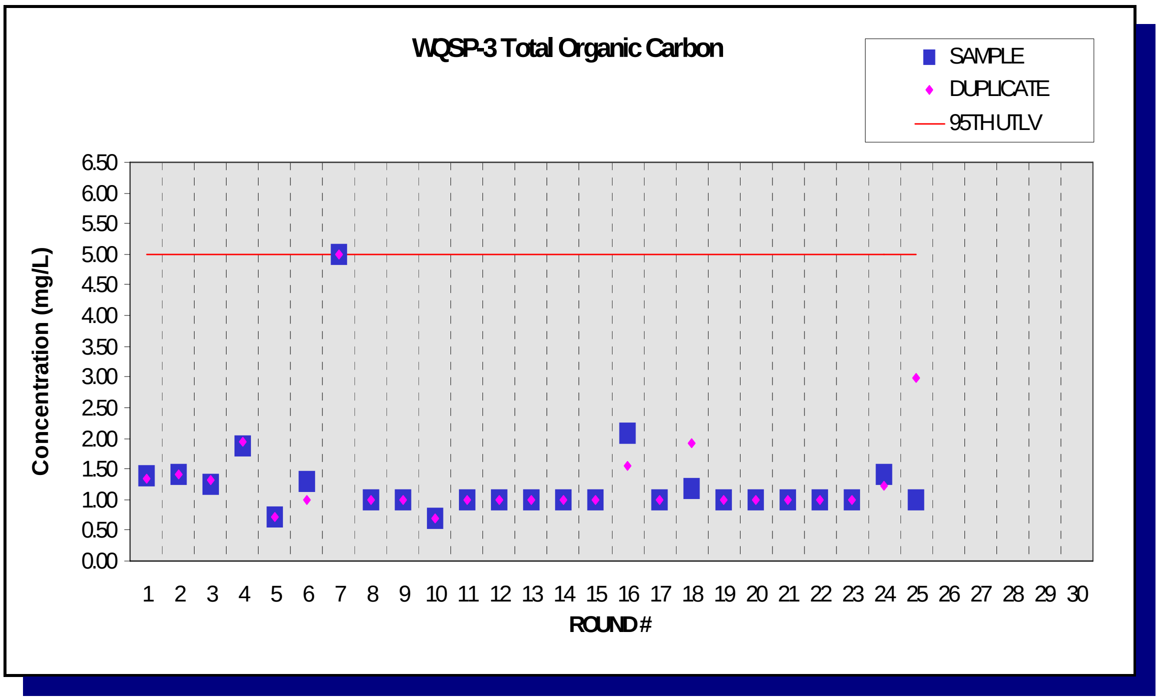

Figure E.40 - Time Trend Plot for Total Organic Carbon at WQSP-3

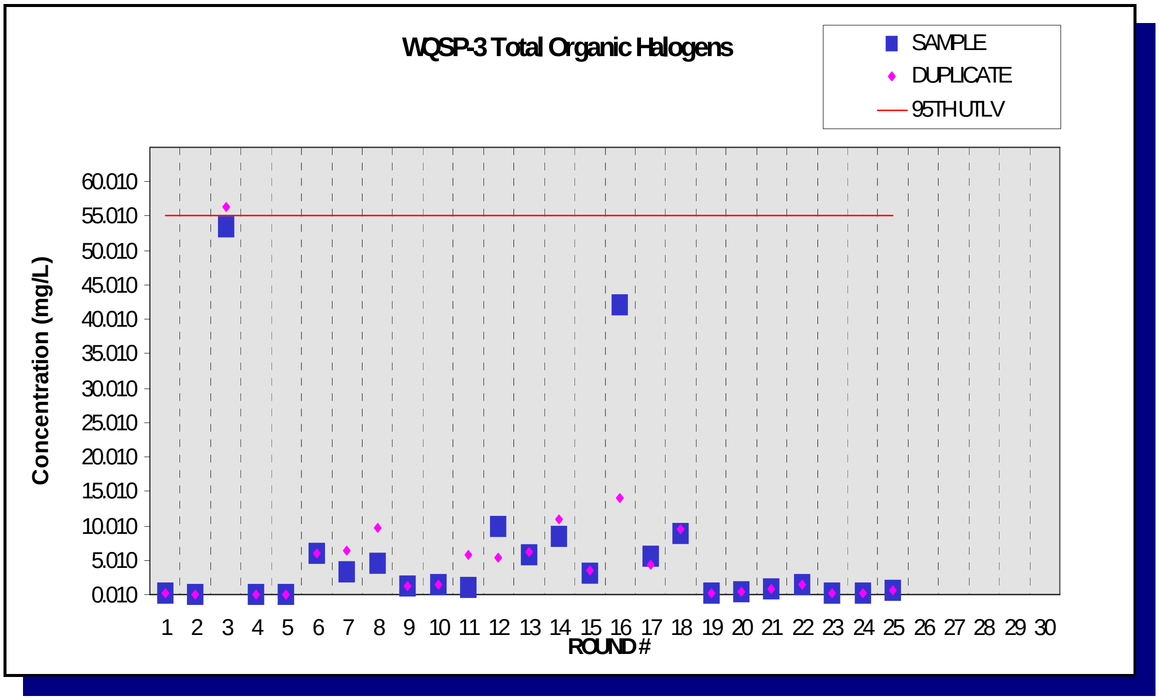

Figure E.41 - Time Trend Plot for Total Organic Halogens at WQSP-3

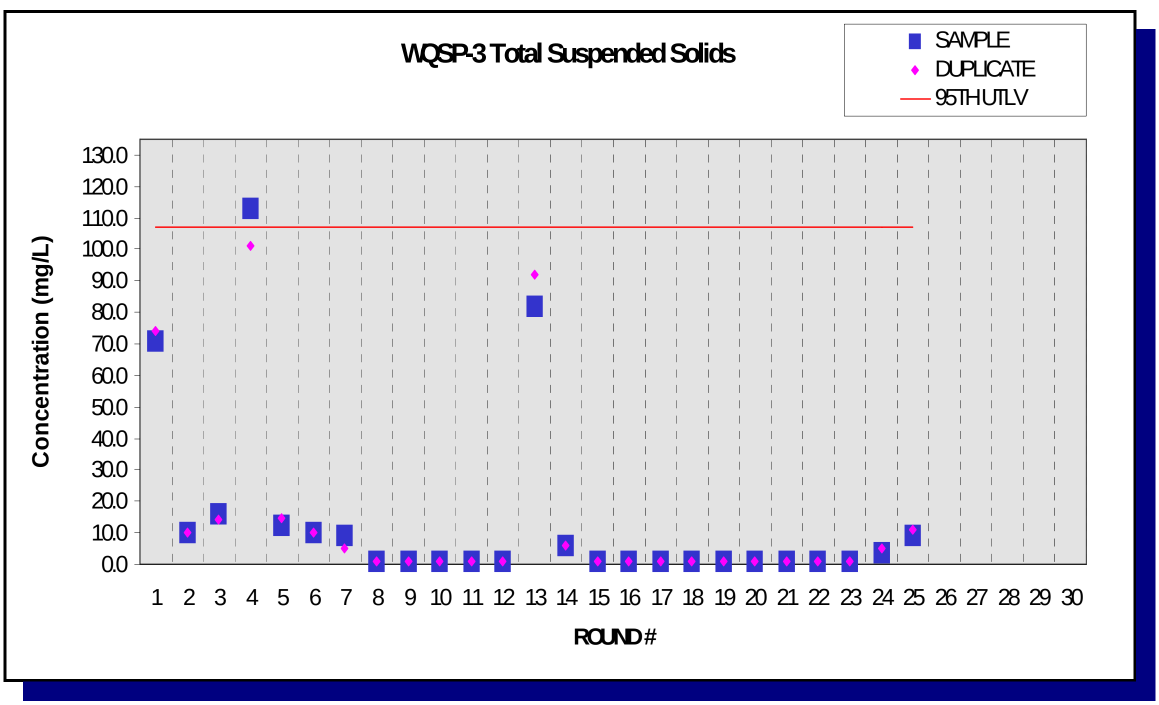

Figure E.42 - Time Trend Plot for Total Suspended Solids at WQSP-3

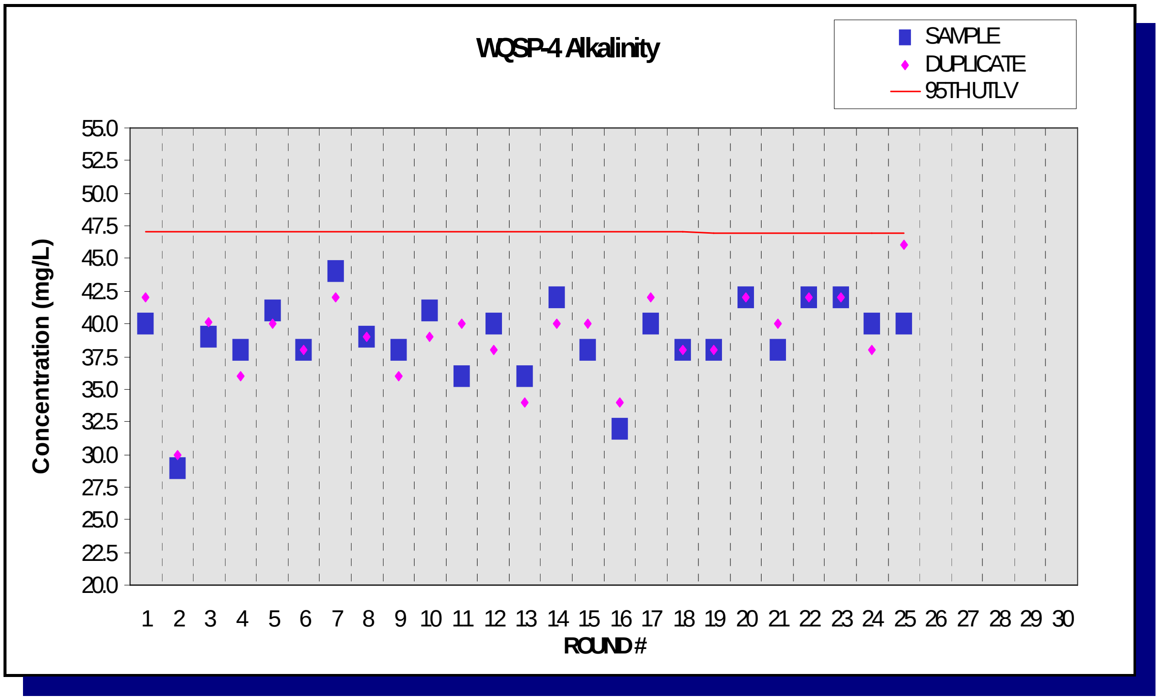

Figure E.43 - Time Trend Plot for Alkalinity for WQSP-4

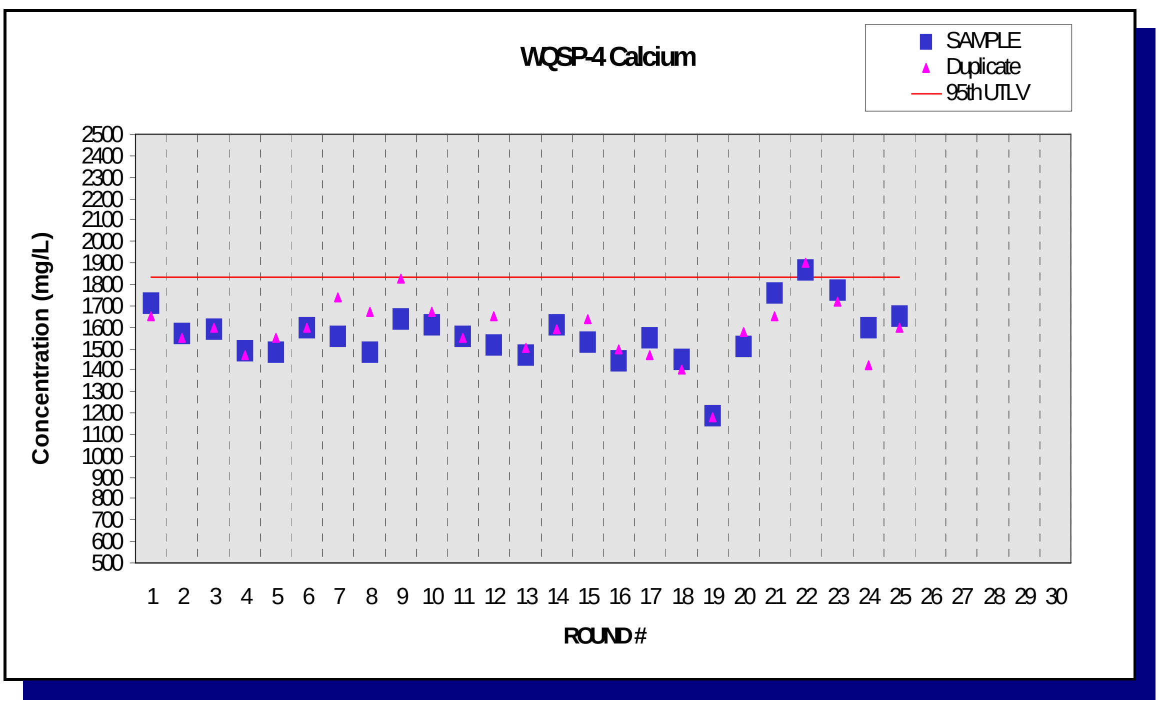

Figure E.44 - Time Trend Plot for Calcium at WQSP-4

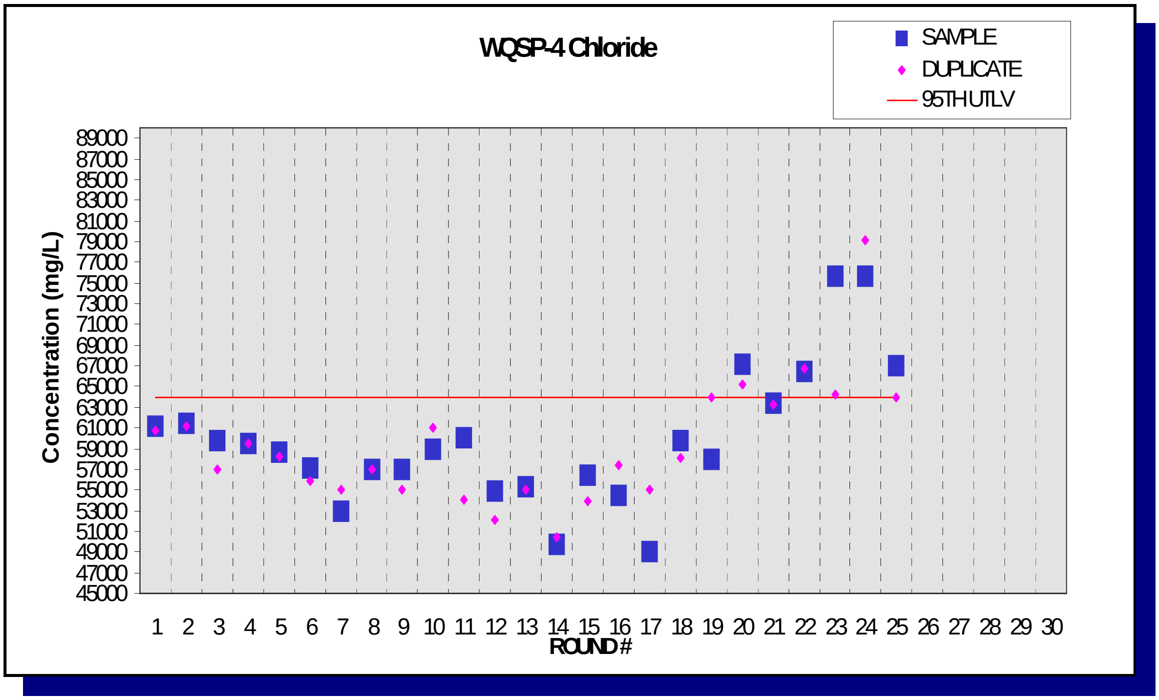

Figure E.45 - Time Trend Plot for Chloride at WQSP-4

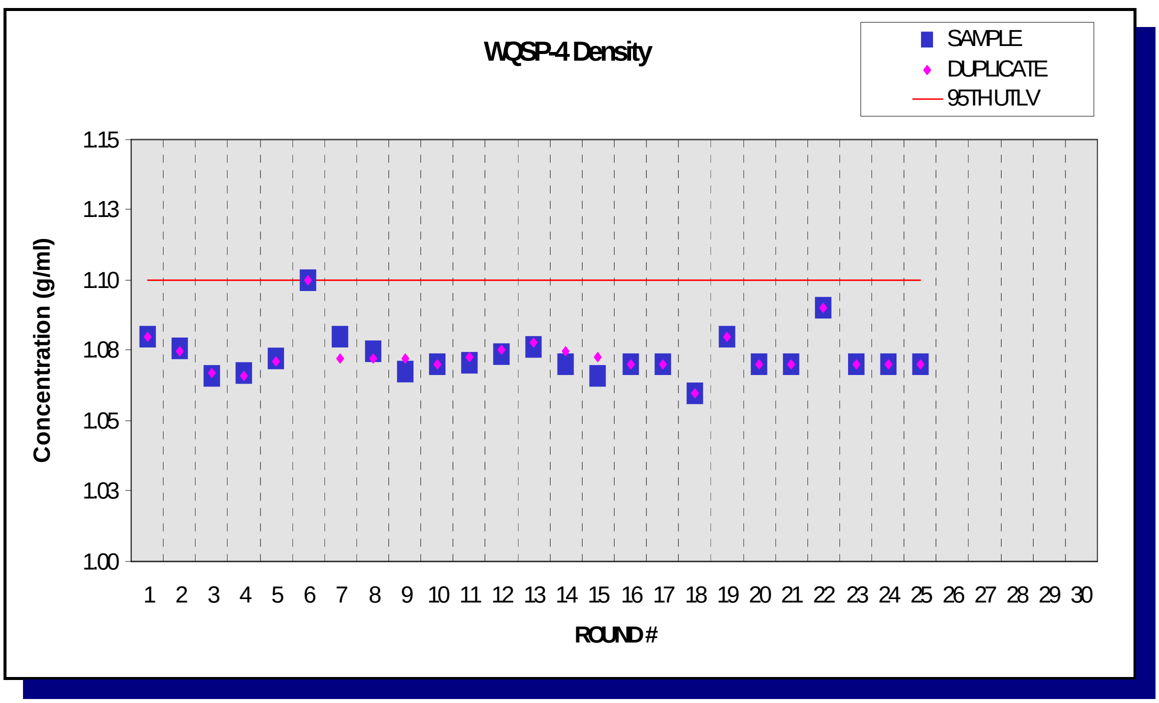

Figure E.46 - Time Trend Plot for Density at WQSP-4

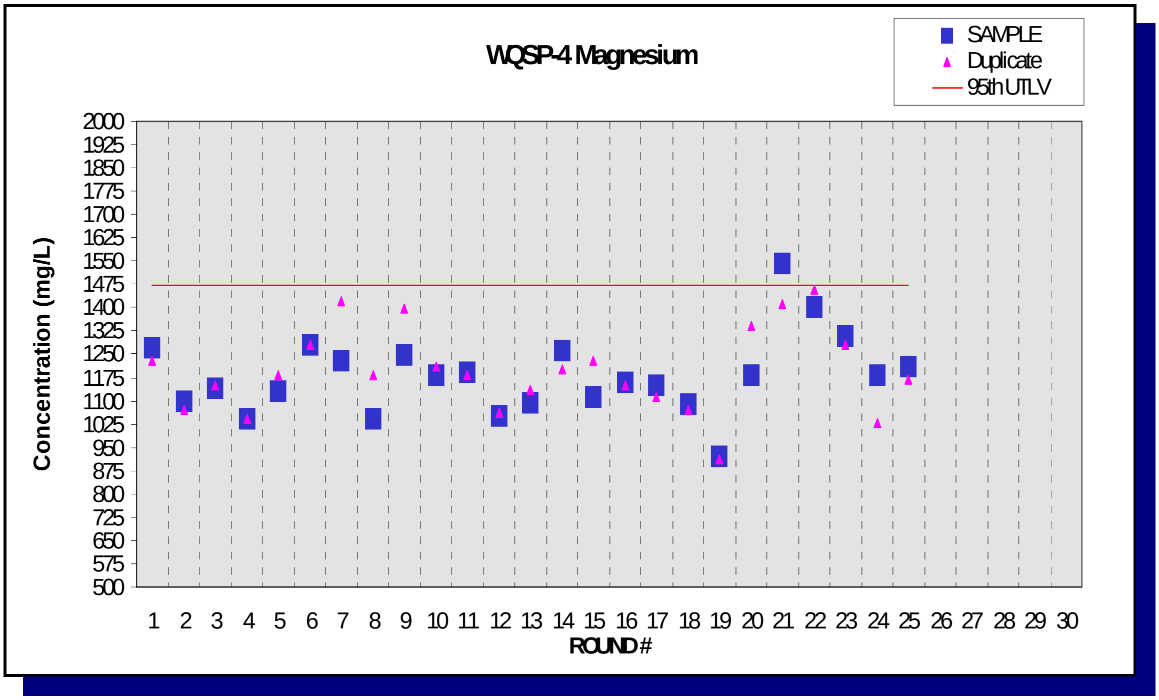

Figure E.47 - Time Trend Plot for Magnesium at WQSP-4

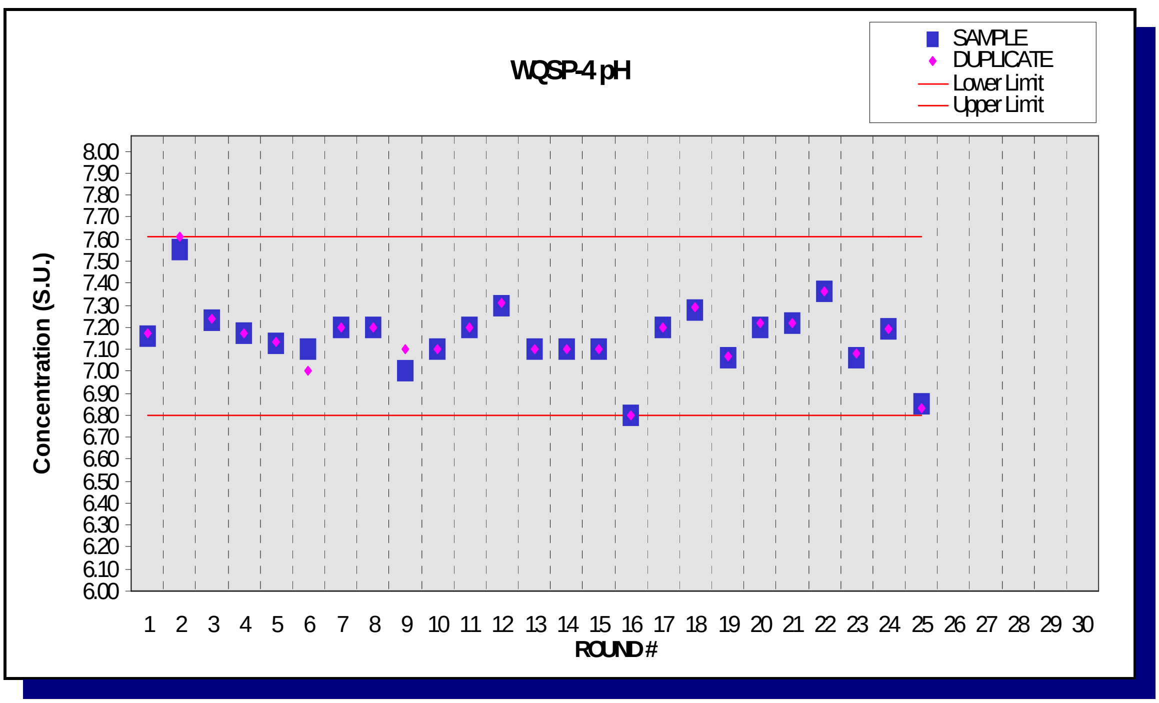

Figure E.48 - Time Trend Plot for pH at WQSP-4

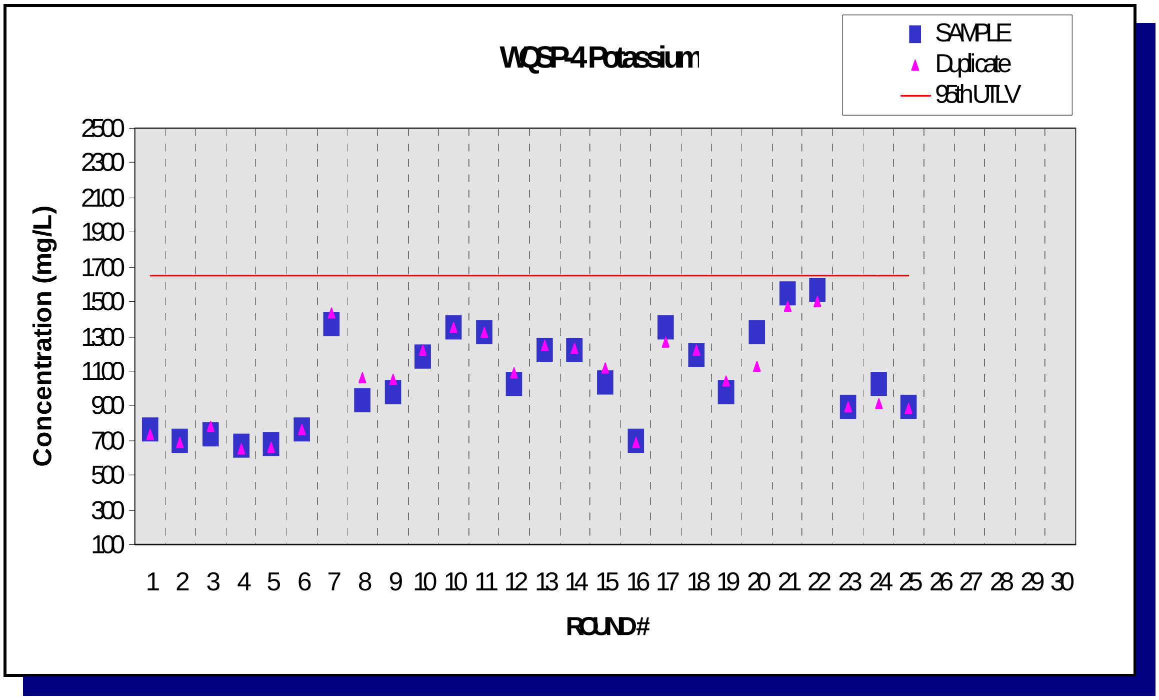

Figure E.49 - Time Trend Plot for Potassium at WQSP-4

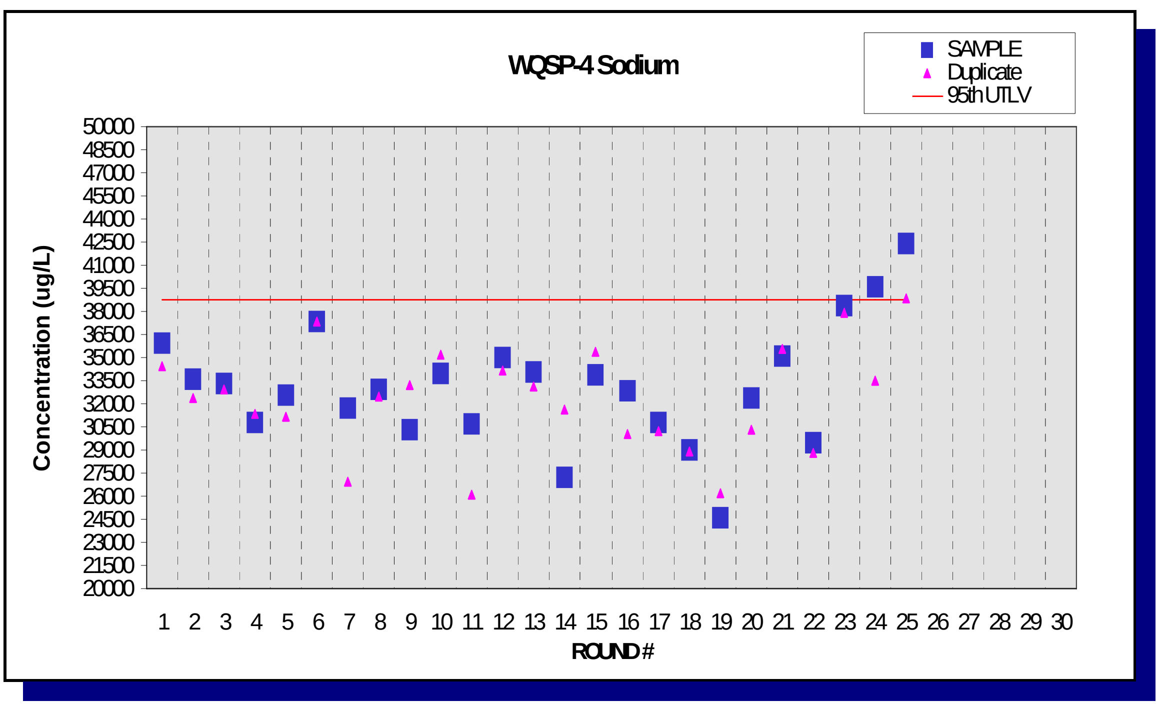

Figure E.50 - Time Trend Plot for Sodium at WQSP-4

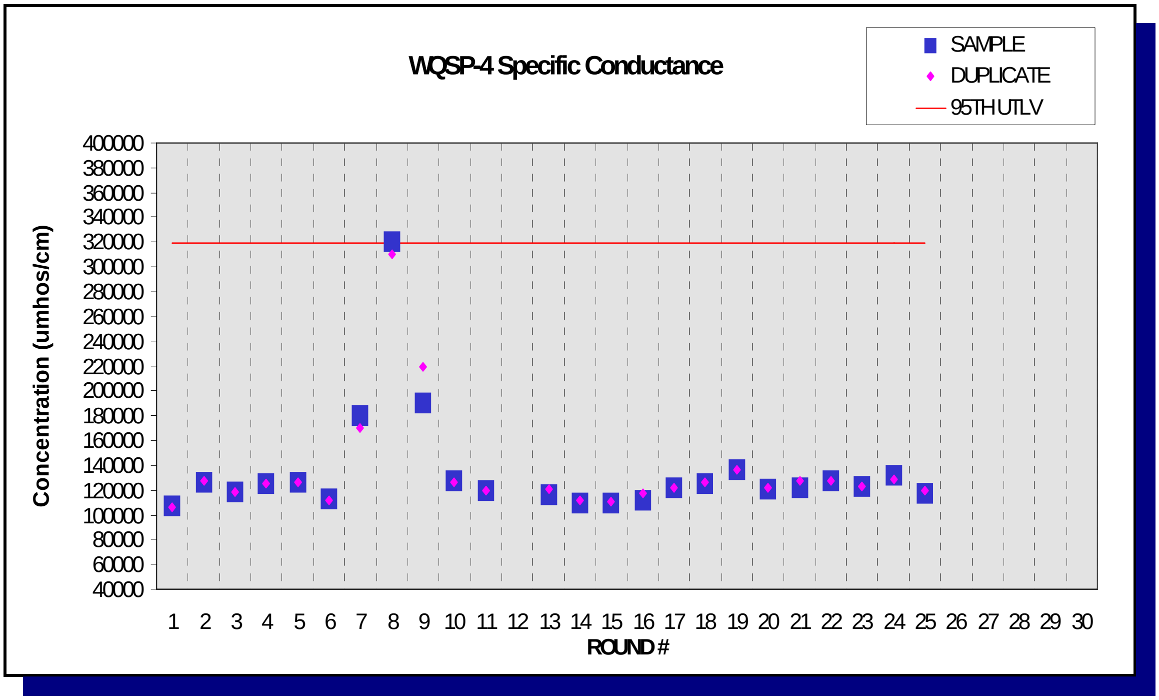

Figure E.51 - Time Trend Plot for Specific Conductance at WQSP-4

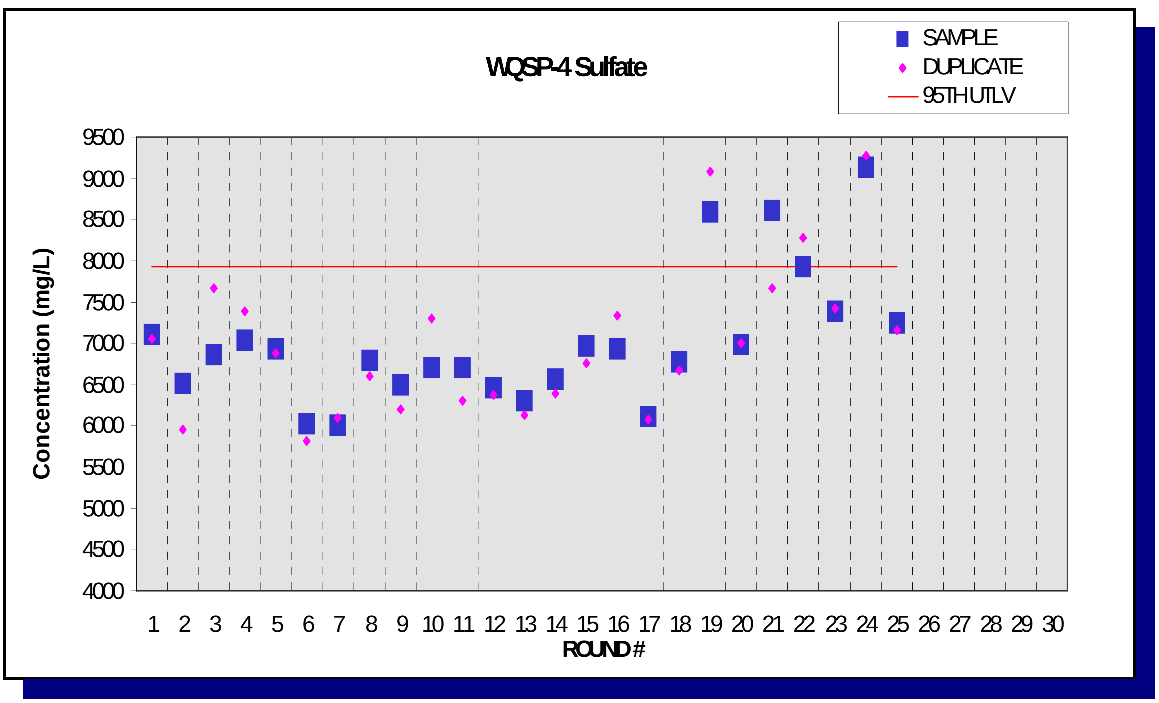

Figure E.52 - Time Trend Plot for Sulfate at WQSP-4

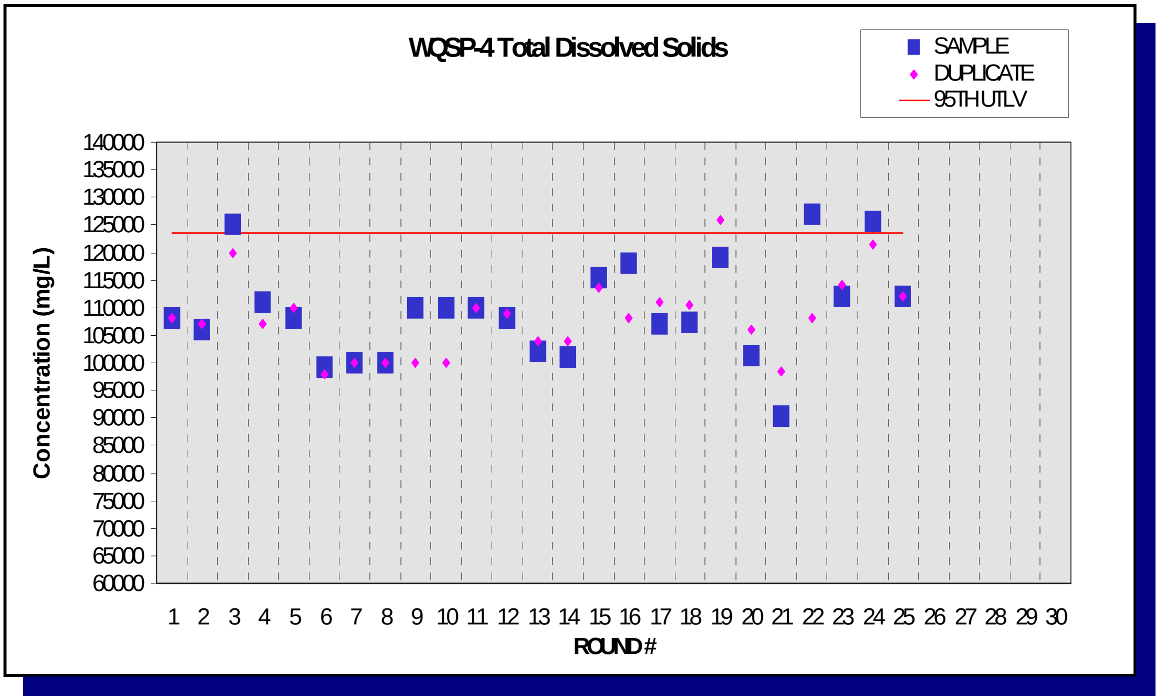

Figure E.53 - Time Trend Plot for Total Dissolved Solids at WQSP-4

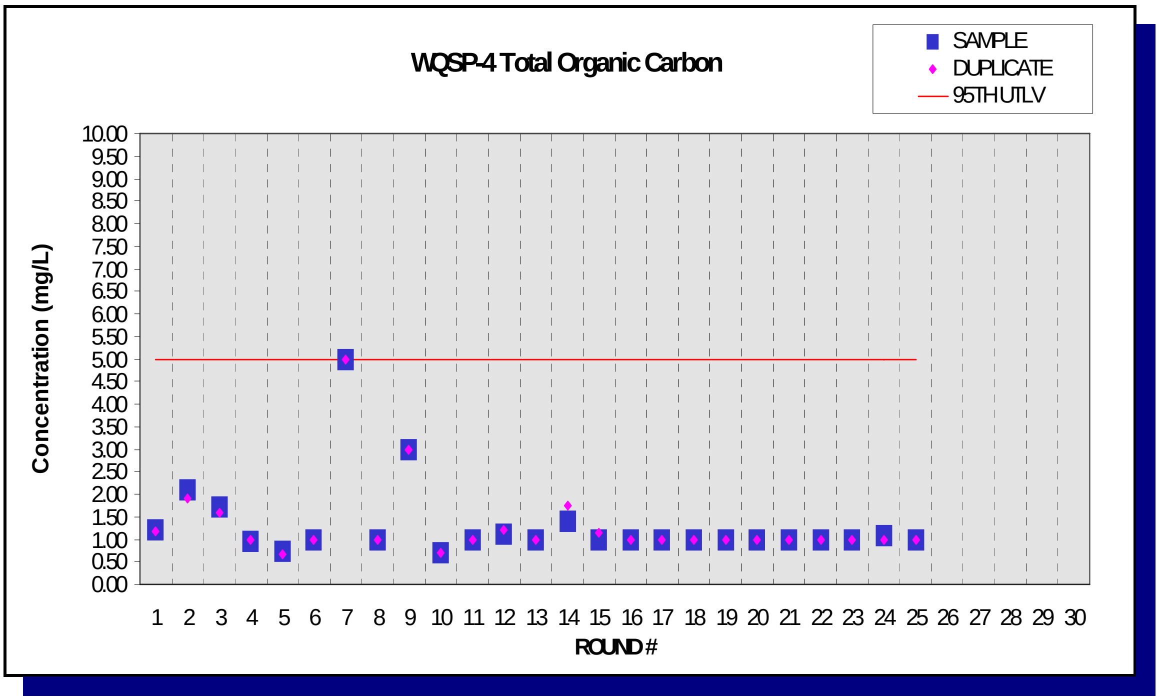

Figure E.54 - Time Trend Plot for Total Organic Carbon at WQSP-4

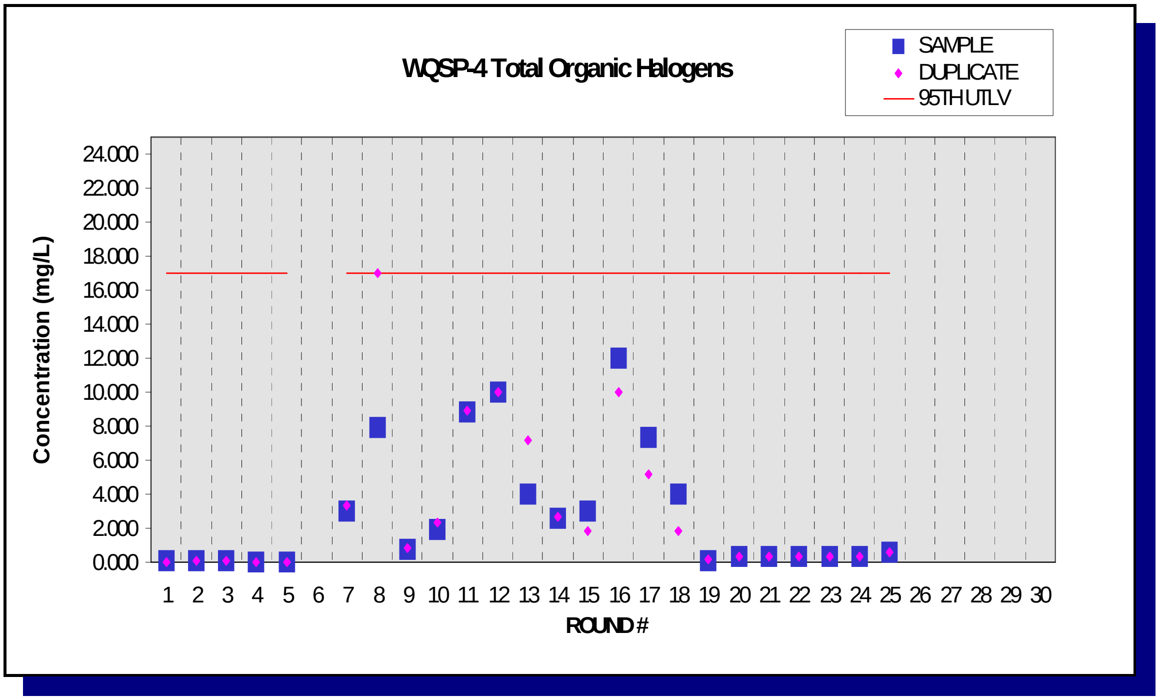

Figure E.55 - Time Trend Plot for Total Organic Halogens at WQSP-4

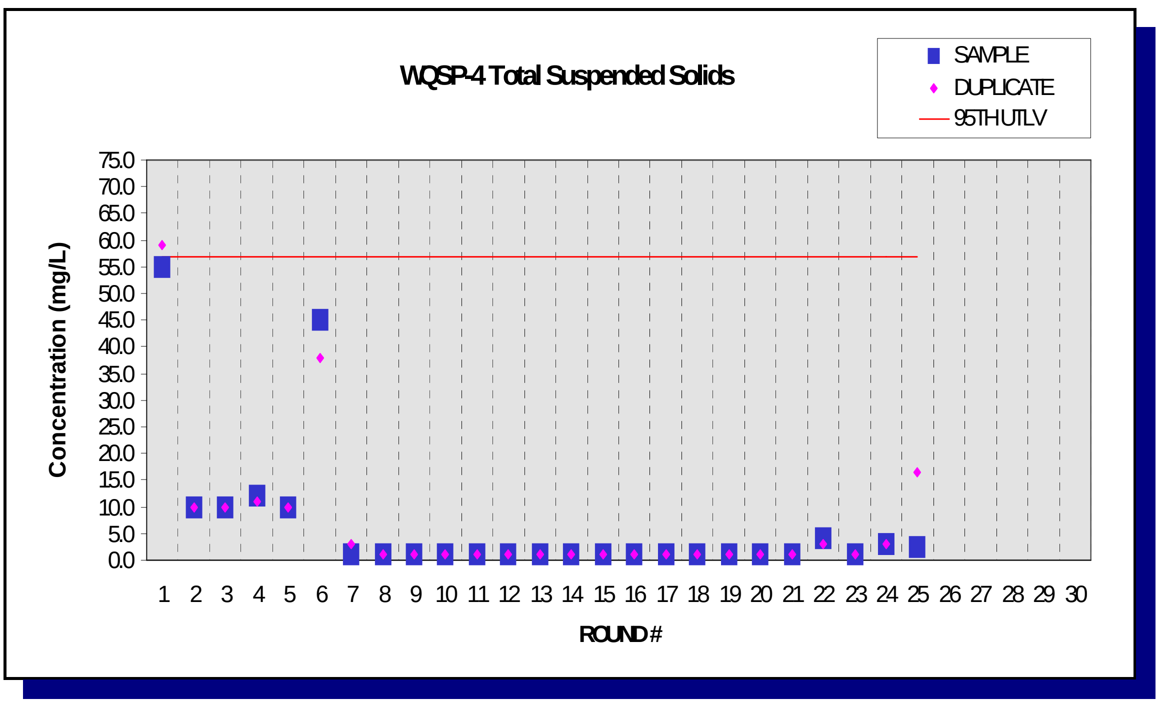

Figure E.56 - Time Trend Plot for Total Suspended Solids at WQSP-4

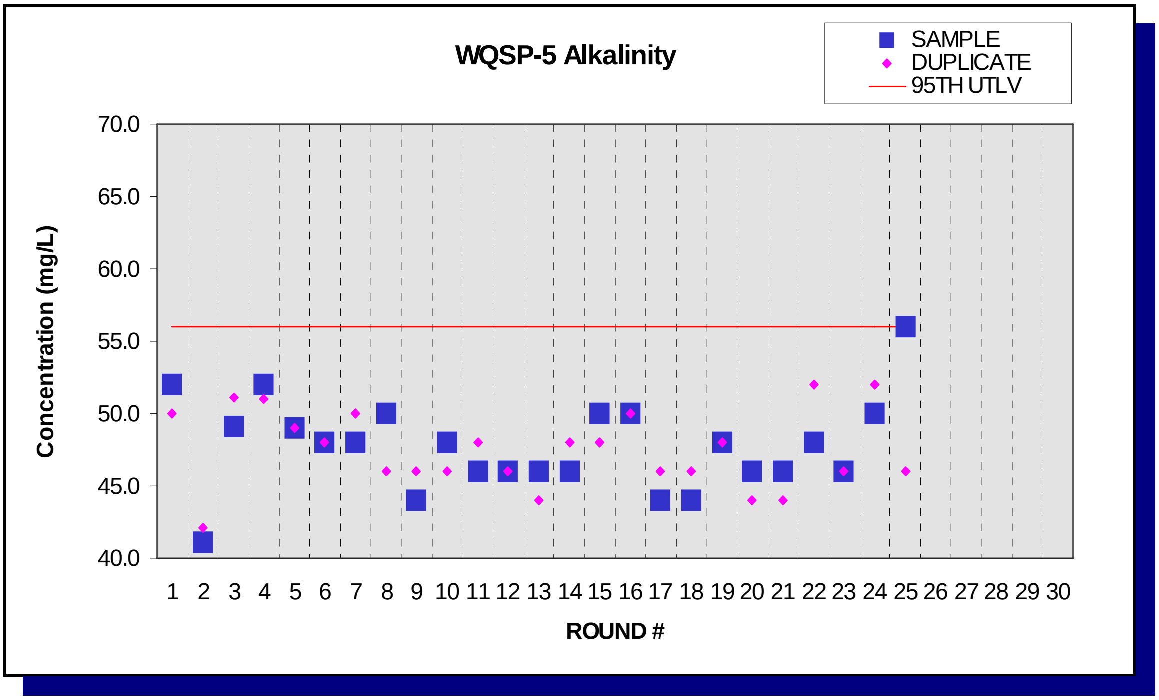

Figure E.57 - Time Trend Plot for Total Suspended Solids at WQSP-5

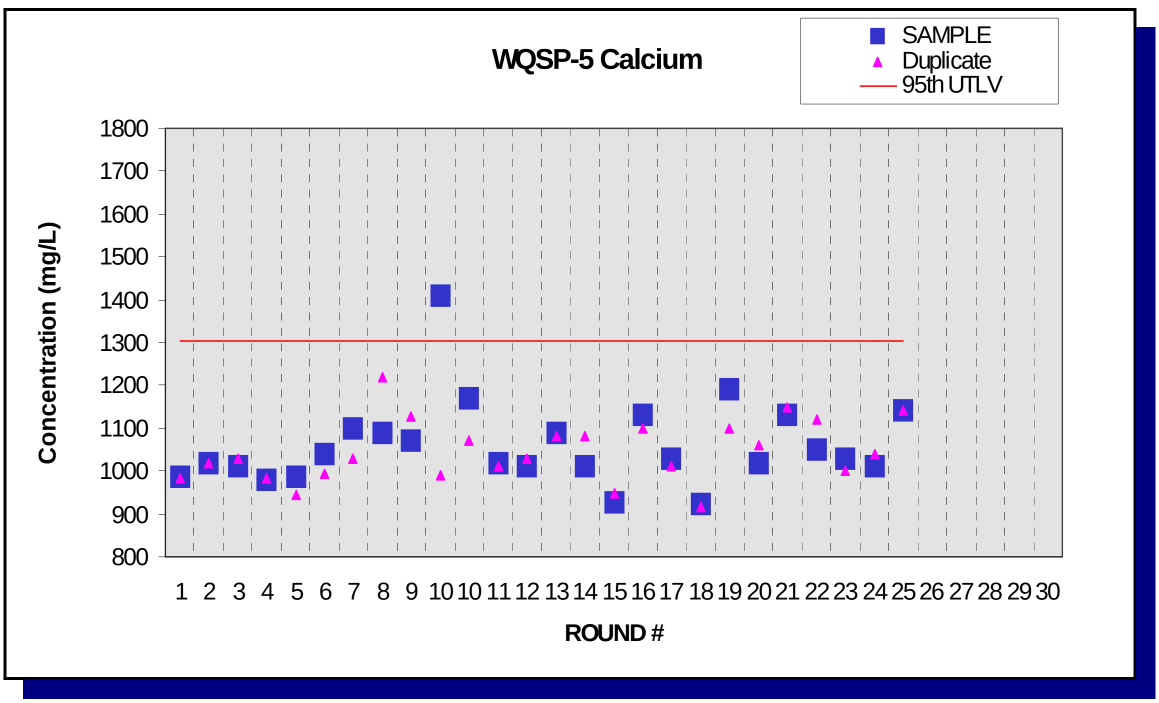

Figure E.58 - Time Trend Plot for Calcium at WQSP-5

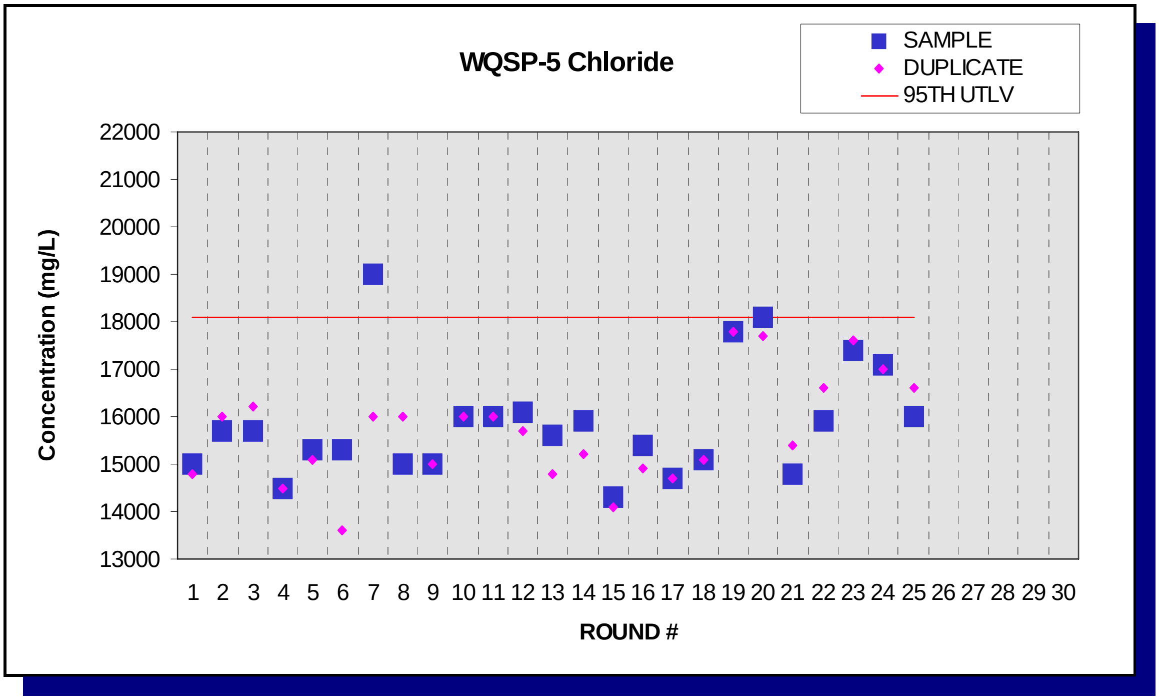

Figure E.59 - Time Trend Plot for Chloride at WQSP-5

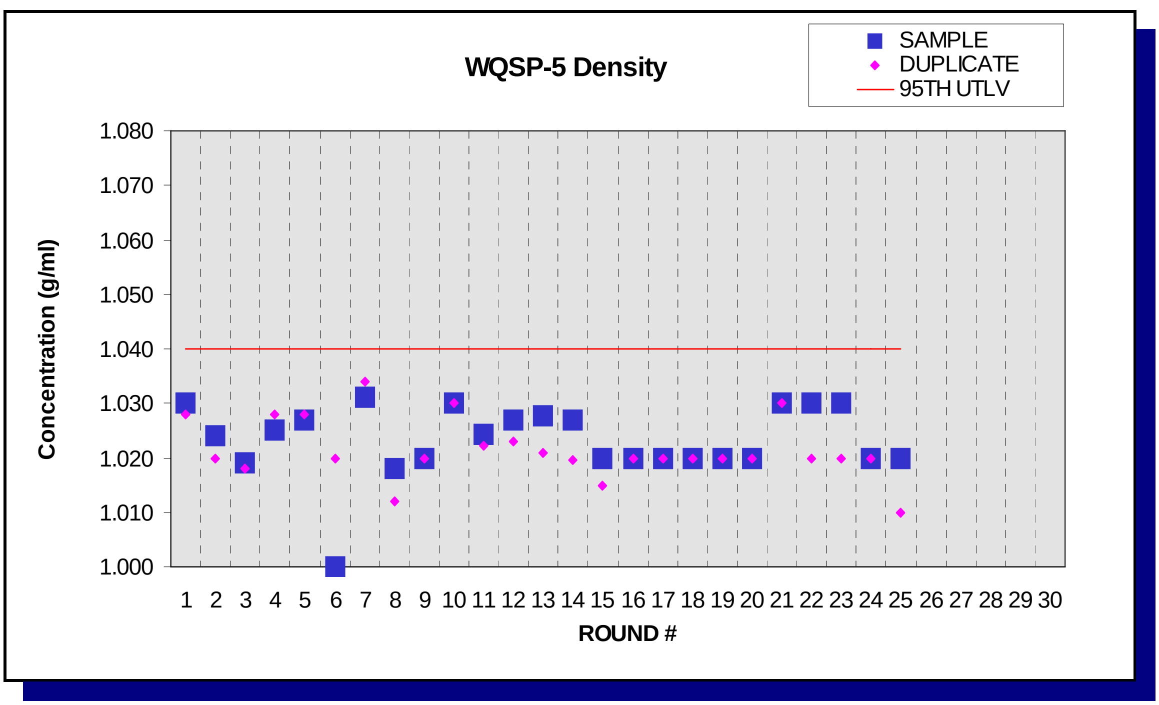

Figure E.60 - Time Trend Plot for Density at WQSP-5

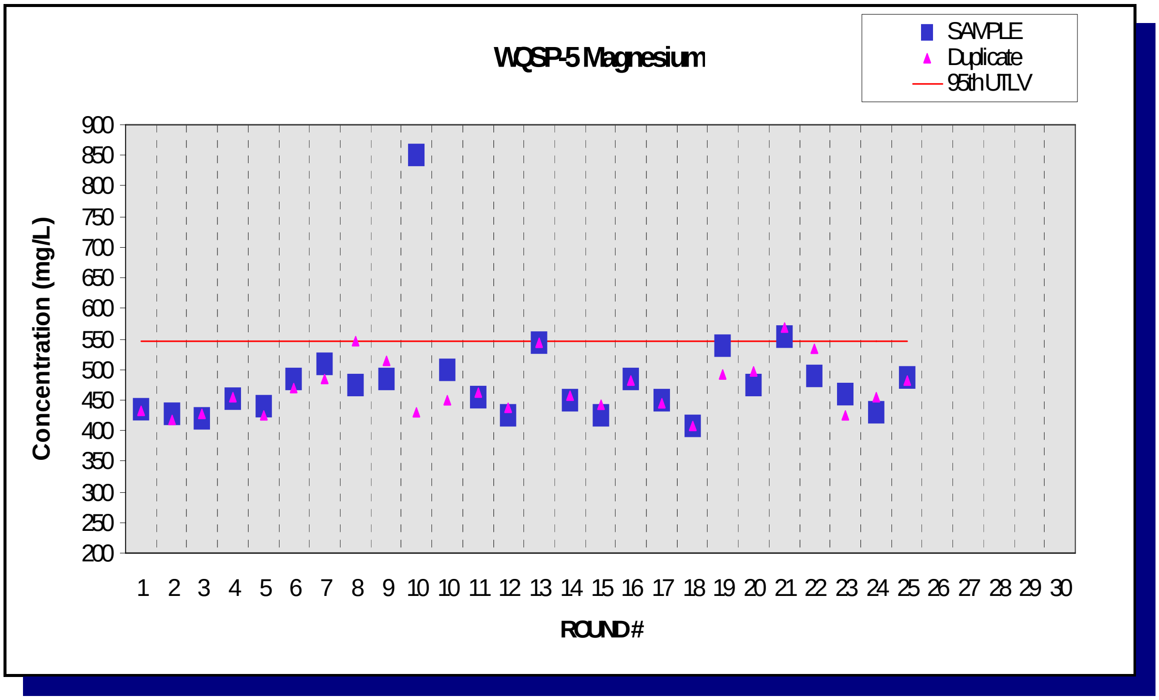

Figure E.61 - Time Trend Plot for Magnesium at WQSP-5

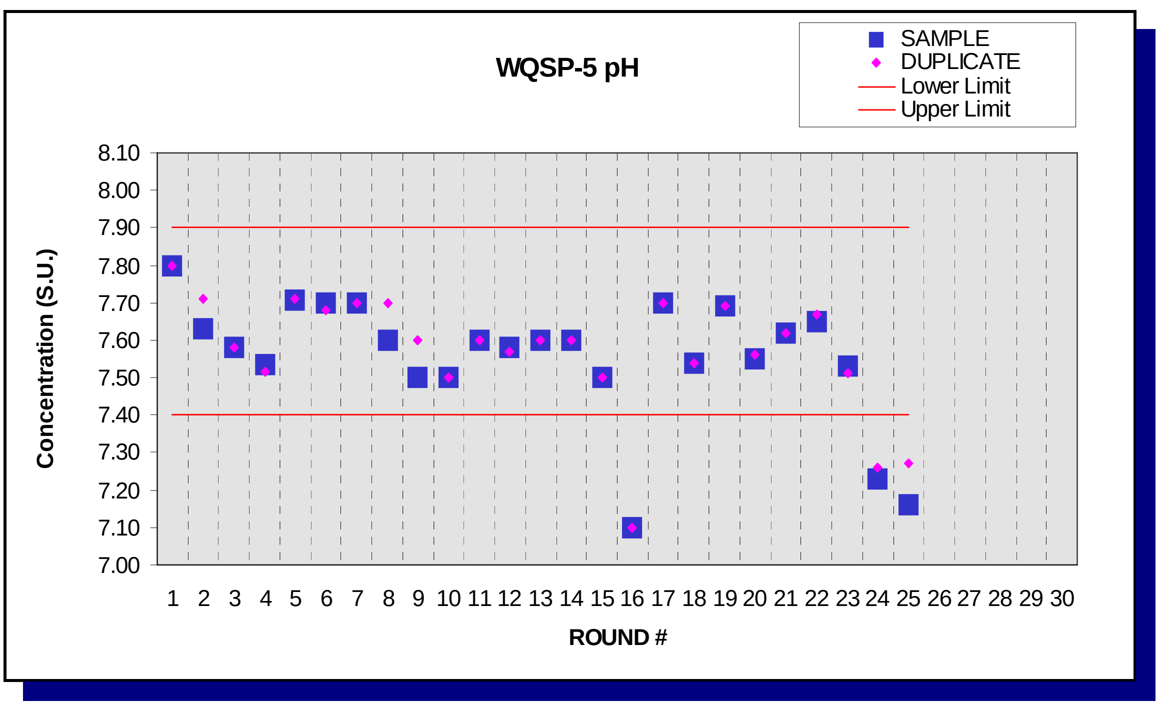

Figure E.62 - Time Trend Plot for pH at WQSP-5

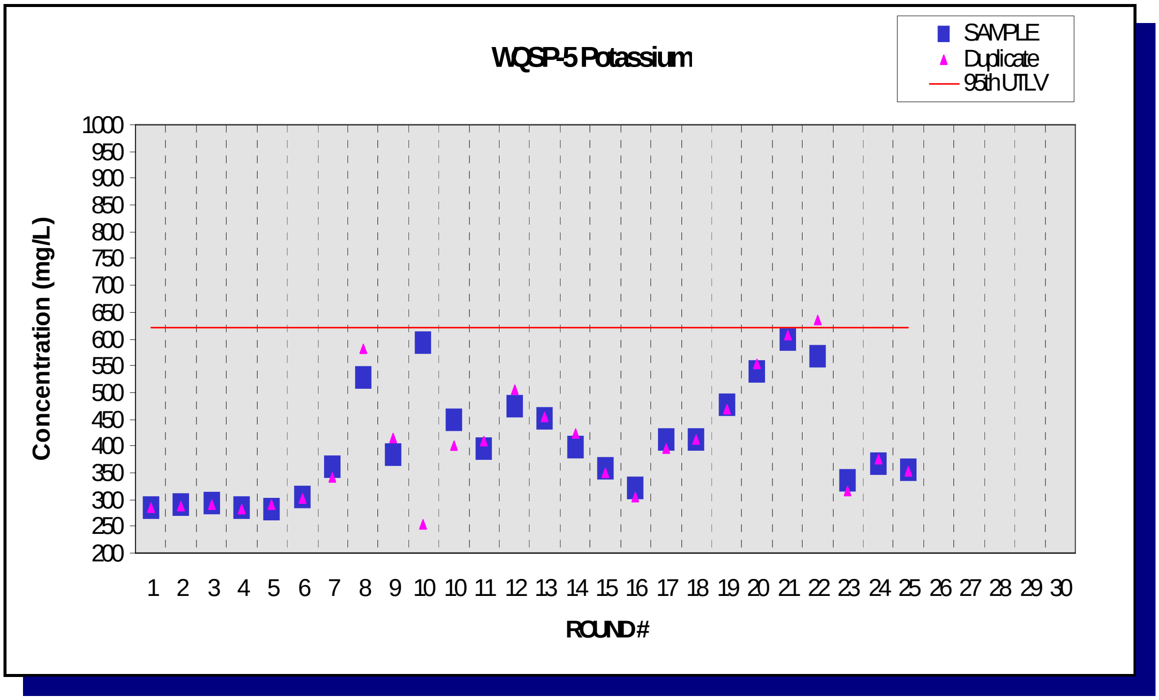

Figure E.63 - Time Trend Plot for Potassium at WQSP-5

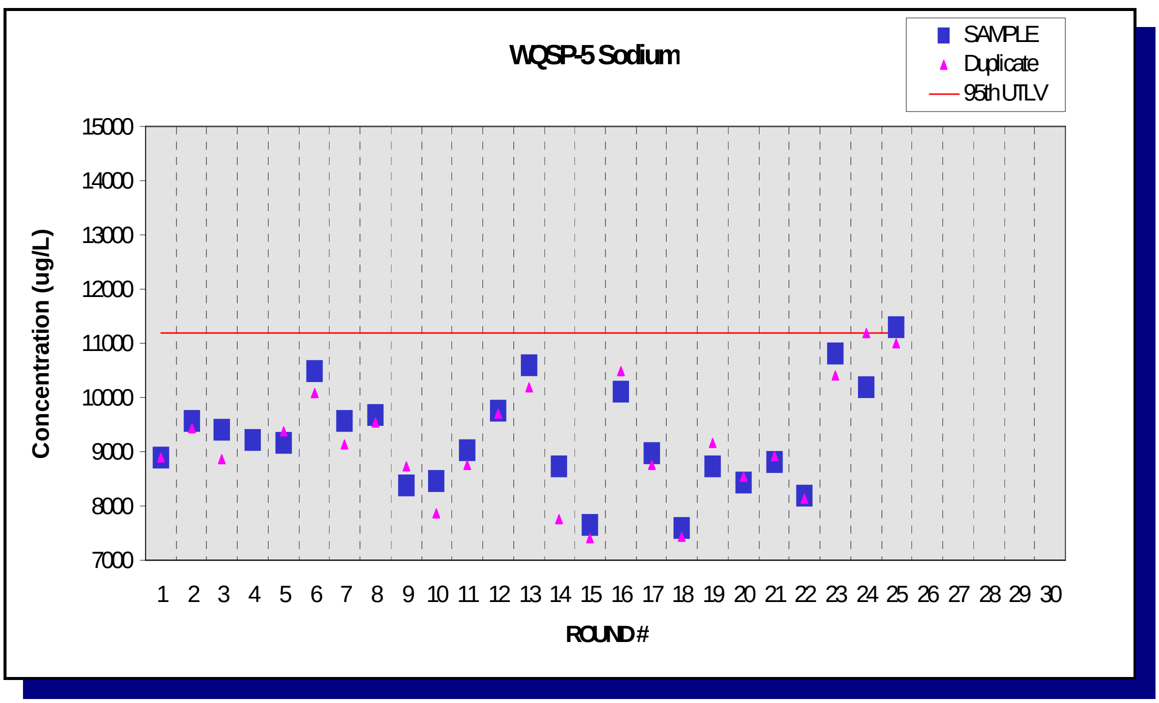

Figure E.64 - Time Trend Plot for Sodium at WQSP-5

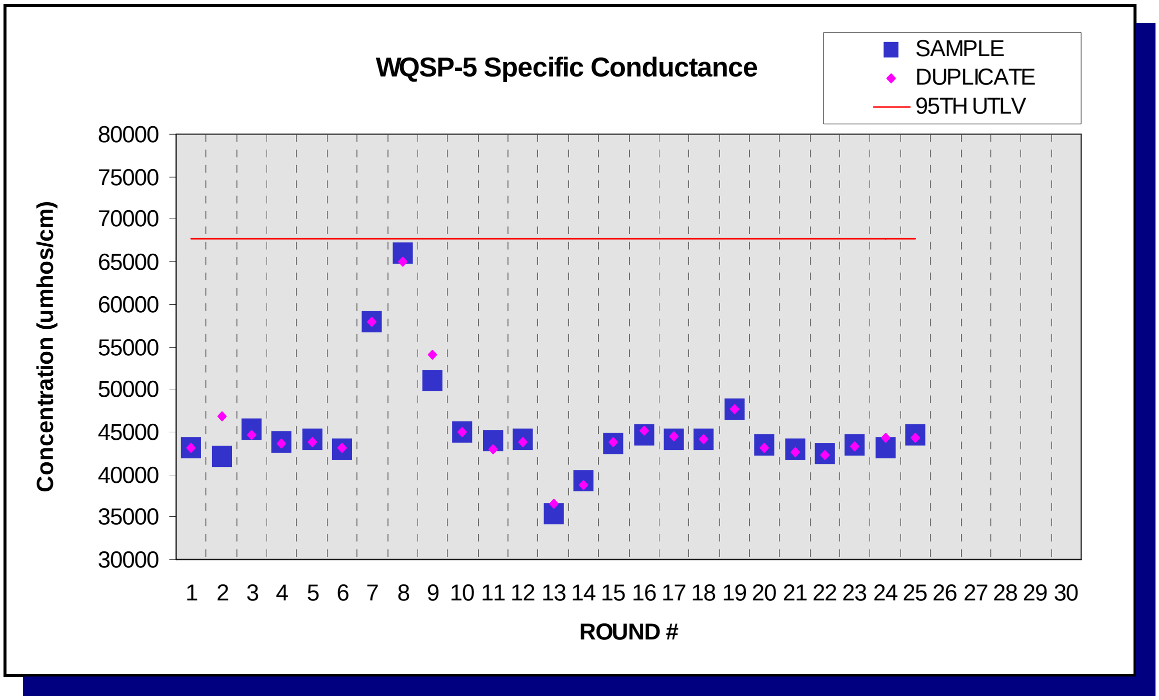

Figure E.65 - Time Trend Plot for Specific Conductance at WQSP-5

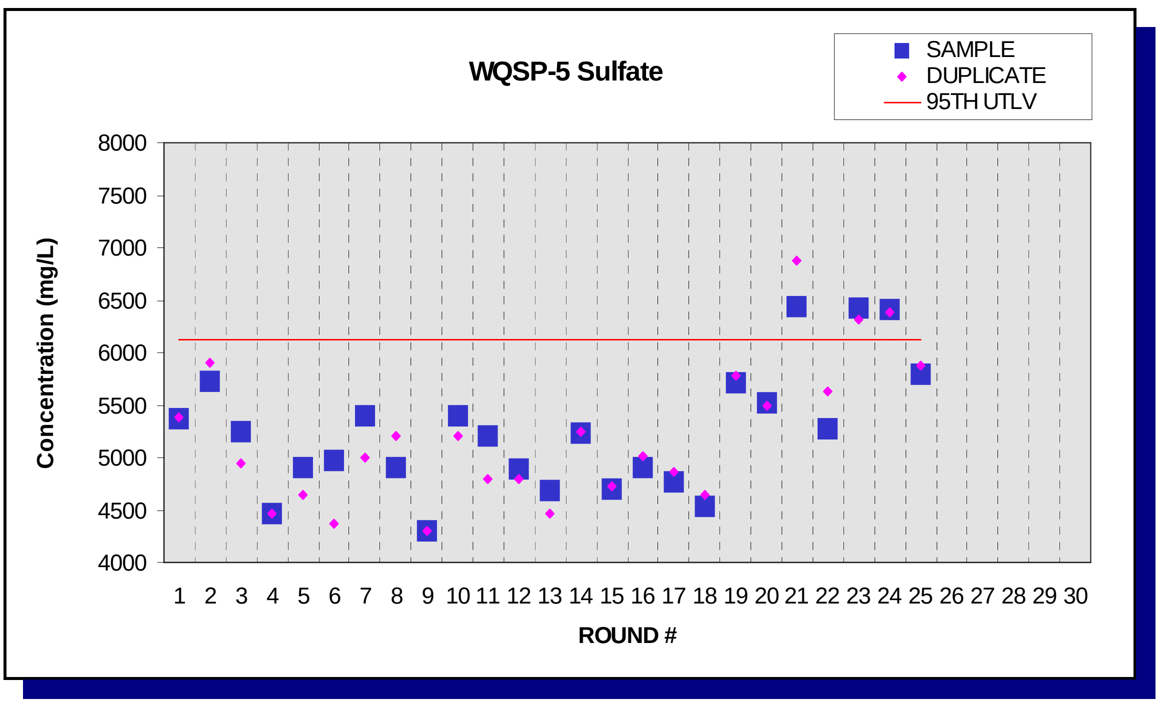

Figure E.66 - Time Trend Plot for Sulfate at WQSP-5

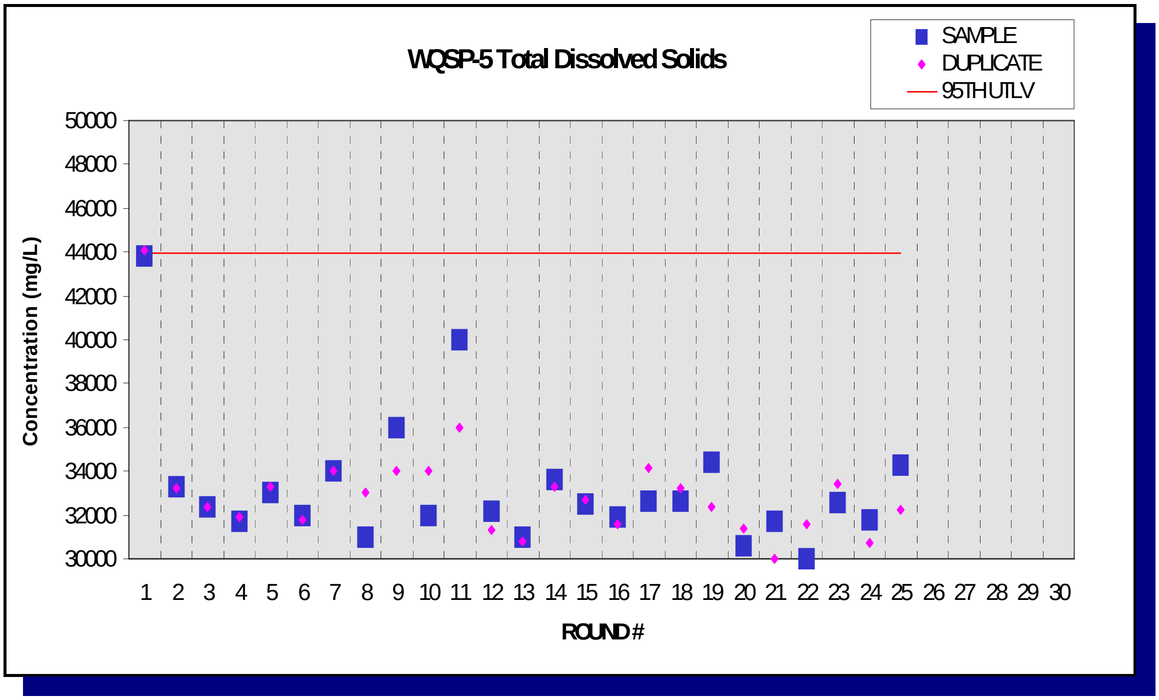

Figure E.67 - Time Trend Plot for Total Dissolved Solids at WQSP-5

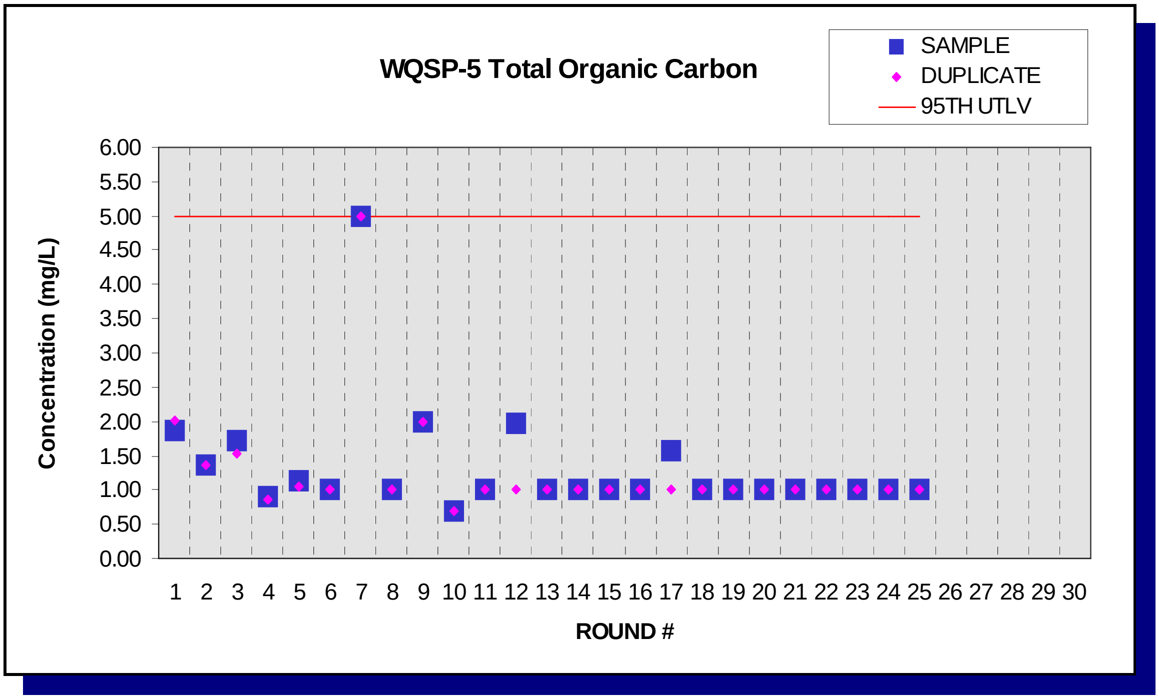

Figure E.68 - Time Trend Plot for Total Organic Carbon at WQSP-5

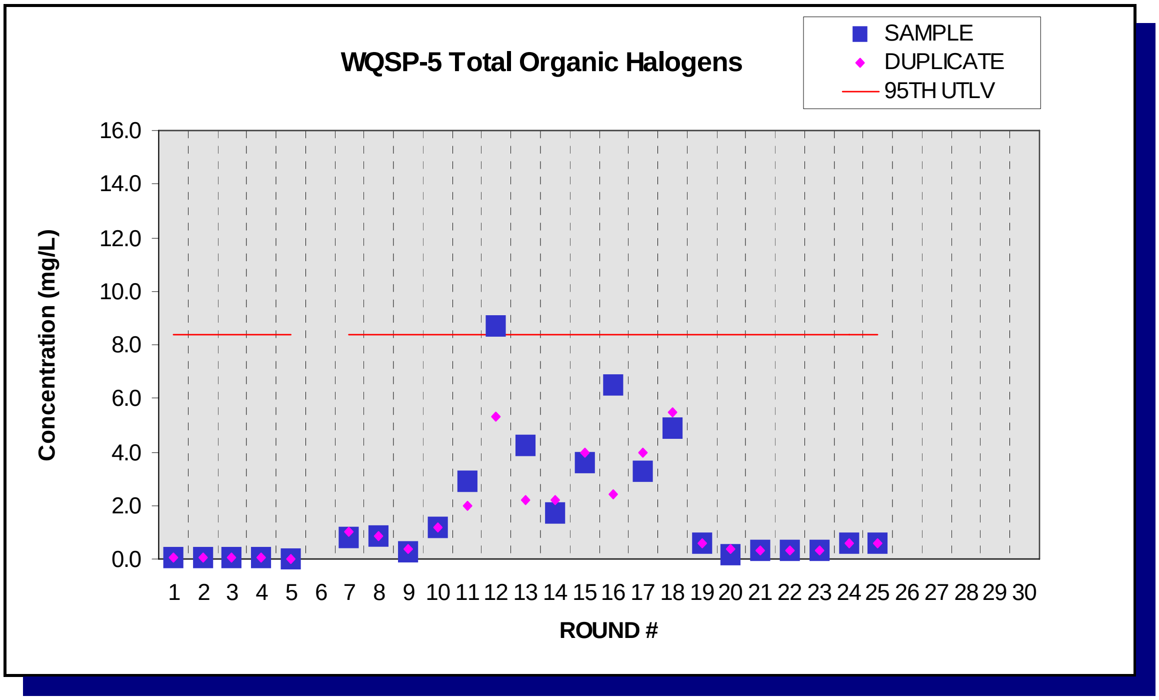

Figure E.69 - Time Trend Plot for Total Organic Halogens at WQSP-5

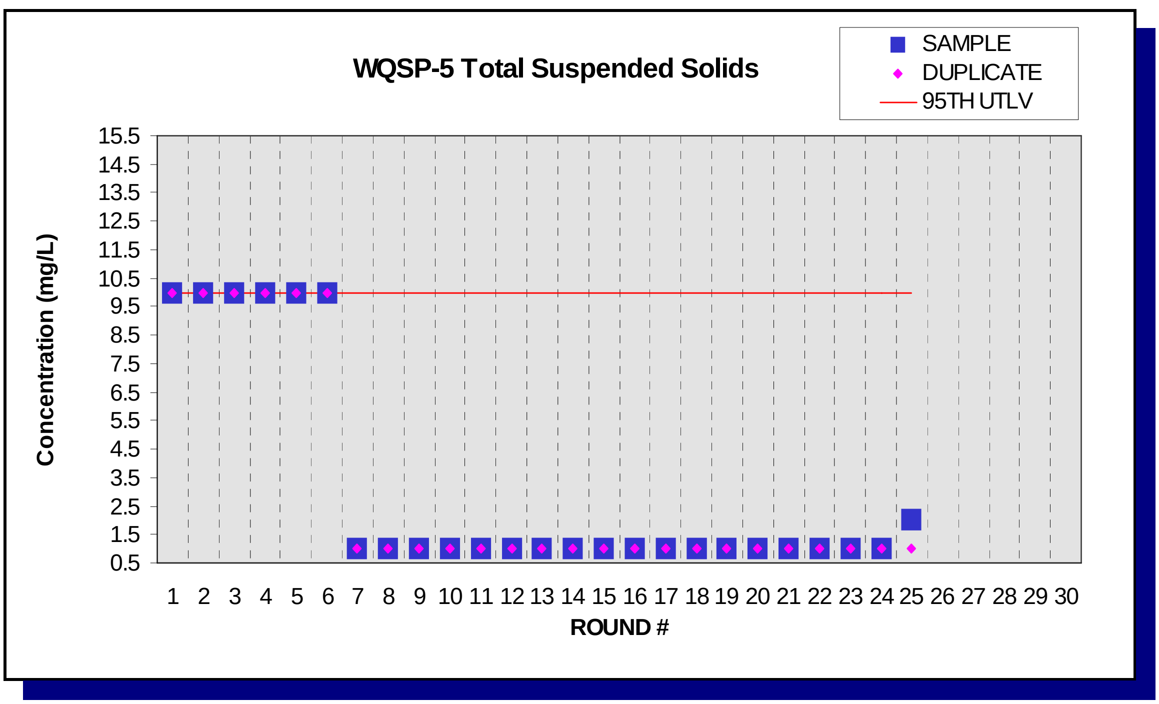

Figure E.70 - Time Trend Plot for Total Suspended Solids at WQSP-5

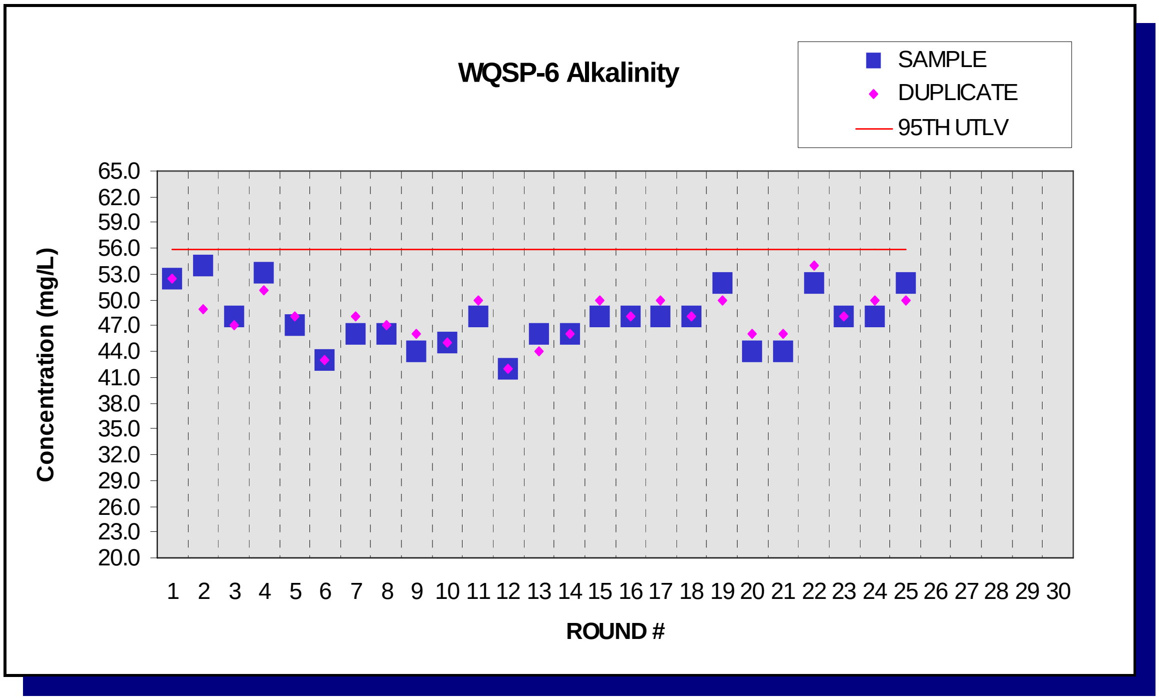

Figure E.71 - Time Trend Plot for Alkalinity at WQSP-6

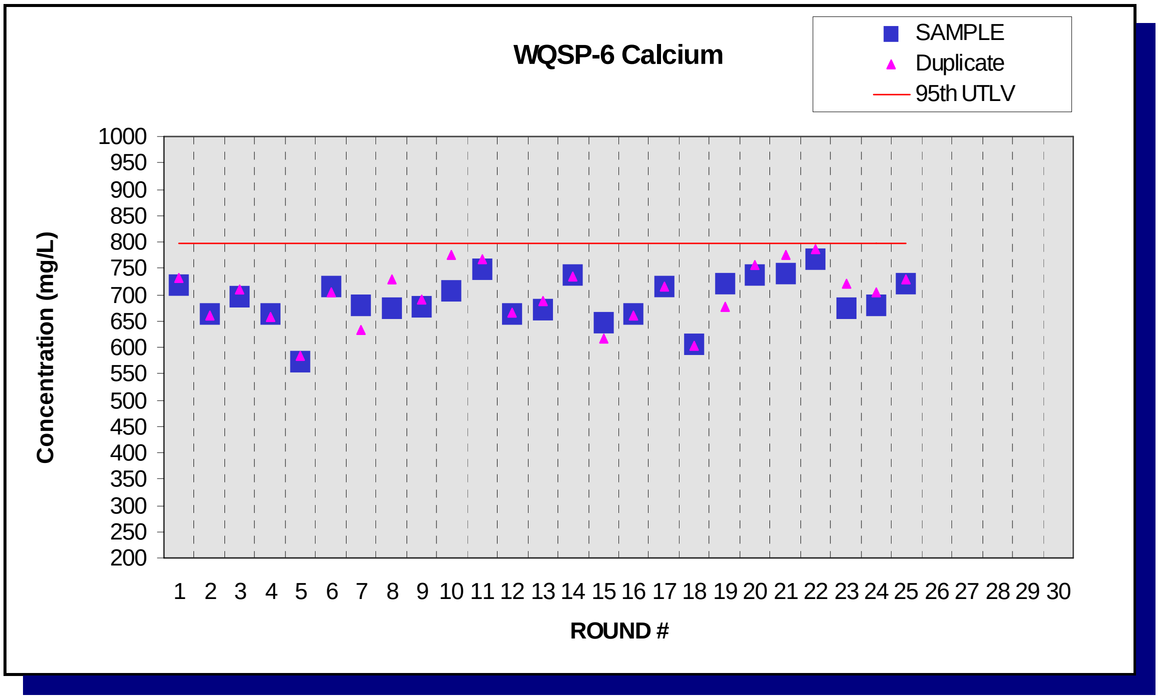

Figure E.72 - Time Trend Plot for Calcium at WQSP-6

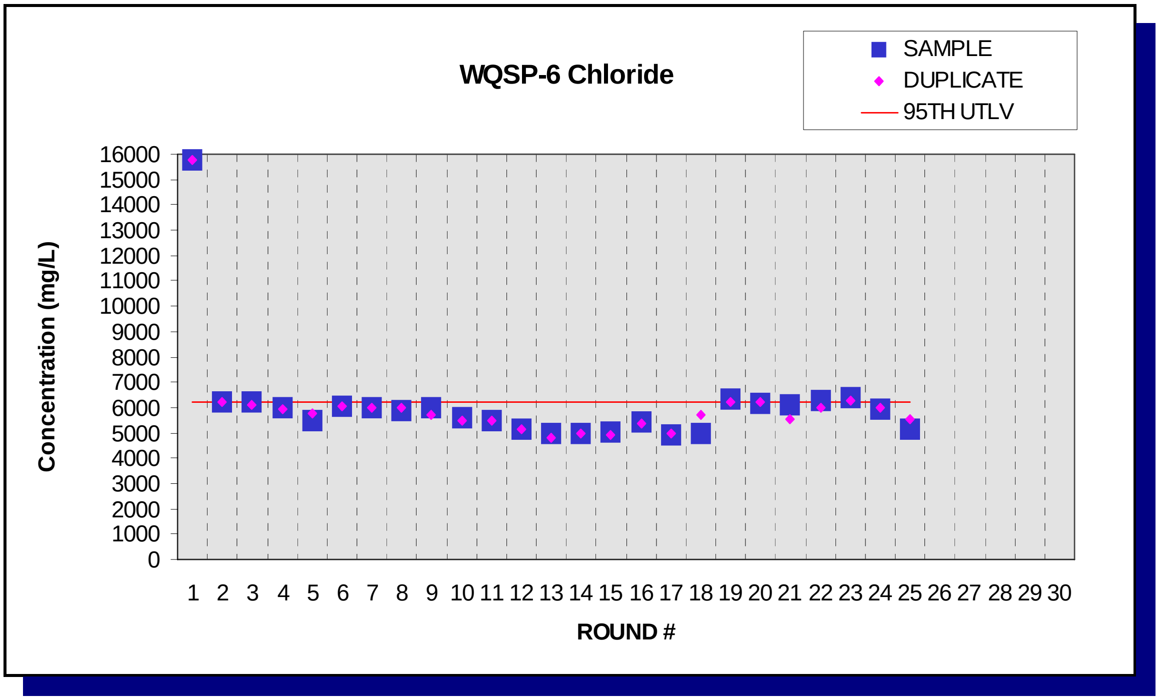

Figure E.73 - Time Trend Plot for Chloride at WQSP-6

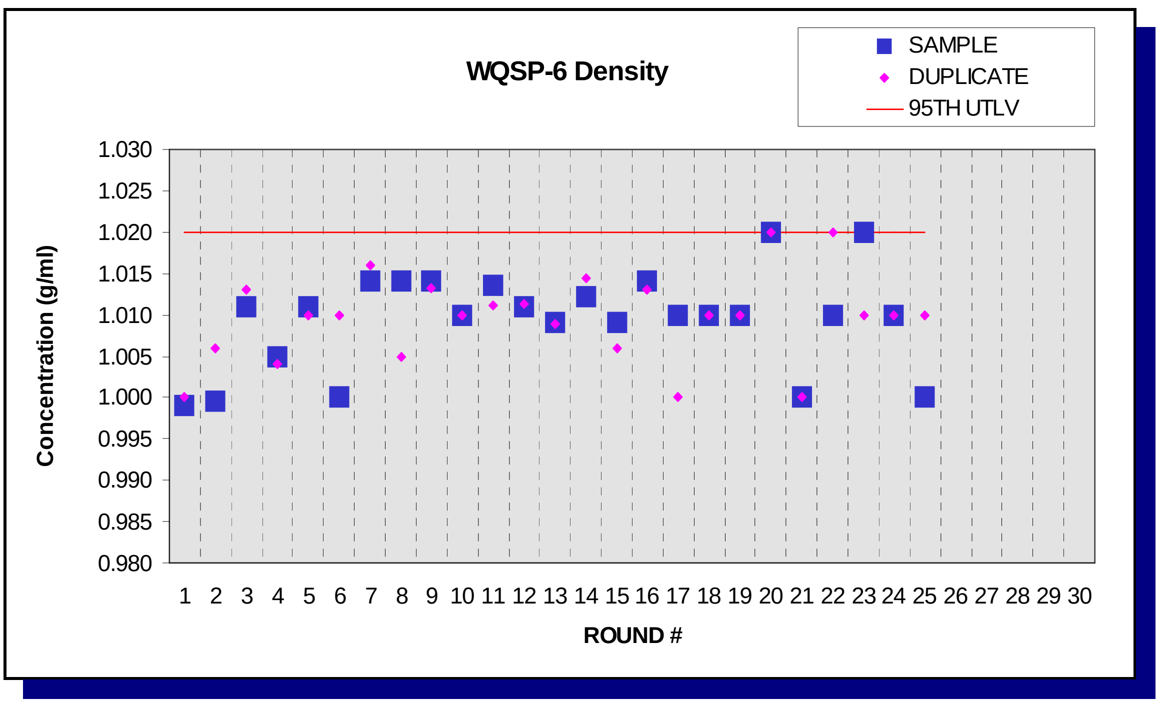

Figure E.74 - Time Trend Plot for Density at WQSP-6

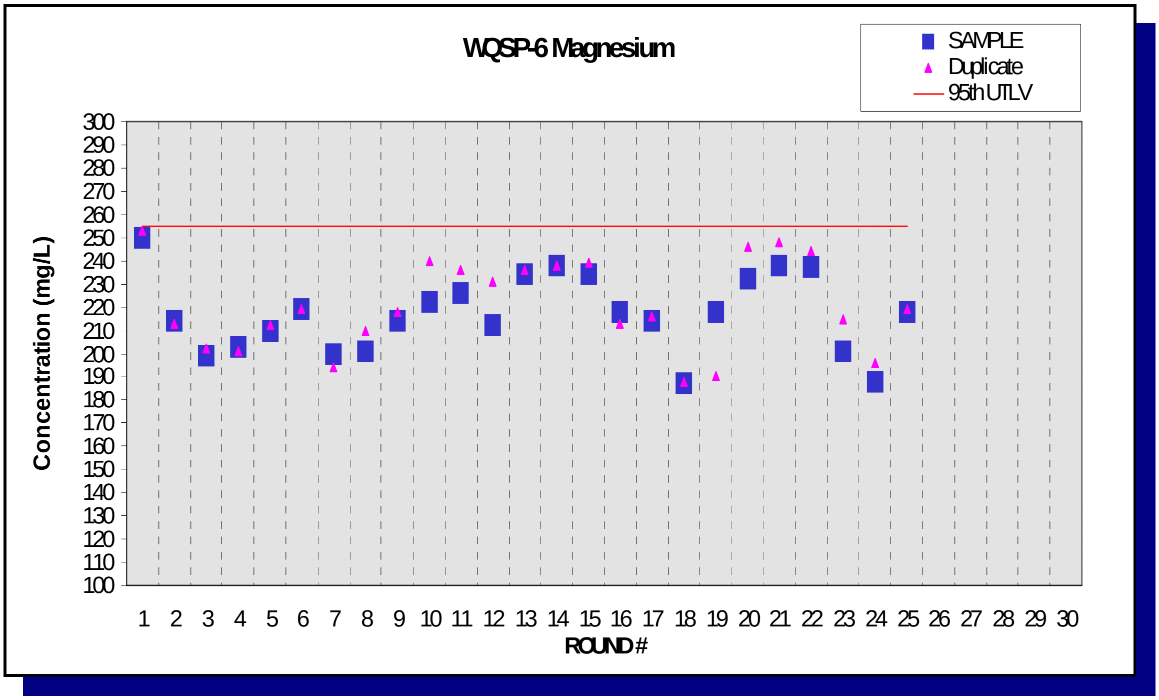

Figure E.75 - Time Trend Plot for Magnesium at WQSP-6

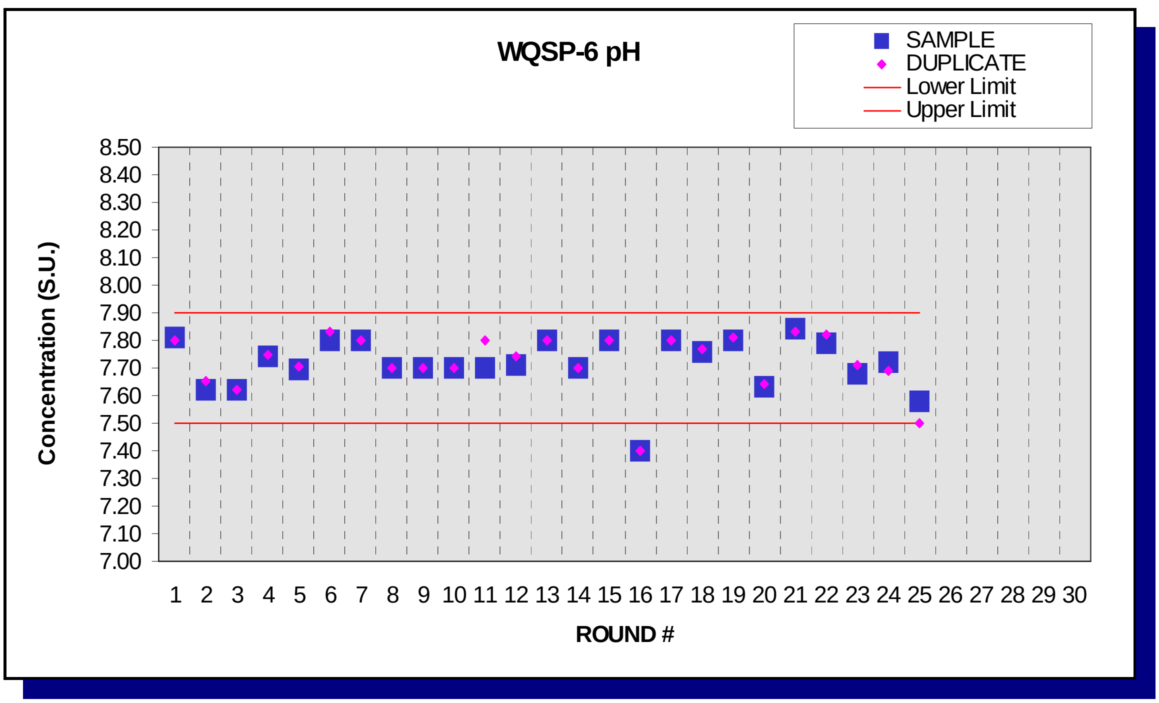

Figure E.76 - Time Trend Plot for pH at WQSP-6

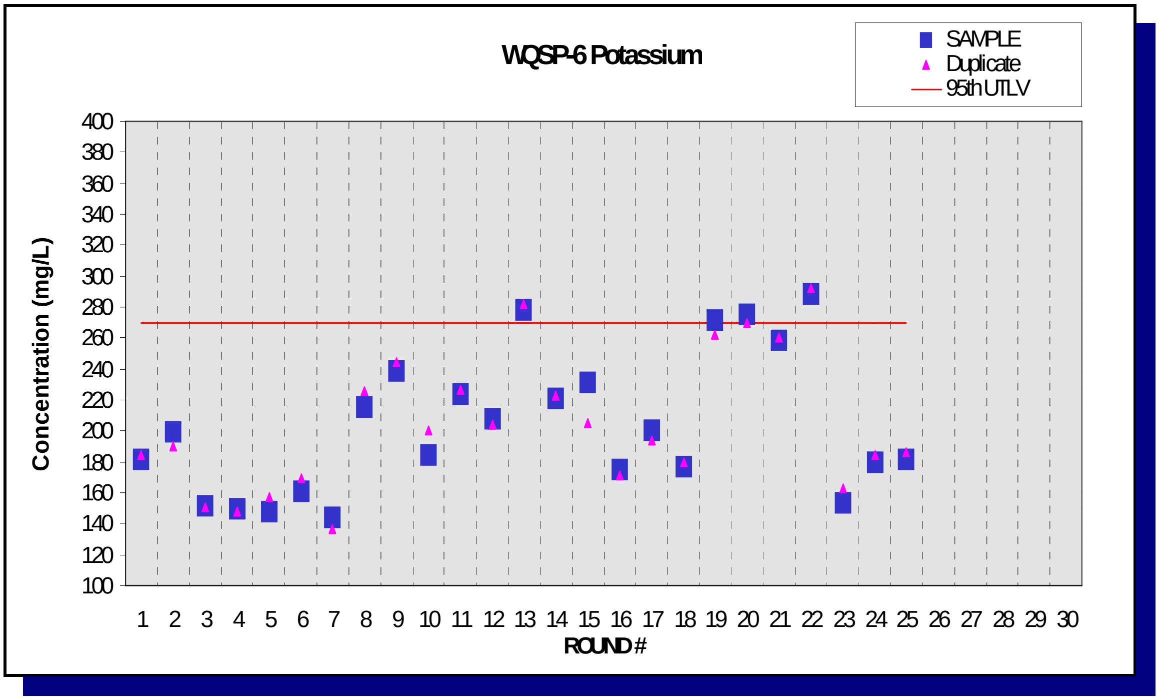

Figure E.77 - Time Trend Plot for Potassium at WQSP-6

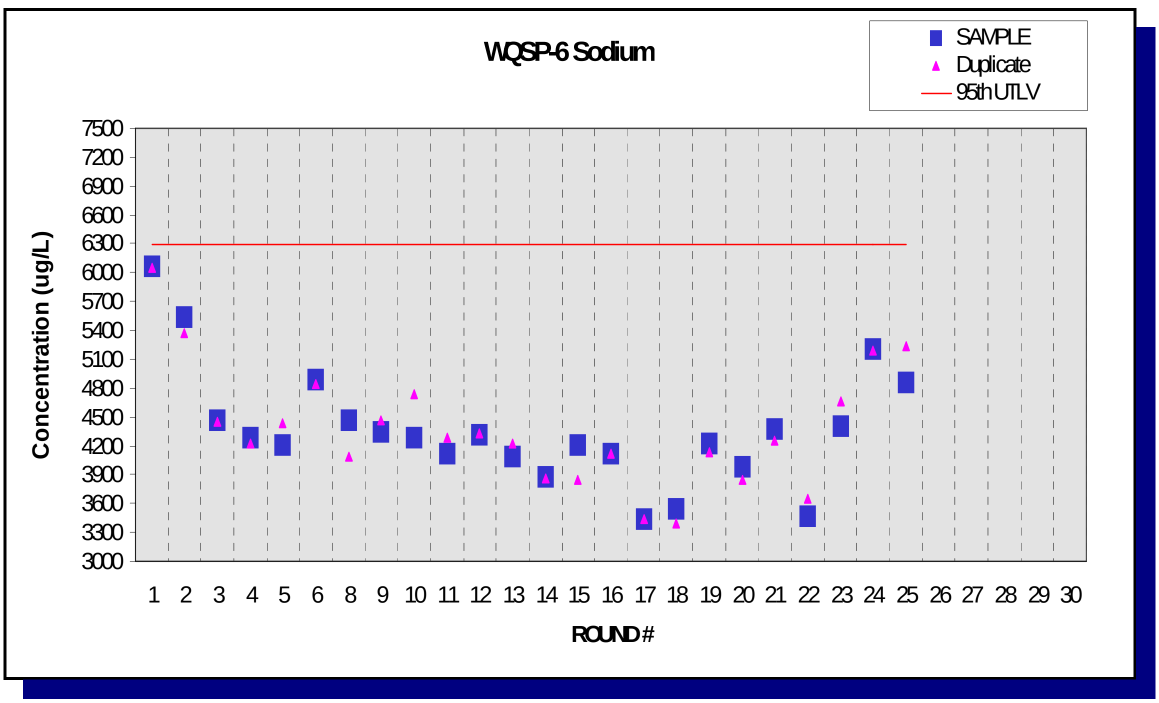

Figure E.78 - Time Trend Plot for Sodium at WQSP-6

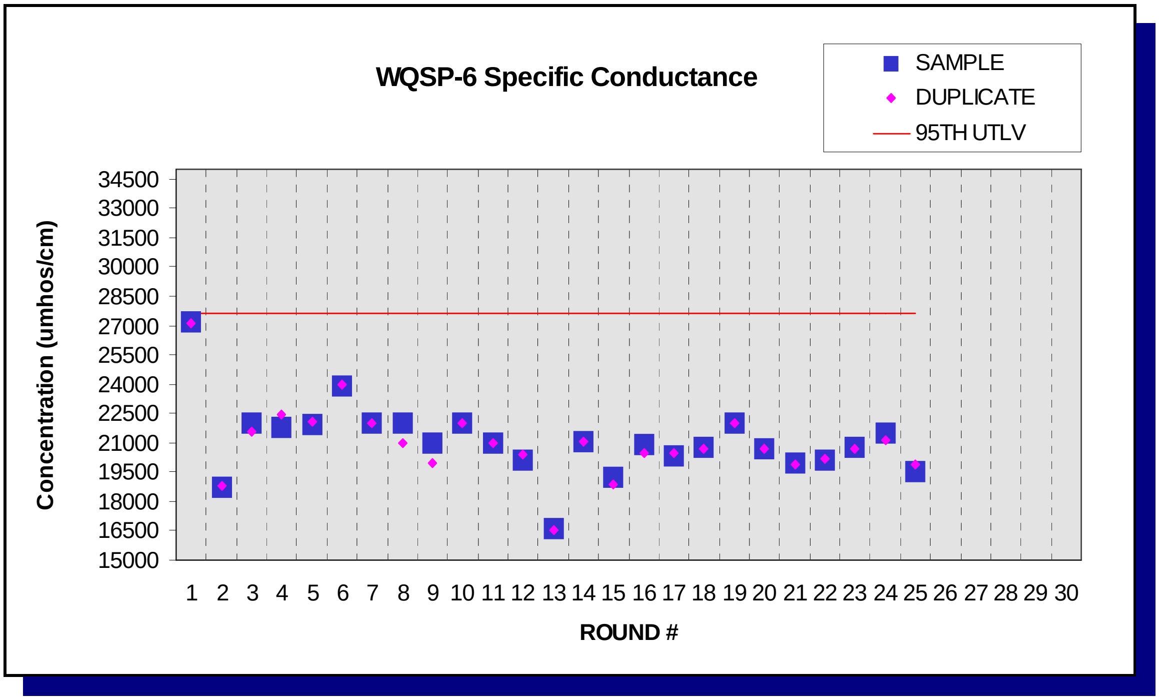

Figure E.79 - Time Trend Plot for Sodium at WQSP-6

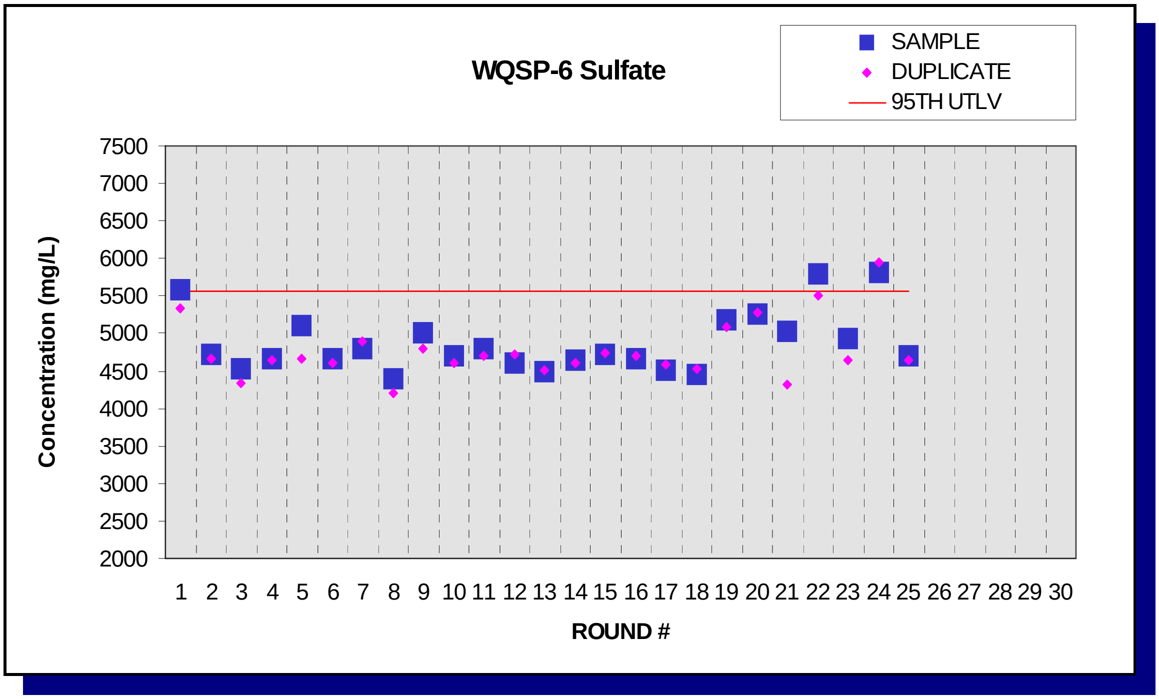

Figure E.80 - Time Trend Plot for Sulfate at WQSP-6

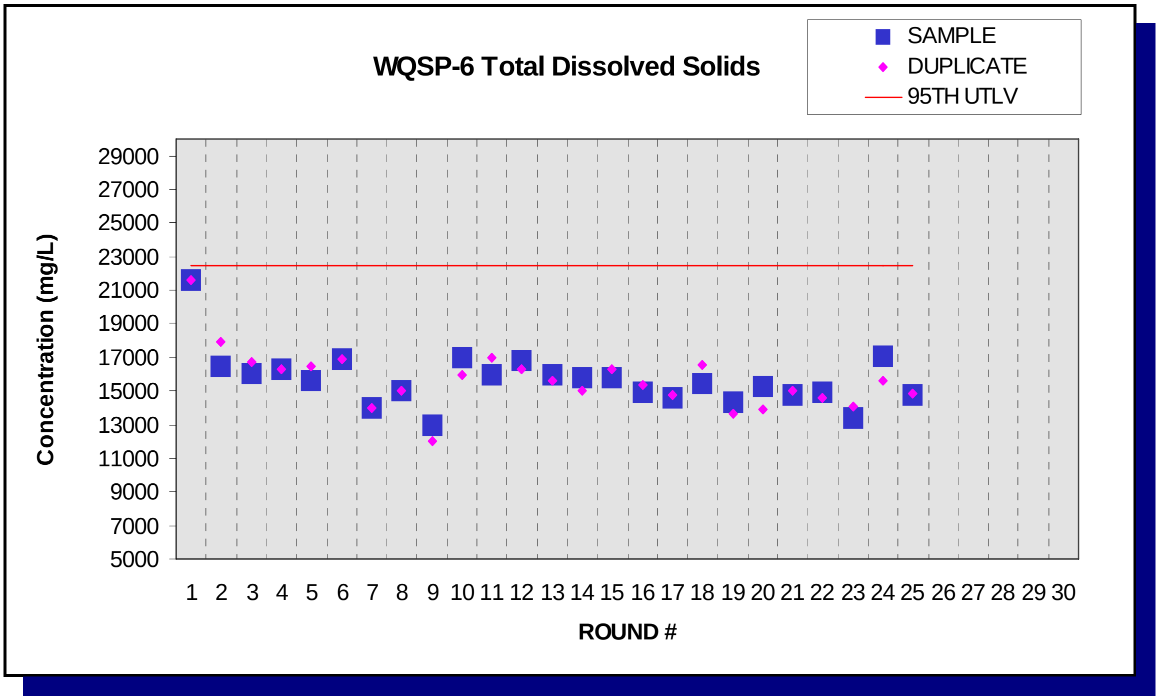

Figure E.81 - Time Trend Plot for Total Dissolved Solids at WQSP-6

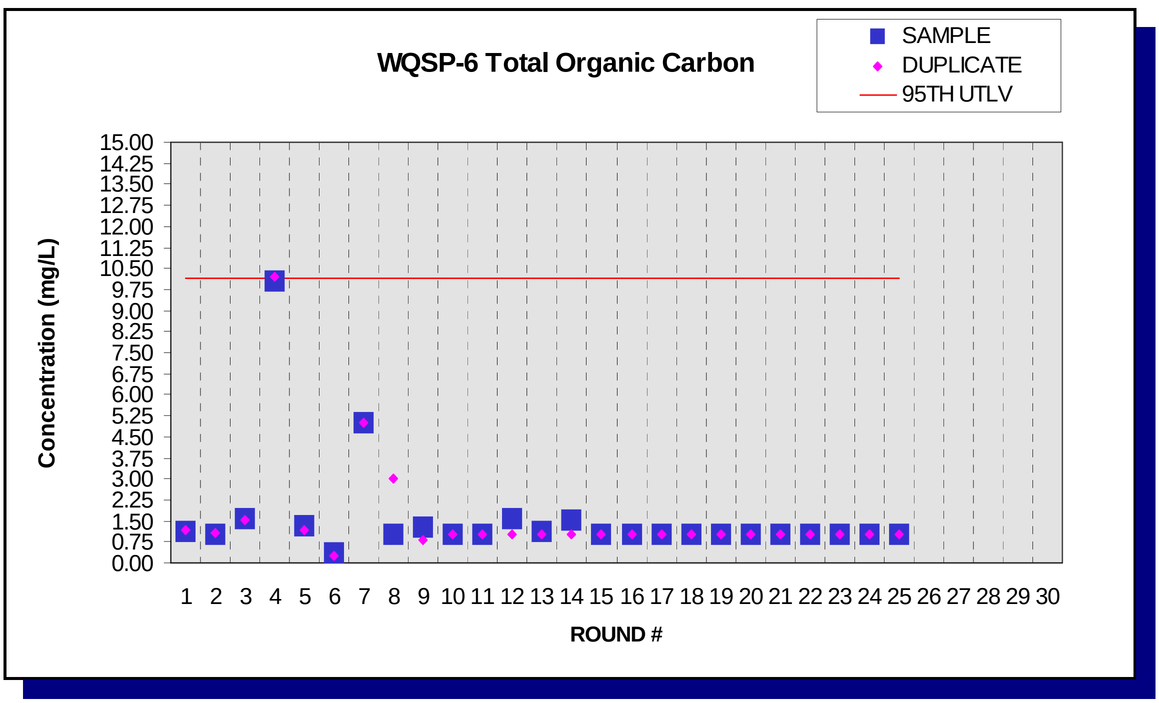

Figure E.82 - Time Trend Plot for Total Organic Carbon at WQSP-6

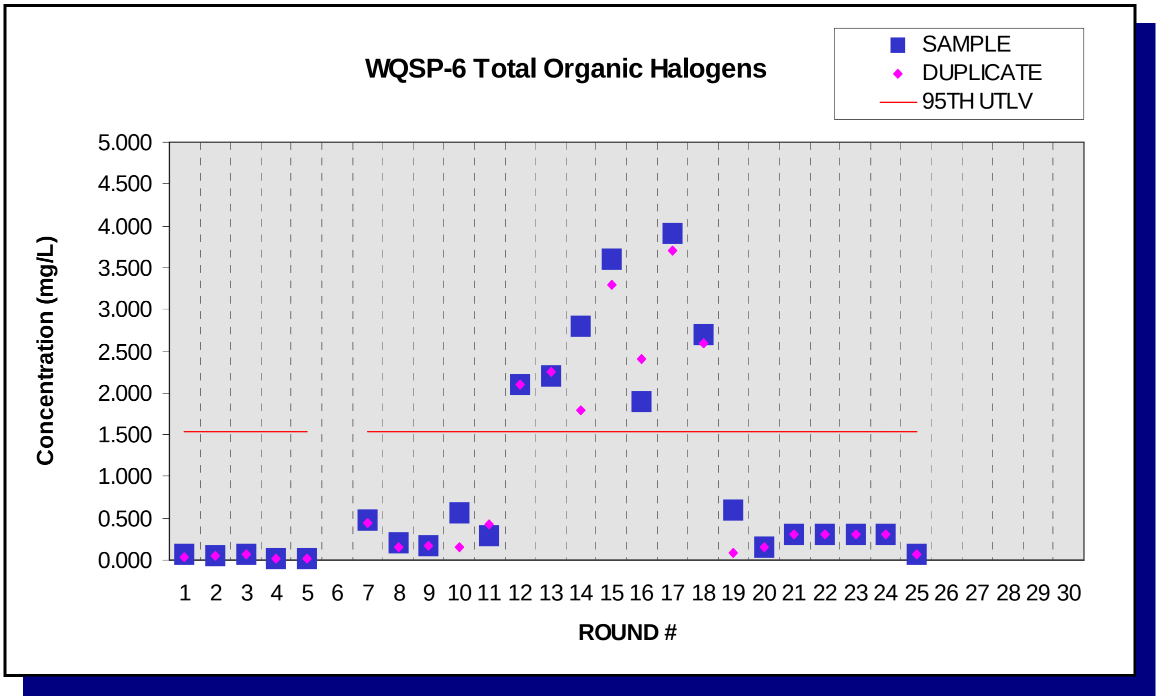

Figure E.83 - Time Trend Plot for Total Organic Halogens at WQSP-6

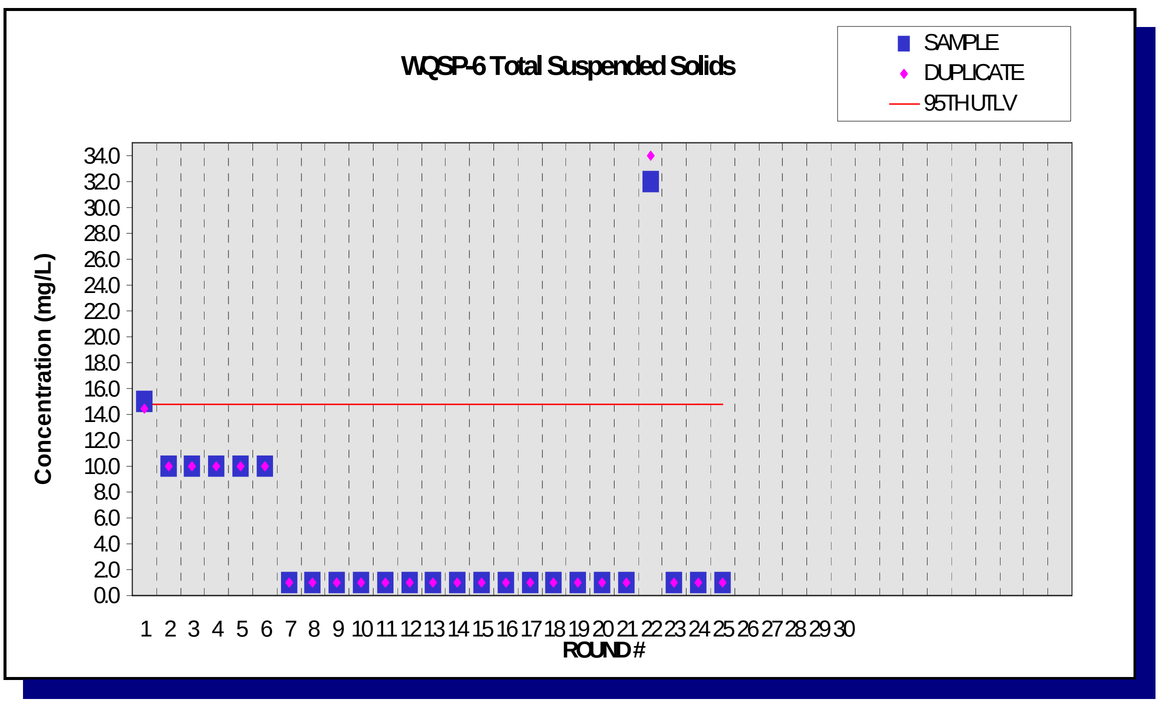

Figure E.84 - Time Trend Plot for Total Suspended Solids at WQSP-6

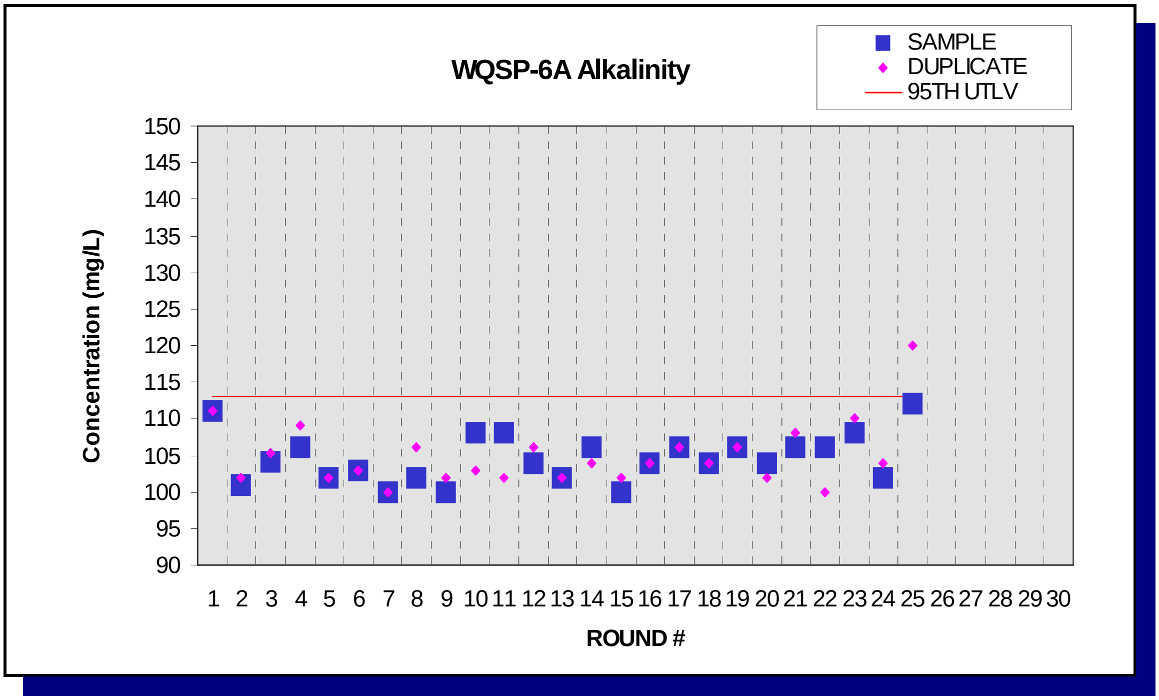

Figure E.85 - Time Trend Plot for Alkalinity at WQSP-4

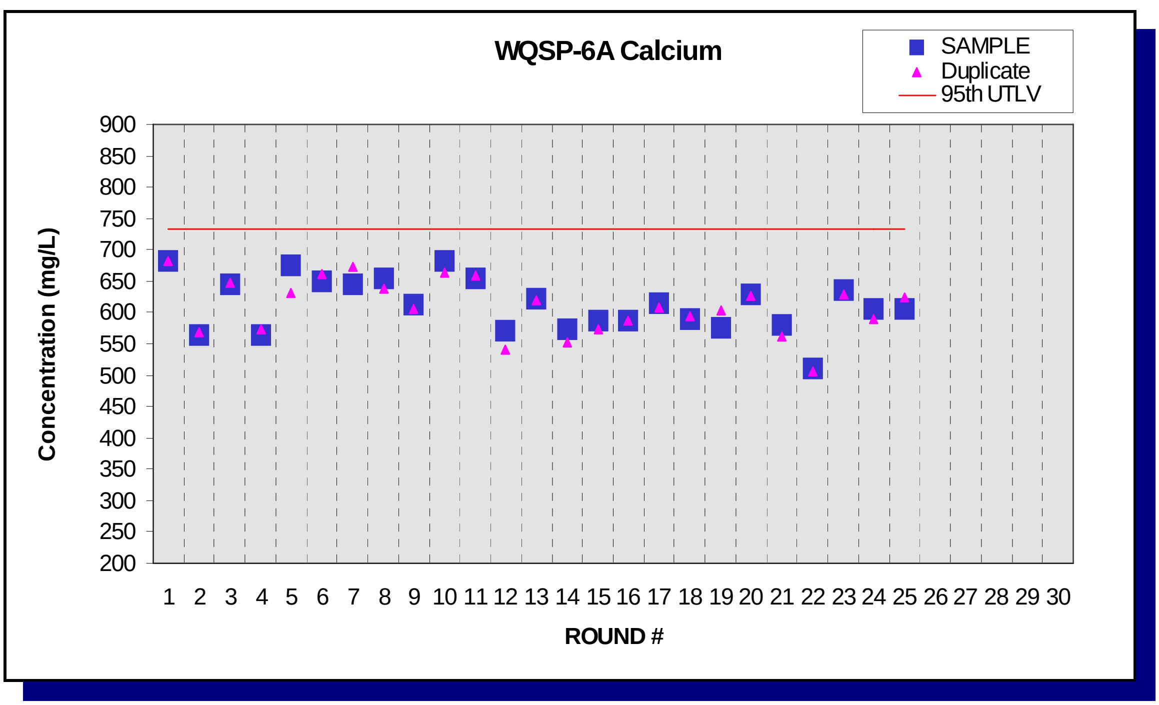

Figure E.86 - Time Trend Plot for Calcium at WQSP-6A

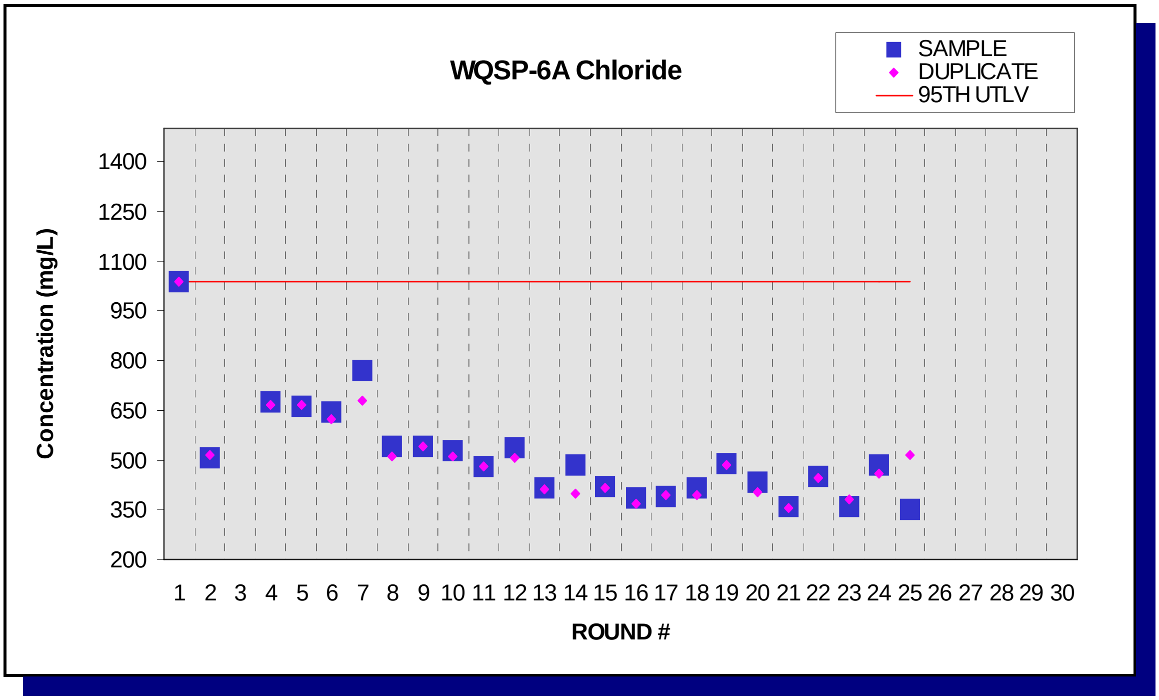

Figure E.87 - Time Trend Plot for Chloride at WQSP-6A

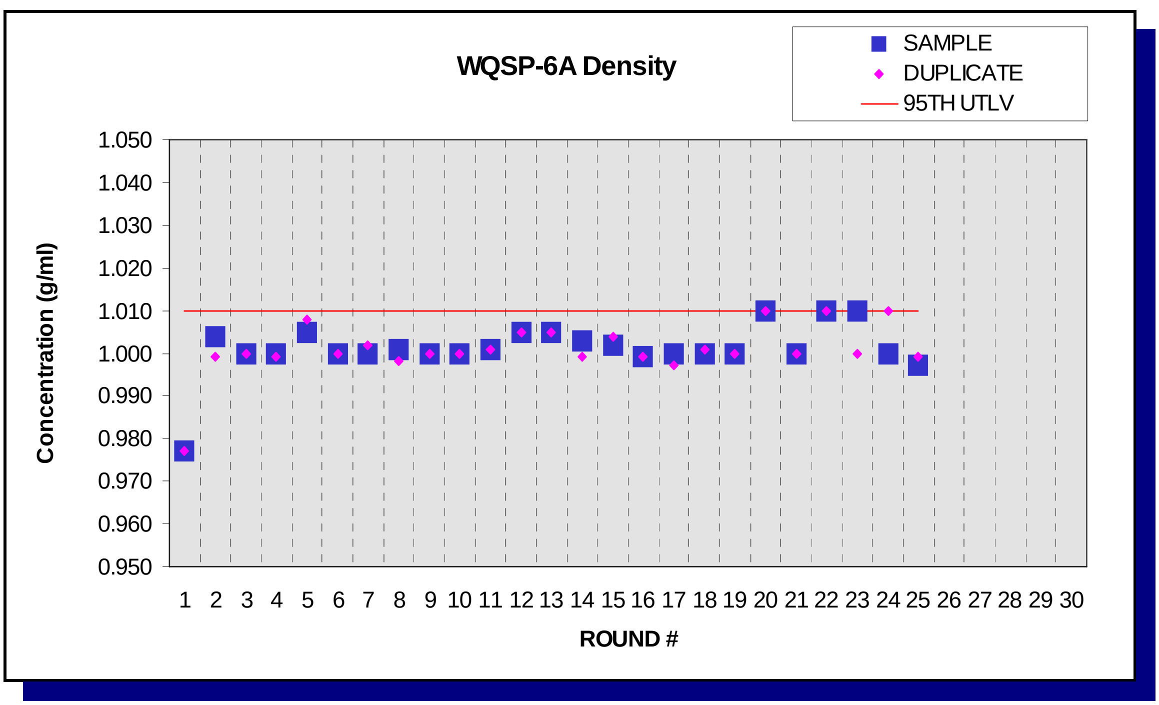

Figure E.88 - Time Trend Plot for Density at WQSP-6A

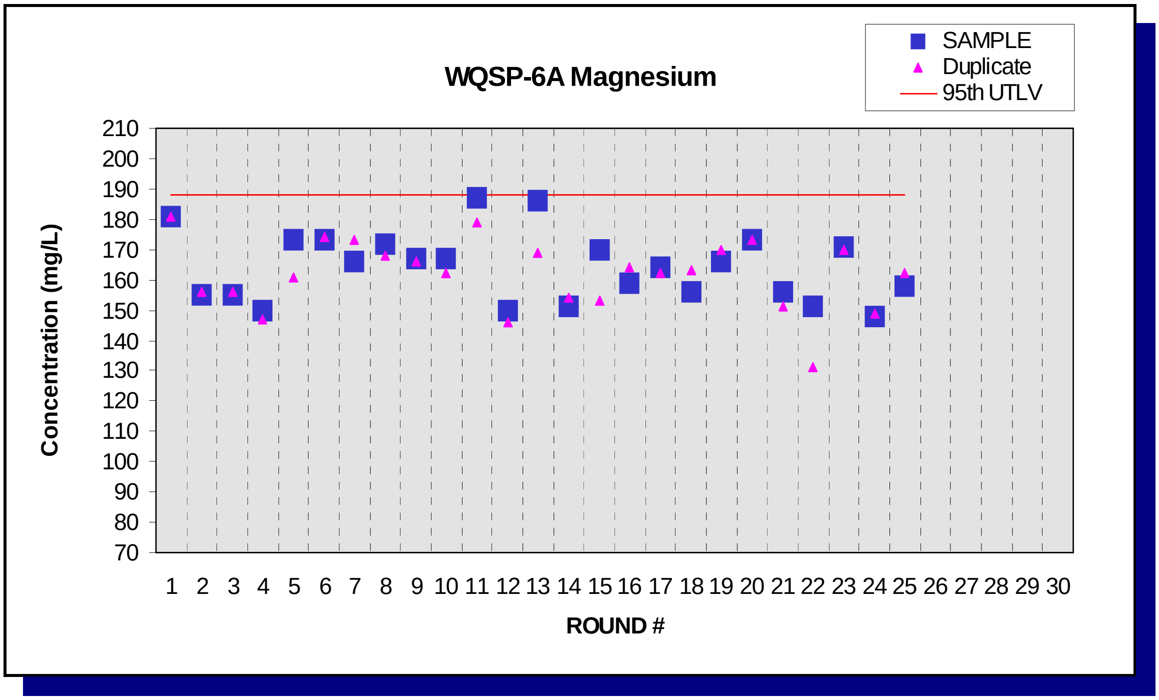

Figure E.89 - Time Trend Plot for Magnesium at WQSP-6A

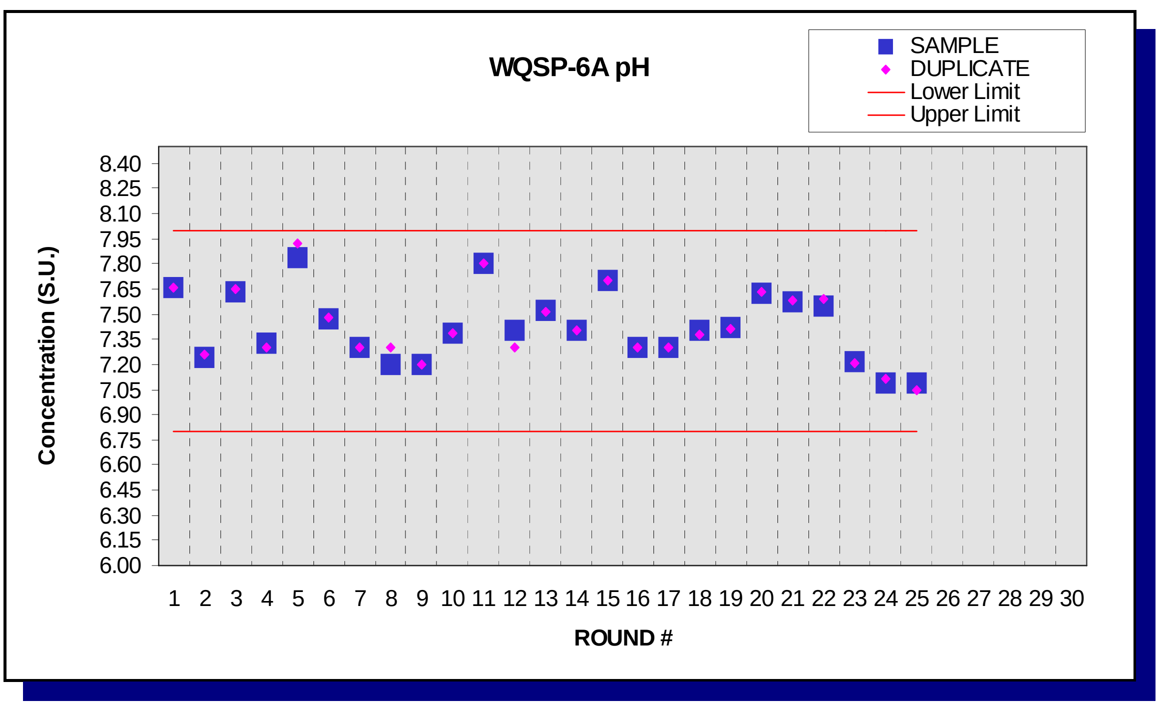

Figure E.90 - Time Trend Plot for pH at WQSP-6A

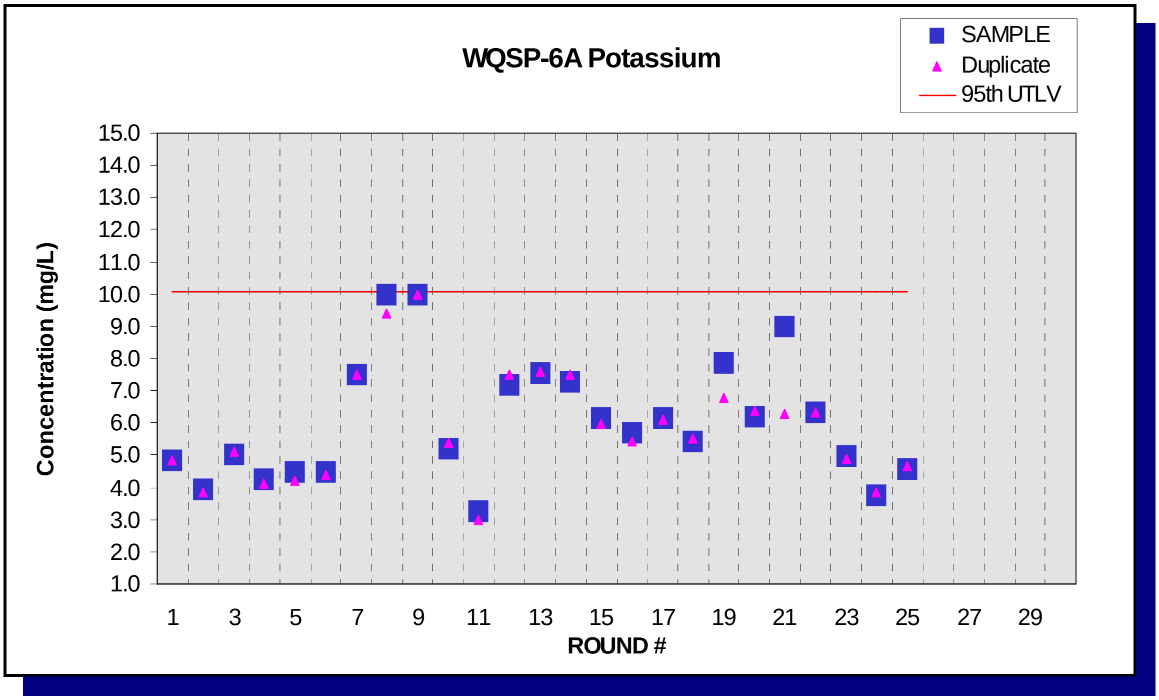

Figure E.91 - Time Trend Plot for Potassium at WQSP-6A

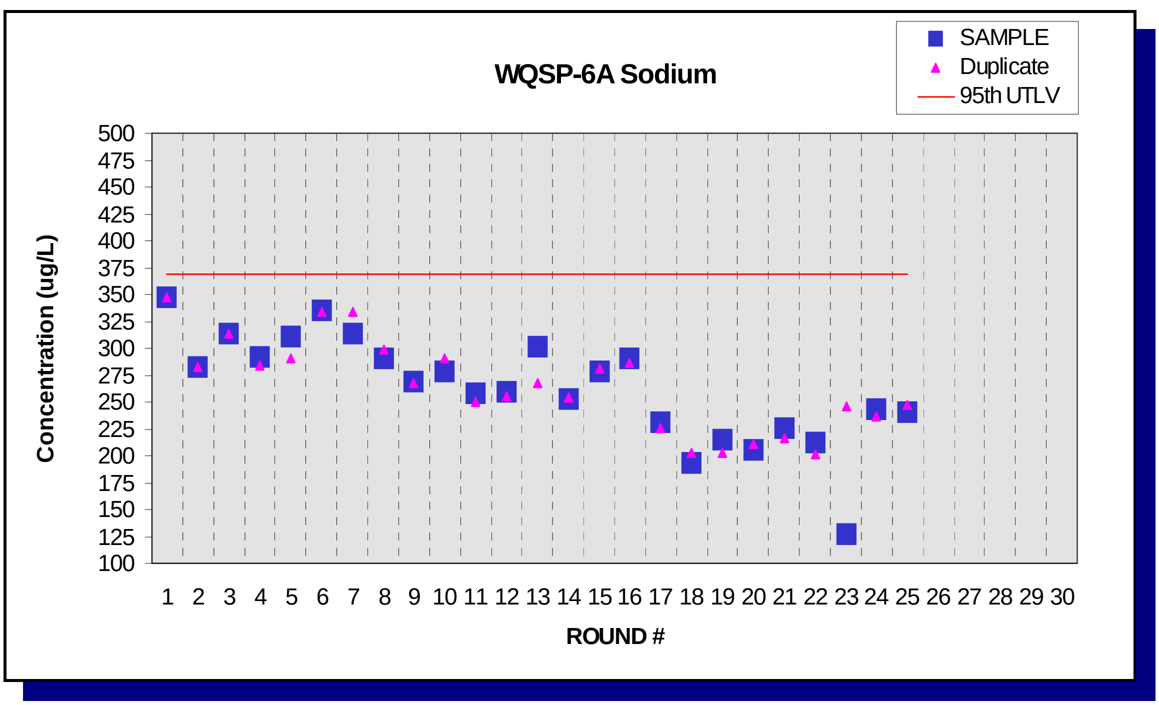

Figure E.92 - Time Trend Plot for Sodium at WQSP-6A

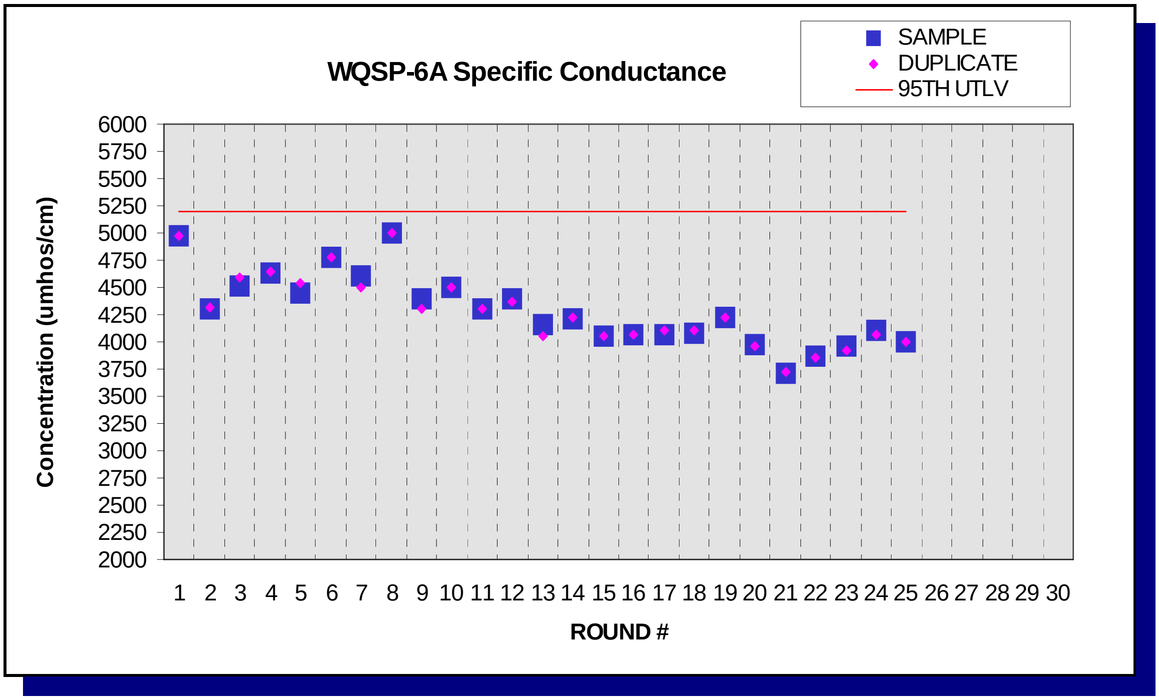

Figure E.93 - Time Trend Plot for Specific Conductance at WQSP-6A

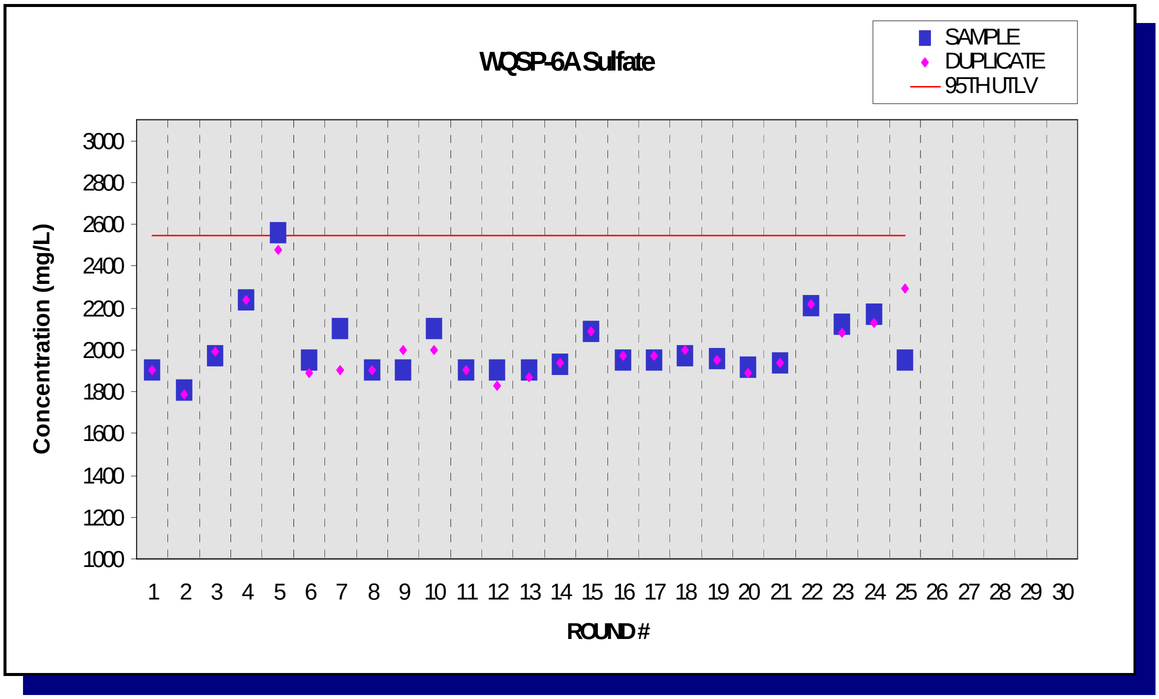

Figure E.94 - Time Trend Plot for Sulfate at WQSP-6A

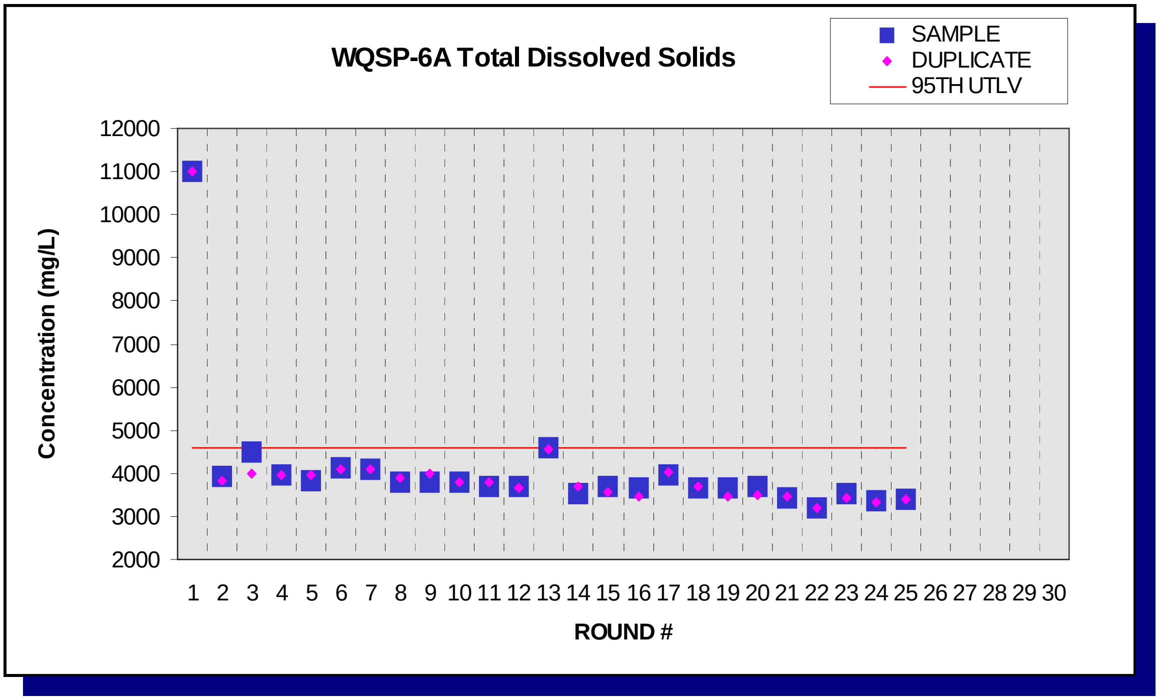

Figure E.95 - Time Trend Plot for Total Dissolved Solids at WQSP-6A

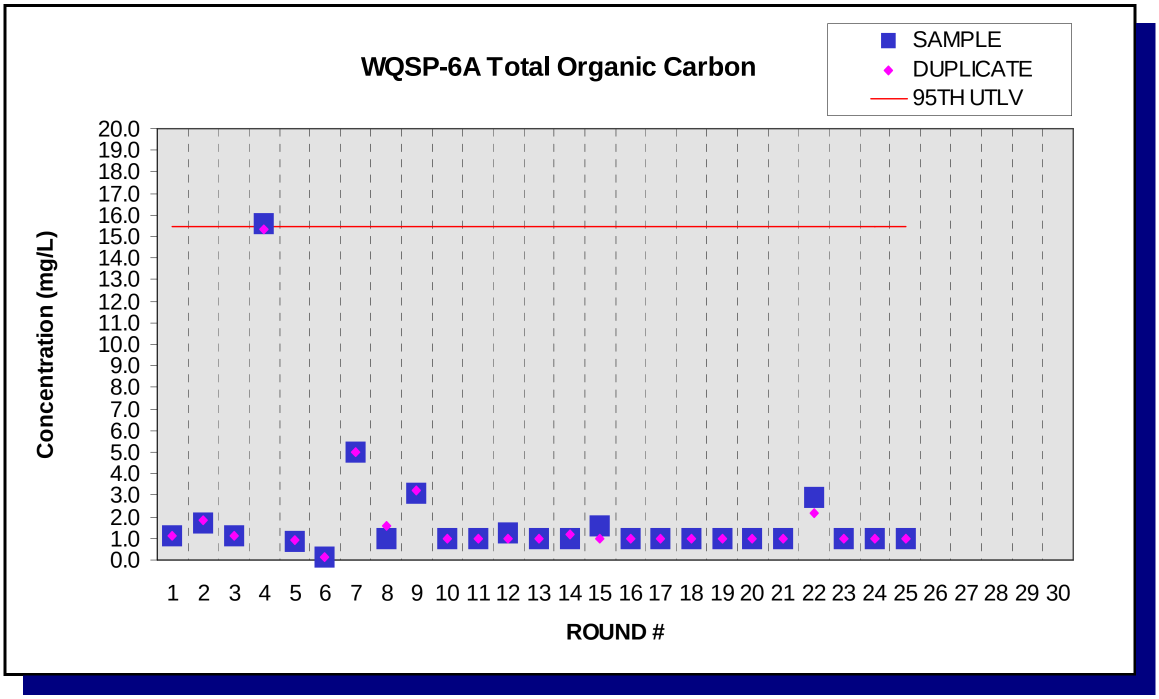

Figure E.96 - Time Trend Plot for Total Organic Carbon at WQSP-6A

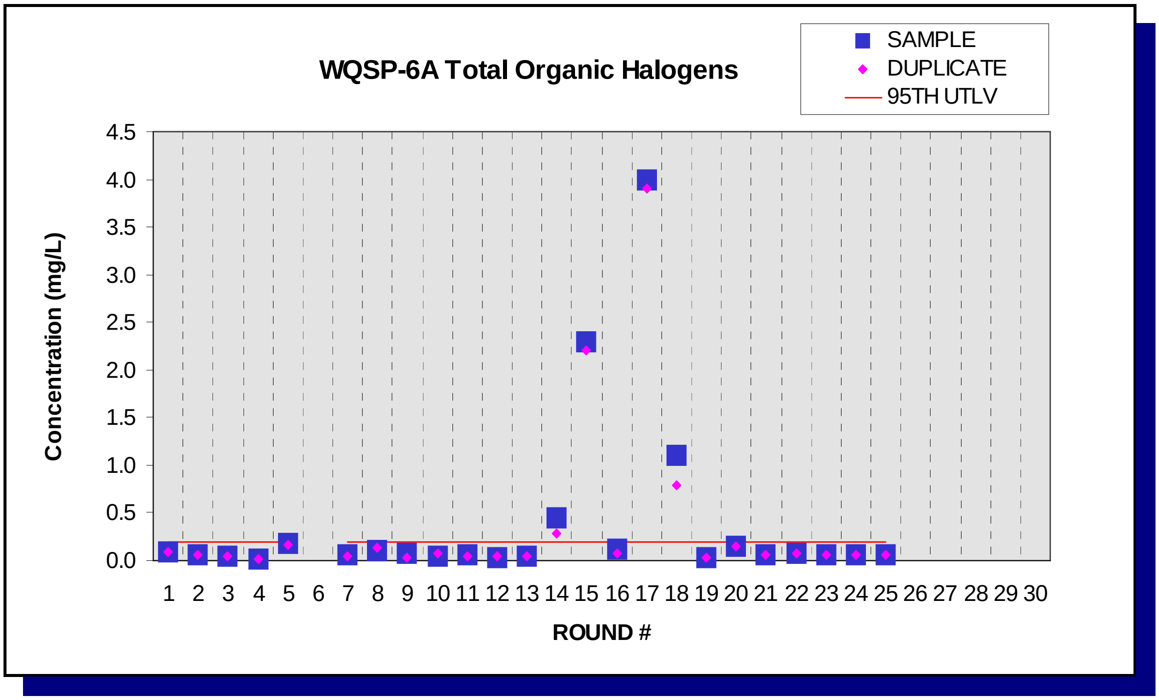

Figure E.97 - Time Trend Plot for Total Organic Halogens at WQSP-6A

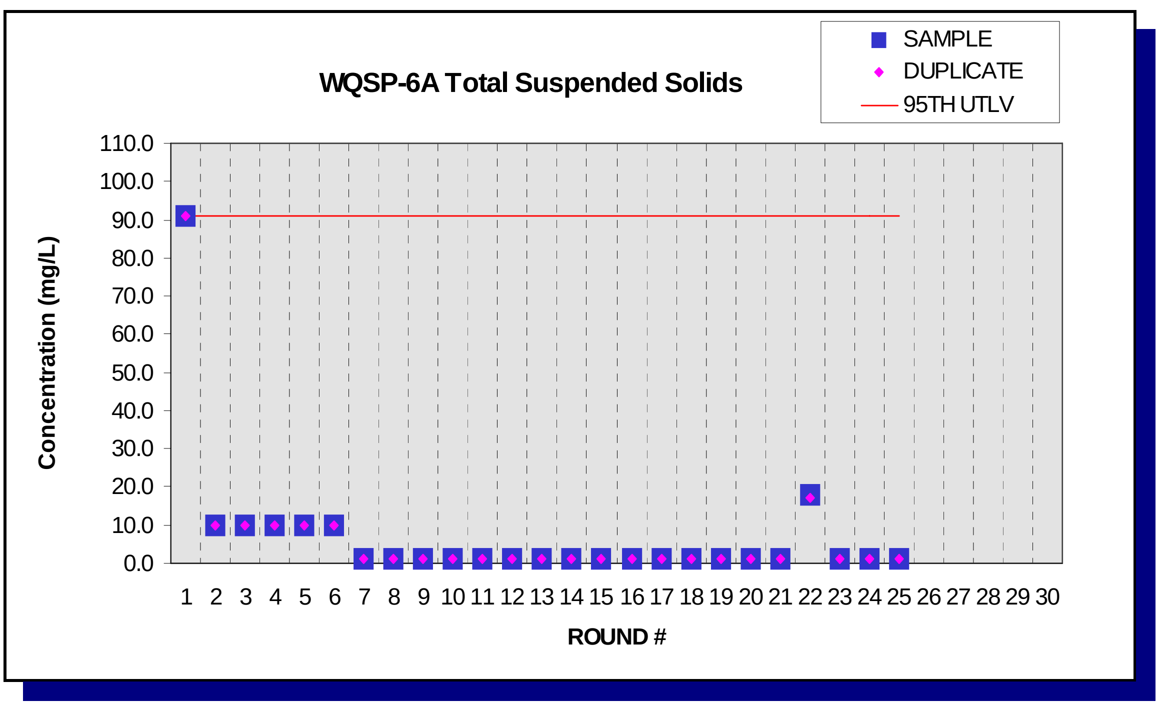

Figure E.98 - Time Trend Plot for Total Suspended Solids at WQSP-6A

Appendix F
Groundwater Data Tables

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

	Concentration					Reporting Limit		
	Round 24		Round 25					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	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	<20	<20	<20	<20	µg/L	20	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	72	54	46	48	mg/L	4	4	55.7
Chloride	44,000	39,400	36,000	36,600	mg/L	0.5	0.5	40,472
Density	1.04	1.04	1.04	1.04	g/ml	N/A[d]	N/A[d]	1.072
Nitrate (as N)	<0.1	<0.1	17.0	15.7	mg/L	0.1	0.1	10
pH	6.97	7.01	7.16	7.20	SU[c]	N/A[d]	N/A[d]	6.89-7.65
Specific conductance	93,000	92,800	80,575	77,724	µmhos/cm	N/A	N/A	175,000
Sulfate	5,340	5,290	4,710	4,730	mg/L	0.5	0.5	5,757
Total dissolved solids	75,000	70,400	65,400	64,000	mg/L	10	10	80,700
Total organic carbon	<1	<1	<1	<1	mg/L	1	1	5

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

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 24		Round 25					
	Sample	Dup.	Sample	Dup.		Round 24	Round 25	
Total organic halogen	<0.6	<0.6	<0.6	<0.6	mg/L	0.6	0.6	14.6
Total suspended solids	1.5	1	4.5	6.5	mg/L	1	1	33.5
Antimony	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.33
Arsenic	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.1
Barium	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	1
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	1,890	1,880	1,720	1,750	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	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	0.5	1.32
Lead	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	0.105
Magnesium	1,220	1,200	1,090	1,100	mg/L	0.5	0.5	1,247
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.49
Potassium	588	583	761	704	mg/L	0.5	0.5	799
Selenium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.15
Silver	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.5
Sodium	24,700	26,100	19,000	20,400	mg/L	0.5	0.5	22,090
Thallium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.98
Vanadium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.1

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

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

Parameter	Concentration				Units	Reporting Limit		95th UTLV[a]
	Round 24		Round 25					
	Sample	Dup.	Sample	Dup.		Round 24	Round 25	
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

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

	Concentration							
	Round 24		Round 25			Reporting Limit		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	95th UTLV[a]
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	<20	<20	µg/L	20	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	46	48	74	130	mg/L	4	4	70.3
Chloride	37,300	41,700	36,500	37,300	mg/L	0.5	0.5	39,670
Density	1.04	1.04	1.03	1.03	g/ml	N/A[c]	N/A[c]	1.06
Nitrate (as N)	0.12	0.12	13.9	14.1	mg/L	0.1	0.1	10
pH	7.17	7.19	7.04	7.03	SU[d]	N/A[c]	N/A[c]	7.00-7.60
Specific conductance	91,000	92,700	76,800	76,900	µmhos/cm	N/A[c]	N/A[c]	124,000
Sulfate	6,140	6,200	5,590	5,740	mg/L	0.5	0.5	6,590
Total dissolved solids	71,600	67,200	73,000	71,400	mg/L	10	10	80,500
Total organic carbon	<1	<1	<1	<1	mg/L	1	1	7.97
Total organic halogen	<0.6	<0.6	<0.6	<0.6	mg/L	0.6	0.6	63.8
Total suspended solids	1.5	1.5	9.5	10	mg/L	1	1	43
Antimony	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.5
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
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	1
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	0.5
Calcium	1,650	1,630	1,610	1,340	mg/L	0.5	0.5	1,827
Chromium	<0.05	<0.05	<0.05	<0.05	mg/L	0.025	0.025	0.5
Iron	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	0.5	1.32
Lead	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.16
Magnesium	1,100	1,100	1,070	888	mg/L	0.5	0.5	1,244
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.49
Potassium	513	508	848	626	mg/L	0.5	0.5	845
Selenium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.15
Silver	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.5

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

	Concentration							
	Round 24		Round 25			Reporting Limit		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	95th UTLV[a]
Sodium	22,200	21,400	22,000	18,100	mg/L	0.5	0.5	21,900
Thallium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.98
Vanadium	<0.025	<0.025	<0.025	<0.025	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

	Concentration							
	Round 24		Round 25			Reporting Limit		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	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	<20	<20	<20	<20	µg/L	20	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

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

	Concentration							
	Round 24		Round 25			Reporting Limit		
Parameter	**Sample**	**Dup.**	**Sample**	**Dup.**	**Units**	**Round 24**	**Round 25**	**95th UTLV[a]**
Alkalinity	42	38	30	38	mg/L	4	4	54.5
Chloride	136,000	145,000	136,000	184,000	mg/L	0.5	0.5	149,100
Density	1.14	1.14	1.13	1.13	g/ml	N/A[c]	N/A[c]	1.17
Nitrate (as N)	0.2	<0.1	<24	<24	mg/L	0.1	0.1	12
pH	7.05	7.04	6.12	6.21	SU[d]	N/A[c]	N/A[c]	6.6-7.2
Specific conductance	351,000	353,000	345,000	345,927	µmhos/cm	N/A[c]	N/A[c]	517,000
Sulfate	8,580	9,330	8,110	8,130	mg/L	1	1	8,015
Total dissolved solids	230,500	235,000	229,500	225,000	mg/L	10	10	261,000
Total organic carbon	1.42	1.22	<1	2.99	mg/L	1	1	5
Total organic halogen	<0.3	<0.3	<0.6	<0.6	mg/L	0.3	0.3	55
Total suspended solids	3.5	5	9	11	mg/L	1	1	107
Antimony	<0.25	<0.25	<0.25	<0.25	mg/L	0.25	0.25	1
Arsenic	<0.25	<0.25	<0.25	<0.25	mg/L	0.25	0.25	0.21
Barium	<0.02	<0.02	0.026	<0.02	mg/L	0.02	0.02	1
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	0.1
Cadmium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.5
Calcium	2,020	1,790	1,380	1,440	mg/L	0.5	0.5	1,680
Chromium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	2
Iron	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	0.5	1
Lead	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	0.8
Magnesium	3,190	2,810	2,200	2,310	mg/L	0.5	0.5	2,625
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	5
Potassium	2,000	1,770	2,000	2,160	mg/L	0.5	0.5	3,438
Selenium	<0.25	<0.25	<0.25	<0.25	mg/L	0.25	0.25	2
Silver	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.31
Sodium	96,400	92,800	77,800	82,500	mg/L	0.5	0.5	140,400
Thallium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	5.8
Vanadium	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	5

[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 Round 24 Sample	Concentration Round 24 Dup.	Concentration Round 25 Sample	Concentration Round 25 Dup.	Units	Reporting Limit Round 24	Reporting Limit Round 25	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	<20	<20	<20	<20	µg/L	20	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	40	38	40	46	mg/L	4	4	47
Chloride	75,600	79,200	67,000	64,000	mg/L	0.5	0.5	63,960
Density	1.07	1.07	1.07	1.07	g/ml	N/A[c]	N/A[c]	1.1
Nitrate (as N)	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	10
pH	7.19	7.19	6.85	6.83	SU[d]	N/A[c]	N/A[c]	6.80-7.61
Specific conductance	132,000	129,000	117,000	120,000	µmhos/cm	N/A[c]	N/A[c]	319,800
Sulfate	9,130	9,270	7,240	7,160	mg/L	0.5	0.5	7,927
Total dissolved solids	125,500	121,500	112,000	112,000	mg/L	10	10	123,500
Total organic carbon	1.07	<1	<1	<1	mg/L	1	1	5
Total organic halogen	<0.3	<0.3	<0.6	<0.6	mg/L	0.3	0.3	17
Total suspended solids	3	3	2.5	16.5	mg/L	1	1	57
Antimony	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.8

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

Parameter	Concentration Round 24 Sample	Round 24 Dup.	Round 25 Sample	Round 25 Dup.	Units	Reporting Limit Round 24	Reporting Limit Round 25	95th UTLV[a]
Arsenic	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.5
Barium	<0.02	<0.02	0.024	0.024	mg/L	0.02	0.02	1
Beryllium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	0.25
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	0.5
Calcium	1,600	1,420	1,650	1,600	mg/L	0.5	0.5	1,834
Chromium	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	2
Iron	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	0.5	4
Lead	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.525
Magnesium	1,180	1,030	1,210	1,170	mg/L	0.5	0.5	1,472
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	5
Potassium	1,020	908	896	888	mg/L	0.5	0.5	1,648
Selenium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	2.009
Silver	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.519
Sodium	39,600	33,500	42,400	38,800	mg/L	0.5	0.5	38,790
Thallium	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	1
Vanadium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	5

[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 Round 24 Sample	Round 24 Dup.	Round 25 Sample	Round 25 Dup.	Units	Reporting Limit Round 24	Reporting Limit Round 25	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

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

	Concentration							
	Round 24		Round 25			Reporting Limit		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	95th UTLV[a]
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	20	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	50	52	56	46	mg/L	4	4	56
Chloride	17,100	17,000	16,000	16,600	mg/L	0.5	0.5	18,100
Density	1.02	1.02	1.02	1.01	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	7.23	7.26	7.16	7.27	SU[d]	N/A[c]	N/A[c]	7.40-7.90
Specific conductance	43,200	44,300	44,700	44,300	µmhos/cm	N/A[c]	N/A[c]	67,700
Sulfate	6,410	6,390	5,790	5,870	mg/L	0.5	0.5	6,129
Total dissolved solids	31,800	30,700	34,250	32,250	mg/L	10	10	43,950
Total organic carbon	<1	<1	<1	<1	mg/L	1	1	5
Total organic halogen	<0.6	<0.6	<0.6	<0.6	mg/L	0.6	0.6	8.37
Total suspended solids	<1	<1	2	1	mg/L	1	1	10
Antimony	<0.05	<0.05	<0.025	<0.025	mg/L	0.05	0.025	0.073
Arsenic	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	0.5
Barium	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	1
Beryllium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.02
Cadmium	<0.01	<0.01	<0.01	<0.01	mg/L	0.01	0.01	0.05
Calcium	1,010	1,040	1,140	1,140	mg/L	0.5	0.5	1,303
Chromium	<0.025	<0.025	<0.250	<0.250	mg/L	0.025	0.025	0.5
Iron	<0.5	<0.5	<0.5	<0.5	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	431	456	487	483	mg/L	0.5	0.5	547
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.1
Potassium	368	376	355	354	mg/L	0.5	0.5	622
Selenium	<0.05	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.1
Silver	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.5

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

Parameter	Concentration Round 24 Sample	Concentration Round 24 Dup.	Concentration Round 25 Sample	Concentration Round 25 Dup.	Units	Reporting Limit Round 24	Reporting Limit Round 25	95th UTLV[a]
Sodium	10,200	11,200	11,300	11,000	mg/L	0.5	0.5	11,190
Thallium	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	0.209
Vanadium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	2.7

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

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

Parameter	Concentration Round 24 Sample	Concentration Round 24 Dup.	Concentration Round 25 Sample	Concentration Round 25 Dup.	Units	Reporting LIMIT Round 24	Reporting LIMIT Round 25	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	<20	<20	<20	<20	µg/L	20	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

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

	Concentration							
	Round 24		Round 25			Reporting LIMIT		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	95th UTLV[a]
Isobutanol	<5	<5	<5	<5	µg/L	5	5	2,000
Alkalinity	48	50	52	50	mg/L	4	4	55.8
Chloride	5,930	5,980	5,130	5,550	mg/L	0.5	0.5	6,200
Density	1.01	1.01	1.00	1.01	g/ml	N/A[c]	N/A[c]	1.02
Nitrate (as N)	<0.1	<0.1	<0.1	0.115	mg/L	0.1	0.1	7.45
pH	7.72	7.69	7.58	7.50	SU[d]	N/A[c]	N/A[c]	7.50-7.90
Specific conductance	21,500	21,100	19,500	19,900	µmhos/cm	N/A[c]	N/A[c]	27,660
Sulfate	5,820	5,940	4,700	4,640	mg/L	0.5	0.5	5,557
Total dissolved solids	17,100	15,600	14,760	14,840	mg/L	10	10	22,500
Total organic carbon	<1	<1	<1	<1	mg/L	1	1	10.14
Total organic halogen	<0.3	<0.3	<0.06	<0.06	mg/L	0.30	0.06	1.54
Total suspended solids	<1	<1	1	<1	mg/L	1	1	14.8
Antimony	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.14
Arsenic	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	0.5
Barium	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	1
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	0.05
Calcium	679	704	721	730	mg/L	0.5	0.5	796
Chromium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.5
Iron	<0.5	<0.5	<0.5	<0.5	mg/L	0.5	0.5	3.105
Lead	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	0.15
Magnesium	188	196	218	219	mg/L	0.5	0.5	255
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	<0.03	<0.03	<0.03	<0.03	mg/L	0.03	0.03	0.5
Potassium	180	184	182	186	mg/L	0.5	0.5	270
Selenium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.1
Silver	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.5
Sodium	5,210	5,190	4,850	5,240	mg/L	0.5	0.5	6,290
Thallium	<0.075	<0.075	<0.025	<0.025	mg/L	0.075	0.025	0.56
Vanadium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.1

[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 24		Round 25					
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	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	<20	<20	<20	<20	µg/L	20	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	mg/L	5	5	<RL
Alkalinity	102	104	112	120	mg/L	4	4	113
Chloride	484	461	350	516	mg/L	0.5	2	1040
Density	1.00	1.01	0.997	0.999	g/ml	N/A[c]	N/A[c]	1.01
Nitrate (as N)	5.78	9.35	5.47	6.98	mg/L	0.1	0.1	12.2
pH	7.09	7.11	7.09	7.05	SU[d]	N/A[c]	N/A[c]	6.80-8.00
Specific conductance	4,100	4,060	4,000	4,004	µmhos/cm	N/A[c]	N/A[c]	5,192
Sulfate	2,170	2,130	1,950	2,290	mg/L	0.5	2	2,543
Total dissolved solids	3,355	3,320	3,400	3,405	mg/L	10	10	4,600
Total organic carbon	<1	<1	<1	<1	mg/L	1	1	15.45
Total organic halogen	<0.06	<0.06	<0.06	<0.06	mg/L	0.06	0.06	0.19
Total suspended solids	<1	<1	<1	<1	mg/L	1	1	91
Antimony	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.48

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

	Concentration							
	Round 24		Round 25			Reporting LIMIT		
Parameter	Sample	Dup.	Sample	Dup.	Units	Round 24	Round 25	95th UTLV[a]
Arsenic	<0.1	<0.1	<0.1	<0.1	mg/L	0.1	0.1	0.5
Barium	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	0.1
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	606	589	606	625	mg/L	0.5	0.5	733
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	0.5	0.5	1
Lead	<0.02	<0.02	<0.02	<0.02	mg/L	0.02	0.02	0.05
Magnesium	148	149	158	162	mg/L	0.5	0.5	188
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	mg/L	0.0002	0.0002	0.002
Nickel	0.031	0.033	0.033	0.034	mg/L	0.025	0.025	0.284
Potassium	3.77	3.86	4.58	4.65	mg/L	0.5	0.5	10.1
Selenium	<0.025	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.22
Silver	<0.013	<0.013	<0.013	<0.013	mg/L	0.013	0.013	0.5
Sodium	243	236	241	247	mg/L	0.5	0.5	369
Thallium	0.04	<0.025	<0.025	<0.025	mg/L	0.025	0.025	0.058
Vanadium	0.056	<0.05	<0.05	<0.05	mg/L	0.05	0.05	0.5

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

Table F.8 - WIPP Well Inventory for 2007

Sorted By Active Wells at Year-End				Sorted By Formation for Wells Measured at Least Once in 2007			
Count	**Well Number**	**Zone**	**Notes**	**Count**	**Well Number**	**Zone**	**Reason Not Assessed for Long-Term Water Level Trend**
1	AEC-7	CUL		1	CB-1(PIP)	B/C	
2	C-2505	SR/D		2	DOE-2	B/C	
3	C-2506	SR/D		3	AEC-7	CUL	Leakage through bottom seal from Salado - water level not representative
4	C-2507	SR/D		4	ERDA-9	CUL	
5	C-2737	MAG / CUL		5	H-02B2	CUL	
6	C-2811	SR/D		6	H-03B2	CUL	
7	CB-1(PIP)	B/C		7	H-04B	CUL	
8	DOE-2	B/C		8	H-05B	CUL	
9	ERDA-9	CUL		9	H-06B	CUL	
10	H-02B1	MAG		10	H-07B1	CUL	
11	H-02B2	CUL		11	H-10C	CUL	
12	H-03B1	MAG		12	H-11B4	CUL	
13	H-03B2	CUL		13	H-12	CUL	
14	H-03D	SR/D	Dry; not measured in 2007	14	H-17	CUL	
15	H-04B	CUL		15	H-19B0	CUL	
16	H-04C	MAG		16	H-19B2	CUL	Redundant to H19B0
17	H-05B	CUL		17	H-19B3	CUL	Redundant to H19B0
18	H-06B	CUL		18	H-19B4	CUL	Redundant to H19B0
19	H-06C	MAG		19	H-19B5	CUL	Redundant to H19B0
20	H-07B1	CUL		20	H-19B6	CUL	Redundant to H19B0
21	H-08A	MAG		21	H-19B7	CUL	Redundant to H19B0
22	H-09C	MAG / CUL		22	I-461	CUL	
23	H-10A	MAG		23	SNL-01	CUL	
24	H-10C	CUL		24	SNL-02	CUL	
25	H-11B2	MAG		25	SNL-03	CUL	
26	H-11B4	CUL		26	SNL-05	CUL	
27	H-12	CUL		27	SNL-08	CUL	Pumping July - Aug 07; not recovered
28	H-14	MAG		28	SNL-09	CUL	
29	H-15	MAG/CUL		29	SNL-10	CUL	
30	H-16	MULTIPLE	Complex multi-packer system; not in WLMP	30	SNL-12	CUL	
31	H-17	CUL		31	SNL-13	CUL	
32	H-18	MAG		32	SNL-14	CUL	Testing July 07; nearly recovered (OK for head map)
33	H-19B0	CUL		33	SNL-15	CUL	Depressed from projected equilibrium
34	H-19B2	CUL		34	SNL-16	CUL	
35	H-19B3	CUL		35	SNL-17	CUL	
36	H-19B4	CUL		36	SNL-18	CUL	
37	H-19B5	CUL		37	SNL-19	CUL	
38	H-19B6	CUL		38	WIPP-11	CUL	
39	H-19B7	CUL		39	WIPP-13	CUL	

Table F.8 - WIPP Well Inventory for 2007

Sorted By Active Wells at Year-End				Sorted By Formation for Wells Measured at Least Once in 2007			
Count	Well Number	Zone	Notes	Count	Well Number	Zone	Reason Not Assessed for Long-Term Water Level Trend
40	I-461	CUL		40	WIPP-19	CUL	
41	SNL-01	CUL		41	WQSP-1	CUL	
42	SNL-02	CUL		42	WQSP-2	CUL	
43	SNL-03	CUL		43	WQSP-3	CUL	
44	SNL-05	CUL		44	WQSP-4	CUL	
45	SNL-06	CUL	No access due to testing throughout 2007	45	WQSP-5	CUL	
46	SNL-08	CUL		46	WQSP-6	CUL	
47	SNL-09	CUL		47	WQSP-6A	DL	
48	SNL-10	CUL		48	H-02B1	MAG	
49	SNL-12	CUL		49	H-03B1	MAG	
50	SNL-13	CUL		50	H-04C	MAG	
51	SNL-14	CUL		51	H-06C	MAG	
52	SNL-15	CUL		52	H-08A	MAG	
53	SNL-16	CUL		53	H-10A	MAG	
54	SNL-17	CUL		54	H-11B2	MAG	
55	SNL-18	CUL		55	H-14	MAG	
56	SNL-19	CUL		56	H-18	MAG	
57	PZ-01	SR/D		57	WIPP-18	MAG	
58	PZ-02	SR/D		58	C-2737	MAG/CUL	
59	PZ-03	SR/D		59	H-09C	MAG/CUL	Erratic behavior
60	PZ-04	SR/D		60	H-15	MAG/CUL	Density not representative of Culebra
61	PZ-05	SR/D		61	WIPP-30	MAG/CUL	Leaky packer / stuck packer
62	PZ-06	SR/D		62	C-2505	SR/D	
63	PZ-07	SR/D		63	C-2506	SR/D	
64	PZ-08	SR/D		64	C-2507	SR/D	
65	PZ-09	SR/D		65	C-2811	SR/D	
66	PZ-10	SR/D		66	PZ-01	SR/D	
67	PZ-11	SR/D		67	PZ-02	SR/D	
68	PZ-12	SR/D		68	PZ-03	SR/D	
69	PZ-13	SR/D	Drilled late 2007; begin quarterly meas. 2008	69	PZ-04	SR/D	
70	PZ-14	SR/D	Drilled late 2007; begin quarterly meas. 2008	70	PZ-05	SR/D	
71	PZ-15	SR/D	Drilled late 2007; begin quarterly meas. 2008	71	PZ-06	SR/D	
72	WIPP-11	CUL		72	PZ-07	SR/D	
73	WIPP-13	CUL		73	PZ-08	SR/D	
74	WIPP-18	MAG		74	PZ-09	SR/D	
75	WIPP-19	CUL		75	PZ-10	SR/D	
76	WIPP-25	MAG/CUL	No access due to testing throughout 2007	76	PZ-11	SR/D	
77	WIPP-30	MAG/CUL		77	PZ-12	SR/D	
78	WQSP-1	CUL					

Table F.8 - WIPP Well Inventory for 2007

Sorted By Active Wells at Year-End				Sorted By Formation for Wells Measured at Least Once in 2007			
Count	Well Number	Zone	Notes	Count	Well Number	Zone	Reason Not Assessed for Long-Term Water Level Trend
79	WQSP-2	CUL		**Not Measured or Not in Water Level Measurement Program in 2007**			
80	WQSP-3	CUL		78	H-03D	SR/D	Dry; not measured in 2007
81	WQSP-4	CUL		79	H-16	MULTIPLE	Complex multi-packer system; not in WLMP
82	WQSP-5	CUL		80	SNL-06	CUL	No access due to testing throughout 2007
83	WQSP-6	CUL		81	WIPP-25	MAG /CUL	No access due to testing throughout 2007
84	WQSP-6A	DL		82	PZ-13	SR/D	Drilled late 2007; begin quarterly meas. 2008
				83	PZ-14	SR/D	Drilled late 2007; begin quarterly meas. 2008
				84	PZ-15	SR/D	Drilled late 2007; begin quarterly meas. 2008

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
AEC-7	CUL	01/17/07	416.13	126.84	3,240.86	987.81	3,281.59
AEC-7	CUL	02/12/07	412.55	125.75	3,244.44	988.91	3,285.49
AEC-7	CUL	03/13/07	408.79	124.60	3,248.20	990.05	3,289.58
AEC-7	CUL	04/10/07	405.03	123.45	3,251.96	991.20	3,293.68
AEC-7	CUL	05/10/07	401.38	122.34	3,255.61	992.31	3,297.65
AEC-7	CUL	06/13/07	398.71	121.53	3,258.28	993.12	3,300.56
AEC-7	CUL	07/17/07	394.94	120.38	3,262.05	994.27	3,304.67
AEC-7	CUL	08/13/07	391.95	119.47	3,265.04	995.18	3,307.92
AEC-7	CUL	09/18/07	387.50	118.11	3,269.49	996.54	3,312.77
AEC-7	CUL	10/15/07	384.50	117.20	3,272.49	997.46	3,316.04
AEC-7	CUL	11/12/07	433.39	132.10	3,223.60	982.55	3,262.79
AEC-7	CUL	12/10/07	455.04	138.70	3,201.95	975.95	3,239.22
C-2737 (PIP)	*CUL*	*02/13/07*	*382.54*	*116.78*	*3,017.62*	*919.77*	*3,020.69*
C-2737 (PIP)	*CUL*	*03/15/07*	*382.38*	*116.73*	*3,017.78*	*919.82*	*3,020.86*
C-2737 (PIP)	*CUL*	*04/11/07*	*382.48*	*116.76*	*3,017.68*	*919.79*	*3,020.76*
C-2737 (PIP)	*CUL*	*05/09/07*	*382.53*	*116.78*	*3,017.63*	*919.77*	*3,020.70*
C-2737 (PIP)	*CUL*	*06/13/07*	*382.33*	*116.72*	*3,017.83*	*919.83*	*3,020.91*
C-2737 (PIP)	*CUL*	*07/18/07*	*382.13*	*116.66*	*3,018.03*	*919.90*	*3,021.11*
C-2737 (PIP)	*CUL*	*08/15/07*	*381.95*	*116.60*	*3,018.21*	*919.95*	*3,021.29*
C-2737 (PIP)	*CUL*	*09/19/07*	*381.90*	*116.59*	*3,018.26*	*919.97*	*3,021.34*
C-2737 (PIP)	*CUL*	*10/17/07*	*381.66*	*116.51*	*3,018.50*	*920.04*	*3,021.58*
C-2737 (PIP)	*CUL*	*11/14/07*	*381.86*	*116.57*	*3,018.30*	*919.98*	*3,021.38*
C-2737 (PIP)	CUL	12/11/07	381.47	116.45	3,018.69	920.10	3,021.78
ERDA-9	*CUL*	*01/16/07*	*398.20*	*121.38*	*3,011.94*	*918.04*	*3,033.29*
ERDA-9	*CUL*	*02/13/07*	*398.24*	*121.39*	*3,011.90*	*918.03*	*3,033.25*
ERDA-9	*CUL*	*03/13/07*	*398.18*	*121.37*	*3,011.96*	*918.05*	*3,033.31*
ERDA-9	*CUL*	*04/11/07*	*397.75*	*121.24*	*3,012.39*	*918.18*	*3,033.77*
ERDA-9	*CUL*	*05/09/07*	*397.81*	*121.26*	*3,012.33*	*918.16*	*3,033.70*
ERDA-9	*CUL*	*06/13/07*	*397.53*	*121.18*	*3,012.61*	*918.24*	*3,034.00*
ERDA-9	*CUL*	*07/18/07*	*397.39*	*121.13*	*3,012.75*	*918.29*	*3,034.15*
ERDA-9	*CUL*	*08/14/07*	*397.24*	*121.09*	*3,012.90*	*918.33*	*3,034.31*
ERDA-9	*CUL*	*09/19/07*	*397.10*	*121.05*	*3,013.04*	*918.37*	*3,034.46*
ERDA-9	CUL	10/16/07	396.83	120.96	3,013.31	918.46	3,034.75
ERDA-9	CUL	11/14/07	396.99	121.01	3,013.15	918.41	3,034.58
ERDA-9	CUL	12/11/07	396.82	120.96	3,013.32	918.46	3,028.38
H-02b2	CUL	01/16/07	333.15	101.54	3,045.21	928.18	3,049.13
H-02b2	CUL	02/13/07	332.73	101.42	3,045.63	928.31	3,049.56
H-02b2	CUL	03/15/07	332.54	101.36	3,045.82	928.37	3,049.75
H-02b2	CUL	04/11/07	332.49	101.34	3,045.87	928.38	3,049.80
H-02b2	CUL	05/09/07	332.64	101.39	3,045.72	928.34	3,049.65
H-02b2	CUL	06/12/07	332.57	101.37	3,045.79	928.36	3,049.72

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-02b2	CUL	07/18/07	332.48	101.34	3,045.88	928.38	3,049.81
H-02b2	CUL	08/14/07	332.36	101.30	3,046.00	928.42	3,049.93
H-02b2	CUL	09/18/07	332.19	101.25	3,046.17	928.47	3,050.10
H-02b2	CUL	10/16/07	332.00	101.19	3,046.36	928.53	3,050.30
H-02b2	CUL	11/15/07	332.39	101.31	3,045.97	928.41	3,049.90
H-02b2	CUL	12/11/07	331.83	101.14	3,046.53	928.58	3,050.47
H-03b2	CUL	01/16/07	388.80	118.51	3,001.11	914.74	3,011.94
H-03b2	CUL	02/13/07	388.44	118.40	3,001.47	914.85	3,012.31
H-03b2	CUL	03/13/07	388.36	118.37	3,001.55	914.87	3,012.39
H-03b2	CUL	04/11/07	388.61	118.45	3,001.30	914.80	3,012.13
H-03b2	CUL	05/09/07	388.54	118.43	3,001.37	914.82	3,012.21
H-03b2	CUL	06/13/07	388.30	118.35	3,001.61	914.89	3,012.46
H-03b2	CUL	07/18/07	388.19	118.32	3,001.72	914.92	3,012.57
H-03b2	CUL	08/14/07	388.17	118.31	3,001.74	914.93	3,012.59
H-03b2	CUL	09/19/07	388.00	118.26	3,001.91	914.98	3,012.77
H-03b2	CUL	10/17/07	388.18	118.32	3,001.73	914.93	3,012.58
H-03b2	CUL	11/14/07	387.87	118.22	3,002.04	915.02	3,012.90
H-03b2	CUL	12/11/07	387.42	118.09	3,002.49	915.16	3,013.37
H-04b	CUL	01/15/07	330.53	100.75	3,003.05	915.33	3,004.95
H-04b	CUL	02/13/07	330.31	100.68	3,003.27	915.40	3,005.17
H-04b	CUL	03/13/07	330.17	100.64	3,003.41	915.44	3,005.31
H-04b	CUL	04/10/07	329.62	100.47	3,003.96	915.61	3,005.87
H-04b	CUL	05/09/07	329.81	100.53	3,003.77	915.55	3,005.68
H-04b	CUL	06/13/07	329.59	100.46	3,003.99	915.62	3,005.90
H-04b	CUL	07/18/07	329.47	100.42	3,004.11	915.65	3,006.02
H-04b	CUL	08/14/07	329.37	100.39	3,004.21	915.68	3,006.12
H-04b	CUL	09/18/07	329.19	100.34	3,004.39	915.74	3,006.30
H-04b	CUL	10/17/07	328.95	100.26	3,004.63	915.81	3,006.55
H-04b	CUL	11/15/07	329.40	100.40	3,004.18	915.67	3,006.09
H-04b	CUL	12/11/07	328.87	100.24	3,004.71	915.84	3,006.63
H-05b	CUL	01/16/07	468.16	142.70	3,038.62	926.17	3,082.35
H-05b	CUL	02/13/07	467.88	142.61	3,038.90	926.26	3,082.66
H-05b	CUL	03/13/07	467.88	142.61	3,038.90	926.26	3,082.66
H-05b	CUL	04/10/07	467.60	142.52	3,039.18	926.34	3,082.97
H-05b	CUL	05/10/07	467.64	142.54	3,039.14	926.33	3,082.92
H-05b	CUL	06/13/07	467.49	142.49	3,039.29	926.38	3,083.09
H-05b	CUL	07/17/07	467.48	142.49	3,039.30	926.38	3,083.10
H-05b	CUL	08/13/07	467.50	142.49	3,039.28	926.37	3,083.08
H-05b	CUL	09/18/07	467.42	142.47	3,039.36	926.40	3,083.17
H-05b	CUL	10/15/07	467.21	142.41	3,039.57	926.46	3,083.40
H-05b	CUL	11/12/07	467.21	142.41	3,039.57	926.46	3,083.40

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-05b	CUL	12/10/07	467.18	142.40	3,039.60	926.47	3,083.43
H-06b	CUL	01/16/07	288.54	87.95	3,059.15	932.43	3,072.56
H-06b	CUL	02/13/07	288.40	87.90	3,059.29	932.47	3,072.71
H-06b	CUL	03/13/07	288.75	88.01	3,058.94	932.36	3,072.34
H-06b	CUL	04/09/07	288.13	87.82	3,059.56	932.55	3,072.99
H-06b	CUL	05/07/07	288.48	87.93	3,059.21	932.45	3,072.62
H-06b	CUL	06/13/07	287.45	87.61	3,060.24	932.76	3,073.70
H-06b	CUL	07/16/07	287.63	87.67	3,060.06	932.71	3,073.51
H-06b	CUL	08/14/07	287.50	87.63	3,060.19	932.75	3,073.64
H-06b	CUL	09/17/07	287.25	87.55	3,060.44	932.82	3,073.90
H-06b	CUL	10/17/07	286.82	87.42	3,060.87	932.95	3,074.35
H-06b	CUL	11/14/07	287.02	87.48	3,060.67	932.89	3,074.14
H-06b	CUL	12/07/07	286.85	87.43	3,060.84	932.94	3,074.32
H-07b1	CUL	01/15/07	163.70	49.90	3,000.02	914.41	3,000.20
H-07b1	CUL	02/13/07	163.52	49.84	3,000.20	914.46	3,000.38
H-07b1	CUL	03/12/07	163.65	49.88	3,000.07	914.42	3,000.25
H-07b1	CUL	04/09/07	163.25	49.76	3,000.47	914.54	3,000.65
H-07b1	CUL	05/07/07	163.35	49.79	3,000.37	914.51	3,000.55
H-07b1	CUL	06/12/07	163.04	49.69	3,000.68	914.61	3,000.87
H-07b1	CUL	07/16/07	163.00	49.68	3,000.72	914.62	3,000.91
H-07b1	CUL	08/13/07	163.16	49.73	3,000.56	914.57	3,000.75
H-07b1	CUL	09/17/07	163.22	49.75	3,000.50	914.55	3,000.68
H-07b1	CUL	10/17/07	163.26	49.76	3,000.46	914.54	3,000.64
H-07b1	CUL	11/12/07	163.54	49.85	3,000.18	914.45	3,000.36
H-07b1	CUL	12/10/07	163.42	49.81	3,000.30	914.49	3,000.48
H-09c (PIP)	CUL	01/16/07	415.88	126.74	2,991.24	911.73	2,992.47
H-09c (PIP)	CUL	02/12/07	414.05	126.18	2,993.07	912.29	2,994.31
H-09c (PIP)	CUL	03/12/07	413.28	125.95	2,993.84	912.52	2,995.09
H-09c (PIP)	CUL	04/10/07	412.73	125.78	2,994.39	912.69	2,995.64
H-09c (PIP)	CUL	05/08/07	412.70	125.77	2,994.42	912.70	2,995.67
H-09c (PIP)	CUL	06/11/07	411.75	125.48	2,995.37	912.99	2,996.62
H-09c (PIP)	CUL	07/17/07	411.36	125.36	2,995.76	913.11	2,997.02
H-09c (PIP)	CUL	08/15/07	411.03	125.26	2,996.09	913.21	2,997.35
H-09c (PIP)	CUL	09/18/07	411.58	125.43	2,995.54	913.04	2,996.80
H-09c (PIP)	CUL	10/16/07	411.10	125.28	2,996.02	913.19	2,997.28
H-09c (PIP)	CUL	11/14/07	410.80	125.19	2,996.32	913.28	2,997.58
H-09c (PIP)	CUL	12/10/07	410.80	125.19	2,996.32	913.28	2,997.58
H-10c	CUL	01/16/07	663.63	202.27	3,024.77	921.95	3,031.18
H-10c	CUL	02/12/07	663.57	202.26	3,024.83	921.97	3,031.24
H-10c	CUL	03/13/07	663.85	202.34	3,024.55	921.88	3,030.96
H-10c	CUL	04/10/07	663.72	202.30	3,024.68	921.92	3,031.09

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-10c	CUL	05/08/07	663.97	202.38	3,024.43	921.85	3,030.84
H-10c	CUL	06/12/07	664.07	202.41	3,024.33	921.82	3,030.74
H-10c	CUL	07/17/07	664.27	202.47	3,024.13	921.75	3,030.53
H-10c	CUL	08/15/07	662.13	201.82	3,026.27	922.41	3,032.69
H-10c	CUL	09/18/07	663.11	202.12	3,025.29	922.11	3,031.70
H-10c	CUL	10/16/07	663.46	202.22	3,024.94	922.00	3,031.35
H-10c	CUL	11/14/07	663.04	202.09	3,025.36	922.13	3,031.77
H-10c	CUL	12/10/07	664.27	202.47	3,024.13	921.75	3,030.53
H-11b4	CUL	01/16/07	424.92	129.52	2,985.87	910.09	3,005.74
H-11b4	CUL	02/12/07	424.45	129.37	2,986.34	910.24	3,006.24
H-11b4	CUL	03/12/07	424.43	129.37	2,986.36	910.24	3,006.26
H-11b4	CUL	04/09/07	423.94	129.22	2,986.85	910.39	3,006.79
H-11b4	CUL	05/07/07	423.93	129.21	2,986.86	910.39	3,006.80
H-11b4	CUL	06/12/07	423.89	129.20	2,986.90	910.41	3,006.84
H-11b4	CUL	07/16/07	423.54	129.09	2,987.25	910.51	3,007.21
H-11b4	CUL	08/13/07	423.71	129.15	2,987.08	910.46	3,007.03
H-11b4	CUL	09/18/07	421.20	128.38	2,989.59	911.23	3,009.70
H-11b4	CUL	10/15/07	422.86	128.89	2,987.93	910.72	3,007.94
H-11b4	CUL	11/14/07	422.27	128.71	2,988.52	910.90	3,008.56
H-11b4	CUL	12/11/07	422.54	128.79	2,988.25	910.82	3,008.28
H-12	CUL	01/16/07	457.46	139.43	2,969.87	905.22	3,001.44
H-12	CUL	02/12/07	457.31	139.39	2,970.02	905.26	3,001.60
H-12	CUL	03/13/07	457.50	139.45	2,969.83	905.20	3,001.40
H-12	CUL	04/10/07	457.22	139.36	2,970.11	905.29	3,001.70
H-12	CUL	05/08/07	457.30	139.39	2,970.03	905.27	3,001.62
H-12	CUL	06/12/07	457.23	139.36	2,970.10	905.29	3,001.69
H-12	CUL	07/17/07	457.24	139.37	2,970.09	905.28	3,001.68
H-12	CUL	08/14/07	457.28	139.38	2,970.05	905.27	3,001.64
H-12	CUL	09/18/07	457.19	139.35	2,970.14	905.30	3,001.73
H-12	CUL	10/16/07	457.03	139.30	2,970.30	905.35	3,001.91
H-12	CUL	11/14/07	457.08	139.32	2,970.25	905.33	3,001.85
H-12	CUL	12/10/07	457.02	139.30	2,970.31	905.35	3,001.92
H-15 (PIP)	*CUL*	*01/16/07*	*476.28*	*144.96*	*3,005.29*	*916.01*	*3,043.67*
H-15 (PIP)	*CUL*	*02/13/07*	*480.24*	*146.17*	*3,001.33*	*914.81*	*3,039.33*
H-15 (PIP)	*CUL*	*03/13/07*	*482.77*	*146.94*	*2,998.80*	*914.03*	*3,036.55*
H-15 (PIP)	*CUL*	*04/11/07*	*484.65*	*147.51*	*2,996.92*	*913.46*	*3,034.49*
H-15 (PIP)	*CUL*	*05/09/07*	*483.55*	*147.18*	*2,998.02*	*913.80*	*3,035.70*
H-15 (PIP)	*CUL*	*06/13/07*	*483.95*	*147.30*	*2,997.62*	*913.67*	*3,035.26*
H-15 (PIP)	*CUL*	*07/18/07*	*484.20*	*147.38*	*2,997.37*	*913.60*	*3,034.98*
H-15 (PIP)	*CUL*	*08/14/07*	*484.53*	*147.48*	*2,997.04*	*913.50*	*3,034.62*
H-15 (PIP)	*CUL*	*09/19/07*	*484.92*	*147.60*	*2,996.65*	*913.38*	*3,034.19*

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-15 (PIP)	*CUL*	*10/17/07*	*485.33*	*147.72*	*2,996.24*	*913.25*	*3,033.74*
H-15 (PIP)	*CUL*	*11/15/07*	*486.00*	*147.93*	*2,995.57*	*913.05*	*3,033.01*
H-15 (PIP)	CUL	12/11/07	483.63	147.20	2,997.94	913.77	3,018.55
H-17	CUL	01/16/07	419.94	128.00	2,965.30	903.82	3,006.08
H-17	CUL	02/12/07	419.71	127.93	2,965.53	903.89	3,006.35
H-17	CUL	03/12/07	419.71	127.93	2,965.53	903.89	3,006.35
H-17	CUL	04/09/07	419.40	127.83	2,965.84	903.99	3,006.70
H-17	CUL	05/07/07	419.13	127.75	2,966.11	904.07	3,007.00
H-17	CUL	06/12/07	419.05	127.73	2,966.19	904.09	3,007.09
H-17	CUL	07/16/07	418.94	127.69	2,966.30	904.13	3,007.22
H-17	CUL	08/13/07	419.07	127.73	2,966.17	904.09	3,007.07
H-17	CUL	09/18/07	418.56	127.58	2,966.68	904.24	3,007.65
H-17	CUL	10/15/07	418.23	127.48	2,967.01	904.34	3,008.03
H-17	CUL	11/14/07	418.19	127.46	2,967.05	904.36	3,008.07
H-17	CUL	12/11/07	418.06	127.42	2,967.18	904.40	3,008.22
H-19b0	CUL	01/16/07	426.42	129.97	2,991.91	911.93	3,013.82
H-19b0	CUL	02/13/07	426.15	129.89	2,992.18	912.02	3,014.11
H-19b0	CUL	03/13/07	426.06	129.86	2,992.27	912.04	3,014.21
H-19b0	CUL	04/11/07	426.03	129.85	2,992.30	912.05	3,014.24
H-19b0	CUL	05/09/07	426.11	129.88	2,992.22	912.03	3,014.15
H-19b0	CUL	06/13/07	425.88	129.81	2,992.45	912.10	3,014.40
H-19b0	CUL	07/18/07	425.78	129.78	2,992.55	912.13	3,014.51
H-19b0	CUL	08/14/07	425.80	129.78	2,992.53	912.12	3,014.48
H-19b0	CUL	09/19/07	425.43	129.67	2,992.90	912.24	3,014.88
H-19b0	CUL	10/17/07	425.63	129.73	2,992.70	912.18	3,014.67
H-19b0	CUL	11/14/07	425.25	129.62	2,993.08	912.29	3,015.07
H-19b0	CUL	12/11/07	424.93	129.52	2,993.40	912.39	3,015.41
H-19b2	CUL	03/13/07	427.37	130.26	2,991.56	911.83	3,013.55
H-19b2	CUL	06/13/07	427.22	130.22	2,991.71	911.87	3,013.71
H-19b2	CUL	09/19/07	426.77	130.08	2,992.16	912.01	3,014.19
H-19b2	CUL	12/11/07	426.28	129.93	2,992.65	912.16	3,014.72
H-19b3	CUL	03/13/07	427.59	130.33	2,991.43	911.79	3,013.31
H-19b3	CUL	06/13/07	427.45	130.29	2,991.57	911.83	3,013.46
H-19b3	CUL	09/19/07	427.00	130.15	2,992.02	911.97	3,013.94
H-19b3	CUL	12/11/07	426.50	130.00	2,992.52	912.12	3,014.48
H-19b4	CUL	03/13/07	426.82	130.09	2,992.16	912.01	3,013.94
H-19b4	CUL	06/13/07	426.70	130.06	2,992.28	912.05	3,014.07
H-19b4	CUL	09/19/07	426.26	129.92	2,992.72	912.18	3,014.54
H-19b4	CUL	12/11/07	425.75	129.77	2,993.23	912.34	3,015.08
H-19b5	CUL	03/13/07	426.87	130.11	2,991.71	911.87	3,013.40
H-19b5	CUL	06/13/07	427.69	130.36	2,990.89	911.62	3,012.53

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-19b5	CUL	09/19/07	426.25	129.92	2,992.33	912.06	3,014.06
H-19b5	CUL	12/11/07	425.75	129.77	2,992.83	912.21	3,014.60
H-19b6	CUL	03/13/07	427.50	130.30	2,991.52	911.82	3,013.34
H-19b6	CUL	06/13/07	427.38	130.27	2,991.64	911.85	3,013.47
H-19b6	CUL	09/19/07	426.91	130.12	2,992.11	912.00	3,013.97
H-19b6	CUL	12/11/07	426.42	129.97	2,992.60	912.14	3,014.50
H-19b7	CUL	03/13/07	427.57	130.32	2,991.37	911.77	3,013.23
H-19b7	CUL	06/13/07	427.40	130.27	2,991.54	911.82	3,013.41
H-19b7	CUL	09/19/07	426.96	130.14	2,991.98	911.96	3,013.88
H-19b7	CUL	12/11/07	426.46	129.99	2,992.48	912.11	3,014.41
I-461	CUL	01/15/07	236.83	72.19	3,046.78	928.66	3,047.31
I-461	CUL	02/12/07	236.60	72.12	3,047.01	928.73	3,047.54
I-461	CUL	03/12/07	237.21	72.30	3,046.40	928.54	3,046.93
I-461	CUL	04/09/07	236.22	72.00	3,047.39	928.84	3,047.93
I-461	CUL	05/07/07	236.58	72.11	3,047.03	928.73	3,047.56
I-461	CUL	06/11/07	235.00	71.63	3,048.61	929.22	3,049.15
I-461	CUL	07/17/07	235.95	71.92	3,047.66	928.93	3,048.20
I-461	CUL	08/13/07	236.05	71.95	3,047.56	928.90	3,048.10
I-461	CUL	09/17/07	236.13	71.97	3,047.48	928.87	3,048.02
I-461	CUL	10/15/07	235.92	71.91	3,047.69	928.94	3,048.23
I-461	CUL	11/12/07	236.15	71.98	3,047.46	928.87	3,048.00
I-461	CUL	12/07/07	236.15	71.98	3,047.46	928.87	3,048.00
SNL-01	CUL	01/15/07	429.72	130.98	3,083.12	939.74	3,088.25
SNL-01	CUL	02/12/07	429.15	130.80	3,083.69	939.91	3,088.84
SNL-01	CUL	03/12/07	429.31	130.85	3,083.53	939.86	3,088.67
SNL-01	CUL	04/10/07	428.91	130.73	3,083.93	939.98	3,089.08
SNL-01	CUL	05/08/07	428.84	130.71	3,084.00	940.00	3,089.16
SNL-01	CUL	06/11/07	427.80	130.39	3,085.04	940.32	3,090.23
SNL-01	CUL	07/16/07	427.32	130.25	3,085.52	940.47	3,090.72
SNL-01	CUL	08/14/07	427.44	130.28	3,085.40	940.43	3,090.60
SNL-01	CUL	09/17/07	427.18	130.20	3,085.66	940.51	3,090.86
SNL-01	CUL	10/17/07	427.25	130.23	3,085.59	940.49	3,090.79
SNL-01	CUL	11/12/07	427.80	130.39	3,085.04	940.32	3,090.23
SNL-01	CUL	12/07/07	428.12	130.49	3,084.72	940.22	3,089.90
SNL-02	CUL	01/15/07	249.74	76.12	3,073.32	936.75	3,075.53
SNL-02	CUL	02/12/07	249.22	75.96	3,073.84	936.91	3,076.05
SNL-02	CUL	03/12/07	250.49	76.35	3,072.57	936.52	3,074.77
SNL-02	CUL	04/09/07	248.62	75.78	3,074.44	937.09	3,076.66
SNL-02	CUL	05/07/07	249.39	76.01	3,073.67	936.85	3,075.88
SNL-02	CUL	06/11/07	247.58	75.46	3,075.48	937.41	3,077.71
SNL-02	CUL	07/17/07	248.84	75.85	3,074.22	937.02	3,076.44

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
SNL-02	CUL	08/13/07	248.39	75.71	3,074.67	937.16	3,076.89
SNL-02	CUL	09/17/07	248.00	75.59	3,075.06	937.28	3,077.29
SNL-02	CUL	10/15/07	247.51	75.44	3,075.55	937.43	3,077.78
SNL-02	CUL	11/14/07	247.63	75.48	3,075.43	937.39	3,077.66
SNL-02	CUL	12/07/07	247.60	75.47	3,075.46	937.40	3,077.69
SNL-03	*CUL*	*01/15/07*	*415.75*	*126.72*	*3,074.60*	*937.14*	*3,082.67*
SNL-03	*CUL*	*02/12/07*	*415.24*	*126.57*	*3,075.11*	*937.29*	*3,083.19*
SNL-03	*CUL*	*03/12/07*	*415.53*	*126.65*	*3,074.82*	*937.21*	*3,082.89*
SNL-03	*CUL*	*04/10/07*	*415.13*	*126.53*	*3,075.22*	*937.33*	*3,083.30*
SNL-03	*CUL*	*05/08/07*	*415.19*	*126.55*	*3,075.16*	*937.31*	*3,083.24*
SNL-03	*CUL*	*06/11/07*	*414.64*	*126.38*	*3,075.71*	*937.48*	*3,083.80*
SNL-03	*CUL*	*07/16/07*	*414.23*	*126.26*	*3,076.12*	*937.60*	*3,084.22*
SNL-03	*CUL*	*08/14/07*	*414.13*	*126.23*	*3,076.22*	*937.63*	*3,084.33*
SNL-03	*CUL*	*09/17/07*	*413.85*	*126.14*	*3,076.50*	*937.72*	*3,084.61*
SNL-03	*CUL*	*10/16/07*	*413.57*	*126.06*	*3,076.78*	*937.80*	*3,084.90*
SNL-03	*CUL*	*11/14/07*	*413.97*	*126.18*	*3,076.38*	*937.68*	*3,084.49*
SNL-03	*CUL*	*12/07/07*	*413.89*	*126.15*	*3,076.46*	*937.71*	*3,084.57*
SNL-05	CUL	01/15/07	304.44	92.79	3,075.54	937.42	3,079.33
SNL-05	CUL	02/12/07	303.86	92.62	3,076.12	937.60	3,079.91
SNL-05	CUL	03/12/07	304.40	92.78	3,075.58	937.44	3,079.37
SNL-05	CUL	04/09/07	303.97	92.65	3,076.01	937.57	3,079.80
SNL-05	CUL	05/07/07	304.05	92.67	3,075.93	937.54	3,079.72
SNL-05	CUL	06/11/07	303.13	92.39	3,076.85	937.82	3,080.65
SNL-05	CUL	07/16/07	303.03	92.36	3,076.95	937.85	3,080.75
SNL-05	CUL	08/13/07	303.04	92.37	3,076.94	937.85	3,080.74
SNL-05	CUL	09/17/07	302.70	92.26	3,077.28	937.95	3,081.08
SNL-05	CUL	10/15/07	302.47	92.19	3,077.51	938.03	3,081.32
SNL-05	CUL	11/14/07	302.71	92.27	3,077.27	937.95	3,081.07
SNL-05	CUL	12/07/07	302.52	92.21	3,077.46	938.01	3,081.27
SNL-08	CUL	01/16/07	528.13	160.97	3,027.60	922.81	3,052.29
SNL-08	CUL	02/12/07	527.62	160.82	3,028.11	922.97	3,052.83
SNL-08	CUL	03/12/07	527.77	160.86	3,027.96	922.92	3,052.67
SNL-08	CUL	04/09/07	527.60	160.81	3,028.13	922.97	3,052.85
SNL-08	CUL	05/07/07	527.51	160.79	3,028.22	923.00	3,052.94
SNL-08	CUL	06/13/07	528.78	161.17	3,026.95	922.61	3,051.60
SNL-08	CUL	09/18/07	536.95	163.66	3,018.78	920.12	3,042.97
SNL-08	CUL	10/15/07	539.08	164.31	3,016.65	919.47	3,040.72
SNL-08	CUL	11/12/07	540.51	164.75	3,015.22	919.04	3,039.21
SNL-08	CUL	12/10/07	541.39	165.02	3,014.34	918.77	3,038.29
SNL-09	CUL	01/16/07	309.29	94.27	3,051.67	930.15	3,057.28
SNL-09	CUL	02/12/07	309.05	94.20	3,051.91	930.22	3,057.53

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
SNL-09	CUL	03/12/07	309.69	94.39	3,051.27	930.03	3,056.87
SNL-09	CUL	04/09/07	309.07	94.20	3,051.89	930.22	3,057.51
SNL-09	CUL	05/07/07	309.33	94.28	3,051.63	930.14	3,057.24
SNL-09	CUL	06/11/07	308.05	93.89	3,052.91	930.53	3,058.55
SNL-09	CUL	07/16/07	308.25	93.95	3,052.71	930.47	3,058.34
SNL-09	CUL	08/13/07	308.45	94.02	3,052.51	930.41	3,058.14
SNL-09	CUL	09/17/07	308.13	93.92	3,052.83	930.50	3,058.47
SNL-09	CUL	10/15/07	307.85	93.83	3,053.11	930.59	3,058.75
SNL-09	CUL	11/14/07	307.89	93.84	3,053.07	930.58	3,058.71
SNL-09	CUL	12/07/07	307.76	93.81	3,053.20	930.62	3,058.84
SNL-10	CUL	04/12/07	326.64	99.56	3,050.95	929.93	3,051.24
SNL-10	CUL	05/07/07	324.43	98.89	3,053.16	930.60	3,053.45
SNL-10	CUL	06/12/07	324.00	98.76	3,053.59	930.73	3,053.88
SNL-10	CUL	07/16/07	323.77	98.69	3,053.82	930.80	3,054.11
SNL-10	CUL	08/13/07	323.88	98.72	3,053.71	930.77	3,054.00
SNL-10	CUL	09/17/07	323.72	98.67	3,053.87	930.82	3,054.16
SNL-10	CUL	10/15/07	323.48	98.60	3,054.11	930.89	3,054.40
SNL-10	CUL	11/14/07	323.41	98.58	3,054.18	930.91	3,054.47
SNL-10	CUL	12/11/07	323.31	98.54	3,054.28	930.94	3,054.57
SNL-12	CUL	01/16/07	339.35	103.43	3,000.11	914.43	3,001.03
SNL-12	CUL	02/12/07	338.51	103.18	3,000.95	914.69	3,001.87
SNL-12	CUL	03/12/07	338.43	103.15	3,001.03	914.71	3,001.95
SNL-12	CUL	04/09/07	337.84	102.97	3,001.62	914.89	3,002.54
SNL-12	CUL	05/07/07	337.88	102.99	3,001.58	914.88	3,002.50
SNL-12	CUL	06/11/07	337.46	102.86	3,002.00	915.01	3,002.93
SNL-12	CUL	07/17/07	337.30	102.81	3,002.16	915.06	3,003.09
SNL-12	CUL	08/13/07	337.30	102.81	3,002.16	915.06	3,003.09
SNL-12	CUL	09/18/07	337.05	102.73	3,002.41	915.13	3,003.34
SNL-12	CUL	10/16/07	336.91	102.69	3,002.55	915.18	3,003.48
SNL-12	CUL	11/14/07	336.90	102.69	3,002.56	915.18	3,003.49
SNL-12	CUL	12/10/07	336.78	102.65	3,002.68	915.22	3,003.61
SNL-13	CUL	01/15/07	285.67	87.07	3,008.55	917.01	3,014.86
SNL-13	CUL	02/12/07	284.42	86.69	3,009.80	917.39	3,016.18
SNL-13	CUL	03/12/07	284.84	86.82	3,009.38	917.26	3,015.74
SNL-13	CUL	04/09/07	284.81	86.81	3,009.41	917.27	3,015.77
SNL-13	CUL	05/07/07	284.90	86.84	3,009.32	917.24	3,015.68
SNL-13	CUL	06/11/07	284.83	86.82	3,009.39	917.26	3,015.75
SNL-13	CUL	07/16/07	284.80	86.81	3,009.42	917.27	3,015.78
SNL-13	CUL	08/13/07	284.86	86.83	3,009.36	917.25	3,015.72
SNL-13	CUL	09/18/07	284.70	86.78	3,009.52	917.30	3,015.89
SNL-13	CUL	10/15/07	284.60	86.75	3,009.62	917.33	3,015.99

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
SNL-13	CUL	11/14/07	284.60	86.75	3,009.62	917.33	3,015.99
SNL-13	CUL	12/10/07	284.59	86.74	3,009.63	917.34	3,016.00
SNL-14	CUL	11/14/07	376.02	114.61	2,992.39	912.08	3,010.08
SNL-14	CUL	12/11/07	375.99	114.60	2,992.42	912.09	3,006.51
SNL-15	CUL	01/16/07	652.40	198.85	2,827.53	861.83	2,888.55
SNL-15	CUL	02/12/07	648.36	197.62	2,831.57	863.06	2,893.52
SNL-15	CUL	03/12/07	645.33	196.70	2,834.60	863.99	2,897.25
SNL-15	CUL	04/09/07	697.25	212.52	2,782.68	848.16	2,833.39
SNL-15	CUL	05/07/07	692.36	211.03	2,787.57	849.65	2,839.40
SNL-15	CUL	06/12/07	686.80	209.34	2,793.13	851.35	2,846.24
SNL-15	CUL	07/16/07	681.99	207.87	2,797.94	852.81	2,852.16
SNL-15	CUL	08/14/07	677.97	206.65	2,801.96	854.04	2,857.10
SNL-15	CUL	09/18/07	673.54	205.29	2,806.39	855.39	2,862.55
SNL-15	CUL	10/15/07	670.18	204.27	2,809.75	856.41	2,866.68
SNL-15	CUL	11/14/07	666.55	203.16	2,813.38	857.52	2,871.15
SNL-15	CUL	12/10/07	663.45	202.22	2,816.48	858.46	2,874.96
SNL-16	CUL	01/15/07	121.78	37.12	3,011.22	917.82	3,012.42
SNL-16	CUL	02/12/07	121.35	36.99	3,011.65	917.95	3,012.86
SNL-16	CUL	03/12/07	121.87	37.15	3,011.13	917.79	3,012.33
SNL-16	CUL	04/09/07	120.18	36.63	3,012.82	918.31	3,014.05
SNL-16	CUL	07/19/07	120.82	36.83	3,012.18	918.11	3,013.40
SNL-16	CUL	08/13/07	121.18	36.94	3,011.82	918.00	3,013.03
SNL-16	CUL	09/17/07	121.50	37.03	3,011.50	917.91	3,012.71
SNL-16	CUL	10/17/07	121.44	37.01	3,011.56	917.92	3,012.77
SNL-16	CUL	11/12/07	121.88	37.15	3,011.12	917.79	3,012.32
SNL-16	CUL	12/10/07	121.89	37.15	3,011.11	917.79	3,011.95
SNL-17	CUL	01/15/07	231.36	70.52	3,006.70	916.44	3,006.81
SNL-17	CUL	02/12/07	231.05	70.42	3,007.01	916.54	3,007.12
SNL-17	CUL	03/12/07	231.24	70.48	3,006.82	916.48	3,006.93
SNL-17	CUL	04/09/07	230.93	70.39	3,007.13	916.57	3,007.24
SNL-17	CUL	05/07/07	230.98	70.40	3,007.08	916.56	3,007.19
SNL-17	CUL	06/11/07	230.75	70.33	3,007.31	916.63	3,007.42
SNL-17	CUL	07/16/07	230.70	70.32	3,007.36	916.64	3,007.47
SNL-17	CUL	08/13/07	230.81	70.35	3,007.25	916.61	3,007.36
SNL-17	CUL	09/18/07	230.71	70.32	3,007.35	916.64	3,007.46
SNL-17	CUL	10/15/07	230.76	70.34	3,007.30	916.63	3,007.41
SNL-17	CUL	11/12/07	230.80	70.35	3,007.26	916.61	3,007.37
SNL-17	CUL	12/10/07	230.71	70.32	3,007.35	916.64	3,007.46
SNL-18	CUL	01/15/07	299.43	91.27	3,076.01	937.57	3,079.77
SNL-18	CUL	02/12/07	298.92	91.11	3,076.52	937.72	3,080.29
SNL-18	CUL	03/12/07	299.34	91.24	3,076.10	937.60	3,079.86

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
SNL-18	CUL	04/10/07	298.80	91.07	3,076.64	937.76	3,080.41
SNL-18	CUL	05/08/07	298.83	91.08	3,076.61	937.75	3,080.38
SNL-18	CUL	06/11/07	298.00	90.83	3,077.44	938.00	3,081.22
SNL-18	CUL	07/16/07	297.98	90.82	3,077.46	938.01	3,081.24
SNL-18	CUL	08/14/07	297.85	90.78	3,077.59	938.05	3,081.38
SNL-18	CUL	09/17/07	297.58	90.70	3,077.86	938.13	3,081.65
SNL-18	CUL	10/17/07	297.46	90.67	3,077.98	938.17	3,081.77
SNL-18	CUL	11/12/07	297.75	90.75	3,077.69	938.08	3,081.48
SNL-18	CUL	12/07/07	297.68	90.73	3,077.76	938.10	3,081.55
SNL-19	CUL	01/15/07	148.28	45.20	3,074.37	937.07	3,075.81
SNL-19	CUL	02/12/07	147.75	45.03	3,074.90	937.23	3,076.34
SNL-19	CUL	03/12/07	148.97	45.41	3,073.68	936.86	3,075.12
SNL-19	CUL	04/09/07	147.11	44.84	3,075.54	937.42	3,076.99
SNL-19	CUL	05/07/07	147.23	44.88	3,075.42	937.39	3,076.87
SNL-19	CUL	06/11/07	145.95	44.49	3,076.70	937.78	3,078.16
SNL-19	CUL	07/17/07	147.04	44.82	3,075.61	937.45	3,077.06
SNL-19	CUL	08/13/07	146.45	44.64	3,076.20	937.63	3,077.65
SNL-19	CUL	09/17/07	146.13	44.54	3,076.52	937.72	3,077.98
SNL-19	CUL	10/15/07	145.78	44.43	3,076.87	937.83	3,078.33
SNL-19	CUL	11/12/07	146.00	44.50	3,076.65	937.76	3,078.11
SNL-19	CUL	12/07/07	146.13	44.54	3,076.52	937.72	3,077.98
WIPP-11	CUL	01/17/07	360.92	110.01	3,066.86	934.78	3,085.72
WIPP-11	CUL	02/13/07	360.74	109.95	3,067.04	934.83	3,085.90
WIPP-11	CUL	03/12/07	360.87	109.99	3,066.91	934.79	3,085.77
WIPP-11	CUL	04/09/07	360.51	109.88	3,067.27	934.90	3,086.14
WIPP-11	CUL	05/09/07	360.54	109.89	3,067.24	934.89	3,086.11
WIPP-11	CUL	06/11/07	359.93	109.71	3,067.85	935.08	3,086.75
WIPP-11	CUL	07/16/07	359.60	109.61	3,068.18	935.18	3,087.09
WIPP-11	CUL	08/13/07	359.61	109.61	3,068.17	935.18	3,087.08
WIPP-11	CUL	09/17/07	359.29	109.51	3,068.49	935.28	3,087.41
WIPP-11	CUL	10/15/07	359.00	109.42	3,068.78	935.36	3,087.71
WIPP-11	CUL	11/14/07	359.30	109.51	3,068.48	935.27	3,087.40
WIPP-11	CUL	12/07/07	359.03	109.43	3,068.75	935.36	3,087.68
WIPP-13	CUL	01/16/07	342.27	104.32	3,063.40	933.72	3,081.93
WIPP-13	CUL	02/13/07	342.09	104.27	3,063.58	933.78	3,082.12
WIPP-13	CUL	03/13/07	342.20	104.30	3,063.47	933.75	3,082.00
WIPP-13	CUL	04/09/07	341.89	104.21	3,063.78	933.84	3,082.33
WIPP-13	CUL	05/09/07	342.00	104.24	3,063.67	933.81	3,082.21
WIPP-13	CUL	06/13/07	341.33	104.04	3,064.34	934.01	3,082.91
WIPP-13	CUL	07/16/07	341.25	104.01	3,064.42	934.04	3,083.00
WIPP-13	CUL	08/14/07	341.10	103.97	3,064.57	934.08	3,083.16

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
WIPP-13	CUL	09/17/07	340.90	103.91	3,064.77	934.14	3,083.37
WIPP-13	CUL	10/16/07	340.48	103.78	3,065.19	934.27	3,083.81
WIPP-13	CUL	11/14/07	340.80	103.88	3,064.87	934.17	3,083.47
WIPP-13	CUL	12/11/07	340.78	103.87	3,064.89	934.18	3,083.49
WIPP-19	CUL	01/17/07	389.01	118.57	3,046.10	928.45	3,068.93
WIPP-19	CUL	02/13/07	388.86	118.52	3,046.25	928.50	3,069.09
WIPP-19	CUL	03/13/07	388.82	118.51	3,046.29	928.51	3,069.13
WIPP-19	CUL	04/11/07	388.55	118.43	3,046.56	928.59	3,069.42
WIPP-19	CUL	05/09/07	388.60	118.45	3,046.51	928.58	3,069.36
WIPP-19	CUL	06/13/07	388.46	118.40	3,046.65	928.62	3,069.51
WIPP-19	CUL	07/18/07	388.13	118.30	3,046.98	928.72	3,069.86
WIPP-19	CUL	08/14/07	387.94	118.24	3,047.17	928.78	3,070.06
WIPP-19	CUL	09/19/07	387.79	118.20	3,047.32	928.82	3,070.22
WIPP-19	CUL	10/17/07	387.33	118.06	3,047.78	928.96	3,070.71
WIPP-19	CUL	11/15/07	387.76	118.19	3,047.35	928.83	3,070.25
WIPP-19	CUL	12/11/07	387.37	118.07	3,047.74	928.95	3,070.67
WIPP-30 (PIP)	*CUL*	*01/15/07*	*348.74*	*106.60*	*3,080.49*	*938.93*	*3,087.87*
WIPP-30 (PIP)	*CUL*	*02/12/07*	*348.33*	*106.47*	*3,080.90*	*939.06*	*3,088.29*
WIPP-30 (PIP)	*CUL*	*03/12/07*	*348.59*	*106.55*	*3,080.64*	*938.98*	*3,088.02*
WIPP-30 (PIP)	*CUL*	*04/10/07*	*348.21*	*106.44*	*3,081.02*	*939.09*	*3,088.41*
WIPP-30 (PIP)	*CUL*	*05/08/07*	*348.31*	*106.47*	*3,080.92*	*939.06*	*3,088.31*
WIPP-30 (PIP)	*CUL*	*06/11/07*	*347.79*	*106.31*	*3,081.44*	*939.22*	*3,088.84*
WIPP-30 (PIP)	*CUL*	*07/16/07*	*347.33*	*106.17*	*3,081.90*	*939.36*	*3,089.31*
WIPP-30 (PIP)	*CUL*	*08/14/07*	*347.03*	*106.08*	*3,082.20*	*939.45*	*3,089.62*
WIPP-30 (PIP)	*CUL*	*09/17/07*	*346.80*	*106.01*	*3,082.43*	*939.52*	*3,089.85*
WQSP-1	CUL	01/17/07	357.40	108.88	3,062.03	933.31	3,079.14
WQSP-1	CUL	02/13/07	357.26	108.84	3,062.17	933.35	3,079.29
WQSP-1	CUL	03/13/07	357.29	108.85	3,062.14	933.34	3,079.25
WQSP-1	CUL	04/11/07	357.16	108.81	3,062.27	933.38	3,079.39
WQSP-1	CUL	05/09/07	357.13	108.80	3,062.30	933.39	3,079.42
WQSP-1	CUL	06/13/07	356.53	108.62	3,062.90	933.57	3,080.05
WQSP-1	CUL	07/18/07	356.25	108.53	3,063.18	933.66	3,080.34
WQSP-1	CUL	08/14/07	356.18	108.51	3,063.25	933.68	3,080.42
WQSP-1	CUL	09/19/07	356.02	108.46	3,063.41	933.73	3,080.58
WQSP-1	CUL	10/17/07	355.50	108.30	3,063.93	933.89	3,081.13
WQSP-1	CUL	11/15/07	356.04	108.47	3,063.39	933.72	3,080.56
WQSP-1	CUL	12/11/07	355.74	108.37	3,063.69	933.81	3,080.88
WQSP-2	CUL	01/17/07	396.90	120.91	3,067.17	934.87	3,087.73
WQSP-2	CUL	02/13/07	396.77	120.87	3,067.30	934.91	3,087.87
WQSP-2	CUL	03/13/07	396.77	120.87	3,067.30	934.91	3,087.87
WQSP-2	CUL	04/11/07	396.66	120.84	3,067.41	934.95	3,087.98

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
WQSP-2	CUL	05/09/07	396.58	120.82	3,067.49	934.97	3,088.07
WQSP-2	CUL	06/13/07	396.03	120.65	3,068.04	935.14	3,088.64
WQSP-2	CUL	07/18/07	395.69	120.55	3,068.38	935.24	3,089.00
WQSP-2	CUL	08/14/07	395.61	120.52	3,068.46	935.27	3,089.08
WQSP-2	CUL	09/19/07	395.50	120.49	3,068.57	935.30	3,089.20
WQSP-2	CUL	10/17/07	395.00	120.34	3,069.07	935.45	3,089.72
WQSP-2	CUL	11/15/07	395.60	120.52	3,068.47	935.27	3,089.09
WQSP-2	CUL	12/11/07	395.25	120.41	3,068.82	935.38	3,089.46
WQSP-3	CUL	01/17/07	462.53	140.92	3,017.80	919.83	3,075.84
WQSP-3	CUL	02/13/07	462.05	140.77	3,018.28	919.97	3,076.39
WQSP-3	CUL	03/13/07	461.94	140.74	3,018.39	920.01	3,076.51
WQSP-3	CUL	04/11/07	461.63	140.65	3,018.70	920.10	3,076.87
WQSP-3	CUL	05/09/07	464.44	141.50	3,015.89	919.24	3,073.65
WQSP-3	CUL	06/13/07	462.13	140.80	3,018.20	919.95	3,076.29
WQSP-3	CUL	07/18/07	461.67	140.66	3,018.66	920.09	3,076.82
WQSP-3	CUL	08/14/07	461.43	140.59	3,018.90	920.16	3,077.10
WQSP-3	CUL	09/19/07	461.19	140.51	3,019.14	920.23	3,077.37
WQSP-3	CUL	10/17/07	460.71	140.37	3,019.62	920.38	3,077.92
WQSP-3	CUL	11/15/07	462.89	141.03	3,017.44	919.72	3,075.42
WQSP-3	CUL	12/11/07	461.49	140.60	3,018.84	920.14	3,077.03
WQSP-4	CUL	01/17/07	443.70	135.18	2,989.57	911.22	3,014.87
WQSP-4	CUL	02/13/07	443.55	135.14	2,989.72	911.27	3,015.03
WQSP-4	CUL	03/13/07	443.44	135.11	2,989.83	911.30	3,015.15
WQSP-4	CUL	04/11/07	443.45	135.11	2,989.82	911.30	3,015.14
WQSP-4	CUL	05/09/07	443.53	135.13	2,989.74	911.27	3,015.06
WQSP-4	CUL	06/13/07	443.33	135.07	2,989.94	911.33	3,015.27
WQSP-4	CUL	07/18/07	443.20	135.03	2,990.07	911.37	3,015.41
WQSP-4	CUL	08/14/07	443.23	135.04	2,990.04	911.36	3,015.38
WQSP-4	CUL	09/19/07	442.89	134.94	2,990.38	911.47	3,015.74
WQSP-4	CUL	10/17/07	442.97	134.96	2,990.30	911.44	3,015.66
WQSP-4	CUL	11/15/07	442.93	134.95	2,990.34	911.46	3,015.70
WQSP-4	CUL	12/11/07	442.36	134.78	2,990.91	911.63	3,016.31
WQSP-5	CUL	01/17/07	379.29	115.55	3,005.29	916.01	3,012.28
WQSP-5	CUL	02/13/07	379.10	115.49	3,005.48	916.07	3,012.47
WQSP-5	CUL	03/13/07	378.97	115.45	3,005.61	916.11	3,012.61
WQSP-5	CUL	04/11/07	379.56	115.63	3,005.02	915.93	3,012.00
WQSP-5	CUL	05/09/07	379.18	115.51	3,005.40	916.05	3,012.39
WQSP-5	CUL	06/13/07	378.96	115.45	3,005.62	916.11	3,012.62
WQSP-5	CUL	07/18/07	378.86	115.42	3,005.72	916.14	3,012.72
WQSP-5	CUL	08/14/07	378.78	115.39	3,005.80	916.17	3,012.80
WQSP-5	CUL	09/19/07	378.68	115.36	3,005.90	916.20	3,012.91

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
WQSP-5	CUL	10/17/07	378.93	115.44	3,005.65	916.12	3,012.65
WQSP-5	CUL	11/15/07	378.90	115.43	3,005.68	916.13	3,012.68
WQSP-5	CUL	12/11/07	378.14	115.20	3,006.44	916.36	3,013.46
WQSP-6	CUL	01/17/07	344.16	104.84	3,020.75	920.72	3,024.29
WQSP-6	CUL	02/13/07	343.76	104.72	3,021.15	920.85	3,024.70
WQSP-6	CUL	03/13/07	343.68	104.70	3,021.23	920.87	3,024.78
WQSP-6	CUL	04/11/07	344.10	104.82	3,020.81	920.74	3,024.35
WQSP-6	CUL	05/09/07	343.92	104.77	3,020.99	920.80	3,024.54
WQSP-6	CUL	06/13/07	343.70	104.70	3,021.21	920.86	3,024.76
WQSP-6	CUL	07/18/07	343.68	104.70	3,021.23	920.87	3,024.78
WQSP-6	CUL	08/14/07	343.57	104.66	3,021.34	920.90	3,024.89
WQSP-6	CUL	09/19/07	343.53	104.65	3,021.38	920.92	3,024.93
WQSP-6	CUL	10/17/07	344.00	104.79	3,020.91	920.77	3,024.46
WQSP-6	CUL	11/15/07	343.99	104.79	3,020.92	920.78	3,024.47
WQSP-6	CUL	12/11/07	343.35	104.60	3,021.56	920.97	3,025.12
C-2737 (ANNULUS)	MAG	02/13/07	257.49	78.48	3,143.27	958.07	NA
C-2737 (ANNULUS)	MAG	03/15/07	255.50	77.88	3,145.26	958.68	NA
C-2737 (ANNULUS)	MAG	04/11/07	255.13	77.76	3,145.63	958.79	NA
C-2737 (ANNULUS)	MAG	05/09/07	255.18	77.78	3,145.58	958.77	NA
C-2737 (ANNULUS)	MAG	06/13/07	255.11	77.76	3,145.65	958.79	NA
C-2737 (ANNULUS)	MAG	07/18/07	255.19	77.78	3,145.57	958.77	NA
C-2737 (ANNULUS)	MAG	08/15/07	255.15	77.77	3,145.61	958.78	NA
C-2737 (ANNULUS)	MAG	09/16/07	255.11	77.76	3,145.65	958.79	NA
C-2737 (ANNULUS)	MAG	10/17/07	254.89	77.69	3,145.87	958.86	NA
C-2737 (ANNULUS)	MAG	11/14/07	255.03	77.73	3,145.73	958.82	NA
C-2737 (ANNULUS)	MAG	12/11/07	254.91	77.70	3,145.85	958.86	NA
H-02b1	MAG	01/16/07	237.06	72.26	3,141.43	957.51	NA
H-02b1	MAG	02/13/07	236.70	72.15	3,141.79	957.62	NA
H-02b1	MAG	03/15/07	236.37	72.05	3,142.12	957.72	NA
H-02b1	MAG	04/11/07	236.15	71.98	3,142.34	957.79	NA
H-02b1	MAG	05/09/07	235.97	71.92	3,142.52	957.84	NA
H-02b1	MAG	06/12/07	235.75	71.86	3,142.74	957.91	NA
H-02b1	MAG	07/18/07	235.67	71.83	3,142.82	957.93	NA
H-02b1	MAG	08/14/07	235.61	71.81	3,142.88	957.95	NA
H-02b1	MAG	09/18/07	235.56	71.80	3,142.93	957.97	NA
H-02b1	MAG	10/16/07	235.52	71.79	3,142.97	957.98	NA
H-02b1	MAG	11/15/07	235.57	71.80	3,142.92	957.96	NA
H-02b1	MAG	12/11/07	235.50	71.78	3,142.99	957.98	NA
H-03b1	MAG	01/16/07	243.96	74.36	3,146.76	959.13	NA
H-03b1	MAG	02/13/07	243.90	74.34	3,146.82	959.15	NA
H-03b1	MAG	03/13/07	244.02	74.38	3,146.70	959.11	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-03b1	MAG	04/11/07	243.78	74.30	3,146.94	959.19	NA
H-03b1	MAG	05/09/07	243.85	74.33	3,146.87	959.17	NA
H-03b1	MAG	06/13/07	243.80	74.31	3,146.92	959.18	NA
H-03b1	MAG	07/18/07	243.93	74.35	3,146.79	959.14	NA
H-03b1	MAG	08/14/07	243.96	74.36	3,146.76	959.13	NA
H-03b1	MAG	09/19/07	243.90	74.34	3,146.82	959.15	NA
H-03b1	MAG	10/17/07	243.74	74.29	3,146.98	959.20	NA
H-03b1	MAG	11/14/07	243.89	74.34	3,146.83	959.15	NA
H-03b1	MAG	12/11/07	243.81	74.31	3,146.91	959.18	NA
H-04c	MAG	01/15/07	187.55	57.17	3,146.73	959.12	NA
H-04c	MAG	02/13/07	187.50	57.15	3,146.78	959.14	NA
H-04c	MAG	03/13/07	187.50	57.15	3,146.78	959.14	NA
H-04c	MAG	04/10/07	187.38	57.11	3,146.90	959.18	NA
H-04c	MAG	05/09/07	187.40	57.12	3,146.88	959.17	NA
H-04c	MAG	06/13/07	187.39	57.12	3,146.89	959.17	NA
H-04c	MAG	07/18/07	187.55	57.17	3,146.73	959.12	NA
H-04c	MAG	08/14/07	187.54	57.16	3,146.74	959.13	NA
H-04c	MAG	09/18/07	187.57	57.17	3,146.71	959.12	NA
H-04c	MAG	10/17/07	187.47	57.14	3,146.81	959.15	NA
H-04c	MAG	11/15/07	187.70	57.21	3,146.58	959.08	NA
H-04c	MAG	12/11/07	187.62	57.19	3,146.66	959.10	NA
H-06c	MAG	01/16/07	280.12	85.38	3,068.57	935.30	NA
H-06c	MAG	02/13/07	279.71	85.26	3,068.98	935.43	NA
H-06c	MAG	03/13/07	279.70	85.25	3,068.99	935.43	NA
H-06c	MAG	04/09/07	279.39	85.16	3,069.30	935.52	NA
H-06c	MAG	05/07/07	279.49	85.19	3,069.20	935.49	NA
H-06c	MAG	06/13/07	279.43	85.17	3,069.26	935.51	NA
H-06c	MAG	07/16/07	279.46	85.18	3,069.23	935.50	NA
H-06c	MAG	08/14/07	279.47	85.18	3,069.22	935.50	NA
H-06c	MAG	09/17/07	279.36	85.15	3,069.33	935.53	NA
H-06c	MAG	10/17/07	279.11	85.07	3,069.58	935.61	NA
H-06c	MAG	11/14/07	279.26	85.12	3,069.43	935.56	NA
H-06c	MAG	12/07/07	279.06	85.06	3,069.63	935.62	NA
H-08a	MAG	01/16/07	405.76	123.68	3,027.52	922.79	NA
H-08a	MAG	02/12/07	405.77	123.68	3,027.51	922.79	NA
H-08a	MAG	03/12/07	405.80	123.69	3,027.48	922.78	NA
H-08a	MAG	04/10/07	405.71	123.66	3,027.57	922.80	NA
H-08a	MAG	05/08/07	405.74	123.67	3,027.54	922.79	NA
H-08a	MAG	06/11/07	405.72	123.66	3,027.56	922.80	NA
H-08a	MAG	07/17/07	405.77	123.68	3,027.51	922.79	NA
H-08a	MAG	08/15/07	405.83	123.70	3,027.45	922.77	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-08a	MAG	09/18/07	405.87	123.71	3,027.41	922.75	NA
H-08a	MAG	10/16/07	405.90	123.72	3,027.38	922.75	NA
H-08a	MAG	11/14/07	405.95	123.73	3,027.33	922.73	NA
H-08a	MAG	12/10/07	406.00	123.75	3,027.28	922.71	NA
H-09c (ANNULUS)	MAG	01/16/07	271.09	82.63	3,135.96	955.84	NA
H-09c (ANNULUS)	MAG	02/12/07	270.61	82.48	3,136.44	955.99	NA
H-09c (ANNULUS)	MAG	03/12/07	270.73	82.52	3,136.32	955.95	NA
H-09c (ANNULUS)	MAG	04/10/07	270.35	82.40	3,136.70	956.07	NA
H-09c (ANNULUS)	MAG	05/08/07	270.52	82.45	3,136.53	956.01	NA
H-09c (ANNULUS)	MAG	06/11/07	270.36	82.41	3,136.69	956.06	NA
H-09c (ANNULUS)	MAG	07/17/07	270.36	82.41	3,136.69	956.06	NA
H-09c (ANNULUS)	MAG	08/15/07	270.36	82.41	3,136.69	956.06	NA
H-09c (ANNULUS)	MAG	09/18/07	270.31	82.39	3,136.74	956.08	NA
H-09c (ANNULUS)	MAG	10/16/07	270.19	82.35	3,136.86	956.11	NA
H-09c (ANNULUS)	MAG	11/14/07	270.23	82.37	3,136.82	956.10	NA
H-09c (ANNULUS)	MAG	12/10/07	270.17	82.35	3,136.88	956.12	NA
H-10a	MAG	01/16/07	464.98	141.73	3,223.47	982.51	NA
H-10a	MAG	02/12/07	464.91	141.70	3,223.54	982.54	NA
H-10a	MAG	03/13/07	464.95	141.72	3,223.50	982.52	NA
H-10a	MAG	04/09/07	464.86	141.69	3,223.59	982.55	NA
H-10a	MAG	05/08/07	464.93	141.71	3,223.52	982.53	NA
H-10a	MAG	06/12/07	464.95	141.72	3,223.50	982.52	NA
H-10a	MAG	07/17/07	465.15	141.78	3,223.30	982.46	NA
H-10a	MAG	08/15/07	465.29	141.82	3,223.16	982.42	NA
H-10a	MAG	09/18/07	465.15	141.78	3,223.30	982.46	NA
H-10a	MAG	10/16/07	465.00	141.73	3,223.45	982.51	NA
H-10a	MAG	11/14/07	465.10	141.76	3,223.35	982.48	NA
H-10a	MAG	12/10/07	465.17	141.78	3,223.28	982.46	NA
H-11b2	MAG	01/16/07	273.52	83.37	3,138.34	956.57	NA
H-11b2	MAG	02/12/07	273.24	83.28	3,138.62	956.65	NA
H-11b2	MAG	03/12/07	273.24	83.28	3,138.62	956.65	NA
H-11b2	MAG	04/09/07	273.00	83.21	3,138.86	956.72	NA
H-11b2	MAG	05/07/07	272.83	83.16	3,139.03	956.78	NA
H-11b2	MAG	06/12/07	272.94	83.19	3,138.92	956.74	NA
H-11b2	MAG	07/16/07	273.05	83.23	3,138.81	956.71	NA
H-11b2	MAG	08/13/07	273.10	83.24	3,138.76	956.69	NA
H-11b2	MAG	09/18/07	273.00	83.21	3,138.86	956.72	NA
H-11b2	MAG	10/15/07	272.45	83.04	3,139.41	956.89	NA
H-14	MAG	01/15/07	212.27	64.70	3,134.81	955.49	NA
H-14	MAG	02/13/07	211.65	64.51	3,135.43	955.68	NA
H-14	MAG	03/15/07	211.06	64.33	3,136.02	955.86	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
H-14	MAG	04/10/07	210.63	64.20	3,136.45	955.99	NA
H-14	MAG	05/09/07	210.23	64.08	3,136.85	956.11	NA
H-14	MAG	06/11/07	209.78	63.94	3,137.30	956.25	NA
H-14	MAG	07/17/07	209.44	63.84	3,137.64	956.35	NA
H-14	MAG	08/14/07	209.20	63.76	3,137.88	956.43	NA
H-14	MAG	09/18/07	208.99	63.70	3,138.09	956.49	NA
H-14	MAG	10/16/07	208.83	63.65	3,138.25	956.54	NA
H-14	MAG	11/14/07	208.69	63.61	3,138.39	956.58	NA
H-15 (ANNULUS)	MAG	01/16/07	355.31	108.30	3,125.58	952.68	NA
H-15 (ANNULUS)	MAG	02/13/07	355.58	108.38	3,125.31	952.59	NA
H-15 (ANNULUS)	MAG	03/13/07	355.96	108.50	3,124.93	952.48	NA
H-15 (ANNULUS)	MAG	04/11/07	355.96	108.50	3,124.93	952.48	NA
H-15 (ANNULUS)	MAG	05/09/07	356.36	108.62	3,124.53	952.36	NA
H-15 (ANNULUS)	MAG	06/13/07	356.70	108.72	3,124.19	952.25	NA
H-15 (ANNULUS)	MAG	07/18/07	356.96	108.80	3,123.93	952.17	NA
H-15 (ANNULUS)	MAG	08/14/07	357.14	108.86	3,123.75	952.12	NA
H-15 (ANNULUS)	MAG	09/19/07	357.27	108.90	3,123.62	952.08	NA
H-15 (ANNULUS)	MAG	10/17/07	357.04	108.83	3,123.85	952.15	NA
H-15 (ANNULUS)	MAG	11/15/07	357.60	109.00	3,123.29	951.98	NA
H-15 (ANNULUS)	MAG	12/11/07	357.43	108.94	3,123.46	952.03	NA
H-18	MAG	01/17/07	271.91	82.88	3,142.30	957.77	NA
H-18	MAG	02/13/07	271.19	82.66	3,143.02	957.99	NA
H-18	MAG	03/13/07	270.79	82.54	3,143.42	958.11	NA
H-18	MAG	04/11/07	270.11	82.33	3,144.10	958.32	NA
H-18	MAG	05/09/07	269.85	82.25	3,144.36	958.40	NA
H-18	MAG	06/13/07	269.41	82.12	3,144.80	958.54	NA
H-18	MAG	07/16/07	269.04	82.00	3,145.17	958.65	NA
H-18	MAG	08/14/07	268.73	81.91	3,145.48	958.74	NA
H-18	MAG	09/17/07	268.31	81.78	3,145.90	958.87	NA
H-18	MAG	10/17/07	267.80	81.63	3,146.41	959.03	NA
H-18	MAG	11/15/07	267.94	81.67	3,146.27	958.98	NA
H-18	MAG	12/07/07	267.32	81.48	3,146.89	959.17	NA
WIPP-18	MAG	01/17/07	308.29	93.97	3,149.28	959.90	NA
WIPP-18	MAG	02/13/07	308.10	93.91	3,149.47	959.96	NA
WIPP-18	MAG	03/13/07	308.08	93.90	3,149.49	959.96	NA
WIPP-18	MAG	04/11/07	307.93	93.86	3,149.64	960.01	NA
WIPP-18	MAG	05/09/07	307.93	93.86	3,149.64	960.01	NA
WIPP-18	MAG	06/13/07	307.93	93.86	3,149.64	960.01	NA
WIPP-18	MAG	07/18/07	308.04	93.89	3,149.53	959.98	NA
WIPP-18	MAG	08/14/07	307.99	93.88	3,149.58	959.99	NA
WIPP-18	MAG	09/19/07	308.00	93.88	3,149.57	959.99	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
WIPP-18	MAG	10/17/07	307.83	93.83	3,149.74	960.04	NA
WIPP-18	MAG	11/15/07	307.99	93.88	3,149.58	959.99	NA
WIPP-18	MAG	12/11/07	307.88	93.84	3,149.69	960.03	NA
WIPP-25 (ANNULUS)	MAG	12/11/07	222.88	67.93	2,991.36	911.77	NA
WIPP-30 (ANNULUS)	MAG	01/15/07	305.55	93.13	3,124.67	952.40	NA
WIPP-30 (ANNULUS)	MAG	02/12/07	305.21	93.03	3,125.01	952.50	NA
WIPP-30 (ANNULUS)	MAG	03/12/07	304.97	92.95	3,125.25	952.58	NA
WIPP-30 (ANNULUS)	MAG	04/10/07	304.62	92.85	3,125.60	952.68	NA
WIPP-30 (ANNULUS)	MAG	05/08/07	304.40	92.78	3,125.82	952.75	NA
WIPP-30 (ANNULUS)	MAG	06/11/07	304.12	92.70	3,126.10	952.84	NA
WIPP-30 (ANNULUS)	MAG	07/16/07	304.03	92.67	3,126.19	952.86	NA
WIPP-30 (ANNULUS)	MAG	08/14/07	305.63	93.16	3,124.59	952.38	NA
WIPP-30 (ANNULUS)	MAG	09/17/07	306.15	93.31	3,124.07	952.22	NA
WQSP-6a	DL	01/17/07	167.32	50.92	3,196.74	974.37	NA
WQSP-6a	DL	02/13/07	167.08	50.85	3,196.98	974.44	NA
WQSP-6a	DL	03/13/07	167.09	50.85	3,196.97	974.44	NA
WQSP-6a	DL	04/11/07	167.00	50.82	3,197.06	974.46	NA
WQSP-6a	DL	05/09/07	167.27	50.90	3,196.79	974.38	NA
WQSP-6a	DL	06/13/07	167.18	50.88	3,196.88	974.41	NA
WQSP-6a	DL	07/18/07	167.18	50.88	3,196.88	974.41	NA
WQSP-6a	DL	08/14/07	167.25	50.90	3,196.81	974.39	NA
WQSP-6a	DL	09/19/07	167.19	50.88	3,196.87	974.41	NA
WQSP-6a	DL	10/17/07	166.94	50.80	3,197.12	974.48	NA
WQSP-6a	DL	11/15/07	167.57	51.00	3,196.49	974.29	NA
WQSP-6a	DL	12/11/07	167.09	50.85	3,196.97	974.44	NA
CB-1	B/C	01/16/07	598.80	182.51	2,730.00	832.10	NA
CB-1	B/C	02/12/07	598.30	182.36	2,730.50	832.26	NA
CB-1	B/C	03/12/07	598.28	182.36	2,730.52	832.26	NA
CB-1	B/C	04/09/07	598.02	182.28	2,730.78	832.34	NA
CB-1	B/C	05/07/07	597.85	182.22	2,730.95	832.39	NA
CB-1	B/C	06/12/07	597.71	182.18	2,731.09	832.44	NA
CB-1	B/C	07/16/07	597.63	182.16	2,731.17	832.46	NA
CB-1	B/C	08/13/07	597.54	182.13	2,731.26	832.49	NA
CB-1	B/C	09/18/07	597.27	182.05	2,731.53	832.57	NA
CB-1	B/C	10/15/07	597.10	182.00	2,731.70	832.62	NA
CB-1	B/C	11/14/07	597.00	181.97	2,731.80	832.65	NA
CB-1	B/C	12/11/07	596.85	181.92	2,731.95	832.70	NA
DOE-2	B/C	01/16/07	729.23	222.27	2,690.41	820.04	NA
DOE-2	B/C	02/13/07	728.87	222.16	2,690.77	820.15	NA
DOE-2	B/C	03/13/07	728.47	222.04	2,691.17	820.27	NA
DOE-2	B/C	04/09/07	728.11	221.93	2,691.53	820.38	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
DOE-2	B/C	05/09/07	727.78	221.83	2,691.86	820.48	NA
DOE-2	B/C	06/13/07	727.36	221.70	2,692.28	820.61	NA
DOE-2	B/C	07/17/07	726.94	221.57	2,692.70	820.74	NA
DOE-2	B/C	08/14/07	726.62	221.47	2,693.02	820.83	NA
DOE-2	B/C	09/17/07	726.28	221.37	2,693.36	820.94	NA
DOE-2	B/C	10/16/07	725.93	221.26	2,693.71	821.04	NA
DOE-2	B/C	11/15/07	725.62	221.17	2,694.02	821.14	NA
DOE-2	B/C	12/11/07	725.35	221.09	2,694.29	821.22	NA
C-2505	SR/D	03/15/07	43.20	13.17	3,369.85	1,027.13	NA
C-2505	SR/D	06/14/07	43.22	13.17	3,369.83	1,027.12	NA
C-2505	SR/D	09/19/07	43.09	13.13	3,369.96	1,027.16	NA
C-2505	SR/D	12/05/07	42.91	13.08	3,370.02	1,027.18	NA
C-2506	SR/D	03/15/07	42.60	12.98	3,370.27	1,027.26	NA
C-2506	SR/D	06/14/07	42.63	12.99	3,370.24	1,027.25	NA
C-2506	SR/D	09/19/07	42.51	12.96	3,370.36	1,027.29	NA
C-2506	SR/D	12/05/07	42.33	12.90	3,370.51	1,027.33	NA
C-2507	SR/D	03/15/07	43.21	13.17	3,366.80	1,026.20	NA
C-2507	SR/D	06/14/07	43.17	13.16	3,366.84	1,026.21	NA
C-2507	SR/D	09/19/07	42.98	13.10	3,367.03	1,026.27	NA
C-2507	SR/D	12/05/07	42.80	13.05	3,367.11	1,026.29	NA
C-2811	SR/D	03/15/07	52.40	15.97	3,346.70	1,020.07	NA
C-2811	SR/D	06/14/07	52.60	16.03	3,346.50	1,020.01	NA
C-2811	SR/D	09/19/07	52.03	15.86	3,347.07	1,020.19	NA
C-2811	SR/D	12/05/07	51.34	15.65	3,347.50	1,020.32	NA
PZ-01	SR/D	03/15/07	40.15	12.24	3,373.26	1,028.17	NA
PZ-01	SR/D	06/14/07	40.30	12.28	3,373.11	1,028.12	NA
PZ-01	SR/D	09/19/07	40.15	12.24	3,373.26	1,028.17	NA
PZ-01	SR/D	12/05/07	39.98	12.19	3,373.30	1,028.18	NA
PZ-02	SR/D	03/15/07	40.37	12.30	3,373.05	1,028.11	NA
PZ-02	SR/D	06/14/07	40.58	12.37	3,372.84	1,028.04	NA
PZ-02	SR/D	09/19/07	40.43	12.32	3,372.99	1,028.09	NA
PZ-02	SR/D	12/05/07	40.09	12.22	3,373.27	1,028.57	NA
PZ-03	SR/D	03/15/07	41.70	12.71	3,374.45	1,028.53	NA
PZ-03	SR/D	06/14/07	41.88	12.77	3,374.27	1,028.48	NA
PZ-03	SR/D	09/19/07	41.86	12.76	3,374.29	1,028.48	NA
PZ-03	SR/D	12/05/07	41.62	12.69	3,374.50	1,028.55	NA
PZ-04	SR/D	03/15/07	43.73	13.33	3,368.37	1,026.68	NA
PZ-04	SR/D	06/14/07	43.73	13.33	3,368.37	1,026.68	NA
PZ-04	SR/D	09/19/07	43.49	13.26	3,368.77	1,026.80	NA
PZ-04	SR/D	12/05/07	43.24	13.18	3,370.41	1,027.30	NA
PZ-05	SR/D	03/15/07	39.81	12.13	3,375.50	1,028.85	NA

Table F.9 - Groundwater Level Measurement Results for 2007

Well Number	Zone	Date	Measured Depth from Top of Casing	Measured Depth in Meters	Elevation in Feet AMSL	Elevation in Meters	Elevation in Feet AMSL, if Adjusted to Equivalent Freshwater Head
PZ-05	SR/D	06/14/07	40.13	12.23	3,375.18	1,028.75	NA
PZ-05	SR/D	09/19/07	40.11	12.23	3,375.20	1,028.76	NA
PZ-05	SR/D	12/05/07	39.95	12.18	3,375.29	1,028.79	NA
PZ-06	SR/D	03/15/07	41.34	12.60	3,372.15	1,027.83	NA
PZ-06	SR/D	06/14/07	41.47	12.64	3,372.02	1,027.79	NA
PZ-06	SR/D	09/19/07	41.32	12.59	3,372.17	1,027.84	NA
PZ-06	SR/D	12/05/07	40.98	12.49	3,372.35	1,027.89	NA
PZ-07	SR/D	03/15/07	35.30	10.76	3,378.69	1,029.82	NA
PZ-07	SR/D	06/14/07	35.57	10.84	3,378.42	1,029.74	NA
PZ-07	SR/D	09/19/07	35.52	10.83	3,378.47	1,029.76	NA
PZ-07	SR/D	12/05/07	35.30	10.76	3,378.54	1,029.78	NA
PZ-08	SR/D	03/15/07	66.55	20.28	3,351.72	1,021.60	NA
PZ-08	SR/D	06/14/07	62.81	19.14	3,355.46	1,022.74	NA
PZ-08	SR/D	09/19/07	62.68	19.10	3,355.59	1,022.78	NA
PZ-08	SR/D	12/05/07	63.49	19.35	3,354.70	1,022.51	NA
PZ-09	SR/D	03/15/07	55.90	17.04	3,365.31	1,025.75	NA
PZ-09	SR/D	06/14/07	56.10	17.10	3,365.11	1,025.69	NA
PZ-09	SR/D	09/19/07	56.28	17.15	3,364.93	1,025.63	NA
PZ-09	SR/D	12/05/07	56.20	17.13	3,364.89	1,025.62	NA
PZ-10	SR/D	03/15/07	33.80	10.30	3,372.00	1,027.79	NA
PZ-10	SR/D	06/14/07	33.61	10.24	3,372.19	1,027.84	NA
PZ-10	SR/D	09/19/07	33.51	10.21	3,372.29	1,027.87	NA
PZ-10	SR/D	12/05/07	33.51	10.21	3,372.22	1,027.85	NA
PZ-11	SR/D	03/15/07	43.25	13.18	3,375.70	1,028.91	NA
PZ-11	SR/D	06/14/07	43.37	13.22	3,375.58	1,028.88	NA
PZ-11	SR/D	09/19/07	43.43	13.24	3,375.52	1,028.86	NA
PZ-11	SR/D	12/05/07	43.28	13.19	3,375.50	1,028.85	NA
PZ-12	SR/D	03/15/07	49.47	15.08	3,359.52	1,023.98	NA
PZ-12	SR/D	06/14/07	49.45	15.07	3,359.54	1,023.99	NA
PZ-12	SR/D	09/19/07	49.27	15.02	3,359.72	1,024.04	NA
PZ-12	SR/D	12/05/07	48.82	14.88	3,360.10	1,024.16	NA
PZ-13	SR/D	12/05/07	63.95	19.49	3,358.29	1,023.61	NA
PZ-14	SR/D	12/05/07	66.60	20.30	3,353.98	1,022.38	NA
PZ-15	SR/D	12/05/07	45.28	13.80	3,385.58	1,031.92	NA

Note: Italicized entries are different than reported in monthly water level reports to the NMED, including errata that pertained to C-2737 (PIP), H-15 (PIP), and WIPP-30 (PIP). The changes are due either to casing elevation, or adjustment for tubing position relative to top of casing, and result in correct datums through 2007.

Appendix G
Air Sampling Data: Concentrations of Radionuclides

Table G.1 - Radionuclide Concentrations (Bq/m³) in Quarterly Composite Air Filters Collected from Locations Surrounding the WIPP Site. See Appendix C for sampling location codes.

Location	Quarter	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
			^{241}Am			^{238}Pu			$^{239+240}$Pu	
CBD	1	6.06E-08	7.35E-08	1.61E-04	2.58E-08	8.43E-08	9.97E-06	-9.96E-09	3.09E-08	9.97E-06
	2	-7.96E-09	2.07E-08	1.49E-04	-1.18E-08	2.83E-08	5.00E-06	-7.63E-09	2.27E-08	2.36E-05
	3	7.68E-08	2.13E-07	1.36E-04	-2.61E-08	6.12E-08	1.00E-05	-8.66E-09	3.52E-08	4.71E-05
	4	1.31E-07	1.27E-07	1.61E-04	-1.54E-08	3.13E-08	4.21E-05	2.31E-08	5.21E-08	4.99E-06
MLR	1	2.41E-08	4.85E-08	1.61E-04	2.17E-08	8.30E-08	9.95E-06	4.46E-09	4.98E-08	9.95E-06
	2	5.36E-08	6.51E-08	1.49E-04	-7.21E-09	2.07E-08	4.99E-06	6.67E-09	3.78E-08	2.36E-05
	3	-9.80E-09	6.08E-08	1.36E-04	4.20E-08	5.73E-08	9.94E-06	-1.16E-08	2.67E-08	4.71E-05
	4	1.96E-08	7.22E-08	1.61E-04	-1.29E-08	2.88E-08	4.21E-05	8.92E-09	3.97E-08	5.00E-06
SEC	1	6.56E-09	3.41E-08	1.61E-04	5.05E-08	8.72E-08	9.95E-06	8.28E-09	4.69E-08	9.95E-06
	2	2.51E-08	4.53E-08	1.49E-04	-9.97E-09	2.52E-08	4.99E-06	8.83E-09	3.93E-08	2.36E-05
	3	0.00E+00	1.21E-07	1.36E-04	-1.57E-08	3.77E-08	9.96E-06	-1.88E-08	4.12E-08	4.71E-05
	4	1.13E-08	8.27E-08	1.61E-04	4.81E-09	5.38E-08	5.20E-05	-9.61E-09	2.76E-08	5.01E-06
SMR	1	2.09E-08	5.36E-08	1.61E-04	5.85E-08	1.09E-07	9.96E-06	-8.67E-09	2.81E-08	9.96E-06
	2	2.42E-08	4.37E-08	1.49E-04	-8.37E-09	2.40E-08	5.00E-06	-8.94E-09	2.48E-08	2.36E-05
	3	2.32E-08	1.25E-07	1.36E-04	-7.96E-09	2.85E-08	9.97E-06	-1.15E-08	3.41E-08	4.71E-05
	4	2.46E-08	1.16E-07	1.61E-04	1.07E-08	7.27E-08	4.22E-05	1.25E-08	7.10E-08	5.03E-06
WEE	1	3.09E-08	4.69E-08	1.61E-04	1.37E-08	8.42E-08	9.95E-06	4.79E-08	6.78E-08	9.95E-06
	2	1.99E-08	4.36E-08	1.49E-04	1.19E-08	4.04E-08	5.00E-06	-1.25E-08	2.92E-08	2.36E-05
	3	1.49E-08	5.94E-08	1.36E-04	1.18E-08	3.24E-08	9.94E-06	6.41E-09	3.67E-08	4.71E-05
	4	5.12E-09	1.18E-07	1.61E-04	9.55E-09	5.41E-08	4.21E-05	9.52E-09	5.40E-08	5.01E-06
WFF	1	2.57E-08	5.59E-08	1.61E-04	4.07E-08	1.15E-07	9.96E-06	7.79E-09	5.92E-08	9.96E-06
	2	2.91E-08	4.65E-08	1.49E-04	-5.50E-09	1.87E-08	4.99E-06	2.42E-08	5.14E-08	2.36E-05
	3	7.75E-10	6.45E-08	1.36E-04	1.19E-08	4.23E-08	9.95E-06	-1.05E-08	2.73E-08	4.71E-05
	4	6.13E-08	8.97E-08	1.61E-04	-5.24E-09	1.69E-08	4.21E-05	2.28E-08	4.32E-08	4.99E-06
WSS	1	7.57E-09	3.94E-08	1.61E-04	3.40E-09	9.84E-08	9.97E-06	-1.70E-08	4.08E-08	9.97E-06
	2	-7.47E-09	2.01E-08	1.49E-04	2.10E-08	4.89E-08	4.99E-06	-7.67E-09	2.13E-08	2.36E-05
	3	-1.09E-08	6.74E-08	1.36E-04	-1.16E-08	2.94E-08	9.95E-06	-1.35E-08	3.16E-08	4.71E-05
	4	4.61E-08	9.43E-08	1.61E-04	7.06E-09	4.82E-08	4.21E-05	-1.02E-08	2.75E-08	5.00E-06
WAB	1	2.86E-04	3.80E-04	4.48E-04	-1.46E-05	4.14E-04	4.04E-04	6.28E-05	3.56E-04	4.03E-04
	2	1.95E-04	3.61E-04	4.72E-04	-6.69E-05	1.94E-04	4.04E-04	9.93E-05	3.36E-04	4.21E-04
	3	-1.22E-04	2.73E-04	5.68E-04	-7.35E-05	1.86E-04	3.42E-04	4.19E-04	5.12E-04	3.78E-04
	4	0.00E+00	1.25E-03	1.12E-03	1.33E-04	5.96E-04	7.21E-04	1.62E-04	5.70E-04	6.82E-04
	Minimum	-1.09E-08	6.74E-08	1.36E-04	-2.61E-08	6.12E-08	1.00E-05	-1.88E-08	4.12E-08	4.71E-05
	Maximum	1.31E-07	1.27E-07	1.61E-04	5.85E-08	1.09E-07	9.96E-06	4.79E-08	6.78E-08	9.95E-06
	Mean	2.52E-08	7.31E-08	1.52E-04	7.40E-09	5.22E-08	1.71E-05	8.80E-10	3.92E-08	2.14E-05

Location	Quarter	RN	2 X TPU	MDC	RN	2 X TPU	MDC	RN	2 X TPU	MDC
			^{234}U			^{235}U			^{238}U	
CBD	1	1.48E-06	4.90E-07	9.03E-04	8.53E-08	9.45E-08	9.90E-05	1.35E-06	4.54E-07	3.47E-04
	2	6.58E-07	2.51E-07	9.16E-04	1.33E-08	4.06E-08	9.90E-05	5.58E-07	2.23E-07	4.08E-04
	3	1.59E-06	5.00E-07	7.80E-04	2.28E-07	2.13E-07	3.73E-05	1.83E-06	5.31E-07	3.96E-04
	4	1.81E-06	3.66E-07	7.92E-04	1.54E-07	1.20E-07	3.72E-05	1.97E-06	3.81E-07	3.22E-04
MLR	1	1.43E-06	4.42E-07	9.03E-04	6.96E-08	7.59E-08	9.90E-05	1.35E-06	4.21E-07	3.47E-04
	2	7.44E-07	2.74E-07	9.16E-04	3.21E-08	5.55E-08	9.90E-05	6.13E-07	2.38E-07	4.08E-04
	3	1.38E-06	3.18E-07	7.80E-04	1.22E-07	1.11E-07	3.72E-05	1.32E-06	3.07E-07	3.96E-04
	4	1.89E-06	3.72E-07	7.92E-04	5.88E-08	8.04E-08	3.72E-05	1.96E-06	3.77E-07	3.22E-04
SEC	1	1.28E-06	4.26E-07	9.03E-04	1.28E-07	1.07E-07	9.90E-05	1.13E-06	3.85E-07	3.47E-04
	2	5.84E-07	2.39E-07	9.16E-04	-3.62E-09	1.66E-08	9.90E-05	5.05E-07	2.16E-07	4.08E-04
	3	1.84E-06	4.30E-07	7.80E-04	1.09E-07	1.27E-07	3.72E-05	8.82E-07	2.95E-07	3.96E-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 sampling location codes.

Location	Quarter	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	4	1.40E-06	3.32E-07	7.92E-04	1.84E-08	5.23E-08	3.72E-05	1.12E-06	2.93E-07	3.22E-04
SMR	1	1.66E-06	5.18E-07	9.03E-04	7.50E-08	7.85E-08	9.90E-05	1.50E-06	4.76E-07	3.47E-04
	2	6.90E-07	2.72E-07	9.16E-04	3.43E-08	5.91E-08	9.90E-05	6.88E-07	2.71E-07	4.08E-04
	3	1.18E-06	3.59E-07	7.80E-04	2.65E-08	7.11E-08	3.72E-05	1.62E-06	4.15E-07	3.96E-04
	4	2.30E-06	5.91E-07	7.92E-04	1.17E-07	1.72E-07	3.72E-05	2.36E-06	5.99E-07	3.22E-04
WEE	1	1.74E-06	5.67E-07	9.03E-04	5.92E-08	7.30E-08	9.90E-05	1.14E-06	4.04E-07	3.47E-04
	2	6.08E-07	2.29E-07	9.16E-04	8.11E-09	4.22E-08	9.90E-05	5.97E-07	2.24E-07	4.08E-04
	3	3.72E-07	2.11E-07	7.80E-04	2.20E-08	7.47E-08	3.72E-05	1.33E-08	6.40E-08	3.96E-04
	4	1.66E-06	4.18E-07	7.92E-04	8.54E-08	1.15E-07	3.72E-05	1.84E-06	4.37E-07	3.22E-04
WFF	1	1.35E-06	4.67E-07	9.03E-04	9.49E-08	9.85E-08	9.91E-05	1.13E-06	4.05E-07	3.47E-04
	2	6.45E-07	2.67E-07	9.16E-04	7.27E-08	8.62E-08	9.90E-05	7.30E-07	2.89E-07	4.08E-04
	3	1.63E-06	3.66E-07	7.80E-04	4.10E-08	7.57E-08	3.72E-05	1.35E-06	3.30E-07	3.96E-04
	4	1.45E-06	3.17E-07	7.92E-04	1.01E-07	9.56E-08	3.72E-05	1.50E-06	3.21E-07	3.22E-04
WSS	1	1.02E-06	3.31E-07	9.03E-04	2.94E-08	5.32E-08	9.90E-05	9.33E-07	3.10E-07	3.47E-04
	2	8.98E-07	3.11E-07	9.16E-04	1.43E-08	3.84E-08	9.90E-05	6.56E-07	2.48E-07	4.08E-04
	3	1.80E-06	3.77E-07	7.80E-04	3.89E-08	7.38E-08	3.72E-05	1.18E-06	3.05E-07	3.96E-04
	4	1.39E-06	3.68E-07	7.92E-04	1.66E-07	1.47E-07	3.72E-05	1.30E-06	3.52E-07	3.22E-04
WAB	1	6.30E-03	2.61E-03	1.29E-03	4.46E-04	6.55E-04	5.76E-04	7.16E-03	2.85E-03	7.32E-04
	2	4.21E-03	1.85E-03	1.26E-03	7.84E-05	3.77E-04	5.24E-04	2.86E-03	1.42E-03	7.51E-04
	3	8.93E-03	2.20E-03	1.14E-03	7.24E-04	7.74E-04	4.87E-04	1.04E-02	2.36E-03	7.60E-04
	4	5.78E-03	2.43E-03	1.46E-03	-1.98E-04	4.83E-04	8.67E-04	3.55E-03	1.92E-03	9.92E-04
	Minimum	3.72E-07	2.11E-07	7.80E-04	-3.62E-09	1.66E-08	9.90E-05	1.33E-08	6.40E-08	3.96E-04
	Maximum	2.30E-06	5.91E-07	7.92E-04	2.28E-07	2.13E-07	3.73E-05	2.36E-06	5.99E-07	3.22E-04
	Mean	1.30E-06	3.72E-07	8.48E-04	7.14E-08	8.74E-08	6.81E-05	1.18E-06	3.42E-07	3.68E-04

Location	Quarter	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
			^{40}K			^{60}Co			^{137}Cs	
CBD	1	3.51E-04*	4.42E-04	5.63E-04	6.22E-05*	4.77E-05	6.01E-05	4.00E-05*	4.10E-05	4.98E-05
	2	1.16E-03*	6.78E-04	7.91E-04	4.47E-05*	6.56E-05	7.58E-05	-5.10E-05*	7.46E-05	7.58E-05
	3	4.16E-04*	3.37E-04	4.33E-04	8.04E-06*	3.68E-05	4.30E-05	6.90E-06	2.73E-05	3.28E-05
	4	4.32E-04*	3.23E-04	4.20E-04	7.75E-06*	2.31E-05	4.08E-08	4.46E-06*	2.71E-05	3.24E-05
MLR	1	3.89E-04	2.20E-04	3.06E-04	7.03E-06*	5.35E-05	5.87E-05	3.82E-05*	4.05E-05	4.93E-05
	2	1.10E-03*	6.73E-04	7.84E-04	2.44E-05*	6.97E-05	7.92E-05	-1.12E-04*	7.86E-05	7.51E-05
	3	3.71E-04*	3.71E-04	4.56E-04	1.75E-05*	3.51E-05	4.22E-05	-3.92E-05*	3.07E-05	3.10E-05
	4	2.54E-04*	3.66E-04	4.45E-04	-4.51E-06*	3.81E-05	4.23E-05	9.01E-06*	2.85E-05	3.42E-05
SEC	1	-1.32E-04*	5.27E-04	5.55E-04	9.62E-06*	5.23E-05	5.93E-05	1.39E-05*	3.75E-05	4.29E-05
	2	2.70E-04*	3.53E-04	4.31E-04	1.11E-05*	3.66E-05	4.33E-05	-2.23E-05*	3.06E-05	3.33E-05
	3	6.16E-04*	6.99E-04	7.97E-04	2.69E-05*	7.03E-05	8.01E-05	-1.08E-04*	8.10E-05	7.80E-05
	4	3.95E-04*	3.67E-04	4.59E-04	-1.33E-05*	4.02E-05	4.33E-05	3.00E-05*	2.76E-05	3.46E-05
SMR	1	2.76E-04	2.18E-04	3.31E-04	1.79E-05*	5.11E-05	5.90E-05	1.87E-05*	3.73E-05	4.31E-05
	2	3.36E-04	1.81E-04	2.51E-04	7.54E-06*	3.44E-05	4.02E-05	1.10E-05*	2.81E-05	3.38E-05
	3	8.84E-04*	6.70E-04	7.73E-04	2.20E-05*	6.63E-05	7.54E-05	-1.21E-04*	7.90E-05	7.47E-05
	4	7.76E-04	5.06E-04	7.78E-04	8.26E-05*	7.31E-05	8.53E-05	-1.21E-04*	8.45E-05	8.07E-05
WEE	1	3.39E-04*	4.54E-04	5.38E-04	5.58E-05*	4.47E-05	5.66E-05	3.62E-06*	4.13E-05	4.62E-05
	2	1.06E-03*	6.84E-04	7.94E-04	8.81E-05*	6.73E-05	7.91E-05	-7.16E-05*	7.67E-05	7.64E-05
	3	2.08E-04	2.34E-04	3.75E-04	-3.04E-05*	4.00E-05	4.06E-05	1.28E-05*	2.72E-05	3.31E-05
	4	2.32E-04	2.54E-04	4.06E-04	1.37E-05*	3.65E-05	4.34E-05	1.67E-06*	2.71E-05	3.22E-05
WFF	1	4.42E-04*	4.46E-04	5.78E-04	4.89E-05*	5.15E-05	6.16E-05	-2.73E-05*	4.51E-05	4.87E-05
	2	5.43E-04*	3.07E-04	4.18E-04	5.43E-06*	3.69E-05	4.26E-05	7.47E-06	2.80E-05	3.36E-05
	3	5.03E-04*	6.65E-04	7.55E-04	-6.18E-06*	6.83E-05	7.60E-05	-1.09E-05*	6.29E-05	7.50E-05
	4	-6.52E-06*	3.94E-04	4.49E-04	-6.32E-06*	4.03E-05	4.49E-05	5.87E-06*	2.92E-05	3.48E-05
WSS	1	4.52E-04	5.50E-04	8.83E-04	1.64E-04*	7.29E-05	8.56E-05	-6.49E-05*	7.05E-05	7.12E-05
	2	2.05E-04	1.69E-04	2.59E-04	5.86E-06*	3.71E-05	4.31E-05	6.77E-06*	2.82E-05	3.38E-05

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

Location	Quarter	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC	[RN]	2 X TPU	MDC
	3	2.16E-04	2.42E-04	3.87E-04	3.35E-05*	3.64E-05	4.54E-05	2.62E-05*	2.65E-05	3.33E-05
	4	1.68E-03*	6.90E-04	8.12E-04	-3.20E-05*	7.10E-05	7.66E-05	-1.04E-04*	7.74E-05	7.44E-05
WAB	1	8.59E+00*	3.10E+00	4.04E+00	1.02E+00*	5.48E-01	6.41E-01	-3.04E-01*	5.14E-01	5.33E-01
	2	4.97E+00*	4.83E+00	5.55E+00	3.24E-01*	5.02E-01	5.77E-01	-2.93E-01*	5.47E-01	5.62E-01
	3	9.64E+00*	5.08E+00	5.93E+00	7.92E-02*	4.99E-01	5.64E-01	-5.81E-01*	5.69E-01	5.63E-01
	4	4.50E+00*	2.52E+00	3.36E+00	5.21E-01*	2.53E-01	3.44E-01	-5.16E-02*	2.07E-01	2.38E-01
	Minimum	-1.32E-04*	5.27E-04	5.55E-04	-3.20E-05*	7.10E-05	7.66E-05	-1.21E-04*	8.45E-05	8.07E-05
	Maximum	1.68E-03*	6.90E-04	8.12E-04	1.64E-04*	7.29E-05	8.56E-05	4.00E-05*	4.10E-05	4.98E-05
	Mean	4.92E-04	4.29E-04	5.44E-04	2.40E-05	4.99E-05	5.65E-05	-2.20E-05	4.62E-05	4.98E-05

Location	Quarter	[RN]	2 X TPU	MDC
			^{90}Sr	
CBD	1	-1.07E-06	3.06E-06	1.86E-03
	2	-1.31E-06	4.47E-06	1.03E-03
	3	-1.35E-06	4.20E-06	9.90E-04
	4	-2.40E-06	3.46E-06	1.40E-03
MLR	1	-8.69E-07	3.05E-06	1.86E-03
	2	-2.28E-06	4.48E-06	1.03E-03
	3	-3.77E-06	4.24E-06	9.90E-04
	4	-1.28E-06	3.70E-06	1.40E-03
SEC	1	1.40E-07	3.06E-06	1.86E-03
	2	-1.97E-06	4.49E-06	1.03E-03
	3	-2.68E-07	4.57E-06	9.90E-04
	4	3.71E-07	4.26E-06	1.40E-03
SMR	1	-8.01E-07	3.05E-06	1.86E-03
	2	-2.50E-06	4.51E-06	1.03E-03
	3	5.86E-07	4.38E-06	9.90E-04
	4	-3.86E-06	4.39E-06	1.40E-03
WEE	1	-7.40E-08	3.12E-06	1.86E-03
	2	-1.42E-06	4.51E-06	1.03E-03
	3	-8.48E-07	4.11E-06	9.90E-04
	4	-1.44E-06	3.92E-06	1.40E-03
WFF	1	-1.48E-07	3.16E-06	1.86E-03
	2	-1.85E-06	4.52E-06	1.03E-03
	3	-1.05E-06	4.11E-06	9.90E-04
	4	-9.90E-07	3.60E-06	1.40E-03
WSS	1	-1.46E-07	3.14E-06	1.86E-03
	2	-2.19E-06	4.57E-06	1.03E-03
	3	5.37E-07	4.34E-06	9.90E-04
	4	-1.78E-06	4.33E-06	1.40E-03
WAB	1	-2.69E-03	2.30E-02	3.31E-03
	2	-8.91E-03	3.22E-02	3.12E-03
	3	-4.59E-03	3.18E-02	3.13E-03
	4	-2.71E-03	2.61E-02	3.14E-03
	Minimum	-3.86E-06	4.39E-06	1.40E-03
	Maximum	5.86E-07	4.38E-06	9.90E-04
	Mean	-1.22E-06	3.96E-06	1.32E-03

*Gamma spectroscopy samples with confidence levels less than 90 percent - not considered "detects."

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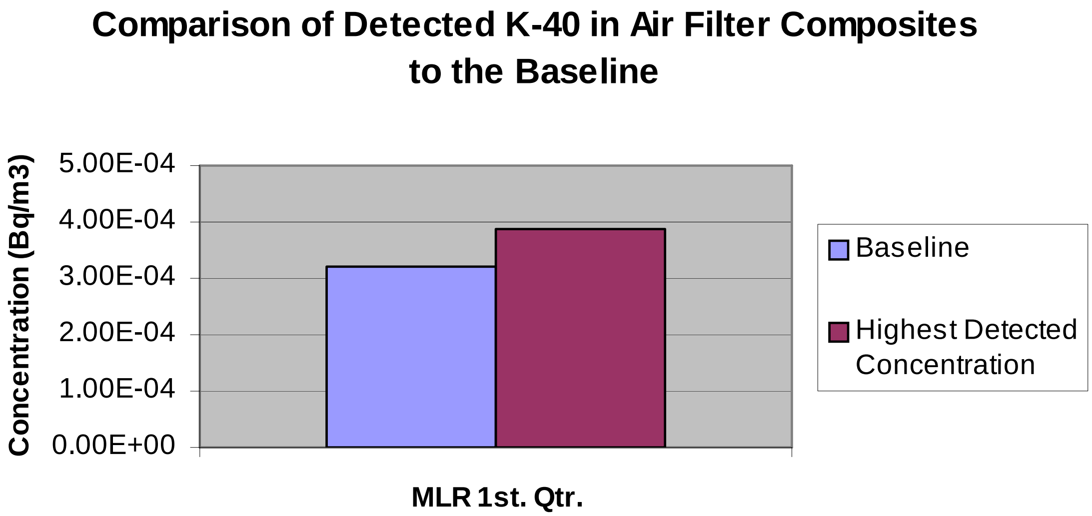
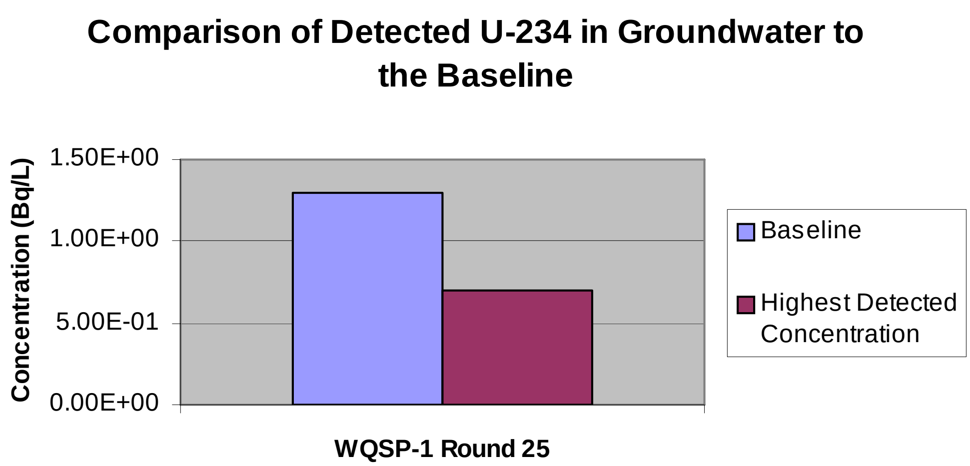
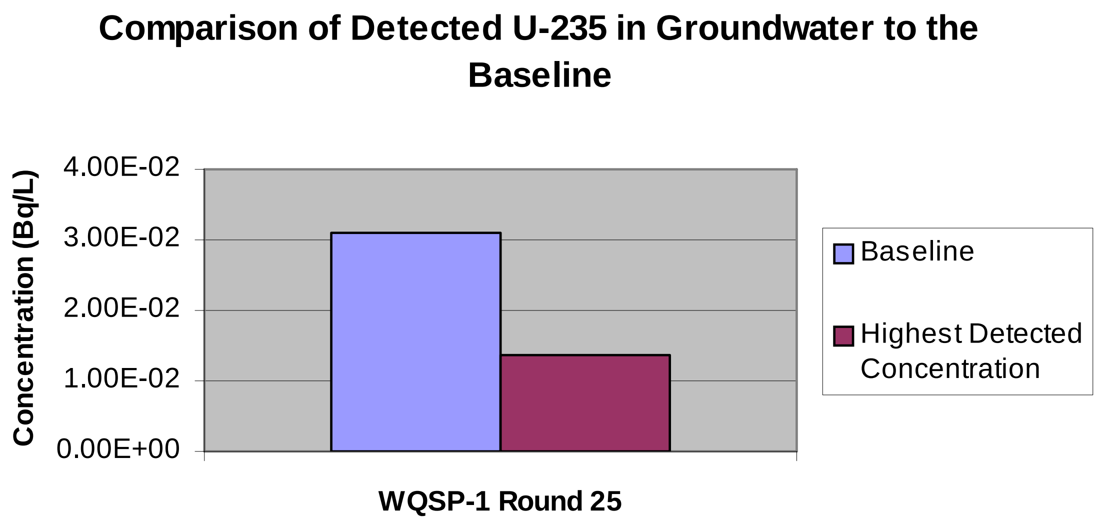
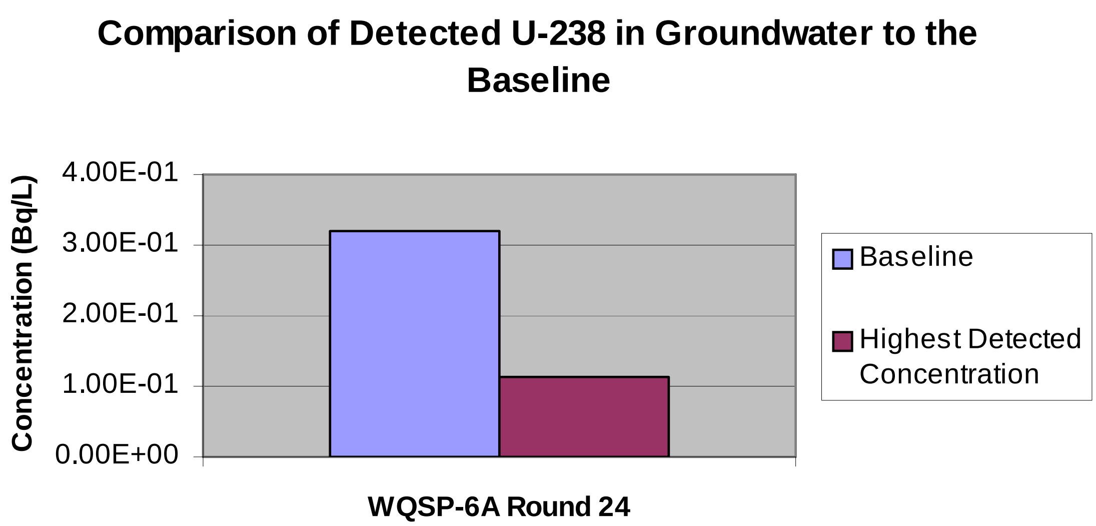
Appendix H
Comparison of Detected Radionuclides to the Radiological Baseline

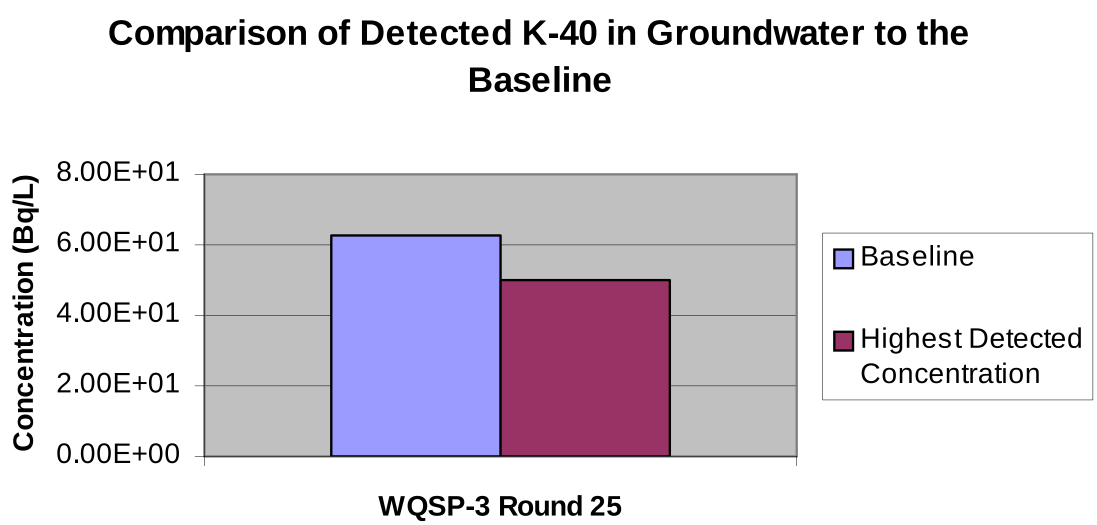
The figures in this appendix show the highest detected radionuclides from 2007 environmental monitoring sample analysis results compared to the 99 percent confidence interval radiological baseline values established for these isotopes (DOE/WIPP-92-037). Figures address air filter composite, groundwater, surface water, sediment, soil, and vegetation results. Note, all results with the exception of vegetation and were compared to the baseline upper 99 percentile probability value. The baseline did not include probability distributions for these; therefore, these sample results are compared to the baseline mean values. A detailed discussion of environmental monitoring radionuclide sample results is contained in Chapter 4.

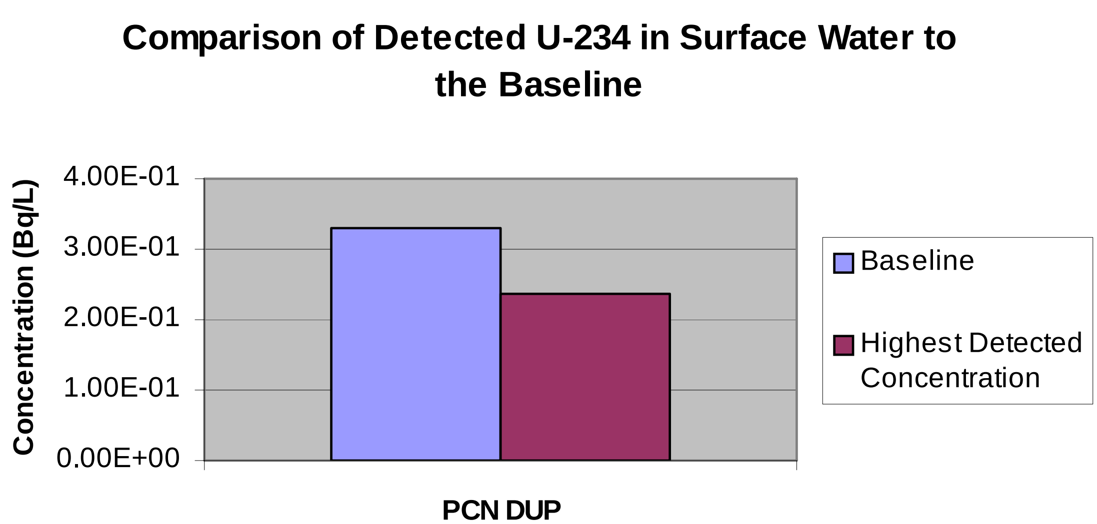




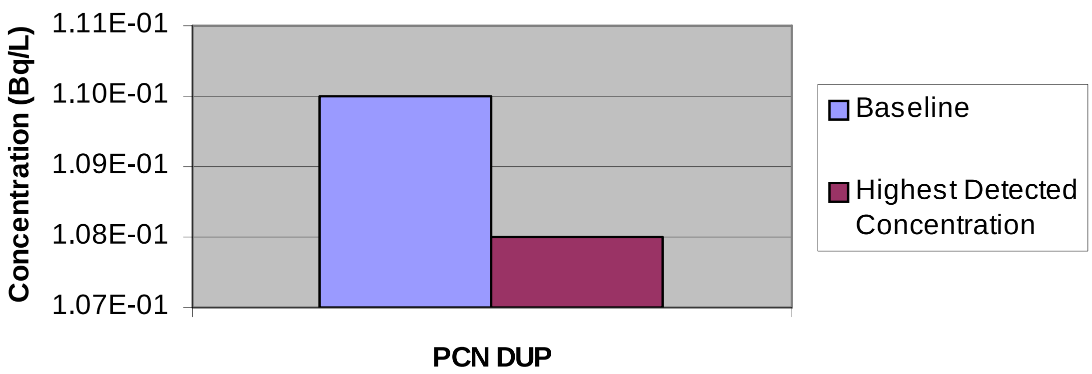

Comparison of Detected U-235 in Groundwater to the Baseline
Concentration (Bq/L)
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Baseline
Highest Detected Concentration
WQSP-1 Round 25


Comparison of Detected U-238 in Groundwater to the Baseline
Concentration (Bq/L)
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Baseline
Highest Detected Concentration
WQSP-6A Round 24

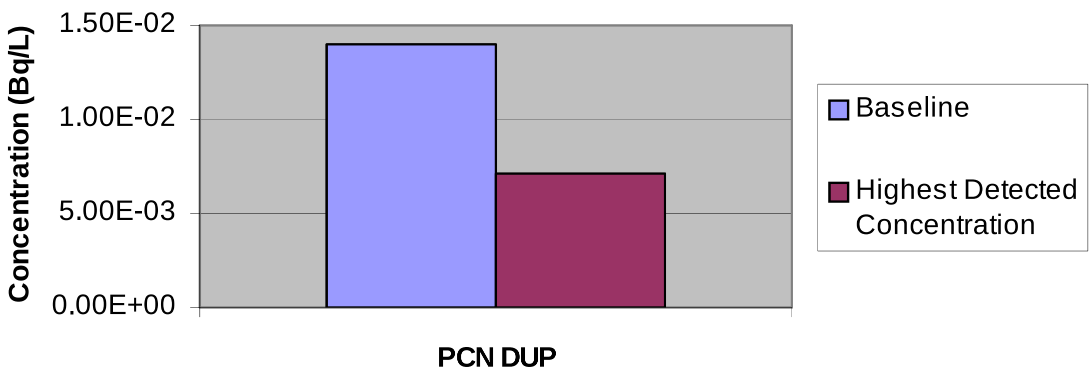

Comparison of Detected K-40 in Groundwater to the Baseline
Concentration (Bq/L)
8.00E+01
6.00E+01
4.00E+01
2.00E+01
0.00E+00
Baseline
Highest Detected Concentration
WQSP-3 Round 25


Comparison of Detected U-234 in Surface Water to the Baseline
Concentration (Bq/L)
4.00E-01
3.00E-01
2.00E-01
1.00E-01
0.00E+00
Baseline
Highest Detected Concentration
PCN DUP

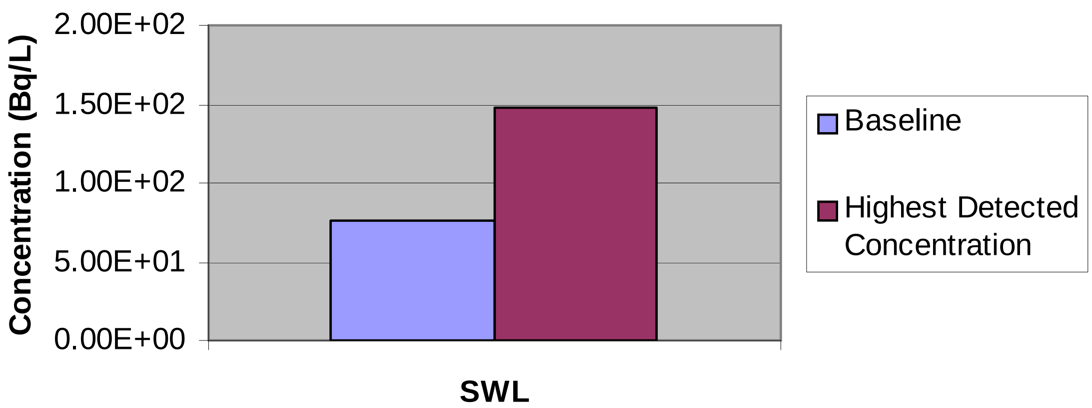
Comparison of Detected U-238 in Surface Water to the Baseline



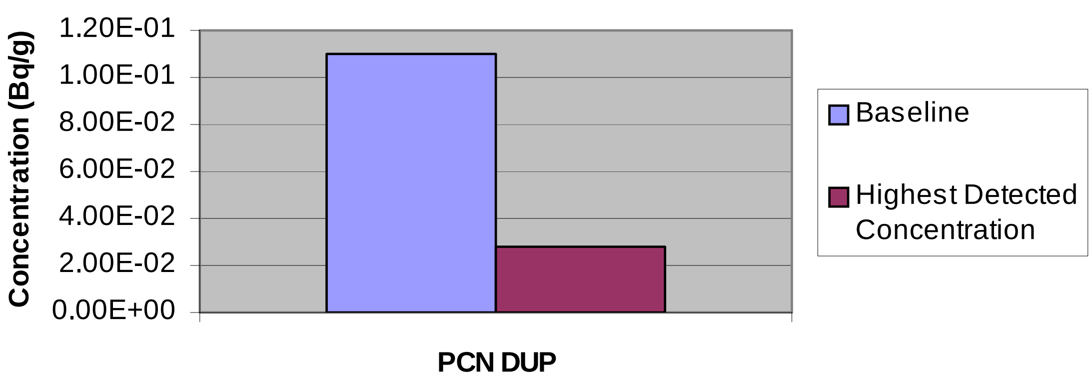
Comparison of Detected U-235 in Surface Water to the Baseline

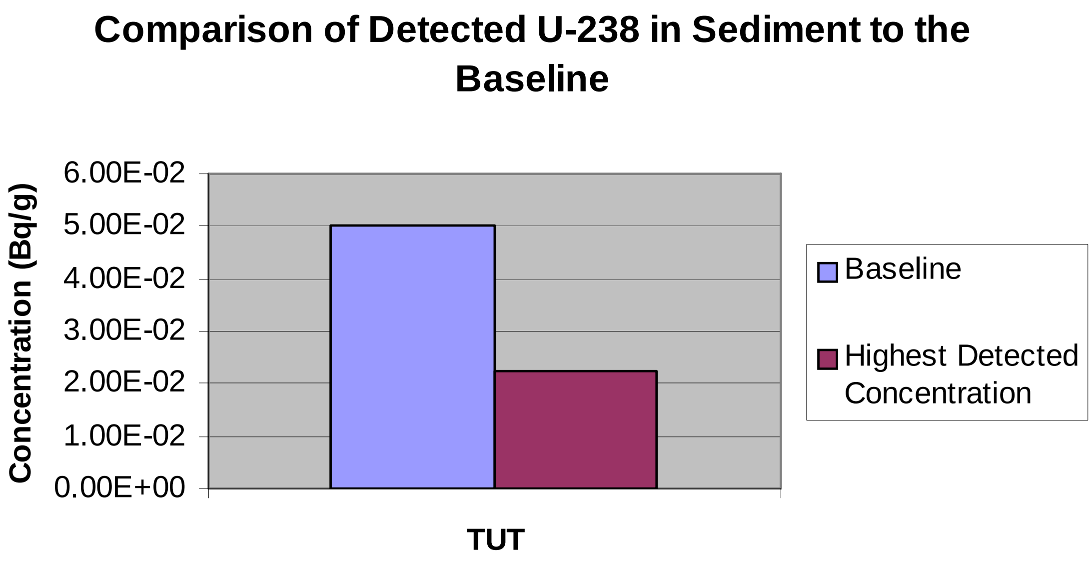


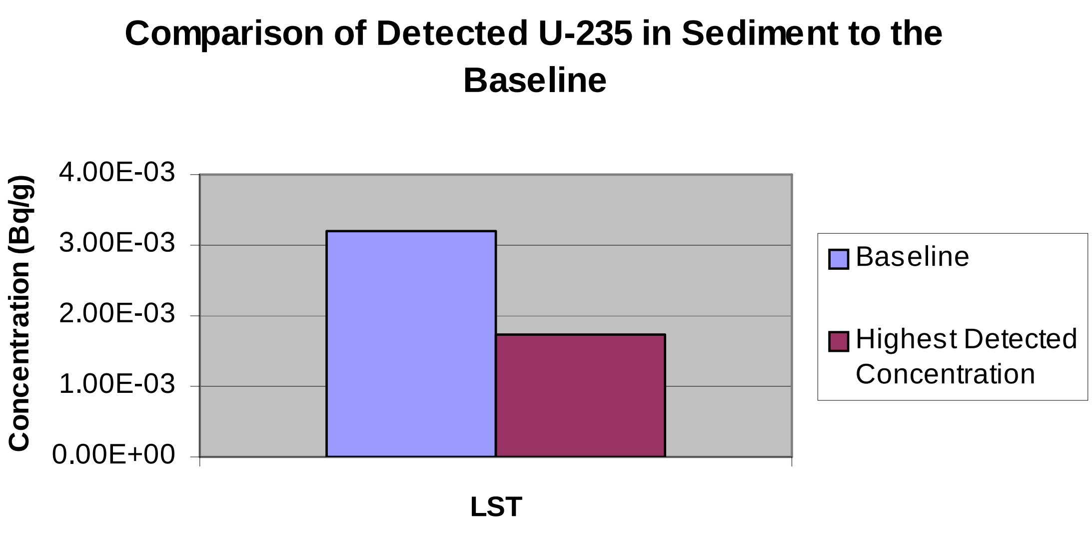
Comparison of Detected K-40 in Surface Water to the Baseline



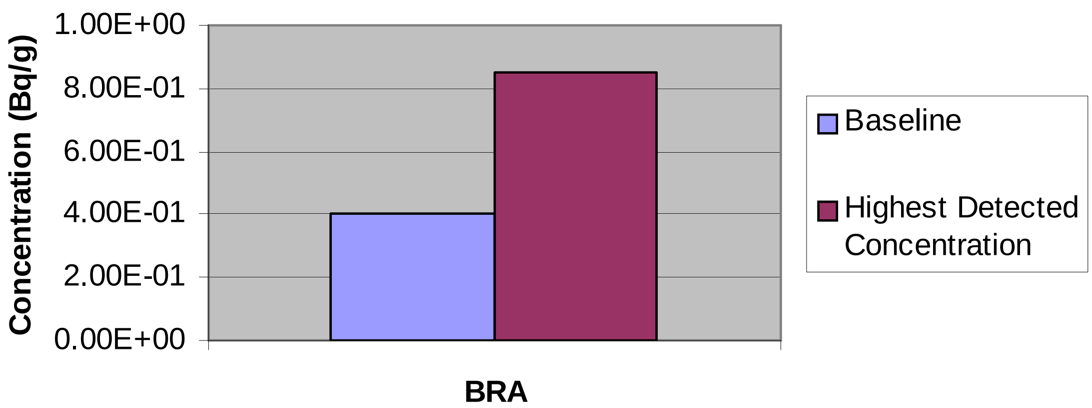
Comparison of Detected U-234 in Sediment to the Baseline



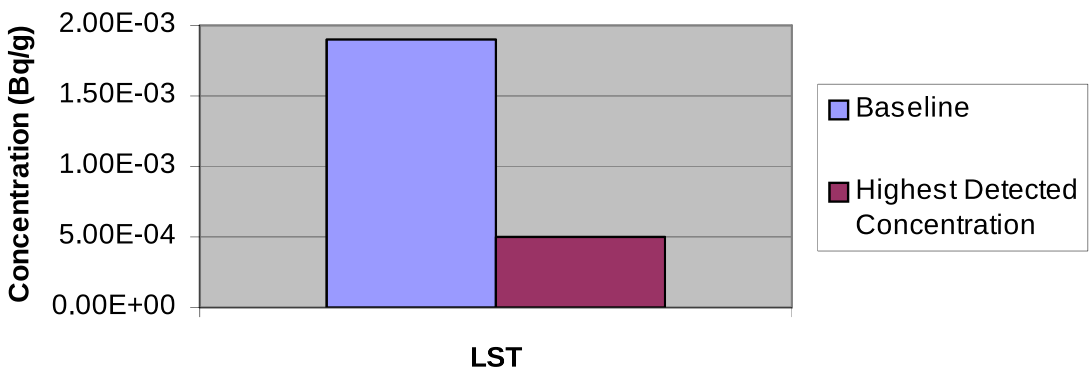

Comparison of Detected U-238 in Sediment to the Baseline
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Concentration (Bq/g)
TUT
Baseline
Highest Detected Concentration

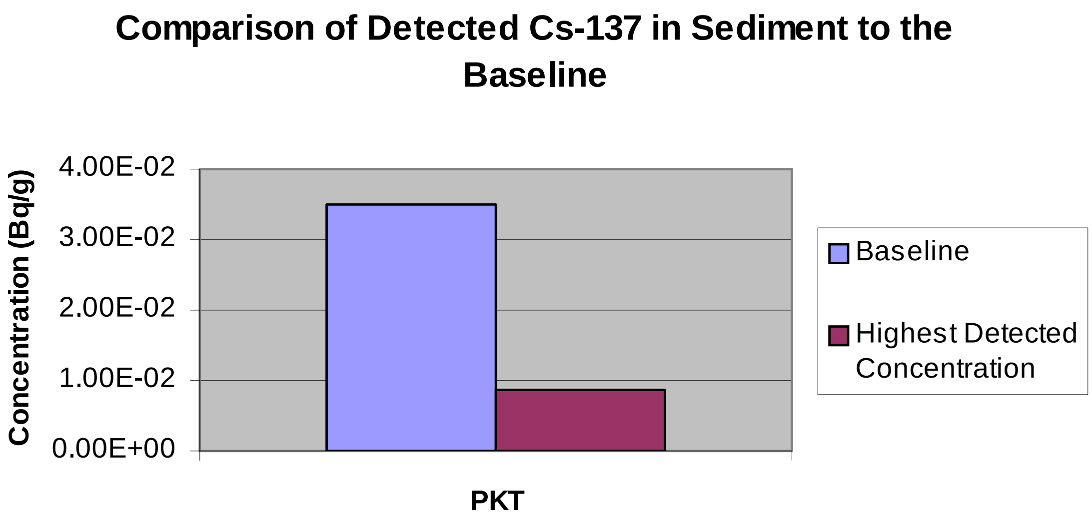

Comparison of Detected U-235 in Sediment to the Baseline
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
Concentration (Bq/g)
LST
Baseline
Highest Detected Concentration

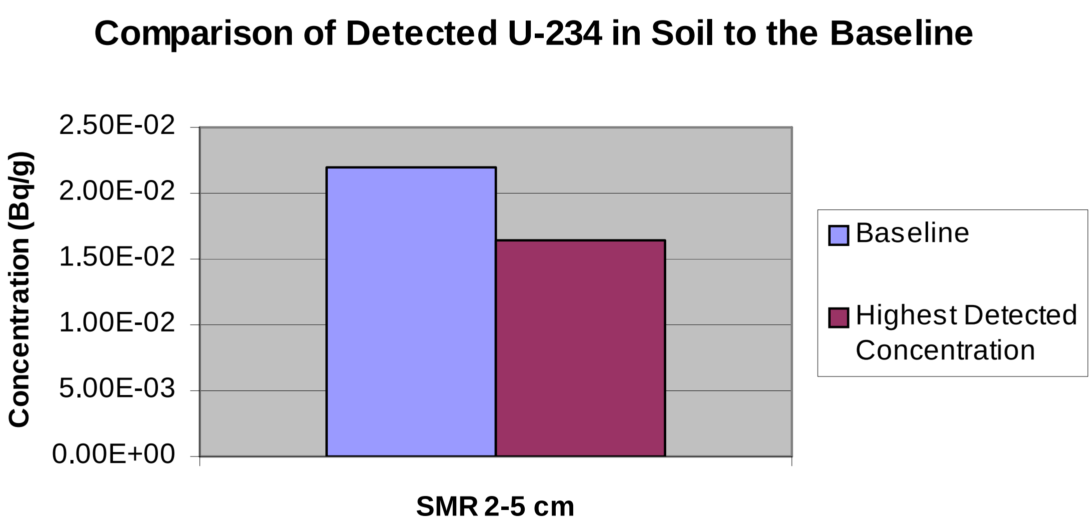
Comparison of Detected K-40 in Sediment to the Baseline

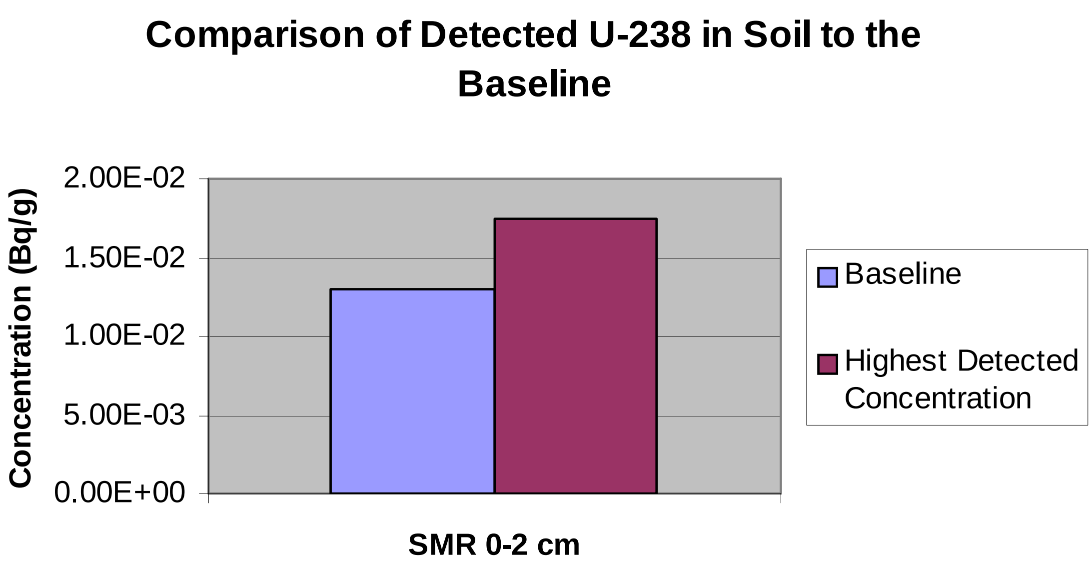


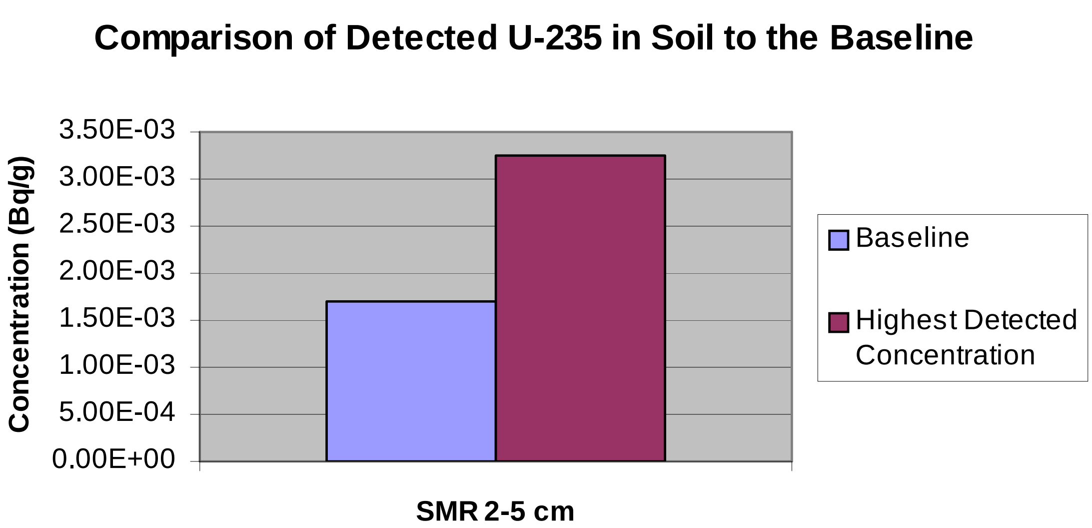
Comparison of Detected Pu-239+240 in Sediment to the Baseline



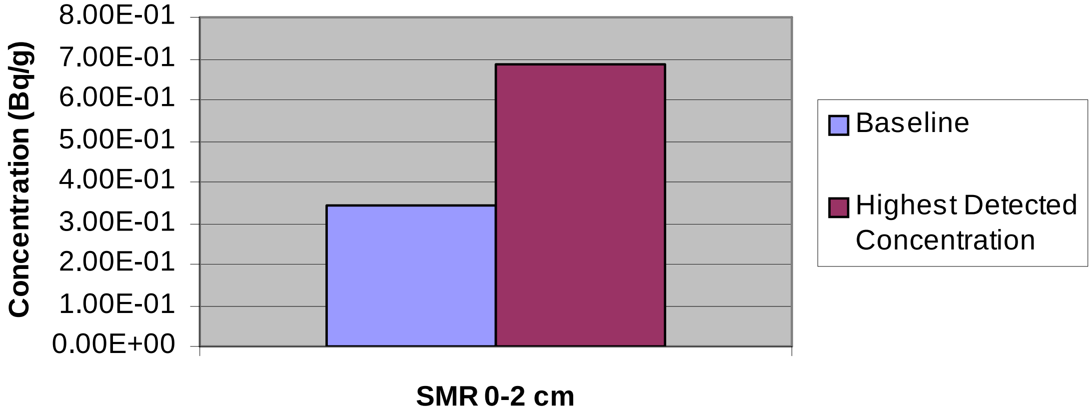

Comparison of Detected Cs-137 in Sediment to the Baseline
Concentration (Bq/g)
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
PKT
Baseline
Highest Detected Concentration


Comparison of Detected U-234 in Soil to the Baseline
Concentration (Bq/g)
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
SMR 2-5 cm
Baseline
Highest Detected Concentration

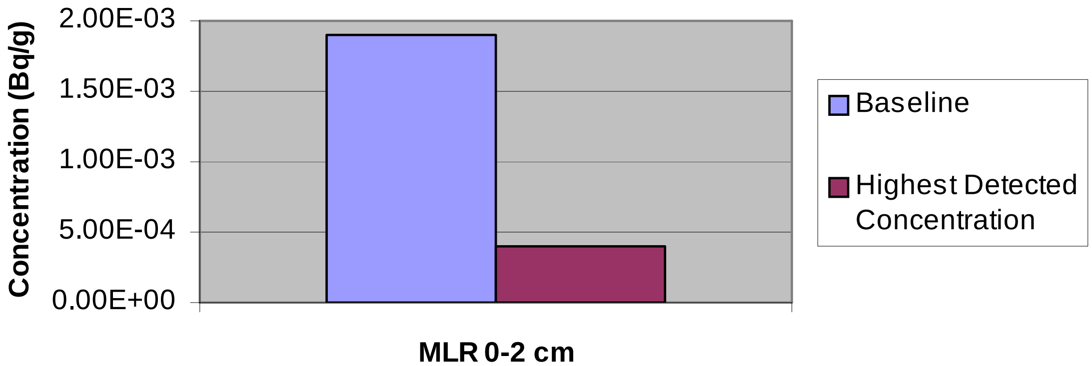

Comparison of Detected U-238 in Soil to the Baseline
Concentration (Bq/g)
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
SMR 0-2 cm
Baseline
Highest Detected Concentration

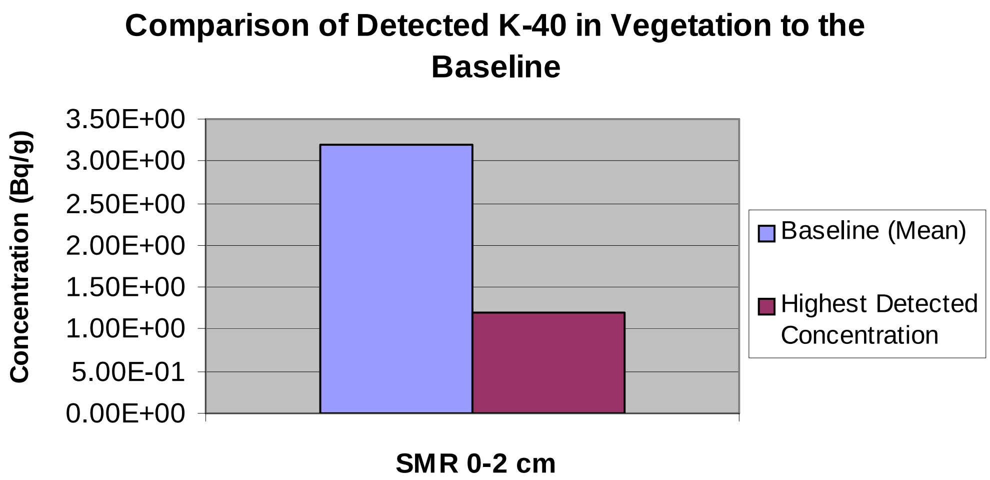

Comparison of Detected U-235 in Soil to the Baseline
Concentration (Bq/g)
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
SMR 2-5 cm
Baseline
Highest Detected Concentration

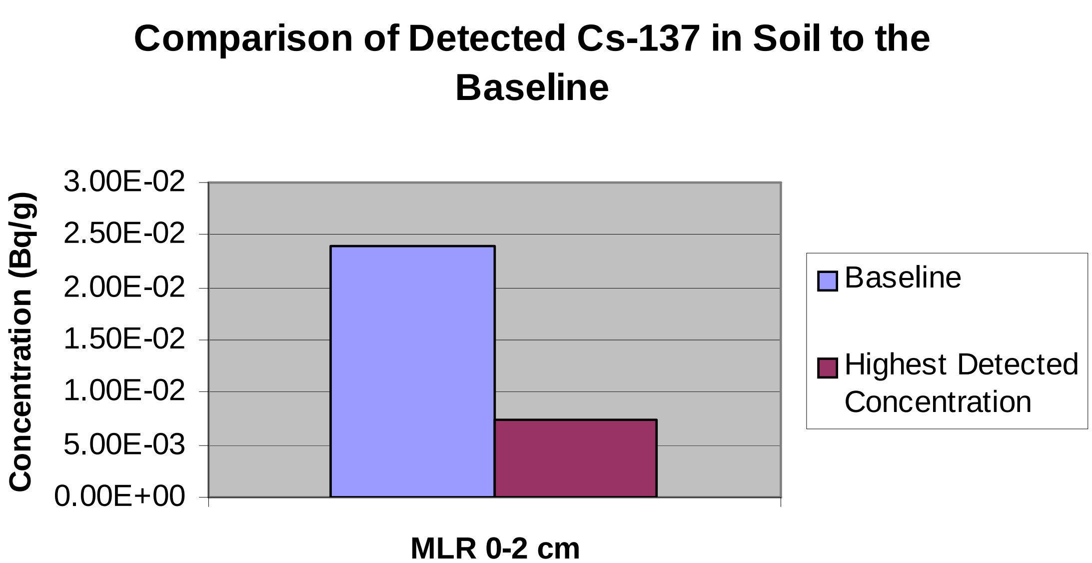
Comparison of Detected K-40 in Soil to the Baseline



Comparison of Detected Pu-239+240 in Soil to the Baseline




Comparison of Detected K-40 in Vegetation to the 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 0-2 cm
Baseline (Mean)
Highest Detected Concentration


Comparison of Detected Cs-137 in Soil to the Baseline
Concentration (Bq/g)
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
MLR 0-2 cm
Baseline
Highest Detected Concentration