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PREOPERATIONAL RADIATION SURVEILLANCE OF THE WIPP PROJECT BY EEG DURING 1989

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FOREWORD

The purpose of the New Mexico Environmental Evaluation Group (EEG) is to conduct an independent technical evaluation of the Waste Isolation Pilot Plant (WIPP) Project to ensure protection of the public health and safety and the environment. The WIPP Project, located in southeastern New Mexico, is being constructed as a repository for permanent disposal of transuranic (TRU) radioactive wastes generated by the national defense programs. The EEG was established in 1978 with funds provided by the U. S. Department of Energy (DOE) to the State of New Mexico. Public Law 100-456, the National Defense Authorization Act, Fiscal Year 1989, Section 1433, assigned EEG to the New Mexico Institute of Mining and Technology and continued the contractual funding from DOE (DE-AC04-89AL58309).

EEG performs independent technical analyses of the suitability of the proposed site; the design of the repository, its planned operation, and its long-term integrity; suitability and safety of the transportation systems; suitability of the Waste Acceptance Criteria and the generator sites' compliance with them; and related subjects. These analyses include assessments of reports issued by the DOE and its contractors, other federal agencies and organizations, as they relate to the potential health, safety and environmental impacts from WIPP. Another important function of EEG is independent environmental monitoring of background radioactivity in air, water, and soil, both on-site and in surrounding communities.

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EXECUTIVE SUMMARY

The purpose of the EEG preoperational environmental monitoring program is to document the existing concentrations of selected radionuclides both at the WIPP site and in the surrounding communities. The basic methodology for conducting environmental surveillance of the WIPP facility has been developed and data presented in this report continue the baseline data published in EEG-43. Such radionuclide baseline data are important prior to operations using actual waste in order to determine whether WIPP operations have affected concentrations of these radionuclides in the environment. EEG data are generally consistent with similar data obtained by DOE during the preoperational phase of WIPP.

Since the beginning of the preoperational radiation monitoring program in late 1985, EEG has obtained 1,244 samples of particulates in air, 158 water samples, 14 biota samples, and 5 soil and sediment samples. Analyses of the majority of these samples have provided 4,299 specific radionuclide concentrations in the environment near WIPP and in surrounding communities.

As expected, analyses of particulates in air frequently indicated a detectable presence of naturally occurring Ra-226, Ra-228, Th-228, Th-230, and Th-232. These air particulate data are consistent with previous findings by EEG from this area. While naturally-occurring radionuclides were not reported in samples from the low volume air samplers (LVAS), they were present in samples collected from high volume air samplers (HVAS). The difference appears to be related to sample inlet height, which causes more resuspended soil particles to be collected in the HVAS which have lower inlet heights than the LVAS.

In an effort to report realistic lower limits of detection, EEG provided the contractor laboratory with unused (blank) air filters for radiochemical analysis. Data from these analyses were used to calculate lower limits of detection (LLD) for air samples based upon procedure blanks rather than instrument counting blanks.

Reported radionuclide concentrations in water, soil and biota samples were consistent with other data reported from the WIPP environment.

1.0 Introduction

The Waste Isolation Pilot Plant (WIPP) project is authorized under Public Law 96-164 for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive waste resulting from the defense activities of the United States. The U. S. Department of Energy (DOE) is responsible for providing a full-scale facility for the permanent isolation of transuranic (TRU) defense waste. The present mission mandates the disposal of up to 176,000 m^3 (6.2 million cubic feet) of contact-handled (CH) TRU waste and 7,080 m^3 (250,000 cubic feet) of remote-handled (RH) TRU waste. The total radioactivity from CH-TRU waste at WIPP is projected to be 1.01×10^7 Ci with the total RH-TRU radioactivity expected to be 5.54×10^4 Ci, (FSEIS 1990). Under authorizing legislation, the WIPP facility is exempt from U. S. Nuclear Regulatory Commission (NRC) regulations.

In addition to DOE Orders, U. S. Environmental Protection Agency (EPA) Standards, 40 CFR Part 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Waste," became effective for the WIPP project in November of 1985. Subpart A of these standards limits the combined annual radiation dose to the public to 25 millirems to the whole body and 75 millirems to any critical organ from waste emplacement and storage operations at DOE disposal facilities which are not regulated by NRC. Subpart B establishes performance standards for long-term containment, thereby limiting releases of radioactivity to the accessible environment. Subpart B of the standards was vacated by the First Circuit Court of Boston in June of 1987 on the grounds that they were less stringent than the requirements of the Clean Water Act of

1971. Subsequently, the State of New Mexico and DOE signed an agreement to continue demonstration of compliance with the vacated standards until new ones are promulgated.

The Environmental Evaluation Group (EEG) established a preoperational environmental monitoring program under terms of a Consultation and Cooperation (C & C) Agreement in July 1981 and a Supplemental Stipulated Agreement in December 1982. EEG environmental monitoring efforts are supported under the contract and the National Defense Authorization Act (Public Law 100-456). Data contained in this report are a continuation of the preoperational monitoring baseline studies outlined in 1984 in EEG-26 and reported in 1989 in EEG-43.

The Department of Energy agreed in correspondence from Arthur to Neill, 1989, and Hunt to Neill, 1990, to provide EEG with access to independent fixed air samplers (FAS) in the filtered and unfiltered exhaust air effluent from the repository. Due to technical problems associated with the sampling systems, these independent FAS units were not made available to EEG until October 1, 1990, and baseline data are now being developed from this effluent air stream.

2.0 Environmental Setting of the WIPP Site

The WIPP facility is located in Eddy County in southeastern New Mexico, approximately 42 km (26 mi) east of Carlsbad (Figure 1). The facility is located on a sandy plain at an elevation of 1,040 m (3,410 ft) above sea level. Prominent natural features near the facility include Livingston Ridge and Nash Draw, about 8 km (5 mi) west of the facility. Nash Draw is a shallow 8 km (5 mi) wide drainage course characterized by surface impoundments of brine water. Livingston Ridge is a northwest-facing bluff that marks the eastern

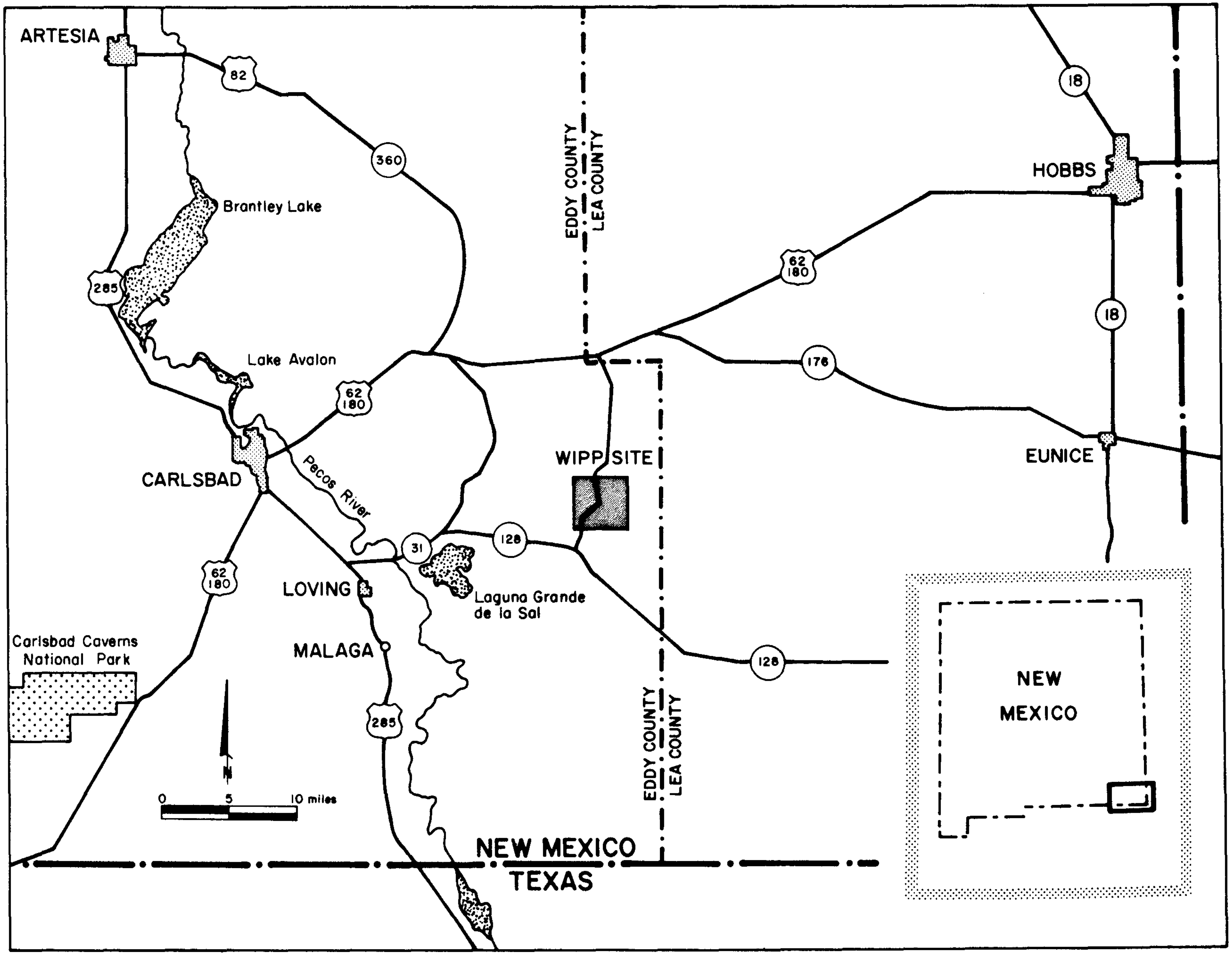

Figure 1. Location of the WIPP Site

edges of Nash Draw. Other prominent features of the region include the Pecos River, located about 22 km (14 mi) west of the facility, and the Carlsbad Caverns about 68 km (42 mi) west-southwest of the WIPP facility.

The nearest population centers are the Village of Loving (population 1,500), located 29 km (18 mi) southwest of the facility, and the City of Carlsbad (population 28,400), located 42 km (26 mi) west of the facility. Other towns within an 80 km (50 mi) radius include Artesia, Eunice, Hobbs, Jal and Lovington.

The climate in the region of the facility is semi-arid with an average annual precipitation of 280 to 330 mm (11 to 13 in). Much of the precipitation falls during intense thunderstorms in the spring and summer. Winds are generally from the southeast with an average speed of 14 km/hr (8.8 mi/hr).

Surface structures of the facility are located in Sections 20 and 21 of Township 22 south, Range 31 east, N.M.P.M., in Eddy County, New Mexico. The surface areas around WIPP are divided into several zones (Figure 2). Zone I, located in Sections 20 and 21 of Township 22 South, Range 31 East, has an area of 14 ha (35 acres). Zone I contains most of the surface structures associated with WIPP and is enclosed by chain link fence and patrolled by security guards to maintain restricted access. The Secured Area Boundary surrounds Zone I and is marked with a barbed wire fence. Zone II, the next largest subdivision of the facility, has no surface markers to identify its boundary. Zone II is 728 ha (1,800 acres) in size and represents the maximum extent of the area available for underground development. The WIPP outermost facility boundary, which encompasses sixteen square miles, provides a one mile buffer area around Zone II and contains 4,144 ha (10,240 acres or 16 sections).

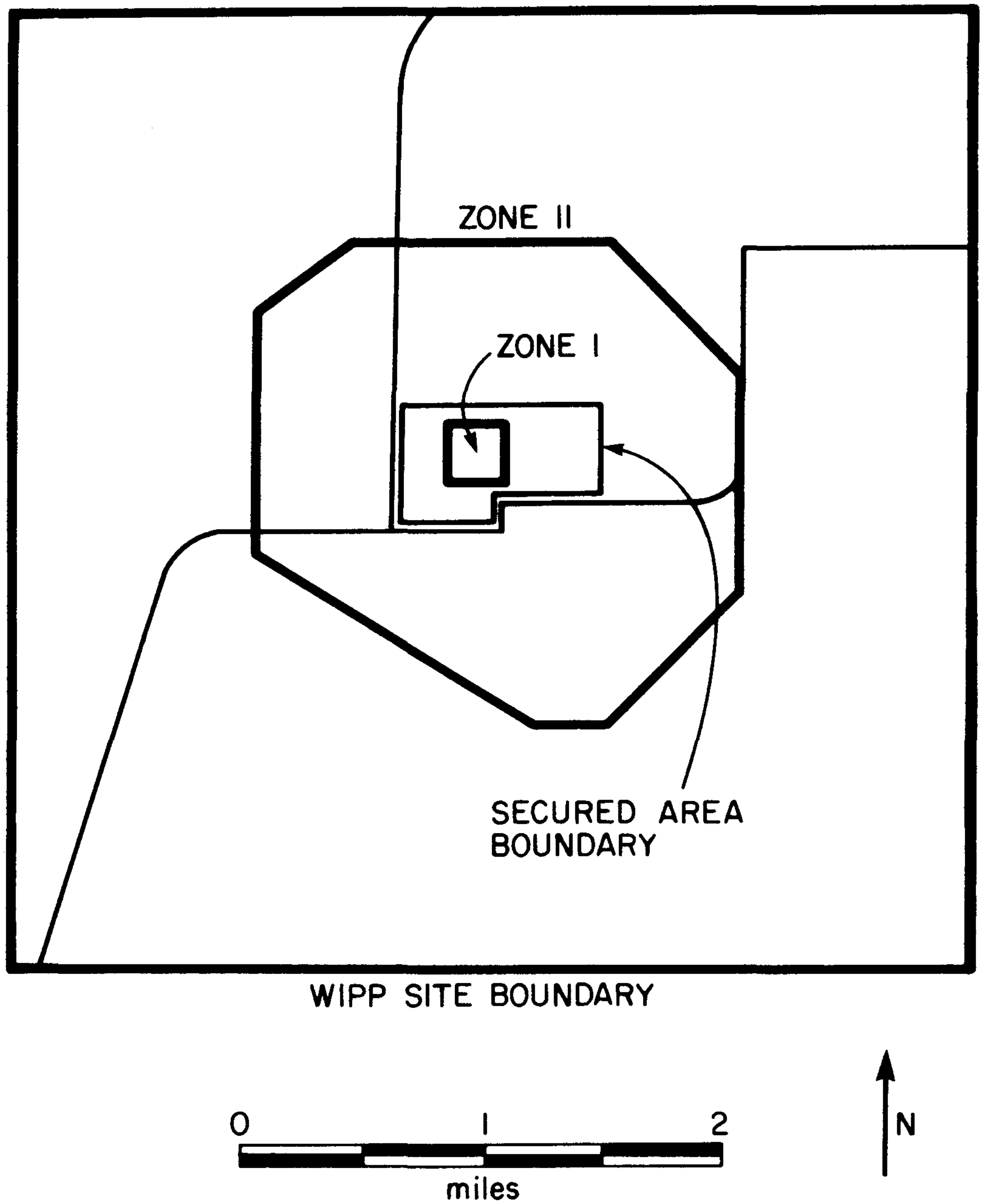

Figure 2. Zones at the WIPP Site

Three ranches (Mills, Smith and Mobley) have property within 8 km (5 mi) of the facility. The Mills ranch headquarters is located 5.6 km (3.5 mi) south-southwest of the facility center, the Smith headquarters is 8.8 km (5.5 mi) west-northwest of the facility and the Mobley ranch is 9.6 km (6 mi) southwest of the facility. The Mills ranch uses water from "house" and "barn" wells for stock and domestic uses. Water is provided to the Smith Ranch for stock and domestic use from pipelines used by International Mineral and Chemical Corporation (IMCC) and New Mexico Potash Corporation from wells completed in the Capitan Reef Formation and the Ogallala Formation, respectively. Mobley Ranch uses water hauled from various public water supply systems for domestic use while stock water is obtained from "Mobley Well" located near the ranch headquarters about 10 km (6 mi) from the facility. All ranches in the area of WIPP use rain catchment ponds for stock water in addition to water produced from wells.

DOE has purchased all potash leases within the 16 sections comprising the WIPP facility. However, extractive oil and gas production will continue as close as 4 km (2.5 mi) from the center of the facility.

Although there are no dairies in the area of the WIPP facility, a large amount of alfalfa is grown in the Pecos Valley between Roswell and Malaga, New Mexico. The alfalfa crop is used in cattle feeding operations in Texas and New Mexico. Cotton and pecans are the other major crops grown in the Pecos Valley.

Geologically, the WIPP repository horizon is situated at a depth of 655 m (2,150 ft) below land surface in the Permian age Salado Formation (Figure 3). The Salado is a 610 m (2,000 ft) thick, bedded-salt formation overlain by the Rustler Formation. The Rustler Formation consists of

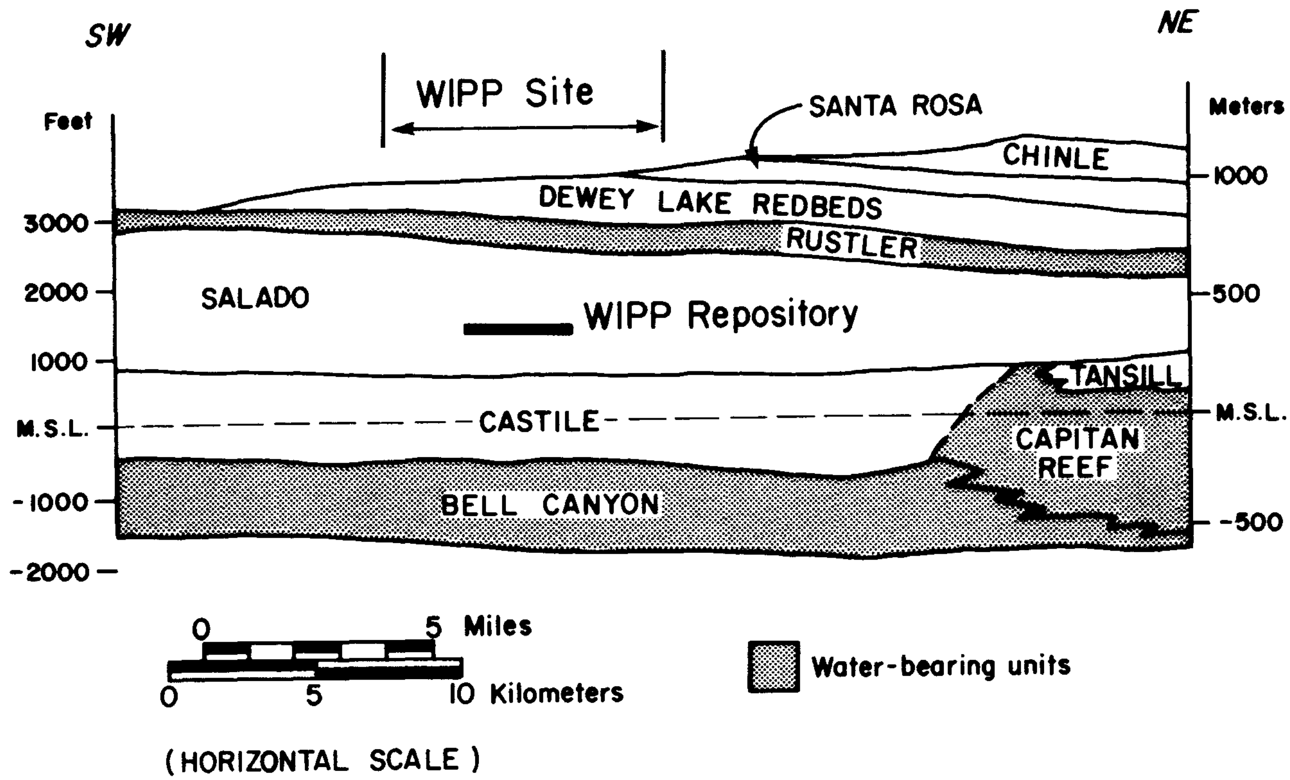

Figure 3. Stratigraphy at the WIPP Site

anhydrite and siltstone beds and contains two water-bearing zones, the Magenta and Culebra Dolomites, at 170 m (568 ft) and 205 m (672 ft) below land surface, respectively. Each of these is approximately 7.5 m (25 ft) thick. Transport in the water-bearing units of the Rustler Formation represent the main potential hydrologic pathway to the biosphere from the repository. The Culebra Dolomite is considered to be the most important hydrologic pathway for release calculations because it is the most transmissive unit in the area. The most recent interpretation (Lappin and Hunter 1989) of Culebra freshwater-head data indicates a southerly flow across the WIPP site with southwesterly flow occurring south of the site. Radiological baseline data for the Culebra and the less productive Magenta Dolomite are being collected by DOE because of their importance to long-term release scenarios.

The Capitan Reef Formation provides public drinking water for the communities of Carlsbad, Loving and Otis. The Reef aquifer and the Rustler water-bearing zones are not connected hydrogeologically. However, in response to the importance of the reef as a water source, water samples data from public water supply systems in these communities are being collected and analyzed for radioactivity.

3.0 Summary of the Preoperational Program

The EEG implemented a preoperational environmental surveillance plan (Spiegler 1984) to establish baseline data on potential exposure pathways as summarized in Table 1. A high priority continues to be assigned to air sampling and analysis because of the potential for accidents which could result in an airborne release. The air sampling system deployed by EEG provides some potential for early detection of releases which could occur from transportation accidents or site releases and subsequent atmospheric dispersion. The

Table 1. EEG Preoperational Radiological Surveillance Program

ENVIRONMENTAL MEDIUM	LOCATION	SAMPLING/ ANALYSIS FREQUENCY	PARAMETER
Air	Offsite High Volume Air Sampler 4 Locations Offsite	Weekly/ Quarterly Composite	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-228, Th-230, Th-232, Ra-226, Ra-228
	Onsite Low Volume Air Sampler 3 Locations Onsite	Continuous/ Quarterly Composite	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-228, Th-230, Th-232, Ra-226, Ra-228
Surface Water	Pecos River 2 Locations Laguna Grande de La Sal Surface Stock Tanks 5 Locations	Semiannually/ Semiannually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Ground Water	21 Wells	Annually/ Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Municipal Drinking Water	4 Systems	Annually/ Annually	gross alpha, gross beta Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Soil and Sediment	3 Sites	Annually/ Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Cs-137, Sr-90, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Biota	2 Specimens*	Annually/ Annually	Pu-238, Pu-239+240, Am-241, Tritium, Cs-137

*Sampling performed by DOE

Table 1 (Cont). EEG Preoperational Radiological Surveillance Program

ENVIRONMENTAL MEDIUM	LOCATION	SAMPLING/ ANALYSIS FREQUENCY	PARAMETER
Facility Effluents			
Air	2 Underground Ventilation Exhaust (Sta. A & B)	Continuously	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Cs-137, Sr-90, Th-232, Th-230, Th-228, Ra-226, Ra-228
Sewage	1 Lagoon	Semiannually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232
Stormwater Runoff	WIPP Zone I	Annually	gross alpha, gross beta, Pu-238, Pu-239+240, Am-241, Tritium, Cs-137, Sr-90, Ra-226, Ra-228, U-233+234, U-235, U-238, Th-228, Th-230, Th-232

preoperational environmental surveillance program includes sampling of other environmental pathways such as groundwater, surface water, public drinking water, biota, soil and sediment. Radiochemical analyses of environmental samples are performed for the long-lived radionuclides Pu-238, Pu-239+240, Am-241, (plus the naturally occurring radionuclides U, Th, Ra) and long-lived fission products, such as Cs-137 and Sr-90, which are found in the WIPP waste.

3.1 Air Surveillance

The exhaust air effluent from the underground will not be continuously filtered because the pressure drop across the high efficiency particulate air (HEPA) filters is so large that the resulting power requirements to adequately ventilate the underground facilities would be prohibitive. Hence, there is the potential for chronic, unfiltered, low-level releases of TRU contaminants during the emplacement or retrieval process. Acute releases could result from accidents prior to the shifting of exhaust air through the HEPA filters.

The first level of air sampling (excluding the effluent air sampling to be done at Stations A and B) occurs inside of Zone I of the facility in the predominant downwind direction. The air samplers used within the facility boundary are continuously operated low volume air samplers (LVAS) which collect air particulate samples on 102 mm (4 in) borosilicate microfiber filters at a rate of 142 l/min (5 ft^3/min).

Air sampling is accomplished by strategic placement of continuously operated LVAS within WIPP Zones I and II (Figure 4). The LVAS designated as S-1 is located approximately 225 m (740 ft) northwest of the underground exhaust stack within the Zone I boundary. The S-1 unit, which is

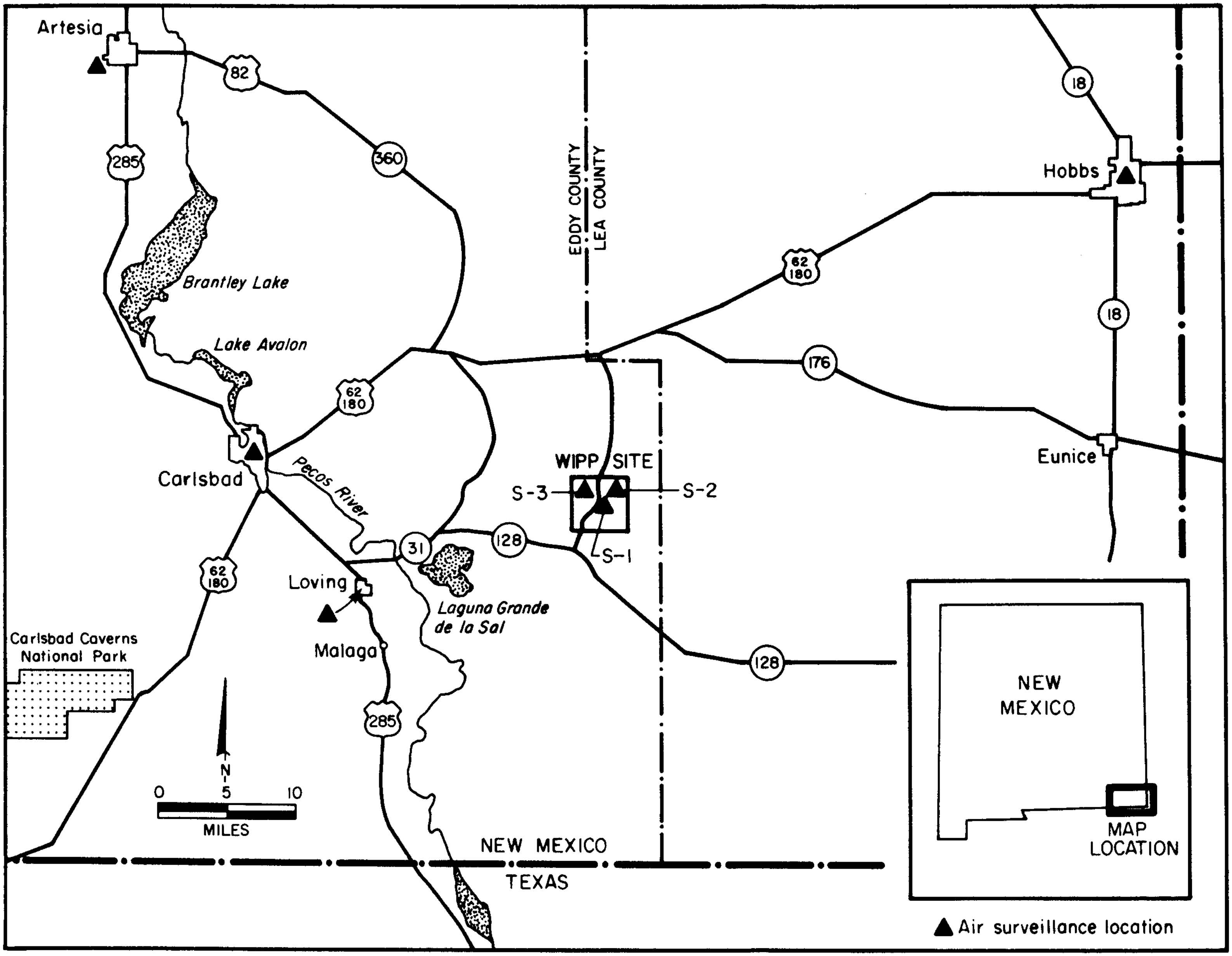

Figure 4. Air Sampling Locations

inside of Zone I, is approximately 90 m (300 ft) from the north line (FNL) of Zone I and 150 m (500 ft) from the east line (FEL) of Zone I. It should be noted that the S-1 LVAS was not operated during the last half of 1989 due to construction activity adjacent to the sampler. The LVAS designated as S-2 is located approximately 500 m (1600 ft) northeast of the WIPP exhaust shaft and unit S-3 is located approximately 1,000 m (3,300 ft) northwest of the WIPP exhaust shaft.

High volume air samplers (HVAS) are operated in Artesia, Carlsbad, Hobbs, and Loving, New Mexico every sixth day at a sampling rate of 1,133 l/min (40 ft^3/min) through a 20.3 cm x 25.4 cm (8 x 10 in) filter paper. A HVAS is located at approximately 1 m (6.5 ft) above ground level in Artesia near the west end of Jaycee Park. The park is located near the intersections of 26th Street and Dr. R. W. Harper Drive (Township 22S, Range 25 E, Section 24). The Carlsbad HVAS is located near the intersection of McKay Street and Guadalupe Street (Township 22S, Range 27E, Section 6). The Loving HVAS is located near the intersection of 5th Street and Elm Street (Township 23S, Range 28E, Section 21) and the Hobbs air sampling unit is located near the intersection of Dalmont Street and Snyder Street (Township 18S, Range 38E, Section 34). The air samplers are located on rooftops in Carlsbad, Hobbs and Loving to provide required security for the samplers. The HVAS system will provide the baseline data necessary to evaluate an airborne release or any long-term changes in the background levels of transuranics in the atmosphere.

3.2 Water Surveillance

Groundwater samples are collected from water-bearing zones of the Santa Rosa, Dewey Lake Redbeds, Culebra Dolomite Member of the Rustler, Magenta Dolomite Member of the

Rustler, Bell Canyon and Capitan Reef Formations. Water samples from 21 WIPP observation wells are collected by DOE and provided to EEG as splits from their sample (Figure 5). The samples provided to EEG are then sent to the contract laboratory for radiochemistry or archived. The location and formation sampled is indicated for each well in Table 2.

Samples collected from surface water sources are collected by EEG staff. In all cases water samples are collected with the aliquot designated for radiochemical analysis being acidified with nitric acid to reduce the pH to less than 2.0. Samples designated for tritium determination are collected in 240 mL glass containers with conical-shaped polyethylene caps to prevent ambient air entrapment with the sample. Surface water, groundwater, public drinking water, storm water, and WIPP wastewater samples are sent to a contractor laboratory for radiochemical analysis or archived by EEG. The radiochemical analyses for all water samples are reported in Tables A11-A15 of Appendix A.

Interpretation of the groundwater chemistry data are discussed by Chapman (1988). The major ion data are useful in determining flow paths in the water bearing units above the level of the WIPP repository. Data on the concentrations and distribution of thorium, radium and uranium may be used to help predict the mobility of similar radionuclides in the hydrogeochemical setting at WIPP. Flow path and radionuclide mobility information are useful for analyzing release scenarios to determine if WIPP complies with long-term disposal requirements contained in EPA regulations (40 CFR Part 191). Radionuclide data collected from groundwater samples will become part of the data base used to evaluate long-term performance of the repository, providing documentation of pre-waste levels for later comparison.

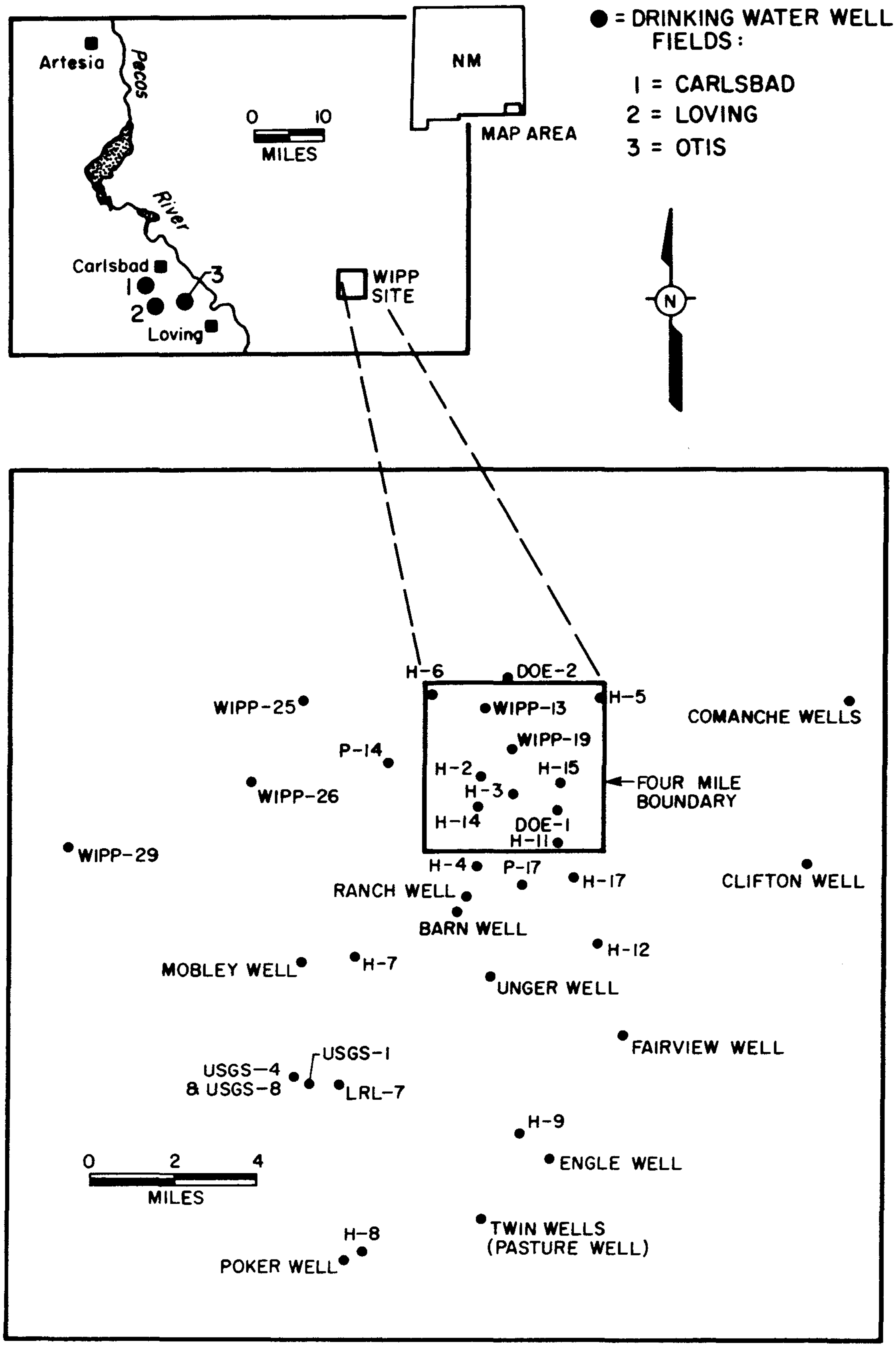

Figure 5. Groundwater Sampling Locations

Table 2. Location of Wells for Groundwater Sampling

WELL I.D.	TOWNSHIP	RANGE	SECTION	DISTANCE FROM SECTION LINE (FT)	FORMATION SAMPLED
Mobley Well	T21S	R32E	Sec.31	Not Available	Culebra Dolomite**
Comanche	T22S	R32E	Sec.14	N/A	Santa Rosa**
Clifton Well	T23S	R32E	Sec. 3	N/A	Santa Rosa**
Barn Well	T23S	R31E	Sec. 7	N/A	Dewey Lake Redbuds**
Fairview Well	T23S	R32E	Sec.26	N/A	Dewey Lake Redbuds**
Unger Well	T23S	R31E	Sec.17	N/A	Dewey Lake Redbuds**
Engle	T24S	R32E	Sec. 4*	240 FSL 1500 FEL	Culebra Dolomite**
Poker Well	T24S	R30E	Sec.12	N/A	Culebra Dolomite**
Ranch Well	T23S	R31E	Sec. 7	N/A	Dewey Lake Redbuds**
DOE-1	T22S	R31E	Sec.28*	182.4 FSL 607.8 FEL	Culebra Dolomite**
DOE-2	T22S	R31E	Sec. 8*	704.07 FSL 128.19 FEL	Bell Canyon/ Culebra**
H-2a	T22S	R31E	Sec.29*	726.96 FNL 1697.64 FWL	Culebra Dolomite**
H-3B-1	T22S	R31E	Sec.29*	2085.3 FSL 138.1 FEL	Magenta Dolomite**
H-3b-3	T22S	R31E	Sec.29*	2022.35 FSL 217.30 FEL	Culebra Dolomite**
H4B	T23S	R31E	Sec. 5*	498.47 FNL 632.54 FWL	Culebra Dolomite**
H-6b	T22S	R31E	Sec.18*	196.34 FNL 322.96 FWL	Culebra**

Table 2 (Continued). Location of Wells for Groundwater Sampling

WELL I.D.	TOWNSHIP	RANGE	SECTION	DISTANCE FROM SECTION LINE (FT)	FORMATION SAMPLED
H-6c	T22S	R31E	Sec.18*	281.06 FNL 374.47 FWL	Magenta**
H-7b	T23S	R30E	Sec.14*	2565.8 FNL 2563.45 FWL	Culebra**
H-8B	T24S	R30E	Sec.23*	1994 FNL 1405.4 FEL	Culebra**
H-9b	T24S	R31E	Sec. 4*	2391.04 FNL 238.63 FWL	Culebra**
H-11b3	T22S	R31E	Sec.33*	1501.7 FSL 105.2 FEL	Culebra**
H-12	T23S	R31E	Sec.15*	23.1 FNL 91.9 FEL	Culebra**
H-14	T22S	R31E	Sec.29*	372.6 FSL 562.4 FWL	Culebra**
H-15	T22S	R31E	Sec.28*	88.7 FNL 174.3 FEL	Culebra**
H-17	T23S	R31E	Sec. 3*	1465.5 FSL 994.1 FWL	Culebra**
P-14	T22S	R30E	Sec.24*	307.9 FSL 615.8 FWL	Culebra**
WIPP-25	T22S	R30E	Sec.15*	1852.77 FSL 2838.10 FEL	Culebra Dolomite**
WIPP-26	T22S	R30E	Sec.29*	2232.27 FNL 12.2 FEL	Culebra Dolomite**

*From Gonzales (1989)
**From Randall (1988)

Note: FNL = feet from north line of section
FEL = feet from east line of section
FSL = feet from south line of section
FWL = feet from west line of section

The surface water surveillance program consists of routine sampling of eight locations by EEG staff as shown in Figure 6. Water collected from the Pecos River in Carlsbad provides radionuclide baseline data and a comparison for similar data from the Pierce Canyon area of the Pecos about 19 km (12 mi) downstream from Carlsbad. Mercer (1983) suggests that saturated zones in the Rustler Formation discharge to the Pecos River near Malaga Bend, about a mile upstream of where the river enters Pierce Canyon. Because of the role of the Rustler Formation as a hydrologic pathway, preoperational data from these regions are important. Radionuclide baseline data are collected from surface water in Laguna Grande de la Sal which is located 13 km (8 mi) southwest of the WIPP facility. The saline lake is in the storm water drainage from the facility and is a discharge point for shallow groundwater in Nash Draw. Because particulates in air emissions from WIPP operations would be expected to fall onto the area watershed, water samples are collected from five nearby rain catchment basins used for stock and game watering and from storm water runoff from the Zone I area of the facility.

New Mexico Water Supply Regulations establish a maximum contaminant level (MCL) for Sr-90, tritium, gross alpha, and Ra-226+228, in public water supply systems. EEG collects and analyzes samples from the Carlsbad, Loving/Malaga, Otis and WIPP water supply systems (Figure 5) to monitor compliance with these MCLs. Radionuclide data obtained from public water supply system samples are presented in Table A15 of Appendix A.

Mercer (1983) summarized chemical analyses performed by the U.S. Geological Survey on samples from wells drilled for WIPP. Simpson et al. (1985) reported a wide variety of radionuclide analyses of surface and groundwater in the Delaware Basin in an investigation of the mobility of

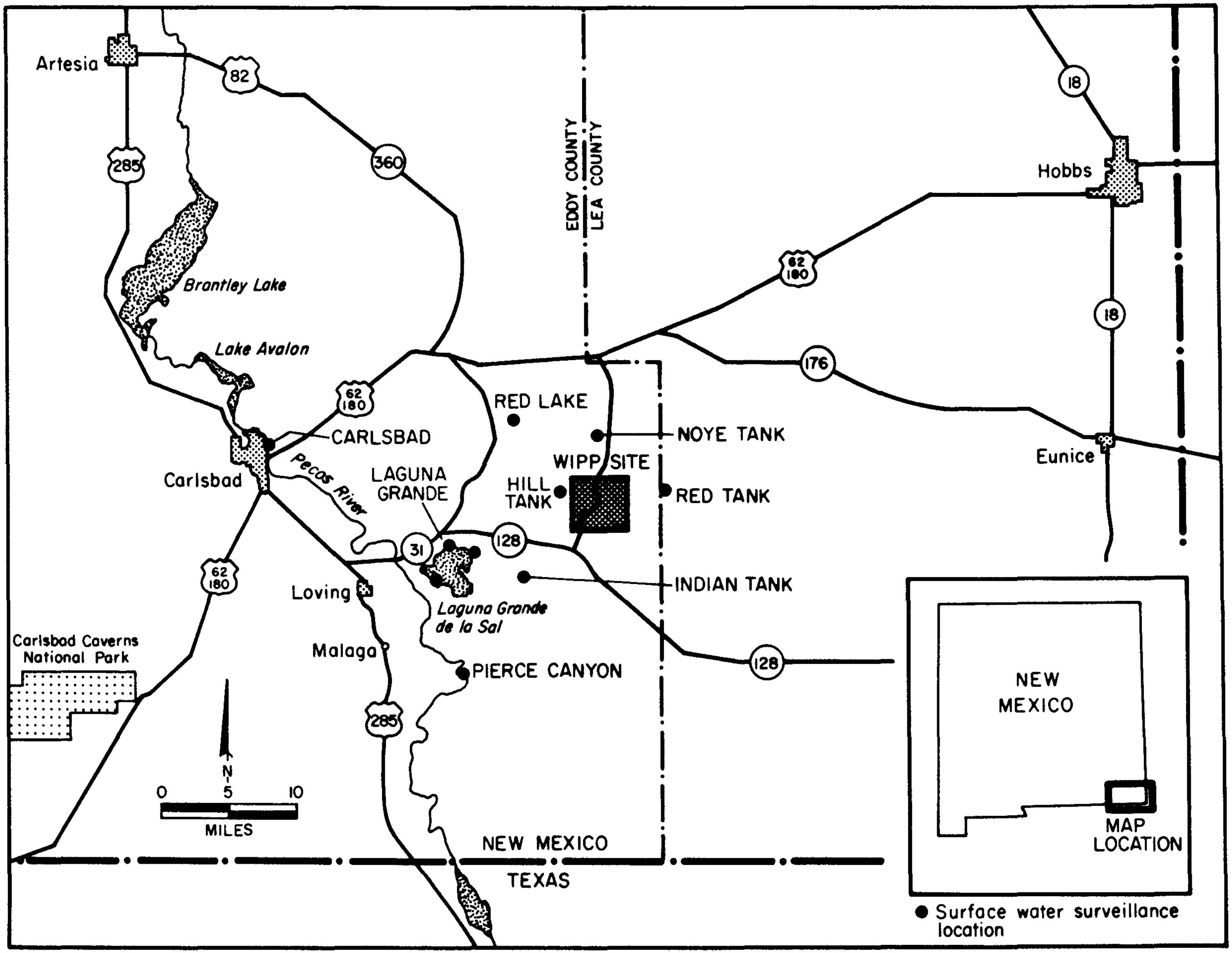

Figure 6. Surface Water Sampling Locations

radionuclides in high-chloride environments. Lambert and Carter (1987) discussed uranium isotope disequilibrium with regard to Rustler groundwater near WIPP.

Field and laboratory results from DOE's Water Quality Sampling Program are available in Uhland and Randall (1986), Uhland et al. (1987) and Randall et al. (1988). Data from groundwater in the Culebra Dolomite Member of the Rustler formation is discussed in Chapman (1988) and Ramey (1985).

3.3 Soil and Sediment Surveillance

Soil and sediment in the area of WIPP contain a record of deposited radioactive fallout from past atmospheric nuclear weapons testing. It is believed that a certain amount of this deposited fallout may become resuspended in air particulates under certain atmospheric and soil conditions. Because fallout contains many of the same radionuclides as WIPP waste, this data is an important component of the environmental baseline data set. Soil sampling stations are located near each air sampling location and within Zone II at WIPP. In addition, soil samples are routinely provided to EEG as split samples from the DOE soil sampling program.

Sediment sampling locations include Indian Tank, Laguna Grande de la Sal and the Pecos River at Pierce Canyon (Figure 6). Sediment samples collected during 1989 were archived.

3.4 Biota Surveillance

Potential ecosystem transport processes at WIPP include the atmospheric dispersion and subsequent contamination of soil, surface water and vegetation surrounding the WIPP facility. Through inhalation as well as ingestion of game, livestock or fish that had access to the contaminated environment, man could be exposed (Till 1983).

EEG biotic samples are received as split samples from the DOE environmental program. Biotic samples are sent to a private laboratory for radiochemical analyses as indicated in Table 1. Radiochemical data from analysis of biota samples are presented in Table A17 of Appendix A.

3.5 WIPP Effluent Surveillance

The two major effluent streams at the WIPP facility are exhaust air from the underground repository waste area and sewage effluent. Unfiltered air is exhausted at approximately 201 m^3/s (425,000 ft^3/min) through an exhaust shaft to the environment. The EEG will be operating a fixed air sampler (FAS) which collects particulates from the unfiltered exhaust air at the top of the exhaust shaft (Station A) before the effluent air is discharged to the environment (Figure 7). Plans are to send the samples from Station A and B to a private laboratory for radiochemical analysis after initial screening in the EEG laboratory. The analytical suite determined radiochemically will be the same as that indicated for air filters in Table 1.

Underground exhaust air will be diverted through high efficiency particulate air (HEPA) filters located on the surface if the continuous air monitors (CAM) in the underground area or the CAMs sampling air in the exhaust shaft near the surface (Station A) detect a radioactive release. HEPA-filtered air will then be exhausted to the environment at a rate of 28.3 m^3/s (60,000 ft^3/min) through an alternate exhaust duct. EEG will operate a second FAS in the sample stream from the alternate exhaust duct. This FAS, located in final discharge air, is designated as Station B. Samples collected from Station B will be analyzed as described above

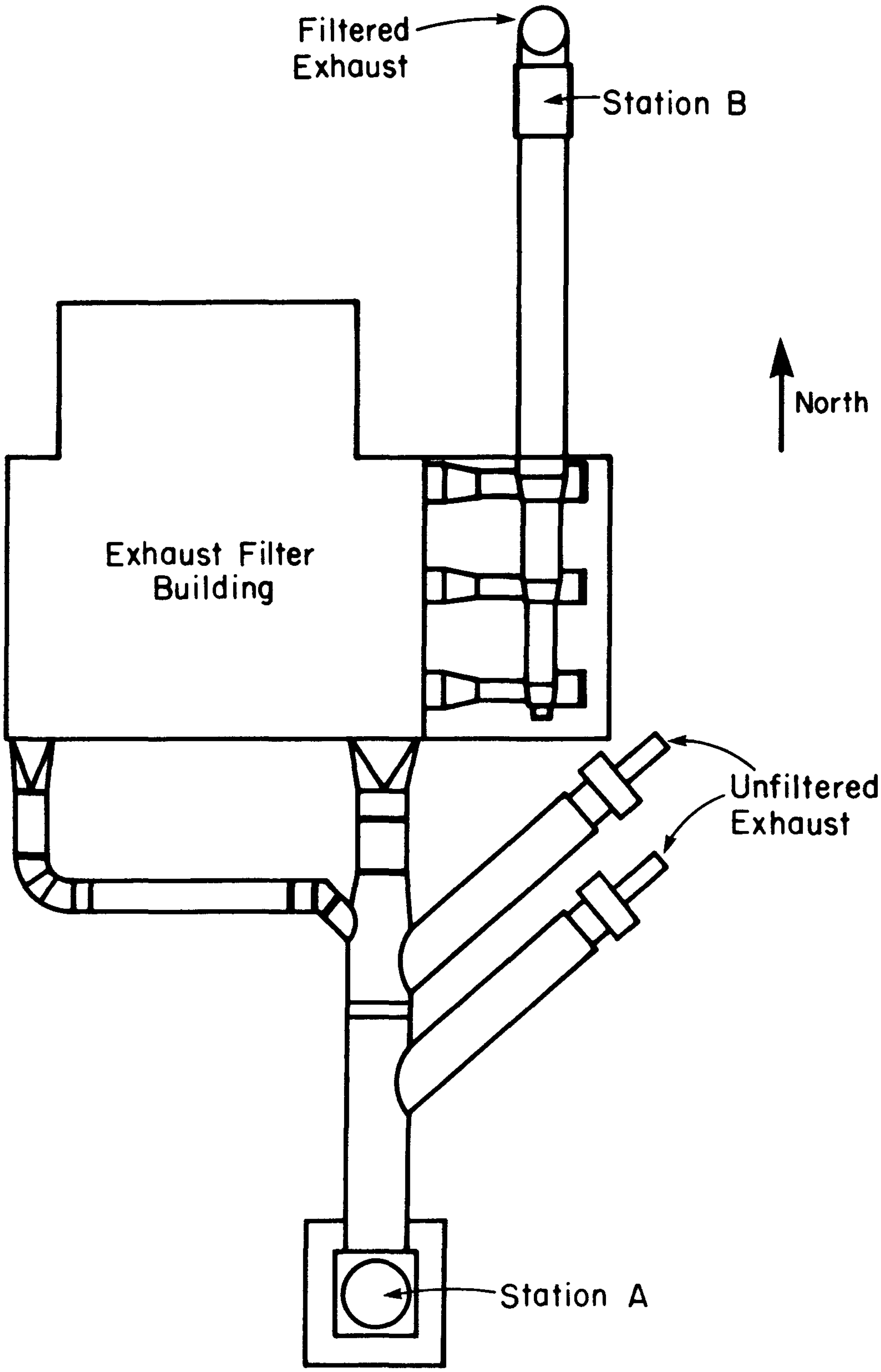

Figure 7. Location of Stations A & B

for Station A samples. EEG will not operate a CAM at either Station A or B and EEG will depend upon DOE to advise of an alarm or accident situation.

In order to determine the total amount of radioactivity released from the underground at WIPP in the event of an accident, it is necessary to operate FAS units at both Station A and B. First, contamination could potentially be released to the environment through the exhaust stacks just beyond Station A before CAM alarms initiate HEPA filtration, or if valves which divert the air flow to the filters fail to close completely during an accident situation. Hence, an FAS at Station A is essential. Second, Station B is sampled with a FAS to quantify any release which might be discharged to the environment through leakage or failure of the HEPA filtration system which serves the underground repository, and otherwise verify that no further discharge occurred once the bypass valves close. Through analysis of filters from Stations A and B, EEG should have enough data to determine the extent of any significant release through the repository exhaust.

Air exhausted from the Waste Handling Building will be double HEPA-filtered continuously before discharge to the environment. DOE will maintain CAM systems and FAS systems in the exhaust duct from this facility. However, due to the low probability of a release through this redundant HEPA-filtered discharge, EEG will not operate a FAS in this exhaust system.

It was expected that the FAS systems at Stations A and B would be made available to EEG during 1989. However, technical problems with the sampling system did not allow turnover until October 1990.

Secondary effluent streams from the WIPP facility are sewage effluent and storm water runoff from the Zone I area. The WIPP sewage treatment plant consists of two lined solar evaporation ponds in parallel followed by lined effluent treatment ponds in parallel with final discharge to an unlined absorption bed. Although DOE procedures indicate that potentially contaminated water from waste handling operations will not be introduced into the WIPP sewage system, preoperational monitoring includes sampling of effluent contained in the lined evaporation ponds. Analytical suites performed on sewage effluent and storm water samples are the same as those for other water samples as designated in Table 1.

4.0 Discussion of Findings

Radiochemical analyses of environmental samples, presented in Appendix A, are required to identify specific radionuclides present in the preoperational WIPP environment. Radiochemical analysis of composite air, water, biota, soil and sediment samples are performed by a private contractor laboratory. Gross alpha and gross beta activity levels in samples of water and soil were determined using proportional counting systems. Analyses were preceded by one or more chemical separations.

The equations used by the contractor laboratory in reporting individual radionuclide activity concentrations and counting error at the 95 percent confidence level are presented below. The activity concentration for most radionuclides was calculated by the following equation:

$$\text{Radionuclide Activity Conc.} = \frac{(\text{Net CPM})}{(E)\ (V)\ (Rc)\ (Rs)}$$

Where: Net cpm = gross cpm - background cpm

E = Counting efficiency (counts per disintegration)

V = Sample volume or weight (ml or g)

Rc = Fractional chemical yield of carrier

Rs = Average recovery for standards

The counting error was calculated from the following equation:

$$\text{Counting Error} = \frac{1.96\ [(S/D_s) + (B/D_b)]^{1/2}}{(E)\ (V)\ (R_c)\ (R_s)}$$

Where: 1.96 = Factor to achieve 95 percent confidence level

S = Sample gross count rate

B = Blank counts

D_s = Sample counting time in minutes

D_b = Blank counting time in minutes

R_c = Fractional chemical yield of carrier

R_s = Average recovery for standards

The EEG contract laboratory routinely reports a lower limit of detection (LLD-C) for each analysis based on the results of a periodic determination of the background of the counting instrument but without other factors of the analytical chemical separation process. The contract laboratory's LLD-C can be summarized as follows:

$$\text{LLD-C} = (4.66)(S_b)/3.7 \times 10^4 (E)(V)(Y)(\exp)[-\lambda(\Delta t)]$$

Where: LLD-C = lower limit of detection (microcuries/milliliter) based upon instrument background alone

S_b = standard deviation of instrument bkg (cpm)

E = counting efficiency (cps/dps)

V = sample volume (cc)

Y = fractional yield of radiochemistry

λ = decay constant

Δt = elapsed time, collection to count

This formulation of the LLD-C for a single measurement is intended to follow the guidance of the HASL Procedures Manual (USDOE, HASL-300) and similar sources.

However, a survey of the radiochemical data from environmental samples collected between 1985 and 1988 (Kenney et al. 1990) found that Cs-137 was reported at a concentration of 3.3 E-9 μCi/ml (LLD-C = 2.0 E-9 μCi/ml) in water from the Rustler Formation. The sample in question was collected from an environmental media and under geophysical conditions that would make it highly unlikely that the sample would contain fallout Cs-137 at the concentration reported. It appears that the high Cs-137 concentration was the result of incomplete potassium (K-40) precipitation followed by a beta count which attributed the activity to Cs-137. The error might have been prevented through the use of a proper procedure blank with similar high potassium brine content.

As a result of these findings, it was decided not to report contractor LLD-Cs in the EEG-43 report (Kenney et al. 1990), but instead, to report a computed Minimum Detectable Level (MDL) for the analyses based on the standard deviation of the count sample plus background ($\sigma_S + \sigma_B$) and the standard deviation of the background count (σ_B):

$$MDL = 1.96\ [\sigma_{S+B}^2 + \sigma_B^2]^{1/2}$$

It was felt that this estimate of the sensitivity of the detection system more accurately reflected the true sensitivity than the contractor-reported LLD-C.

It is recognized that this MDL is not equivalent to the recognized definition of LLD (Currie 1984). An independent computation of LLD based upon NRC Regulatory Guide 4.14 (1980) is used in this report based on the concept that, in order for the conditions under which the formula for calculating LLD was derived to be realized in a given analytical measurement, the value of S_b must be well known from theoretical considerations and knowledge of the measurement system stability or determined under current conditions from a series of replicate measurements on a stable, dependable well-known blank. The re-stated definition of LLD is:

$$LLD = (4.66)(S_b)/3.7 \times 10^4 (E)(V)(Y)(\exp)[-\lambda(\Delta t)]$$

Where:

Where:	LLD	=	the lower limit of detection (microcuries per milliliter) based upon measurements of a stable well-known blank
	S_b	=	the standard deviation of repeated measurements of appropriate procedure blanks
	E	=	the counting efficiency (counts per disintegration)
	V	=	the sample volume (milliliters)
	Y	=	the fractional radiochemical yield (when applicable)
	λ	=	the radioactive decay constant for the particular radionuclide
	Δt	=	the elapsed time between sample collection and counting

It is clear that a procedure for determining S_b based solely on the observed counts in a detector with a blank sample (or no sample at all) would be subject to a systematic error if the analytic procedure itself added counts to the background in addition to electronic noise, background radiation penetrating the detector shield, etc. The most reliable source of data with which to estimate S_b in such cases is then data from a blank "sample", which is a quantity of the environmental medium (air sample filter or water) devoid of the activity of interest. Suitable blanks of this sort have been submitted to the contractor laboratory for analysis in the past. At the time of this report, enough data of this sort has accumulated to begin to estimate air sample LLDs on this basis (Table 3).

Due to the lack of sufficient data from blank water samples (procedure blanks), LLDs based upon the above equation were not calculated by EEG for water sample data and, therefore, the contractor's LLD-Cs continue to be reported here.

One important objective of the EEG's preoperational environmental surveillance program is to better understand the radionuclide concentration values and lower limits of detection in environmental samples associated with the WIPP facility. In a method consistent with the format outlined in NRC Regulatory Guide 4.14 (1980), EEG reports all environmental radionuclide concentrations as values, including values less than the lower limit of detection (LLD) or less than zero.

4.1 Air Data

Gross alpha and gross beta data are summarized in Figures B1-B7 of Appendix B and presented in Tables B1-B7 of Appendix B. Nondestructive measurements of gross alpha and gross beta activity were performed on air samples in the EEG laboratory in Carlsbad, New Mexico. Gross alpha activity of air filters averaged 2.52 E-15 μCi/ml, and gross beta activity averaged 2.52 E-14 μCi/ml following a minimum decay of 170 hours. These average activities are consistent with data reported in EEG-43 (Kenney et al. 1990) and DOE preoperational data (Reith et al. 1986, Banz et al. 1987, Flynn 1988 and Flynn 1989).

Analytical radiochemistry data obtained from composites of air filter samples are contained in Tables A1-A10 of Appendix A. As discussed previously the LLD values are

TABLE 3. RADIONUCLIDE LLD DATA (AIR FILTERS)

RADIONUCLIDE	NUMBER OF BLANKS	MEAN CONCENTRATION pCi/FILTER COMPOSITE	STANDARD DEVIATION (Sb)	LLD AT pCi/FILTER COMPOSITE 95% CONFIDENCE
STRONTIUM-90	17	0.36	1.86	8.67
PLUTONIUM-239+240	17	0.03	0.24	1.12
AMERICIUM-241	17	0.25	0.33	1.54
CESIUM-137	17	1.41	2.58	12.02
RADIUM-226	17	0.37	0.8	3.73
RADIUM-228	17	0.55	2.26	10.53
PLUTONIUM-238	17	-0.29	0.6	2.80
THORIUM-228	17	0.09	0.42	1.96
THORIUM-230	17	0.39	0.75	3.50
THORIUM-232	17	0.26	0.43	2.00

calculated using activity data from procedure blanks. Radiochemistry data are consistent with previously reported data collected as part of the DOE preoperational baseline program.

The most obvious difference in air particulate samples is the presence (concentrations greater than LLD) of naturally occurring radionuclides in HVAS samples and the non-detection or non-collection of such radionuclides in LVAS samples (Table 4). Due to the difference in the air sample inlet height above the ground (or roof), a different population of particulates was collected in these systems. The relationship of particle size distribution as a function of distance above ground has been characterized by Gallegos (1978). Direct visual observation of filters collected from the HVAS system supports this assumption. HVAS filters with an inlet height of 1.1 m (43 in) above ground level show the presence of large amounts of soil particles, following wind events during dry periods. LVAS with an inlet height of 2 m (78 in) above ground level do not exhibit such soil collection. Resuspended soil appears to be more readily sampled in the HVAS than the LVAS.

Since HVAS would be used in an emergency response situation, these HVAS data could be useful in the evaluation of a release. LVAS data are probably more representative of the radionuclides carried on the respirable size particles and, therefore, should be useful in dose calculations. However, sampling methodology is an area that can be better understood only after more resources are available and these data are used to make enhancements to the ambient air sampling systems.

TABLE 4. SUMMARY OF RADIOCHEMICAL DATA

ANALYSIS	GROUNDWATER*		SURFACE WATER*		SOIL & SEDIMENT*		BIOTA*		PUBLIC WATER*		LOW VOLUME AIR SAMPLE		HIGH VOLUME AIR SAMPLE	
	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLDc	TOTAL	NO.>LLD	TOTAL	NO.>LLD	TOTAL
GROSS ALPH	0	3	0	5	0	1	NA		0	1	0	12	0	20
GROSS BETA	2	3	4	5	1	1	NA		1	1	0	12	0	20
Cs-137	0	3	0	5	1	1	0	2	0	1	0	12	0	20
Pu-238	0	3	1	5	0	1	0	2	0	1	0	12	0	20
Pu-239+240	0	3	0	5	0	1	0	2	0	1	0	12	0	20
Am-241	0	3	0	5	NA		0	2	0	1	0	12	0	20
Sr-90	0	3	0	5	1	1	NA		0	1	0	12	1	20
Ra-226	2	3	2	5	NA		NA		0	1	0	12	5	20
Ra-228	0	3	2	5	NA		NA		0	1	0	12	1	20
U-238	2	3	4	5	0	1	NA		1	1	NA		NA	
U-235	0	0	1	5	0	1	NA		0	1	NA		NA	
U-233+234	3	3	4	5	0	1	NA		1	1	NA		NA	
Th-232	0	3	0	5	0	1	NA		0	1	0	12	5	20
Th-230	1	3	4	5	0	1	NA		1	1	0	12	8	20
Th-228	0	3	3	5	0	1	NA		0	1	0	12	6	20
TRITIUM	0	3	0	5	NA		0	2	0	1	NA		NA	

* LLDc IS CONTRACTOR REPORTED LOWER LIMIT OF DETECTION

4.2 Water Data

Radiochemistry data provided by the contract laboratory are presented in Table A11 through A15 of Appendix A. Table 1 is a tabulation of the number of instances where the WIPP samples exceeded the lower limit of detection (LLD). The LLD-Cs reported for all water data are those provided by the contract laboratory and are based upon a standard deviation of instrument background as discussed previously. As more procedure blanks are provided to the laboratory for analysis, the data base will be used to calculate LLDs based upon the above method derived from the formula in NUREG Guide 4.14 (1980).

Radionuclides from the uranium and thorium decay chains were reported above the LLD-C, which is consistent with previous work by EEG (Kenney et al. 1990) and DOE (Reith et al. 1986, Banz et al. 1987, Flynn 1988 and Flynn 1989). Pu-238 was reported above the LLD-C in the Noye Tank sample. Although Pu-238 concentrations are infrequently reported above the LLD in surface water samples, similar concentrations have been found in surface water samples near WIPP as reported by Reith et al. (1986).

Many water samples collected during 1989 were not analyzed due to scheduling problems with the contract laboratory. These problems have been resolved and more radiochemistry data will be acquired in the future.

4.3 Soil and Sediment Data

Data obtained from radiochemical analysis of a soil sample collected 100 meters NW of the WIPP exhaust shaft are contained in Table A16 of Appendix A. The concentration of Cs-137 exceeds the LLD and is consistent with previous studies by EEG (Kenney et al. 1990) and DOE (Reith et al. 1986, Banz et al. 1987, Flynn 1988 and Flynn 1989).

Sr-90 was also detected above the contractor reported LLD. This finding is consistent with earlier analyses of soil and sediment from the area of the WIPP facility which found Sr-90 above the reported LLD (Reith et al. 1986, Banz et al. 1987, and Kenney et al. 1990).

The measurement of Pu-238 at the same concentration as the contractor's LLD is similar to soil data presented in Banz (1987).

4.4 Biota Data

Table A17 of Appendix A contains radiochemical data obtained from analysis of Brantley Lake catfish and vegetation from the WIPP site. There were no radionuclide concentrations above the contractor's reported LLD which is comparable to previous data found in Kenney (1990) and historical data collected by Bradshaw and Louderbough (1987).

5.0 Quality Assurance

Quality Assurance (QA) for the purposes of this report is defined as the use of standardized practices and procedures to assure that the highest level of quality is maintained for the data. The QA program consists of an ongoing comparison of analytical data with previous data collected by EEG and other organizations, radiochemical quality control through the use of blank or duplicate samples, recognized reference standards and the use of accepted practices for sample acquisition, handling, and analysis.

The procedures used for sample acquisition, handling and analysis are contained in the Environmental Evaluation

Group's Environmental Procedures Manual (EPM). This manual is based upon widely recognized procedures such as Standard Methods for the Examination of Water and Wastewater (APHA 1971), EPA "National Primary and Secondary Ambient Air Quality Standards" (40 CFR Part 50), and "A Guide for Environmental Radiation Surveillance at U.S. Department of Energy Installations" (Corley 1981).

The Environmental Evaluation Group's vendor laboratory for radiochemical analysis of environmental samples maintains a separate QA program. The major components of the contractor program are periodic calibration of counting instruments using standards traceable to the National Institute of Standards Technology, routine determination of chemical yields, and ongoing assessment of reagent quality. An independent check on the quality of the contractor laboratory data is provided by the Crosscheck Inter-laboratory Program which is administered by the Environmental Protection Agency.

6.0 Conclusions and Recommendations

The data contained in this report represent a continuation of the establishment of a baseline of radionuclide concentrations in certain critical environmental media in the vicinity of the WIPP facility. The data found in this report closely parallel those found in previous reports generated for the WIPP site (Reith et al. 1986, Banz et al. 1987, Flynn 1988, Flynn 1989, and Kenney et al. 1990) in terms of preoperational levels of the primordial and fallout radionuclides in the WIPP environment.

As more procedure blank data become available from the analysis of air filter blanks and water blanks, more realistic lower limits of detection (LLDs) can be calculated. However, other problems associated with measuring very low environmental levels of radionuclides will continue. One purpose of conducting environmental baseline measurements is to better understand these uncertainties before waste arrives at the WIPP facility.

EEG's plans are to establish an additional program to independently collect and analyze the airborne effluent from the underground ventilation system before WIPP begins waste operations. The capability to screen samples using gamma spectroscopy is being developed in the EEG laboratory to support this program. Such screening capability will be expanded to allow "in situ" field measurements of radionuclides in the environment near WIPP. Other programmatic changes will include the replacement of intermittently operated high volume air samplers in the communities near the WIPP facility with continuously operated low volume air samplers and shifting of sampling emphasis from groundwater samples to surface water tanks near the facility.

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Appendix A

Note: Counting Error is 1.966 σ (95% Confidence Level)

TABLE A1. RADIOCHEMICAL ANALYSIS OF HVAS AIR FILTERS. FOURTH QUARTER 1988.

ARTESIA

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	9.2E-17	1.8E-16	4.4E-16
PLUTONIUM-239+240	5.1E-18	5.1E-18	5.7E-17
AMERICIUM-241	2.6E-17	3.6E-17	7.8E-17
CESIUM-137	-1.7E-16	2.8E-16	6.1E-16
RADIUM-226	1.3E-16	1.2E-16	1.9E-16
RADIUM-228	-1.8E-16	3.8E-16	5.4E-16
PLUTONIUM-238	5.1E-18	5.1E-18	1.4E-16
THORIUM-228	2.0E-17	3.1E-17	9.9E-17
THORIUM-230	-5.1E-18	7.2E-17	1.8E-16
THORIUM-232	4.6E-17	4.1E-17	1.0E-16

CARLSBAD

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-9.4E-18	3.0E-16	4.1E-16
PLUTONIUM-239+240	4.7E-18	4.7E-18	5.3E-17
AMERICIUM-241	3.3E-17	3.3E-17	7.2E-17
CESIUM-137	-2.8E-17	2.2E-16	5.7E-16
RADIUM-226	1.4E-16	1.0E-16	1.8E-16
RADIUM-228	-2.4E-17	4.1E-16	4.9E-16
PLUTONIUM-238	1.4E-17	9.4E-18	1.3E-16
THORIUM-228	7.1E-17	5.7E-17	9.2E-17
THORIUM-230	5.2E-17	8.5E-17	1.6E-16
THORIUM-232	5.7E-17	4.7E-17	9.5E-17

HOBBS

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.7E-16	2.9E-16	3.8E-16
PLUTONIUM-239+240	4.7E-18	4.7E-18	4.9E-17
AMERICIUM-241	2.8E-17	3.3E-17	6.7E-17
CESIUM-137	-2E-16	6E-16	5.3E-16
RADIUM-226	9.9E-17	1.1E-16	1.6E-16
RADIUM-228	-4.2E-17	3.4E-16	4.6E-16
PLUTONIUM-238	9.4E-18	4.7E-18	1.2E-16
THORIUM-228	2.8E-17	3.3E-17	8.5E-17
THORIUM-230	9.9E-17	8.0E-17	1.5E-16
THORIUM-232	1.9E-17	2.8E-17	8.8E-17

LOVING

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-6.9E-17	2.4E-16	3.5E-16
PLUTONIUM-239+240	4.1E-18	4.7E-18	4.6E-17
AMERICIUM-241	2.5E-17	3.3E-17	6.3E-17
CESIUM-137	-4E-17	5E-16	4.9E-16
RADIUM-226	9.4E-17	1.0E-16	1.5E-16
RADIUM-228	1.6E-17	4.4E-16	4.3E-16
PLUTONIUM-238	4.1E-18	4.7E-18	1.1E-16
THORIUM-228	4.9E-17	4.7E-17	7.9E-17
THORIUM-230	3.7E-17	7.5E-17	1.4E-16
THORIUM-232	6.9E-17	5.2E-17	8.2E-17

TABLE A2. RADIOCHEMICAL ANALYSIS OF HVAS AIR FILTERS. FIRST QUARTER 1989.

ARTESIA

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	4.9E-17	1.6E-16	3.5E-16
PLUTONIUM-239+240	4.1E-18	4.1E-18	4.6E-17
AMERICIUM-241	2.0E-17	2.9E-17	6.3E-17
CESIUM-137	-1.1E-16	2.3E-16	4.9E-16
RADIUM-226	4.5E-17	9.0E-17	1.5E-16
RADIUM-228	-3E-16	5E-16	4.3E-16
PLUTONIUM-238	0.0E+00	4.1E-18	1.1E-16
THORIUM-228	1.2E-17	2.5E-17	7.9E-17
THORIUM-230	1.6E-17	6.1E-17	1.4E-16
THORIUM-232	2.5E-17	2.9E-17	1.6E-17

CARLSBAD

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	9.2E-17	1.5E-16	3.8E-16
PLUTONIUM-239+24	4.4E-18	4.4E-18	4.9E-17
AMERICIUM-241	2.6E-17	3.1E-17	6.7E-17
CESIUM-137	-2.2E-17	2.6E-17	5.3E-16
RADIUM-226	8.3E-17	9.6E-17	1.6E-16
RADIUM-228	-1E-16	1E-15	4.6E-16
PLUTONIUM-238	8.8E-18	4.4E-18	1.2E-16
THORIUM-228	3.9E-17	4.4E-17	8.5E-17
THORIUM-230	3.9E-17	7.4E-17	1.5E-16
THORIUM-232	1.6E-17	2.0E-17	1.6E-17

HOBBS

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-6.1E-17	1.2E-16	3.5E-16
PLUTONIUM-239+240	4.1E-18	4.1E-18	4.6E-17
AMERICIUM-241	2.9E-17	2.9E-17	6.3E-17
CESIUM-137	-4E-17	6E-16	4.9E-16
RADIUM-226	8.2E-18	1.2E-16	1.5E-16
RADIUM-228	1E-16	5E-16	4.3E-16
PLUTONIUM-238	4.1E-18	4.1E-18	1.1E-16
THORIUM-228	-8.2E-18	1.2E-17	7.9E-17
THORIUM-230	3.7E-17	8.2E-17	1.4E-16
THORIUM-232	0.0E+00	4.1E-18	8.2E-17

LOVING

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	5.7E-17	1.6E-16	3.5E-16
PLUTONIUM-239+24	0.0E+00	4.1E-18	4.6E-17
AMERICIUM-241	2.5E-17	2.9E-17	6.3E-17
CESIUM-137	-6.1E-17	3.2E-16	4.9E-16
RADIUM-226	8.2E-17	1.1E-16	1.5E-16
RADIUM-228	4.9E-17	2.9E-16	4.3E-16
PLUTONIUM-238	0.0E+00	4.1E-18	1.1E-16
THORIUM-228	2.0E-17	3.3E-17	7.9E-17
THORIUM-230	-2.9E-17	5.3E-17	1.4E-16
THORIUM-232	8.2E-18	1.6E-17	8.2E-17

TABLE A3. RADIOCHEMICAL ANALYSIS OF HVAS AIR FILTERS. SECOND QUARTER 1989.

ARTESIA

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.2E-16	4.1E-16	3.8E-16
PLUTONIUM-239+240	4.4E-18	4.4E-18	4.9E-17
AMERICIUM-241	8.8E-18	8.8E-18	6.7E-17
CESIUM-137	-1.2E-16	3.4E-16	5.3E-16
RADIUM-226	2.1E-16	1.0E-16	1.6E-16
RADIUM-228	3.9E-17	2.7E-16	4.6E-16
PLUTONIUM-238	-4.4E-18	8.8E-18	1.2E-16
THORIUM-228	8.8E-17	6.1E-17	8.5E-17
THORIUM-230	1.9E-16	8.3E-17	1.5E-16
THORIUM-232	6.1E-17	4.8E-17	8.8E-17

CARLSBAD

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.6E-16	3.5E-16	3.8E-16
PLUTONIUM-239+240	4.4E-18	4.4E-18	4.9E-17
AMERICIUM-241	0.0E+00	8.8E-18	6.7E-17
CESIUM-137	-1E-16	6E-16	5.3E-16
RADIUM-226	3.9E-17	8.3E-17	1.6E-16
RADIUM-228	3.1E-17	2.9E-16	4.6E-16
PLUTONIUM-238	-4.4E-18	8.8E-18	1.2E-16
THORIUM-228	3.1E-17	3.5E-17	8.5E-17
THORIUM-230	4.4E-18	1.8E-17	1.5E-16
THORIUM-232	6.6E-17	4.8E-17	8.8E-17

HOBBS

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.2E-16	3.6E-16	3.5E-16
PLUTONIUM-239+240	0.0E+00	4.1E-18	4.6E-17
AMERICIUM-241	0.0E+00	8.1E-18	6.2E-17
CESIUM-137	2E-16	4E-16	4.9E-16
RADIUM-226	1.4E-16	8.1E-17	1.5E-16
RADIUM-228	-8.1E-18	2.8E-16	4.3E-16
PLUTONIUM-238	4.1E-18	4.1E-18	1.1E-16
THORIUM-228	8.1E-17	2.4E-17	7.9E-17
THORIUM-230	1.7E-16	2.8E-17	1.4E-16
THORIUM-232	9.4E-17	2.0E-17	8.2E-17

LOVING

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-3.3E-17	2.2E-16	3.5E-16
PLUTONIUM-239+240	1.2E-17	1.2E-17	4.6E-17
AMERICIUM-241	-4.1E-18	8.2E-18	6.3E-17
CESIUM-137	2E-16	4E-16	4.9E-16
RADIUM-226	8.6E-17	8.2E-17	1.5E-16
RADIUM-228	-2.0E-17	2.2E-16	4.3E-16
PLUTONIUM-238	0.0E+00	8.2E-18	1.1E-16
THORIUM-228	4.5E-17	3.7E-17	7.9E-17
THORIUM-230	2.7E-16	8.2E-17	1.4E-16
THORIUM-232	1.6E-17	2.0E-17	8.2E-17

TABLE A4. RADIOCHEMICAL ANALYSIS OF HVAS AIR FILTERS. THIRD QUARTER 1989.

	ARTESIA				CARLSBAD		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	4.4E-18	2.4E-16	3.8E-16	STRONTIUM-90	-5.3E-17	1.6E-16	3.5E-16
PLUTONIUM-239+240	0.0E+00	4.4E-18	4.9E-17	PLUTONIUM-239+240	0.0E+00	4.1E-18	4.6E-17
AMERICIUM-241	0.0E+00	8.8E-18	6.7E-17	AMERICIUM-241	1.6E-17	1.6E-17	6.3E-17
CESIUM-137	5.7E-17	2.4E-16	5.3E-16	CESIUM-137	-5.7E-17	1.9E-16	4.9E-16
RADIUM-226	2.2E-17	4.4E-17	1.6E-16	RADIUM-226	5.7E-17	5.7E-17	1.5E-16
RADIUM-228	-2.2E-16	3.6E-16	4.6E-16	RADIUM-228	-1.6E-16	3.6E-16	4.3E-16
PLUTONIUM-238	-4.4E-18	8.8E-18	1.2E-16	PLUTONIUM-238	0.0E+00	8.2E-17	1.1E-16
THORIUM-228	3.5E-17	3.1E-17	8.5E-17	THORIUM-228	4.1E-18	2.0E-16	7.9E-17
THORIUM-230	5.3E-17	3.5E-17	1.5E-16	THORIUM-230	6.9E-17	4.1E-17	1.4E-16
THORIUM-232	3.5E-17	2.6E-17	8.8E-17	THORIUM-232	4.1E-17	3.3E-17	8.2E-17

	HOBBS				LOVING		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-7.4E-17	2.8E-16	3.8E-16	STRONTIUM-90	-2.4E-17	2.5E-16	4.1E-16
PLUTONIUM-239+240	0.0E+00	8.8E-18	4.9E-17	PLUTONIUM-239+240	4.7E-18	9.4E-18	5.3E-17
AMERICIUM-241	0.0E+00	4.4E-18	6.7E-17	AMERICIUM-241	0.0E+00	4.7E-18	7.2E-17
CESIUM-137	1.9E-16	2.3E-16	5.3E-16	CESIUM-137	-2.4E-17	2.4E-16	5.7E-16
RADIUM-226	1.2E-16	5.7E-17	1.6E-16	RADIUM-226	8.5E-17	5.2E-17	1.8E-16
RADIUM-228	-4.4E-18	3.8E-16	4.6E-16	RADIUM-228	0.0E+00	7.5E-16	4.9E-16
PLUTONIUM-238	-4.4E-18	8.8E-18	1.2E-16	PLUTONIUM-238	9.4E-18	1.9E-17	1.3E-16
THORIUM-228	8.8E-18	2.2E-17	8.5E-17	THORIUM-228	2.4E-17	3.3E-17	9.2E-17
THORIUM-230	1.4E-16	4.8E-17	1.5E-16	THORIUM-230	3.0E-16	8.5E-17	1.6E-16
THORIUM-232	2.6E-17	2.2E-17	8.8E-17	THORIUM-232	2.4E-17	2.4E-17	9.5E-17

TABLE A5. RADIOCHEMICAL ANALYSIS OF HVAS AIR FILTERS. FOURTH QUARTER 1989.

	ARTESIA				CARLSBAD		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-2.0E-16	6.1E-16	4.4E-16	STRONTIUM-90	2.8E-17	3.1E-16	4.1E-16
PLUTONIUM-239+240	0.0E+00	5.1E-18	5.7E-17	PLUTONIUM-239+240	0.0E+00	4.7E-18	5.3E-17
AMERICIUM-241	-1.0E-17	2.0E-17	7.8E-17	AMERICIUM-241	-4.7E-18	1.9E-17	7.2E-17
CESIUM-137	1.1E-16	3.4E-16	6.1E-16	CESIUM-137	-3.3E-17	2.7E-16	5.7E-16
RADIUM-226	4.2E-16	8.2E-17	1.9E-16	RADIUM-226	4.2E-16	8.0E-17	1.8E-16
RADIUM-228	1.5E-16	1.0E-15	5.4E-16	RADIUM-228	0.0E+00	6.1E-16	4.9E-16
PLUTONIUM-238	0.0E+00	5.1E-18	1.4E-16	PLUTONIUM-238	0.0E+00	4.7E-18	1.3E-16
THORIUM-228	2.6E-16	1.2E-16	9.9E-17	THORIUM-228	1.8E-16	6.6E-17	9.2E-17
THORIUM-230	5.1E-16	1.5E-16	1.8E-16	THORIUM-230	5.2E-16	1.4E-16	1.6E-16
THORIUM-232	1.3E-16	8.7E-17	1.0E-16	THORIUM-232	1.7E-16	9.0E-17	9.5E-17

	HOBBS				LOVING		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	3.8E-16	2.5E-16	3.8E-16	STRONTIUM-90	-2.7E-16	4.0E-16	3.5E-16
PLUTONIUM-239+240	4.4E-18	4.4E-18	4.9E-17	PLUTONIUM-239+240	0.0E+00	4.1E-18	4.6E-17
AMERICIUM-241	-4.4E-18	1.8E-17	6.7E-17	AMERICIUM-241	-4.1E-18	1.6E-17	6.3E-17
CESIUM-137	-9.6E-17	2.9E-16	5.3E-16	CESIUM-137	3.0E-16	2.8E-16	4.9E-16
RADIUM-226	5.3E-16	8.8E-17	1.6E-16	RADIUM-226	5.3E-16	8.2E-17	1.5E-16
RADIUM-228	6.1E-16	4.8E-16	4.6E-16	RADIUM-228	1.2E-16	4.5E-16	4.3E-16
PLUTONIUM-238	4.4E-18	4.4E-18	1.2E-16	PLUTONIUM-238	0.0E+00	4.1E-18	1.1E-16
THORIUM-228	1.7E-16	7.4E-17	8.5E-17	THORIUM-228	2.2E-16	7.4E-17	7.9E-17
THORIUM-230	5.3E-16	1.3E-16	1.5E-16	THORIUM-230	5.3E-16	1.2E-16	1.4E-16
THORIUM-232	1.3E-16	6.1E-17	8.8E-17	THORIUM-232	1.8E-16	6.5E-17	8.2E-17

TABLE A6. RADIOCHEMICAL ANALYSIS OF LVAS AIR FILTERS. FOURTH QUARTER 1988.

	S2-WIPP				S3-WIPP		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.5E-17	2.6E-16	6.5E-16	STRONTIUM-90	4.1E-17	1.9E-16	4.4E-16
PLUTONIUM-239+240	7.5E-18	7.5E-18	8.5E-17	PLUTONIUM-239+240	5.1E-18	5.1E-18	5.8E-17
AMERICIUM-241	3.8E-17	5.3E-17	1.2E-16	AMERICIUM-241	3.1E-17	3.6E-17	7.9E-17
CESIUM-137	-6.8E-17	4.3E-16	9.0E-16	CESIUM-137	1.9E-16	5.0E-16	6.2E-16
RADIUM-226	-5.3E-17	1.6E-16	2.8E-16	RADIUM-226	1.3E-16	1.2E-16	1.9E-16
RADIUM-228	2.0E-16	4.3E-16	7.9E-16	RADIUM-228	5.6E-17	3.2E-16	5.4E-16
PLUTONIUM-238	7.5E-18	7.5E-18	2.1E-16	PLUTONIUM-238	1.0E-17	5.1E-18	1.4E-16
THORIUM-228	1.5E-17	3.8E-17	1.5E-16	THORIUM-228	7.2E-17	5.6E-17	1.00E-16
THORIUM-230	-8.3E-17	8.3E-17	2.6E-16	THORIUM-230	6.7E-17	9.2E-17	1.8E-16
THORIUM-232	3.0E-17	3.8E-17	1.5E-16	THORIUM-232	0.0E+00	5.1E-18	1.0E-16

TABLE A7. RADIOCHEMICAL ANALYSIS OF LVAS AIR FILTERS. FIRST QUARTER 1989

S1-WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-2.8E-17	3.1E-16	8.1E-16
PLUTONIUM-239+240	1.9E-17	9.4E-18	1.1E-16
AMERICIUM-241	5.6E-17	6.6E-17	1.4E-16
CESIUM-137	-1.9E-17	4.0E-16	1.1E-15
RADIUM-226	-9.4E-18	2.0E-16	3.5E-16
RADIUM-228	-1.7E-16	5.6E-16	9.8E-16
PLUTONIUM-238	1.9E-17	9.4E-18	2.6E-16
THORIUM-228	2.8E-17	6.6E-17	1.8E-16
THORIUM-230	-6.6E-17	1.2E-16	3.3E-16
THORIUM-232	0.0E+00	9.4E-18	1.9E-16

S2-WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.7E-16	1.9E-16	4.4E-16
PLUTONIUM-239+240	4.1E-17	1.5E-17	5.8E-17
AMERICIUM-241	2.6E-17	3.6E-17	7.9E-17
CESIUM-137	2.6E-17	4.7E-16	6.2E-16
RADIUM-226	9.2E-17	1.1E-16	1.9E-16
RADIUM-228	6.7E-17	3.1E-16	5.4E-16
PLUTONIUM-238	5.6E-17	2.0E-17	1.4E-16
THORIUM-228	5.6E-17	6.1E-17	1.00E-16
THORIUM-230	7.2E-17	9.7E-17	1.8E-16
THORIUM-232	1.0E-17	2.6E-17	1.0E-16

S3-WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	9.9E-17	2.2E-16	5.7E-16
PLUTONIUM-239+240	0.0E+00	6.6E-18	7.4E-17
AMERICIUM-241	3.3E-17	4.6E-17	1.0E-16
CESIUM-137	-2.4E-16	5.5E-16	7.9E-16
RADIUM-226	-2.6E-17	1.3E-16	2.5E-16
RADIUM-228	2.6E-17	3.5E-16	6.9E-16
PLUTONIUM-238	6.6E-18	6.6E-18	1.8E-16
THORIUM-228	2.0E-17	4.0E-17	1.3E-16
THORIUM-230	-4.0E-17	8.6E-17	2.3E-16
THORIUM-232	0.0E+00	6.6E-18	1.3E-16

TABLE A8. RADIOCHEMICAL ANALYSIS OF LVAS AIR FILTERS. SECOND QUARTER 1989.

S1-WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-2.9E-16	6.6E-16	6.3E-16
PLUTONIUM-239+240	0.0E+00	7.3E-18	8.2E-17
AMERICIUM-241	-7.3E-18	7.3E-18	1.1E-16
CESIUM-137	2.5E-16	5.5E-16	8.8E-16
RADIUM-226	5.1E-17	1.4E-16	2.7E-16
RADIUM-228	3.6E-16	3.8E-16	7.7E-16
PLUTONIUM-238	-7.3E-18	1.5E-17	2.0E-16
THORIUM-228	2.9E-17	2.9E-17	1.4E-16
THORIUM-230	2.9E-17	2.9E-17	2.5E-16
THORIUM-232	1.5E-17	1.5E-17	1.5E-16

S-2 WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.6E-16	4.2E-16	5.5E-16
PLUTONIUM-239+240	0.0E+00	6.3E-18	7.1E-17
AMERICIUM-241	0.0E+00	6.3E-18	9.7E-17
CESIUM-137	2.3E-16	6.0E-16	7.6E-16
RADIUM-226	1.1E-16	1.2E-16	2.4E-16
RADIUM-228	-1.3E-17	3.2E-16	6.6E-16
PLUTONIUM-238	0.0E+00	1.3E-17	1.8E-16
THORIUM-228	6.3E-18	1.9E-17	1.2E-16
THORIUM-230	1.3E-17	2.5E-17	2.2E-16
THORIUM-232	6.3E-18	1.3E-17	1.3E-16

S-3 WIPP

NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	-1.1E-16	3.5E-16	5.6E-16
PLUTONIUM-239+240	1.3E-17	1.3E-17	7.2E-17
AMERICIUM-241	-6.4E-18	6.4E-18	9.8E-17
CESIUM-137	2.3E-16	5.4E-16	7.7E-16
RADIUM-226	2.2E-16	1.2E-16	2.4E-16
RADIUM-228	-1.8E-16	3.8E-16	6.7E-16
PLUTONIUM-238	0.0E+00	1.3E-17	1.8E-16
THORIUM-228	1.9E-17	2.6E-17	1.2E-16
THORIUM-230	5.8E-17	3.8E-17	2.2E-16
THORIUM-232	3.8E-17	2.6E-17	1.3E-16

TABLE A9. RADIOCHEMICAL ANALYSIS OF LVAS AIR FILTERS. THIRD QUARTER 1989.

	S2-W1PP				S3-WIPP		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	1.8E-17	2.8E-16	5.2E-16	STRONTIUM-90	1.2E-16	2.9E-16	6.2E-16
PLUTONIUM-239+240	0.0E+00	6.0E-18	6.8E-17	PLUTONIUM-239+240	7.2E-18	1.4E-17	8.1E-17
AMERICIUM-241	0.0E+00	1.2E-17	9.2E-17	AMERICIUM-241	0.0E+00	1.4E-17	1.1E-16
CESIUM-137	9.1E-17	3.9E-16	7.2E-16	CESIUM-137	1.6E-16	3.2E-16	8.6E-16
RADIUM-226	1.1E-16	5.4E-17	2.2E-16	RADIUM-226	7.9E-17	7.2E-17	2.7E-16
RADIUM-228	-1.7E-16	4.3E-16	6.3E-16	RADIUM-228	-1.2E-16	4.6E-16	7.5E-16
PLUTONIUM-238	0.0E+00	6.0E-18	1.7E-16	PLUTONIUM-238	7.2E-18	2.2E-17	2.0E-16
THORIUM-228	6.0E-18	2.4E-17	1.2E-16	THORIUM-228	0.0E+00	2.9E-17	1.4E-16
THORIUM-230	7.9E-17	4.2E-17	2.1E-16	THORIUM-230	7.2E-18	2.9E-17	2.5E-16
THORIUM-232	1.2E-17	1.8E-17	1.2E-16	THORIUM-232	7.2E-18	1.4E-17	1.4E-16

TABLE A10. RADIOCHEMICAL ANALYSIS OF LVAS AIR FILTERS. FOURTH QUARTER 1989.

	S2-WIPP				S3-WIPP		
NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml	NUCLIDE	ACTIVITY CONC uCi/ml	COUNTING ERROR uCi/ml	LLD uCi/ml
STRONTIUM-90	3.3E-16	3.4E-16	6.5E-16	STRONTIUM-90	2.9E-16	1.8E-16	4.9E-16
PLUTONIUM-239+240	7.5E-18	1.5E-17	8.5E-17	PLUTONIUM-239+240	5.6E-18	5.6E-18	6.3E-17
AMERICIUM-241	-7.5E-18	3.0E-17	1.2E-16	AMERICIUM-241	-5.6E-18	2.2E-17	8.6E-17
CESIUM-137	2.3E-17	3.8E-16	9.0E-16	CESIUM-137	3.4E-17	3.2E-16	6.7E-16
RADIUM-226	1.7E-16	1.2E-16	2.8E-16	RADIUM-226	6.7E-17	8.4E-17	2.1E-16
RADIUM-228	2.9E-16	6.0E-16	7.9E-16	RADIUM-228	-4.2E-16	5.4E-16	5.9E-16
PLUTONIUM-238	0.0E+00	7.5E-18	2.1E-16	PLUTONIUM-238	5.6E-18	5.6E-18	1.6E-16
THORIUM-228	3.8E-17	5.3E-17	1.5E-16	THORIUM-228	1.7E-17	2.2E-17	1.1E-16
THORIUM-230	6.8E-17	7.5E-17	2.6E-16	THORIUM-230	1.7E-16	7.8E-17	2.0E-16
THORIUM-232	7.5E-17	6.0E-17	1.5E-16	THORIUM-232	2.2E-17	2.8E-17	1.1E-16

TABLE A11. RADIOCHEMICAL ANALYSIS OF SURFACE WATER.

LAGUNA GRANDE 12/21/88

ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml
GROSS ALPHA	-4.00E-07	3.40E-06	5.90E-06
GROSS BETA	3.30E-05	3.00E-06	3.30E-06
URANIUM-233, 234	2.60E-08	5.00E-09	1.40E-09
URANIUM-235	-4.00E-10	7.00E-10	5.00E-10
URANIUM-238	1.30E-08	4.00E-09	1.20E-09
STRONTIUM-90	3.00E-10	3.30E-09	1.10E-09
PLUTONIUM-239+240	***	***	***
AMERICIUM-241	***	***	***
CESIUM-137	0.00E+00	1.20E-09	2.00E-09
TRITIUM	3.00E-08	1.40E-07	2.40E-07
RADIUM-226	1.50E-08	2.00E-09	1.90E-09
RADIUM-228	5.90E-09	2.10E-09	2.10E-09
PLUTONIUM-238	***	***	***
THORIUM-228	1.30E-09	1.20E-09	1.20E-09
THORIUM-230	2.00E-09	1.00E-09	7.00E-10
THORIUM-232	-3.00E-10	7.00E-10	1.30E-09

NOYE TANK 2/24/89

ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR mCi/ml	LLD-C uCi/ml
GROSS ALPHA	0.00E+00	6.00E-09	1.00E-08
GROSS BETA	3.20E-08	5.00E-09	5.00E-09
URANIUM-233, 234	5.00E-10	5.00E-10	3.00E-10
URANIUM-235	0.00E+00	2.00E-10	2.00E-10
URANIUM-238	7.00E-10	5.00E-10	3.00E-10
STRONTIUM-90	0.00E+00	4.00E-10	6.00E-10
PLUTONIUM-239+240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	-1.00E-11	2.00E-11	1.00E-11
CESIUM-137	-3.00E-10	6.00E-10	1.10E-09
TRITIUM	-9.00E-08	1.40E-07	2.40E-07
RADIUM-226	6.00E-10	3.00E-10	2.00E-10
RADIUM-228	9.00E-10	1.70E-09	1.90E-09
PLUTONIUM-238	2.00E-11	3.00E-11	1.00E-11
THORIUM-228	3.00E-10	2.00E-10	2.00E-10
THORIUM-230	4.00E-10	3.00E-10	1.00E-10
THORIUM-232	1.00E-10	1.00E-10	1.00E-10

TABLE A12. RADIOCHEMICAL ANALYSIS OF SURFACE WATER.

PECOS RIVER AT CARLSBAD 12/21/88				PECOS AT PIERCE 6/16/89			
ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml	ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml
GROSS ALPHA	-7.00E-09	2.00E-08	3.70E-08	GROSS ALPHA	-2.70E-08	5.00E-08	3.20E-08
GROSS BETA	1.50E-08	1.10E-08	1.70E-08	GROSS BETA	1.10E-07	5.00E-08	7.80E-08
URANIUM-233, 234	3.60E-09	8.00E-10	2.00E-10	URANIUM-233, 234	7.50E-09	6.00E-10	1.00E-10
URANIUM-235	-1.00E-10	2.00E-10	1.00E-10	URANIUM-235	2.00E-10	1.00E-10	1.00E-10
URANIUM-238	1.30E-09	5.00E-10	2.00E-10	URANIUM-238	3.80E-09	5.00E-10	1.00E-10
STRONTIUM-90	-2.00E-10	4.00E-10	7.00E-10	STRONTIUM-90	4.00E-10	4.00E-10	6.00E-10
PLUTONIUM-239+240	0.00E+00	3.00E-11	1.00E-11	PLUTONIUM-239+240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	3.20E-10	3.80E-10	3.60E-10	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	-5.00E-10	6.00E-10	1.10E-09	CESIUM-137	-2.00E-10	5.00E-10	7.00E-10
TRITIUM	8.00E-08	1.40E-07	2.40E-07	TRITIUM	2.20E-07	2.70E-07	3.60E-07
RADIUM-226	3.00E-10	2.00E-10	3.00E-10	RADIUM-226	0.00E+00	2.00E-10	1.00E-10
RADIUM-228	2.00E-10	1.00E-09	1.10E-09	RADIUM-228	1.00E-09	8.00E-10	8.00E-10
PLUTONIUM-238	-1.00E-11	6.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	-7.00E-10	7.00E-10	1.00E-09	THORIUM-228	0.00E+00	1.00E-10	1.00E-10
THORIUM-230	2.40E-09	3.10E-09	4.00E-09	THORIUM-230	3.00E-10	2.00E-10	1.00E-10
THORIUM-232	2.00E-10	1.10E-09	1.70E-09	THORIUM-232	0.00E+00	1.00E-10	1.00E-10

TABLE A13. RADIOCHEMICAL ANALYSIS OF GROUNDWATER

	MOBLEY WELL 10/11/89				TWIN WELLS (PASTURE) 9/28/89		
ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml	ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml
GROSS ALPHA	3.70E-08	3.10E-08	4.00E-08	GROSS ALPHA	3.00E-09	4.00E-09	5.00E-09
GROSS BETA	6.00E-09	1.90E-08	9.40E-08	GROSS BETA	5.00E-09	3.00E-09	4.00E-09
URANIUM-233, 234	9.00E-09	7.00E-10	1.00E-10	URANIUM-233, 234	2.40E-09	4.00E-10	1.00E-10
URANIUM-235	1.00E-10	1.00E-10	1.00E-10	URANIUM-235	1.00E-10	1.00E-10	1.00E-10
URANIUM-238	3.60E-09	4.00E-10	1.00E-10	URANIUM-238	9.00E-10	2.00E-10	1.00E-10
STRONTIUM-90	3.00E-10	4.00E-10	6.00E-10	STRONTIUM-90	0.00E+00	4.00E-10	7.00E-10
PLUTONIUM-239+240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239+240	0.00E+00	1.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	-1.00E-10	6.00E-10	1.00E-09	CESIUM-137	-2.00E-10	5.00E-10	9.00E-10
TRITIUM	4.00E-08	2.60E-07	3.60E-07	TRITIUM	-2.00E-08	2.30E-07	3.20E-07
RADIUM-226	4.00E-10	2.00E-10	1.00E-10	RADIUM-226	3.00E-10	3.00E-10	1.00E-10
RADIUM-228	2.00E-09	2.00E-09	2.20E-09	RADIUM-228	7.00E-10	8.00E-10	9.00E-10
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11
THORIUM-228	-1.00E-10	1.00E-10	1.00E-10	THORIUM-228	0.00E+00	3.00E-10	2.00E-10
THORIUM-230	1.00E-10	1.00E-10	1.00E-10	THORIUM-230	2.00E-10	3.00E-10	1.00E-10
THORIUM-232	0.00E+00	1.00E-10	1.00E-10	THORIUM-232	-1.00E-10	2.00E-10	1.00E-10

TABLE A14. RADIOCHEMICAL ANALYSIS OF EFFLUENT WATER

	WIPP RUN OFF 8/7/89				WIPP SEWAGE LAGOON 10/4/89		
ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml	ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml
GROSS ALPHA	0.00E+00	2.50E-08	4.20E-08	GROSS ALPHA	2.00E-09	3.00E-09	5.00E-09
GROSS BETA	-5.00E-09	4.00E-08	6.70E-08	GROSS BETA	3.50E-08	4.00E-09	4.00E-09
URANIUM-233, 234	2.00E-10	2.00E-10	1.00E-10	URANIUM-233, 234	5.00E-10	5.00E-10	1.00E-10
URANIUM-235	0.00E+00	1.00E-10	1.00E-10	URANIUM-235	0.00E+00	1.00E-10	1.00E-10
URANIUM-238	0.00E+00	1.00E-10	1.00E-10	URANIUM-238	0.00E+00	3.00E-10	1.00E-10
STRONTIUM-90	-1.00E-10	5.00E-10	9.00E-10	STRONTIUM-90	7.00E-10	1.80E-09	2.10E-09
PLUTONIUM-239+240	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-239+240	-1.00E-11	4.00E-11	2.00E-11
AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11	AMERICIUM-241	0.00E+00	1.00E-11	1.00E-11
CESIUM-137	3.00E-10	6.00E-10	8.00E-10	CESIUM-137	2.00E-10	9.00E-10	1.10E-09
TRITIUM	2.00E-08	2.30E-07	3.10E-07	TRITIUM	-2.00E-08	2.30E-07	3.20E-07
RADIUM-226	1.00E-10	2.00E-10	1.00E-10	RADIUM-226	1.00E-10	3.00E-10	2.00E-10
RADIUM-228	2.00E-10	9.00E-10	1.10E-09	RADIUM-228	8.00E-10	1.70E-09	1.90E-09
PLUTONIUM-238	0.00E+00	1.00E-11	1.00E-11	PLUTONIUM-238	0.00E+00	5.00E-11	2.00E-11
THORIUM-228	1.60E-09	1.30E-09	1.00E-09	THORIUM-228	-2.00E-10	2.00E-10	5.00E-10
THORIUM-230	9.00E-10	1.00E-09	4.00E-10	THORIUM-230	-2.00E-10	2.00E-10	7.00E-10
THORIUM-232	2.00E-10	5.00E-10	5.00E-10	THORIUM-232	3.00E-10	5.00E-10	3.00E-10

TABLE A15. RADIOCHEMICAL ANALYSIS OF PUBLIC DRINKING WATER

WIPP WATER SUPPLY
12/21/88

ANALYTIC PARAMETER	ACTIVITY uCi/ml	COUNTING ERROR uCi/ml	LLD-C uCi/ml
GROSS ALPHA	6.00E-09	5.00E-09	7.00E-09
GROSS BETA	6.00E-09	3.00E-09	4.00E-09
URANIUM-233, 234	9.00E-10	5.00E-10	1.00E-10
URANIUM-235	-1.00E-10	2.00E-10	1.00E-10
URANIUM-238	5.00E-10	4.00E-10	1.00E-10
STRONTIUM-90	-1.00E-10	4.00E-10	7.00E-10
PLUTONIUM-239+240	0.00E+00	3.00E-11	1.00E-11
AMERICIUM-241	0.00E+00	2.00E-11	1.00E-11
CESIUM-137	1.00E-10	6.00E-10	1.10E-09
TRITIUM	7.00E-08	1.40E-07	2.40E-07
RADIUM-226	2.00E-10	2.00E-10	2.00E-10
RADIUM-228	-6.00E-10	1.30E-09	1.60E-09
PLUTONIUM-238	-1.00E-11	6.00E-11	1.00E-11
THORIUM-228	1.00E-10	1.00E-10	1.00E-10
THORIUM-230	6.00E-10	4.00E-10	1.00E-10
THORIUM-232	1.00E-10	1.00E-10	1.00E-10

TABLE A16. RADIOCHEMICAL ANALYSIS OF SOIL

1000 METERS NW of WIPP EXHAUST SHAFT
8/7/89

NUCLIDE	ACTIVITY uCi/g	COUNTING ERROR uCi/g	LLD-C uCi/g
GROSS ALPHA	1.1E-05	1.2E-05	1.6E-05
GROSS BETA	1.1E-05	5.0E-06	8.0E-06
STRONTIUM-90	4.0E-07	6.0E-07	1.0E-07
PLUTONIUM-239+240	0.0E+00	1.0E-08	1.0E-08
CESIUM-137	2.0E-07	1.0E-07	1.0E-07
PLUTONIIUM-238	1.0E-08	1.0E-08	1.0E-08

TABLE A17. RADIOCHEMICAL ANALYSIS OF BIOTA

BRANTLEY LAKE CATFISH

7/28/89

NUCLIDE	ACTIVITY	COUNTING ERROR	LLD-C
PLUTONIUM-239+240 uCi/g	0.0E+00	1.0E-08	2.0E-08
TRITIUM-total uCi/ml	6.0E-08	2.1E-07	2.8E-07
PLLUTONIUM-238 uCi/g	0.0E+00	1.0E-08	1.0E-08

VEGETATION
1000 METERS NW of WIPP EXHAUST SHAFT
10/20/88

NUCLIDE	ACTIVITY	COUNTING ERROR	LLD-C
PLUTONIUM 239+240 uCi/ml	0.0E+00	1.0E-08	1.0E-08
AMERICIUM-241 uCi/ml	0.0E+00	1.0E-08	1.0E-08
CESIUM-137 uCi/ml	0.0E+00	1.0E-06	1.0E-06

Appendix B

TABLE B1. HVAS DATA. ARTESIA - 1989

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
01/04/89	300.8	1.1E-02	6.1E-03	2.6E+00	2.3E+00	325	0.22	0.33	1.68E-15	7.41E-14
01/10/89	180.0	4.4E-03	5.6E-04	2.7E+00	2.5E+00	325	0.22	0.33	1.47E-15	6.23E-14
01/16/89	180.5	7.8E-03	3.3E-03	2.3E+00	2.3E+00	325	0.22	0.33	1.68E-15	1.78E-14
01/22/89	195.5	7.2E-03	5.0E-03	2.7E+00	2.6E+00	325	0.22	0.33	8.40E-16	1.51E-14
01/28/89	226.5	3.9E-03	1.1E-03	2.5E+00	2.5E+00	325	0.22	0.33	1.05E-15	2.04E-14
02/03/89	243.5	2.0E-02	2.8E-03	2.6E+00	2.5E+00	325	0.22	0.31	6.51E-15	2.71E-14
02/09/89	274.5	1.2E-02	1.1E-03	2.6E+00	2.4E+00	325	0.22	0.31	3.99E-15	5.10E-14
02/15/89	300.0	6.1E-03	2.2E-03	2.5E+00	2.3E+00	325	0.22	0.31	1.47E-15	5.69E-14
02/21/89	180.5	5.6E-03	2.8E-03	2.4E+00	2.3E+00	325	0.22	0.33	1.05E-15	2.04E-14
02/27/89	250.5	8.3E-03	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.33	1.47E-15	2.59E-14
03/05/89	179.8	9.4E-03	6.1E-03	2.3E+00	2.2E+00	325	0.22	0.33	1.26E-15	4.19E-14
03/11/89	227.5	4.4E-03	2.2E-03	2.2E+00	2.2E+00	325	0.22	0.33	8.40E-16	-7.00E-15
03/17/89	294.5	3.9E-03	2.8E-03	2.4E+00	2.3E+00	325	0.22	0.33	4.20E-16	1.43E-14
03/23/89	273.8	1.0E-02	2.8E-03	2.3E+00	2.1E+00	325	0.22	0.33	2.73E-15	5.19E-14
03/29/89	297.5	6.1E-03	5.6E-03	2.1E+00	2.1E+00	325	0.22	0.33	2.10E-16	3.78E-15
04/04/89	322.0	1.3E-02	2.2E-03	2.2E+00	2.2E+00	325	0.22	0.30	3.99E-15	-9.24E-16
04/10/89	322.0	5.6E-03	2.8E-03	2.2E+00	2.1E+00	325	0.22	0.30	1.05E-15	2.14E-14
04/16/89	268.0	7.2E-03	1.1E-03	2.3E+00	2.3E+00	325	0.22	0.30	2.31E-15	-2.00E-14
04/22/89	395.0	1.4E-02	3.3E-03	2.4E+00	2.2E+00	325	0.22	0.30	3.99E-15	6.05E-14
05/04/89	275.0	1.2E-02	1.1E-03	2.4E+00	2.3E+00	325	0.22	0.30	4.20E-15	4.67E-14
05/10/89	297.5	8.3E-03	1.7E-03	2.4E+00	2.3E+00	325	0.22	0.30	2.52E-15	4.22E-14
05/28/89	1086.0	1.9E-02	3.3E-03	2.7E+00	2.6E+00	325	0.22	0.31	5.88E-15	2.35E-14
06/03/89	968.0	1.3E-02	3.3E-03	2.7E+00	2.7E+00	325	0.22	0.31	3.57E-15	-1.21E-14
06/09/89	519.5	1.6E-02	3.3E-03	2.8E+00	2.7E+00	325	0.22	0.31	4.83E-15	1.89E-14
06/15/89	986.5	2.1E-02	6.7E-03	2.6E+00	2.6E+00	325	0.22	0.31	5.46E-15	-1.04E-14
06/21/89	852.0	2.1E-02	6.7E-03	2.7E+00	2.6E+00	325	0.22	0.31	5.46E-15	2.31E-14
06/27/89	709.0	2.0E-02	6.7E-03	2.7E+00	2.6E+00	325	0.22	0.31	5.04E-15	3.06E-14
07/03/89	585.5	1.7E-02	7.8E-03	2.8E+00	2.6E+00	325	0.22	0.33	3.36E-15	3.72E-14
07/09/89	444.0	1.7E-02	7.8E-03	2.6E+00	2.6E+00	325	0.22	0.33	3.36E-15	2.52E-15
07/15/89	417.0	1.3E-02	3.3E-03	2.6E+00	2.5E+00	325	0.22	0.33	3.57E-15	2.58E-14
07/21/89	275.5	1.8E-02	3.3E-03	2.7E+00	2.5E+00	325	0.22	0.33	5.46E-15	2.79E-14
07/27/89	276.0	6.1E-03	3.9E-03	2.7E+00	2.6E+00	325	0.22	0.33	8.40E-16	2.94E-14
08/02/89	303.5	1.4E-02	4.4E-03	2.6E+00	2.5E+00	325	0.22	0.33	3.78E-15	3.18E-14
08/08/89	178.5	1.7E-02	6.7E-03	2.7E+00	2.6E+00	325	0.22	0.33	3.78E-15	2.46E-14

TABLE B1. HVAS DATA. ARTESIA - 1989, cont.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
08/14/89	249.5	8.3E-03	7.2E-03	2.6E+00	2.4E+00	325	0.22	0.33	4.20E-16	4.47E-14
08/20/89	396.0	8.9E-03	3.3E-03	2.5E+00	2.5E+00	325	0.22	0.33	2.10E-15	-4.76E-15
08/26/89	296.5	1.0E-02	5.0E-03	2.6E+00	2.4E+00	325	0.22	0.33	1.89E-15	4.70E-14
09/01/89	275.2	1.0E-02	5.6E-03	2.4E+00	2.3E+00	325	0.22	0.34	1.68E-15	8.83E-15
09/13/89	445.7	6.7E-03	6.1E-03	2.3E+00	2.3E+00	325	0.22	0.33	2.10E-16	5.88E-15
09/19/89	319.5	2.0E-02	4.4E-03	2.4E+00	2.3E+00	325	0.22	0.33	5.88E-15	2.74E-14
09/25/89	225.0	7.8E-03	3.3E-03	2.4E+00	2.3E+00	325	0.22	0.33	1.68E-15	2.52E-14
10/01/89	201.5	2.2E-02	5.6E-03	2.4E+00	2.3E+00	325	0.22	0.33	6.30E-15	3.36E-14
10/07/89	224.5	1.8E-02	4.4E-03	2.4E+00	2.2E+00	325	0.22	0.33	5.04E-15	4.79E-14
10/13/89	296.0	7.8E-03	5.6E-04	2.4E+00	2.2E+00	325	0.22	0.33	2.73E-15	4.06E-14
10/19/89	297.0	1.3E-02	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.34	3.15E-15	2.83E-14
10/25/89	178.5	8.9E-03	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.34	1.68E-15	2.60E-14
10/31/89	362.6	1.3E-02	4.4E-03	2.3E+00	2.1E+00	325	0.22	0.34	3.36E-15	4.02E-14
11/06/89	222.8	1.8E-02	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.34	5.25E-15	1.43E-14
11/20/89	360.1	7.2E-03	4.4E-03	2.2E+00	2.2E+00	325	0.22	0.32	1.05E-15	-6.64E-15
11/24/89	274.5	7.2E-03	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.32	1.05E-15	1.82E-14
11/30/89	318.0	5.6E-03	2.2E-03	2.3E+00	2.1E+00	325	0.22	0.32	1.26E-15	5.27E-14
12/06/89	196.8	2.4E-02	3.3E-03	2.3E+00	2.2E+00	325	0.22	0.32	7.77E-15	1.91E-14
12/30/89	226.0	2.8E-02	3.9E-03	2.3E+00	2.2E+00	325	0.22	0.34	9.24E-15	2.80E-14

TABLE B2. HVAS DATA. CARLSBAD - 1989.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
01/10/89	179.5	8.89E-03	5.56E-04	2.77E+00	2.47E+00	325	0.22	0.33	3.15E-15	7.52E-14
01/16/89	174.5	7.22E-03	3.33E-03	2.41E+00	2.25E+00	325	0.22	0.33	1.47E-15	3.82E-14
01/28/89	226.0	2.22E-03	1.11E-03	2.54E+00	2.47E+00	325	0.22	0.33	4.20E-16	1.69E-14
02/03/89	250.0	1.89E-02	2.78E-03	2.68E+00	2.53E+00	325	0.22	0.31	6.09E-15	3.98E-14
02/09/89	268.5	8.89E-03	1.11E-03	2.46E+00	2.36E+00	325	0.22	0.31	2.94E-15	2.44E-14
02/15/89	298.5	5.00E-03	2.22E-03	2.45E+00	2.33E+00	325	0.22	0.31	1.05E-15	3.19E-14
02/21/89	180.0	7.22E-03	2.78E-03	2.39E+00	2.30E+00	325	0.22	0.33	1.68E-15	2.07E-14
02/27/89	198.0	7.78E-03	2.22E-03	2.42E+00	2.19E+00	325	0.22	0.33	2.10E-15	5.80E-14
03/05/89	226.5	5.00E-03	5.00E-03	2.39E+00	2.35E+00	325	0.22	0.33	0.00E+00	1.11E-14
03/17/89	298.5	8.89E-03	2.78E-03	2.39E+00	2.31E+00	325	0.22	0.33	2.31E-15	1.97E-14
03/23/89	273.3	7.78E-03	2.78E-03	2.27E+00	2.13E+00	325	0.22	0.33	1.89E-15	3.56E-14
03/29/89	298.5	6.67E-03	5.56E-03	2.17E+00	2.11E+00	325	0.22	0.33	4.20E-16	1.30E-14
04/04/89	321.5	6.11E-03	2.22E-03	2.26E+00	2.19E+00	325	0.22	0.30	1.47E-15	1.91E-14
04/10/89	339.8	1.22E-02	2.78E-03	2.32E+00	2.30E+00	325	0.22	0.30	3.57E-15	5.08E-15
04/22/89	394.0	1.11E-02	3.33E-03	2.35E+00	2.18E+00	325	0.22	0.30	2.94E-15	4.68E-14
04/28/89	275.0	6.11E-03	3.33E-03	2.39E+00	2.18E+00	325	0.22	0.30	1.05E-15	5.87E-14
05/04/89	270.0	1.50E-02	1.11E-03	2.44E+00	2.26E+00	325	0.22	0.30	5.25E-15	4.99E-14
05/10/89	324.5	6.67E-03	2.22E-03	2.28E+00	2.21E+00	325	0.22	0.30	1.68E-15	1.93E-14
05/17/89	181.0	1.06E-02	2.22E-03	2.27E+00	2.21E+00	325	0.22	0.30	3.15E-15	1.69E-14
06/03/89	973.5	1.94E-02	3.33E-03	2.66E+00	2.70E+00	325	0.22	0.31	6.09E-15	-1.10E-14
06/09/89	1095.5	1.28E-02	5.00E-03	2.70E+00	2.54E+00	325	0.22	0.31	2.94E-15	4.25E-14
06/15/89	992.0	1.94E-02	6.67E-03	2.68E+00	2.63E+00	325	0.22	0.31	4.83E-15	1.24E-14
06/21/89	851.5	3.89E-02	6.67E-03	2.72E+00	2.63E+00	325	0.22	0.31	1.22E-14	2.46E-14
06/27/89	710.5	1.56E-02	6.67E-03	2.72E+00	2.63E+00	325	0.22	0.31	3.36E-15	2.52E-14
07/03/89	567.0	1.44E-02	6.67E-03	2.74E+00	2.63E+00	325	0.28	0.33	2.31E-15	2.81E-14
07/15/89	302.0	1.06E-02	7.78E-03	2.73E+00	2.62E+00	325	0.28	0.33	8.25E-16	2.77E-14
07/21/89	276.5	1.28E-02	3.33E-03	2.74E+00	2.54E+00	325	0.28	0.33	2.81E-15	4.94E-14
07/27/89	276.5	6.67E-03	3.89E-03	2.72E+00	2.56E+00	325	0.28	0.33	8.25E-16	3.93E-14
08/02/89	299.5	1.50E-02	4.44E-03	2.55E+00	2.46E+00	325	0.28	0.33	3.14E-15	2.18E-14
08/08/89	179.5	1.39E-02	6.11E-03	2.60E+00	2.54E+00	325	0.28	0.33	2.31E-15	1.62E-14
08/14/89	243.0	8.89E-03	7.22E-03	2.57E+00	2.44E+00	325	0.28	0.33	4.95E-16	3.47E-14
08/26/89	302.0	1.00E-02	5.00E-03	2.48E+00	2.47E+00	325	0.28	0.33	1.49E-15	5.60E-16
09/01/89	276.5	9.44E-03	5.56E-03	2.38E+00	2.35E+00	325	0.28	0.34	1.16E-15	7.75E-15
09/07/89	322.0	7.78E-03	6.11E-03	2.45E+00	2.34E+00	325	0.28	0.34	4.95E-16	2.74E-14

TABLE B2. HVAS DATA. CARLSBAD - 1989, cont.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
09/13/89	443.5	6.67E-03	6.11E-03	2.24E+00	2.26E+00	325	0.23	0.33	2.01E-16	-3.78E-15
09/19/89	320.0	1.50E-02	4.44E-03	2.43E+00	2.31E+00	325	0.23	0.33	3.82E-15	3.08E-14
09/25/89	225.5	1.00E-02	3.33E-03	2.53E+00	2.34E+00	325	0.23	0.33	2.41E-15	4.62E-14
10/07/89	225.5	2.83E-02	4.44E-03	2.36E+00	2.17E+00	325	0.23	0.33	8.64E-15	4.93E-14
10/13/89	299.5	9.44E-03	5.56E-04	2.39E+00	2.24E+00	325	0.23	0.33	3.21E-15	4.00E-14
10/19/89	321.5	9.44E-03	4.44E-03	2.28E+00	2.16E+00	325	0.23	0.34	1.81E-15	2.92E-14
10/25/89	179.5	7.78E-03	4.44E-03	2.27E+00	2.22E+00	325	0.23	0.34	1.21E-15	1.40E-14
10/31/89	369.8	2.39E-02	4.44E-03	2.30E+00	2.13E+00	325	0.23	0.34	7.03E-15	4.17E-14
11/18/89	205.3	8.33E-03	1.67E-03	2.40E+00	2.18E+00	325	0.23	0.34	2.41E-15	5.30E-14
11/24/89	297.0	1.00E-02	4.44E-03	2.30E+00	2.20E+00	325	0.23	0.32	2.01E-15	2.82E-14
11/30/89	327.0	7.22E-03	2.22E-03	2.25E+00	2.13E+00	325	0.23	0.32	1.81E-15	2.96E-14
12/12/89	486.0	9.44E-03	1.67E-03	2.27E+00	2.17E+00	325	0.23	0.34	2.81E-15	2.49E-14
12/18/89	368.0	7.22E-03	1.67E-03	2.27E+00	2.20E+00	325	0.23	0.34	2.01E-15	1.77E-14
12/30/89	225.5	7.78E-03	3.89E-03	2.24E+00	2.17E+00	325	0.23	0.34	1.41E-15	1.83E-14

TABLE B3. HVAS DATA. HOBBS - 1989.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
01/04/89	300.3	4.44E-03	6.11E-03	2.55E+00	2.26E+00	325	0.22	0.33	-6.30E-16	7.36E-14
01/10/89	180.5	8.33E-03	5.56E-04	2.77E+00	2.47E+00	325	0.22	0.33	2.94E-15	7.52E-14
01/16/89	181.0	5.56E-03	3.33E-03	2.44E+00	2.25E+00	325	0.22	0.33	8.40E-16	4.63E-14
01/22/89	203.3	7.78E-03	5.00E-03	2.77E+00	2.60E+00	325	0.22	0.33	1.05E-15	4.47E-14
02/03/89	261.0	1.33E-02	2.78E-03	2.64E+00	2.53E+00	325	0.22	0.31	3.99E-15	2.83E-14
02/09/89	275.0	7.22E-03	1.11E-03	2.53E+00	2.36E+00	325	0.22	0.31	2.31E-15	4.47E-14
02/15/89	292.0	1.28E-02	2.22E-03	2.51E+00	2.33E+00	325	0.22	0.31	3.99E-15	4.72E-14
02/21/89	179.5	5.56E-03	2.78E-03	2.38E+00	2.30E+00	325	0.22	0.33	1.05E-15	2.02E-14
02/27/89	231.0	1.17E-02	3.89E-03	2.30E+00	2.23E+00	325	0.22	0.33	2.94E-15	1.75E-14
03/11/89	220.0	7.78E-03	2.22E-03	2.15E+00	2.24E+00	325	0.22	0.33	2.10E-15	-2.34E-14
03/17/89	299.0	5.56E-03	2.78E-03	2.45E+00	2.31E+00	325	0.22	0.33	1.05E-15	3.49E-14
03/23/89	272.8	9.44E-03	2.78E-03	2.27E+00	2.13E+00	325	0.22	0.33	2.52E-15	3.47E-14
03/29/89	298.0	8.89E-03	5.56E-03	2.15E+00	2.11E+00	325	0.22	0.33	1.26E-15	9.52E-15
04/04/89	465.0	1.00E-02	2.78E-03	2.25E+00	2.15E+00	325	0.22	0.30	2.73E-15	2.91E-14
04/10/89	321.5	8.89E-03	2.78E-03	2.22E+00	2.15E+00	325	0.22	0.30	2.31E-15	1.88E-14
04/16/89	273.5	8.89E-03	1.11E-03	2.22E+00	2.33E+00	325	0.22	0.30	2.94E-15	-2.97E-14
04/28/89	417.5	8.89E-03	1.11E-03	2.33E+00	2.26E+00	325	0.22	0.30	2.94E-15	1.96E-14
05/04/89	274.5	1.33E-02	1.11E-03	2.37E+00	2.26E+00	325	0.22	0.30	4.62E-15	2.91E-14
05/10/89	301.0	7.78E-03	1.67E-03	2.37E+00	2.26E+00	325	0.22	0.30	2.31E-15	3.00E-14
05/16/89	176.0	8.33E-03	2.22E-03	2.26E+00	2.21E+00	325	0.22	0.30	2.31E-15	1.29E-14
06/03/89	973.0	1.33E-02	3.33E-03	2.66E+00	2.70E+00	325	0.22	0.31	3.78E-15	-9.84E-15
06/09/89	519.0	1.11E-02	3.33E-03	2.77E+00	2.70E+00	325	0.22	0.31	2.94E-15	1.80E-14
06/15/89	993.0	1.67E-02	6.67E-03	2.69E+00	2.63E+00	325	0.22	0.31	3.78E-15	1.56E-14
06/21/89	843.0	2.50E-02	6.67E-03	2.71E+00	2.63E+00	325	0.22	0.31	6.93E-15	2.15E-14
06/27/89	708.5	1.67E-02	6.67E-03	2.66E+00	2.63E+00	325	0.22	0.31	3.78E-15	8.79E-15
07/03/89	586.0	1.33E-02	7.78E-03	2.76E+00	2.62E+00	325	0.28	0.33	1.65E-15	3.47E-14
07/09/89	444.5	1.56E-02	7.78E-03	2.71E+00	2.62E+00	325	0.28	0.33	2.31E-15	2.13E-14
07/21/89	277.0	2.11E-02	3.33E-03	2.80E+00	2.54E+00	325	0.28	0.33	5.28E-15	6.54E-14
07/27/89	277.0	1.33E-02	3.89E-03	2.59E+00	2.56E+00	325	0.28	0.33	2.81E-15	8.96E-15
08/02/89	294.0	1.50E-02	4.44E-03	2.58E+00	2.46E+00	325	0.28	0.33	3.14E-15	2.97E-14
08/08/89	180.0	1.39E-02	6.11E-03	2.62E+00	2.54E+00	325	0.28	0.33	2.31E-15	2.23E-14
08/14/89	248.5	1.50E-02	7.22E-03	2.61E+00	2.44E+00	325	0.28	0.33	2.31E-15	4.41E-14
08/20/89	395.5	7.78E-03	3.33E-03	2.47E+00	2.48E+00	325	0.28	0.33	1.32E-15	-2.94E-15
08/26/89	300.0	1.17E-02	5.00E-03	2.57E+00	2.42E+00	325	0.28	0.33	1.98E-15	3.95E-14

TABLE B3. HVAS DATA. HOBBS - 1989, cont.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
09/01/89	274.5	1.06E-02	5.56E-03	2.42E+00	2.35E+00	325	0.28	0.34	1.49E-15	1.66E-14
09/07/89	322.5	9.44E-03	6.11E-03	2.45E+00	2.34E+00	325	0.28	0.34	9.90E-16	2.76E-14
09/19/89	323.5	3.00E-02	4.44E-03	2.47E+00	2.31E+00	325	0.23	0.33	9.24E-15	4.10E-14
09/25/89	226.0	5.00E-03	3.33E-03	2.52E+00	2.34E+00	325	0.23	0.33	6.03E-16	4.55E-14
10/01/89	201.0	1.39E-02	5.56E-03	2.46E+00	2.21E+00	325	0.23	0.33	3.01E-15	6.23E-14
10/07/89	220.0	1.00E-02	4.44E-03	2.33E+00	2.17E+00	325	0.23	0.33	2.01E-15	4.07E-14
10/13/89	300.0	1.28E-02	5.56E-04	2.45E+00	2.24E+00	325	0.23	0.33	4.42E-15	5.49E-14
10/25/89	180.0	7.22E-03	4.44E-03	2.31E+00	2.22E+00	325	0.23	0.34	1.00E-15	2.19E-14
10/31/89	369.3	2.50E-02	4.44E-03	2.28E+00	2.13E+00	325	0.23	0.34	7.43E-15	3.51E-14
11/06/89	227.0	3.56E-02	4.44E-03	2.29E+00	2.24E+00	325	0.23	0.34	1.12E-14	1.35E-14
11/12/89	345.0	1.33E-02	1.67E-03	2.29E+00	2.18E+00	325	0.23	0.34	4.22E-15	2.72E-14
11/24/89	298.0	9.44E-03	4.44E-03	2.29E+00	2.20E+00	325	0.23	0.32	1.81E-15	2.35E-14
11/30/89	346.0	1.00E-02	2.78E-03	2.18E+00	2.12E+00	325	0.23	0.32	2.61E-15	1.50E-14
12/06/89	203.5	2.11E-02	3.33E-03	2.28E+00	2.21E+00	325	0.23	0.32	6.43E-15	1.91E-14
12/12/89	491.0	1.00E-02	1.11E-03	2.24E+00	2.14E+00	325	0.23	0.34	3.21E-15	2.45E-14
12/18/89	362.5	7.78E-03	1.67E-03	2.29E+00	2.20E+00	325	0.23	0.34	2.21E-15	2.24E-14
12/30/89	226.5	4.06E-02	3.89E-03	2.42E+00	2.17E+00	325	0.23	0.34	1.33E-14	6.22E-14

TABLE B4. HVAS DATA. LOVING - 1989.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
01/04/89	299.8	8.9E-03	6.1E-03	2.5E+00	2.3E+00	325	0.22	0.33	1.05E-15	6.86E-14
01/10/89	175.0	7.8E-03	5.6E-04	2.7E+00	2.5E+00	325	0.22	0.33	2.73E-15	6.59E-14
01/16/89	180.0	1.2E-02	3.3E-03	2.4E+00	2.3E+00	325	0.22	0.33	3.36E-15	4.48E-14
01/28/89	227.0	6.7E-03	1.1E-03	2.6E+00	2.5E+00	325	0.22	0.33	2.10E-15	2.39E-14
02/03/89	250.5	1.1E-02	2.8E-03	2.7E+00	2.5E+00	325	0.22	0.31	3.15E-15	5.51E-14
02/09/89	274.0	6.7E-03	1.1E-03	2.4E+00	2.4E+00	325	0.22	0.31	2.10E-15	1.88E-14
02/15/89	299.5	3.3E-03	2.2E-03	2.4E+00	2.3E+00	325	0.22	0.31	4.20E-16	3.00E-14
02/27/89	251.0	9.4E-03	4.4E-03	2.3E+00	2.2E+00	325	0.22	0.33	1.89E-15	2.09E-14
03/05/89	249.1	1.2E-02	2.2E-03	2.2E+00	2.1E+00	325	0.22	0.33	3.57E-15	2.81E-14
03/17/89	297.5	7.2E-03	2.8E-03	2.4E+00	2.3E+00	325	0.22	0.33	1.68E-15	2.04E-14
03/23/89	270.5	3.9E-03	2.8E-03	2.3E+00	2.1E+00	325	0.22	0.33	4.20E-16	4.28E-14
03/29/89	294.5	1.1E-02	5.6E-03	2.3E+00	2.1E+00	325	0.22	0.33	2.10E-15	5.70E-14
04/04/89	322.5	7.2E-03	2.2E-03	2.2E+00	2.2E+00	325	0.22	0.30	1.89E-15	1.46E-14
04/10/89	322.5	6.1E-03	2.8E-03	2.3E+00	2.1E+00	325	0.22	0.30	1.26E-15	3.22E-14
04/22/89	394.5	1.5E-02	3.3E-03	2.4E+00	2.2E+00	325	0.22	0.30	4.41E-15	6.47E-14
04/28/89	414.0	1.1E-02	1.1E-03	2.4E+00	2.3E+00	325	0.22	0.30	3.57E-15	2.51E-14
05/04/89	271.5	5.0E-03	1.1E-03	2.4E+00	2.3E+00	325	0.22	0.30	1.47E-15	4.22E-14
05/10/89	300.5	1.0E-02	1.7E-03	2.3E+00	2.3E+00	325	0.22	0.30	3.15E-15	2.08E-14
05/16/89	181.5	8.9E-03	2.2E-03	2.3E+00	2.2E+00	325	0.22	0.30	2.52E-15	1.88E-14
05/28/89	1096.0	2.1E-02	3.3E-03	2.7E+00	2.6E+00	325	0.22	0.31	6.51E-15	2.04E-14
06/09/89	514.5	1.6E-02	3.3E-03	2.7E+00	2.7E+00	325	0.22	0.31	4.62E-15	-9.54E-15
06/15/89	993.5	1.5E-02	6.7E-03	2.7E+00	2.6E+00	325	0.22	0.31	3.15E-15	2.52E-14
06/21/89	850.5	3.3E-02	6.7E-03	2.6E+00	2.6E+00	325	0.22	0.31	1.01E-14	2.98E-16
06/27/89	705.0	2.0E-02	6.7E-03	2.7E+00	2.6E+00	325	0.22	0.31	5.04E-15	2.24E-14
07/03/89	567.5	1.8E-02	6.7E-03	2.8E+00	2.6E+00	325	0.22	0.31	4.20E-15	3.77E-14
07/15/89	301.0	1.2E-02	7.8E-03	2.7E+00	2.6E+00	325	0.28	0.33	1.32E-15	2.38E-14
07/21/89	274.5	1.3E-02	3.3E-03	2.7E+00	2.5E+00	325	0.28	0.33	2.81E-15	3.95E-14
07/27/89	318.5	1.1E-02	7.2E-03	2.7E+00	2.6E+00	325	0.28	0.33	1.16E-15	2.90E-14
08/02/89	303.0	1.2E-02	4.4E-03	2.6E+00	2.5E+00	325	0.28	0.33	2.15E-15	3.75E-14
08/20/89	443.0	9.4E-03	5.0E-03	2.5E+00	2.4E+00	325	0.28	0.33	1.32E-15	1.86E-14
08/26/89	302.5	1.1E-02	5.0E-03	2.4E+00	2.5E+00	325	0.28	0.33	1.65E-15	-1.04E-14
09/01/89	275.8	6.7E-03	5.6E-03	2.4E+00	2.3E+00	325	0.28	0.34	3.30E-16	1.48E-14
09/13/89	445.2	2.2E-02	6.1E-03	2.3E+00	2.3E+00	325	0.23	0.33	5.62E-15	1.82E-15
09/19/89	316.5	1.1E-02	4.4E-03	2.5E+00	2.3E+00	325	0.23	0.33	2.21E-15	4.17E-14

TABLE B4. HVAS DATA. LOVING - 1989.

SAMPLE DATE	SAMPLE DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	GROSS BETA c/s	BKG BETA c/s	SAMPLE VOLUME m3	ALPHA EFF c/d	BETA EFF c/d	ALPHA CONC uCi/ml	BETA CONC uCi/ml
09/25/89	224.5	1.0E-02	3.3E-03	2.5E+00	2.3E+00	325	0.23	0.33	2.41E-15	3.40E-14
10/01/89	200.5	1.1E-02	5.6E-03	2.4E+00	2.2E+00	325	0.23	0.33	1.81E-15	4.40E-14
10/13/89	300.5	8.3E-03	5.6E-04	2.4E+00	2.2E+00	325	0.23	0.33	2.81E-15	4.45E-14
10/19/89	320.5	8.3E-03	4.4E-03	2.2E+00	2.2E+00	325	0.23	0.34	1.41E-15	1.94E-14
10/25/89	181.0	5.6E-03	5.6E-03	2.3E+00	2.2E+00	325	0.23	0.34	0.00E+00	1.89E-14
10/31/89	370.3	2.3E-02	4.4E-03	2.3E+00	2.1E+00	325	0.23	0.34	6.83E-15	4.39E-14
11/18/89	201.5	1.6E-02	1.7E-03	2.3E+00	2.2E+00	325	0.23	0.34	5.22E-15	3.13E-14
11/24/89	297.5	1.3E-02	4.4E-03	2.3E+00	2.2E+00	325	0.23	0.32	3.21E-15	2.99E-14
11/30/89	345.0	2.5E-02	2.8E-03	2.1E+00	2.1E+00	325	0.23	0.32	8.03E-15	6.79E-15
12/06/89	204.3	1.3E-02	3.3E-03	2.4E+00	2.2E+00	325	0.23	0.32	3.62E-15	4.06E-14
12/12/89	657.0	8.9E-03	3.9E-03	2.2E+00	2.2E+00	325	0.23	0.34	1.81E-15	5.44E-15
12/18/89	494.8	1.3E-02	1.7E-03	2.3E+00	2.2E+00	325	0.23	0.34	4.02E-15	2.65E-14
12/24/89	225.5	7.2E-03	1.7E-03	2.4E+00	2.2E+00	325	0.23	0.34	2.01E-15	4.28E-14

TABLE B5. LVAS DATA S-1 AT WIPP - 1989

SAMPLE DATE	SAMPLE VOLUME m3	ALPHA DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	ALPHA EFF c/d	ALPHA CONC uCi/ml	BETA DECAY hours	GROSS BETA c/s	BKG BETA c/s	BETA EFF c/d	BETA CONC uCi/ml
01/31/89	1388.0	171.5	3.56E-02	2.78E-03	0.22	2.90E-15	172.0	3.1E+00	2.5E+00	0.31	3.62E-14
02/14/89	1398.0	170.5	1.67E-02	1.11E-03	0.22	1.37E-15	171.0	2.9E+00	2.4E+00	0.31	3.52E-14
02/21/89	1411.0	172.0	1.17E-02	2.78E-03	0.22	7.74E-16	172.5	2.6E+00	2.3E+00	0.33	1.90E-14
02/28/89	1315.0	170.0	9.44E-03	2.22E-03	0.22	6.75E-16	169.5	2.6E+00	2.2E+00	0.33	2.58E-14
03/07/89	1339.0	217.0	2.28E-02	6.11E-03	0.22	1.53E-15	217.5	2.6E+00	2.2E+00	0.33	2.23E-14
03/21/89	1002.0	171.0	1.11E-02	2.22E-03	0.22	1.09E-15	171.5	2.5E+00	2.2E+00	0.33	2.99E-14
03/28/89	1369.0	171.6	1.67E-02	3.33E-03	0.22	1.20E-15	173.0	2.5E+00	2.3E+00	0.33	1.61E-14
04/04/89	1440.0	194.5	1.72E-02	1.67E-03	0.22	1.33E-15	196.5	2.3E+00	2.1E+00	0.30	1.09E-14
04/11/89	1374.0	337.5	1.44E-02	3.89E-03	0.22	9.44E-16	338.0	2.5E+00	2.3E+00	0.30	1.41E-14
04/18/89	1396.0	171.0	1.67E-02	3.89E-03	0.22	1.12E-15	170.5	2.7E+00	2.3E+00	0.30	2.66E-14
04/25/89	1334.0	507.5	3.17E-02	3.89E-03	0.22	2.56E-15	507.0	2.8E+00	2.4E+00	0.30	3.01E-14
05/03/89	1551.0	313.5	2.39E-02	3.89E-03	0.22	1.58E-15	314.0	2.8E+00	2.4E+00	0.30	2.50E-14
05/09/89	1168.0	337.0	1.83E-02	3.33E-03	0.22	1.58E-15	337.5	2.6E+00	2.2E+00	0.30	2.80E-14
05/30/89	1332.0	1039.0	4.39E-02	2.22E-03	0.22	3.84E-15	1038.5	3.1E+00	2.9E+00	0.31	1.21E-14
06/06/89	1418.0	1010.8	4.94E-02	9.44E-03	0.22	3.47E-15	1011.3	2.9E+00	2.7E+00	0.31	1.13E-14
06/13/89	1387.0	845.5	3.67E-02	9.44E-03	0.22	2.41E-15	846.0	3.0E+00	2.7E+00	0.31	1.73E-14
06/21/89	1545.0	675.0	4.50E-02	7.22E-03	0.22	3.00E-15	675.5	3.0E+00	2.7E+00	0.31	1.49E-14
06/27/89	1222.0	530.8	2.56E-02	7.22E-03	0.22	1.84E-15	531.8	2.8E+00	2.7E+00	0.31	7.77E-15

TABLE B6. LVAS DATA S-2 WIPP - 1989

SAMPLE DATE	SAMPLE VOLUME m3	ALPHA DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	ALPHA EFF c/d	ALPHA uCi/ml	BETA DECAY hours	GROSS BETA c/s	BKG BETA c/s	BETA EFF c/d	BETA uCi/ml
01/03/89	1341.0	194.5	1.8E-02	3.3E-03	0.22	1.32E-15	195.0	2.9E+00	2.3E+00	0.33	4.16E-14
01/10/89	1402.0	172.5	1.4E-02	6.1E-03	0.22	6.82E-16	174.0	3.0E+00	2.3E+00	0.33	4.38E-14
01/17/89	1360.0	220.0	2.4E-02	0.0E+00	0.22	2.21E-15	220.5	2.7E+00	2.3E+00	0.33	2.01E-14
01/24/89	1349.0	171.8	1.6E-02	4.4E-03	0.22	1.01E-15	172.3	3.0E+00	2.6E+00	0.33	2.52E-14
01/31/89	1425.0	171.5	2.1E-02	1.1E-03	0.22	1.72E-15	172.0	2.9E+00	2.5E+00	0.31	2.76E-14
02/07/89	1426.0	171.5	3.2E-02	2.8E-03	0.22	2.49E-15	172.0	3.2E+00	2.5E+00	0.31	4.31E-14
02/14/89	1412.0	172.0	1.3E-02	1.1E-03	0.22	1.02E-15	171.5	3.0E+00	2.4E+00	0.31	3.75E-14
02/21/89	1439.0	173.0	9.4E-03	2.2E-03	0.22	6.17E-16	173.5	2.6E+00	2.3E+00	0.33	1.61E-14
02/28/89	1329.0	172.3	1.6E-02	2.2E-03	0.22	1.23E-15	172.8	2.7E+00	2.2E+00	0.33	3.01E-14
03/07/89	1403.0	218.5	1.9E-02	6.1E-03	0.22	1.17E-15	218.0	2.6E+00	2.2E+00	0.33	2.29E-14
03/15/89	1626.0	170.3	2.9E-02	2.8E-03	0.22	2.01E-15	170.8	2.7E+00	2.3E+00	0.33	1.80E-14
03/21/89	1214.0	172.2	1.9E-02	2.2E-03	0.22	1.69E-15	171.7	2.5E+00	2.2E+00	0.33	1.91E-14
03/28/89	1384.0	196.0	1.8E-02	5.0E-03	0.22	1.13E-15	171.5	2.5E+00	2.3E+00	0.33	1.57E-14
04/04/89	1425.0	196.0	1.4E-02	1.7E-03	0.22	1.05E-15	195.5	2.4E+00	2.1E+00	0.30	1.58E-14
04/11/89	1410.0	339.0	1.8E-02	3.9E-03	0.22	1.21E-15	338.5	2.5E+00	2.3E+00	0.30	1.56E-14
04/18/89	1428.0	172.8	1.7E-02	3.9E-03	0.22	1.10E-15	174.3	2.6E+00	2.3E+00	0.30	2.11E-14
04/25/89	1397.0	340.3	2.9E-02	1.7E-03	0.22	2.44E-15	341.8	2.8E+00	2.4E+00	0.30	2.65E-14
05/03/89	1648.0	336.5	2.1E-02	2.2E-03	0.22	1.37E-15	337.0	2.6E+00	2.2E+00	0.30	2.14E-14
05/09/89	1193.0	338.5	2.2E-02	3.3E-03	0.22	1.95E-15	338.0	2.5E+00	2.2E+00	0.30	2.20E-14
05/30/89	1370.0	1038.5	4.9E-02	2.2E-03	0.22	4.23E-15	1038.0	3.1E+00	2.9E+00	0.31	1.33E-14
06/06/89	1416.0	1012.3	4.1E-02	9.4E-03	0.22	2.70E-15	1011.8	2.9E+00	2.7E+00	0.31	1.25E-14
06/13/89	1429.0	864.0	4.9E-02	7.2E-03	0.22	3.63E-15	863.5	2.9E+00	2.7E+00	0.31	1.07E-14
06/21/89	1601.0	676.0	5.8E-02	7.2E-03	0.22	3.88E-15	675.5	3.0E+00	2.7E+00	0.31	1.69E-14
06/27/89	1223.0	530.3	2.3E-02	7.2E-03	0.22	1.56E-15	530.8	2.9E+00	2.7E+00	0.31	1.07E-14
07/05/89	1652.0	485.0	2.5E-02	8.9E-03	0.22	1.20E-15	484.5	3.0E+00	2.6E+00	0.31	1.96E-14
07/11/89	1196.0	343.0	2.6E-02	8.9E-03	0.28	1.39E-15	343.5	3.0E+00	2.6E+00	0.33	2.76E-14
07/18/89	1416.0	171.0	1.8E-02	6.1E-03	0.28	8.33E-16	170.5	2.9E+00	2.6E+00	0.33	1.57E-14
07/25/89	1390.0	317.5	2.9E-02	3.3E-03	0.28	1.77E-15	317.0	3.0E+00	2.7E+00	0.33	1.56E-14
08/01/89	1411.0	366.0	3.3E-02	6.1E-03	0.28	1.86E-15	366.5	2.8E+00	2.6E+00	0.33	9.25E-15
08/07/89	1240.0	341.5	2.1E-02	7.8E-03	0.28	9.95E-16	341.0	2.8E+00	2.5E+00	0.33	1.54E-14
08/15/89	1414.0	245.0	2.6E-02	3.9E-03	0.28	1.52E-15	246.0	3.0E+00	2.6E+00	0.33	2.16E-14
08/22/89	1426.0	364.5	2.7E-02	7.2E-03	0.28	1.35E-15	365.3	2.7E+00	2.5E+00	0.33	1.25E-14
08/30/89	1665.0	309.9	1.1E-02	6.1E-03	0.28	2.58E-16	309.4	2.6E+00	2.4E+00	0.34	1.05E-14
09/12/89	1416.0	218.5	1.3E-02	3.3E-03	0.28	6.44E-16	221.0	2.8E+00	2.5E+00	0.34	2.02E-14

TABLE B6. LVAS DATA S-2 WIPP - 1989, cont.

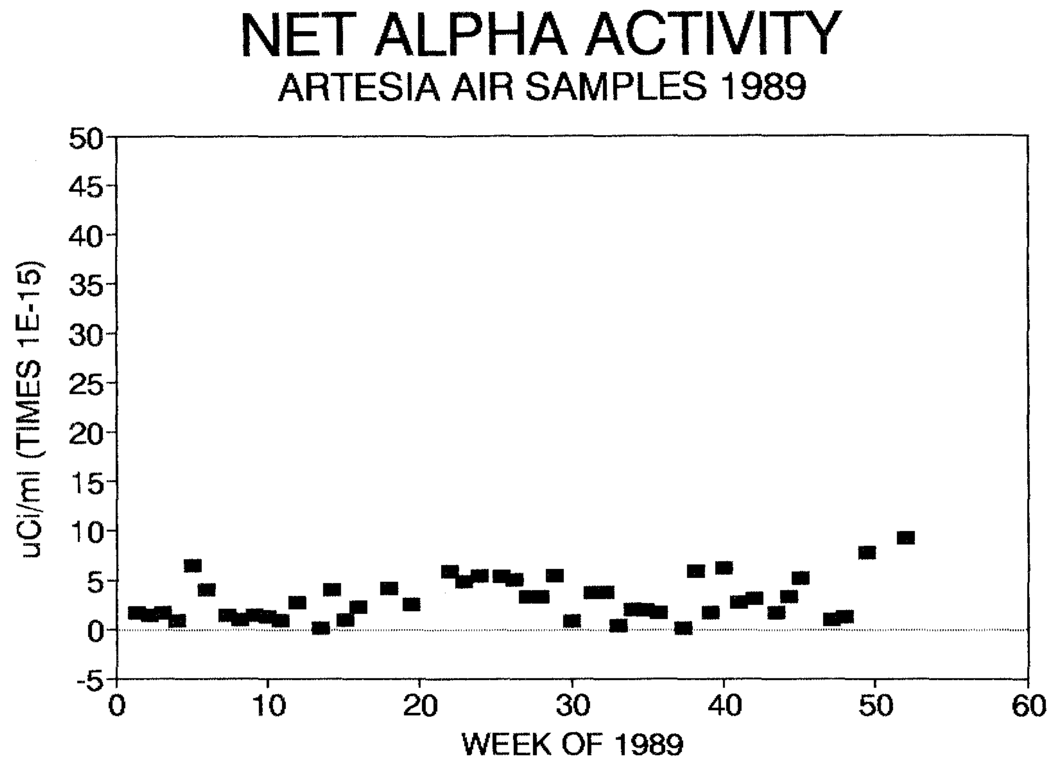
SAMPLE DATE	SAMPLE VOLUME m3	ALPHA DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	ALPHA EFF c/d	ALPHA uCi/ml	BETA DECAY hours	GROSS BETA c/s	BKG BETA c/s	BETA EFF c/d	BETA uCi/ml
09/20/89	1595.0	312.8	2.4E-02	5.6E-03	0.23	1.35E-15	335.4	2.8E+00	2.4E+00	0.33	1.82E-14
09/26/89	1213.0	197.0	1.2E-02	1.0E-02	0.23	1.61E-16	197.5	2.7E+00	2.4E+00	0.33	2.52E-14
10/02/89	1319.0	195.0	2.2E-02	3.3E-03	0.23	1.63E-15	195.5	2.8E+00	2.3E+00	0.33	2.99E-14
10/09/89	1372.0	194.5	2.8E-02	1.7E-03	0.23	2.24E-15	195.0	2.7E+00	2.3E+00	0.33	2.21E-14
10/16/89	1384.0	268.5	2.5E-02	6.1E-03	0.23	1.60E-15	269.0	2.8E+00	2.3E+00	0.33	3.01E-14
10/25/89	1796.0	313.8	4.1E-02	3.3E-03	0.23	2.44E-15	317.8	2.7E+00	2.3E+00	0.34	1.53E-14
10/30/89	1007.0	195.3	2.5E-02	3.3E-03	0.23	2.53E-15	198.2	2.5E+00	2.3E+00	0.34	1.84E-14
11/07/89	1572.0	222.3	3.9E-02	1.5E-02	0.23	1.83E-15	221.8	2.8E+00	2.3E+00	0.34	2.90E-14
11/13/89	1160.0	341.3	2.9E-02	3.9E-03	0.23	2.53E-15	340.8	2.7E+00	2.3E+00	0.34	2.91E-14
11/20/89	1438.0	189.5	1.6E-02	3.3E-03	0.23	1.04E-15	190.5	2.6E+00	2.2E+00	0.34	2.13E-14
12/04/89	1170.0	190.8	2.0E-02	5.6E-03	0.23	1.45E-15	191.3	2.4E+00	2.2E+00	0.32	1.32E-14
12/18/89	1060.0	357.0	1.9E-02	3.9E-03	0.23	1.72E-15	356.5	2.6E+00	2.3E+00	0.34	2.60E-14

TABLE B7. LVAS DATA. S-3 WIPP - 1989.

SAMPLE DATE	SAMPLE VOLUME m3	ALPHA DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	ALPHA EFF c/d	ALPHA CONC uCi/ml	BETA DECAY hours	GROSS BETA c/s	BKG BETA c/s	BETA EFF c/d	BETA CONC uCi/ml
01/03/89	1335.0	194.5	1.8E-02	3.3E-03	0.22	1.38E-15	194.0	2.9E+00	2.3E+00	0.33	3.90E-14
01/10/89	1423.0	174.5	1.5E-02	6.1E-03	0.22	7.67E-16	173.0	2.8E+00	2.3E+00	0.33	3.11E-14
01/17/89	1383.0	220.0	2.1E-02	0.0E+00	0.22	1.88E-15	219.5	2.7E+00	2.3E+00	0.33	2.16E-14
01/24/89	1417.0	171.3	2.3E-02	4.4E-03	0.22	1.64E-15	171.8	3.1E+00	2.6E+00	0.33	2.76E-14
01/31/89	1387.0	171.5	1.6E-02	1.1E-03	0.22	1.28E-15	171.0	3.0E+00	2.5E+00	0.31	3.49E-14
02/07/89	1437.0	171.5	2.9E-02	2.8E-03	0.22	2.23E-15	171.0	3.2E+00	2.5E+00	0.31	3.83E-14
02/14/89	1369.0	172.0	1.5E-02	1.1E-03	0.22	1.25E-15	172.5	2.9E+00	2.4E+00	0.31	3.65E-14
02/28/89	1355.0	170.0	1.5E-02	2.2E-03	0.22	1.16E-15	170.5	2.7E+00	2.2E+00	0.33	2.94E-14
03/07/89	1423.0	339.8	2.1E-02	7.8E-03	0.22	1.10E-15	340.3	2.5E+00	2.2E+00	0.33	1.99E-14
03/28/89	1197.0	170.5	2.2E-02	3.3E-03	0.22	1.88E-15	196.5	2.6E+00	2.3E+00	0.33	2.44E-14
04/04/89	1445.0	171.5	1.6E-02	2.2E-03	0.22	1.18E-15	173.0	2.4E+00	2.2E+00	0.30	1.44E-14
04/11/89	1359.0	339.0	2.4E-02	3.9E-03	0.22	1.86E-15	339.5	2.5E+00	2.3E+00	0.30	1.58E-14
04/18/89	1368.0	196.3	1.8E-02	2.2E-03	0.22	1.40E-15	197.8	2.6E+00	2.2E+00	0.30	2.32E-14
04/25/89	1466.0	506.5	3.3E-02	3.9E-03	0.22	2.47E-15	507.0	2.9E+00	2.4E+00	0.30	3.14E-14
05/03/89	1512.0	480.3	2.1E-02	3.3E-03	0.22	1.44E-15	479.8	2.6E+00	2.2E+00	0.30	2.35E-14
05/09/89	1199.0	336.5	2.1E-02	3.3E-03	0.22	1.76E-15	337.0	2.5E+00	2.2E+00	0.30	2.27E-14
05/30/89	1322.0	1039.0	5.0E-02	2.2E-03	0.22	4.44E-15	1039.5	3.1E+00	2.9E+00	0.31	1.51E-14
06/06/89	1478.0	1013.8	4.9E-02	9.4E-03	0.22	3.32E-15	1013.3	2.9E+00	2.7E+00	0.31	1.08E-14
06/13/89	1443.0	864.5	4.3E-02	7.2E-03	0.22	3.07E-15	865.0	3.0E+00	2.7E+00	0.31	1.49E-14
06/21/89	1605.0	676.0	5.2E-02	7.2E-03	0.22	3.44E-15	675.5	3.1E+00	2.7E+00	0.31	2.04E-14
06/27/89	1187.0	532.5	2.6E-02	7.2E-03	0.22	1.90E-15	531.5	2.8E+00	2.7E+00	0.31	7.02E-15
07/05/89	1675.0	485.0	3.8E-02	8.9E-03	0.22	2.16E-15	485.5	3.0E+00	2.6E+00	0.31	2.28E-14
07/11/89	1158.0	342.5	3.2E-02	8.9E-03	0.28	1.90E-15	342.0	3.0E+00	2.6E+00	0.33	2.54E-14
07/18/89	1424.0	171.0	2.3E-02	6.1E-03	0.28	1.17E-15	171.5	2.9E+00	2.6E+00	0.33	1.69E-14
07/25/89	1348.0	316.5	3.3E-02	3.3E-03	0.28	2.11E-15	317.0	2.9E+00	2.7E+00	0.33	1.47E-14
08/07/89	1268.0	341.5	2.3E-02	7.8E-03	0.28	1.18E-15	342.0	2.8E+00	2.5E+00	0.33	1.94E-14
08/15/89	1588.0	341.5	2.3E-02	7.8E-03	0.28	9.46E-16	342.0	2.8E+00	2.5E+00	0.33	1.55E-14
08/22/89	1421.0	364.5	2.3E-02	7.2E-03	0.28	1.09E-15	363.8	2.7E+00	2.5E+00	0.33	1.39E-14
08/30/89	1685.0	311.0	2.0E-02	6.1E-03	0.28	7.96E-16	311.5	2.7E+00	2.4E+00	0.34	1.20E-14
09/05/89	1169.0	171.0	1.3E-02	6.1E-03	0.28	5.96E-16	170.5	2.6E+00	2.4E+00	0.34	1.34E-14
09/20/89	1610.0	335.7	2.2E-02	1.0E-02	0.23	8.52E-16	313.2	2.8E+00	2.4E+00	0.33	2.16E-14
09/26/89	1212.0	197.0	1.8E-02	1.0E-02	0.23	7.54E-16	196.5	2.8E+00	2.4E+00	0.33	2.43E-14
10/02/89	1334.0	196.0	3.0E-02	3.3E-03	0.23	2.35E-15	195.5	2.8E+00	2.3E+00	0.33	3.22E-14
10/09/89	1393.0	194.5	2.9E-02	1.7E-03	0.23	2.30E-15	194.0	2.7E+00	2.3E+00	0.33	2.20E-14

TABLE B7. LVAS DATA. S-3 WIPP - 1989, cont.

SAMPLE DATE	SAMPLE VOLUME m3	ALPHA DECAY hours	GROSS ALPHA c/s	BKG ALPHA c/s	ALPHA EFF c/d	ALPHA CONC uCi/ml	BETA DECAY hours	GROSS BETA c/s	BKG BETA c/s	BETA EFF c/d	BETA CONC uCi/ml
10/16/89	1353.0	268.5	2.0E-02	6.1E-03	0.23	1.21E-15	268.0	2.7E+00	2.3E+00	0.33	2.51E-14
10/25/89	1853.0	318.0	2.7E-02	3.3E-03	0.23	1.48E-15	313.0	2.6E+00	2.3E+00	0.34	1.43E-14
10/30/89	1033.0	197.7	1.7E-02	3.3E-03	0.23	1.52E-15	194.8	2.5E+00	2.3E+00	0.34	1.47E-14
11/07/89	1539.0	221.3	5.3E-02	1.5E-02	0.23	2.88E-15	221.8	2.7E+00	2.3E+00	0.34	2.46E-14
11/13/89	1085.0	340.3	2.3E-02	1.7E-03	0.23	2.35E-15	341.8	2.7E+00	2.2E+00	0.34	3.91E-14
11/20/89	1489.0	191.0	2.7E-02	3.3E-03	0.23	1.89E-15	190.0	2.5E+00	2.2E+00	0.34	1.68E-14
11/28/89	1382.0	338.3	1.7E-02	5.6E-03	0.23	9.45E-16	339.0	2.5E+00	2.2E+00	0.32	1.75E-14
12/04/89	1246.0	191.1	2.2E-02	5.6E-03	0.23	1.57E-15	190.6	2.4E+00	2.2E+00	0.32	1.30E-14
12/12/89	1549.0	531.8	3.8E-02	3.9E-03	0.23	2.57E-15	530.8	2.8E+00	2.3E+00	0.34	2.71E-14
12/18/89	1214.0	357.0	4.2E-02	3.9E-03	0.23	3.71E-15	357.5	2.7E+00	2.3E+00	0.34	2.50E-14



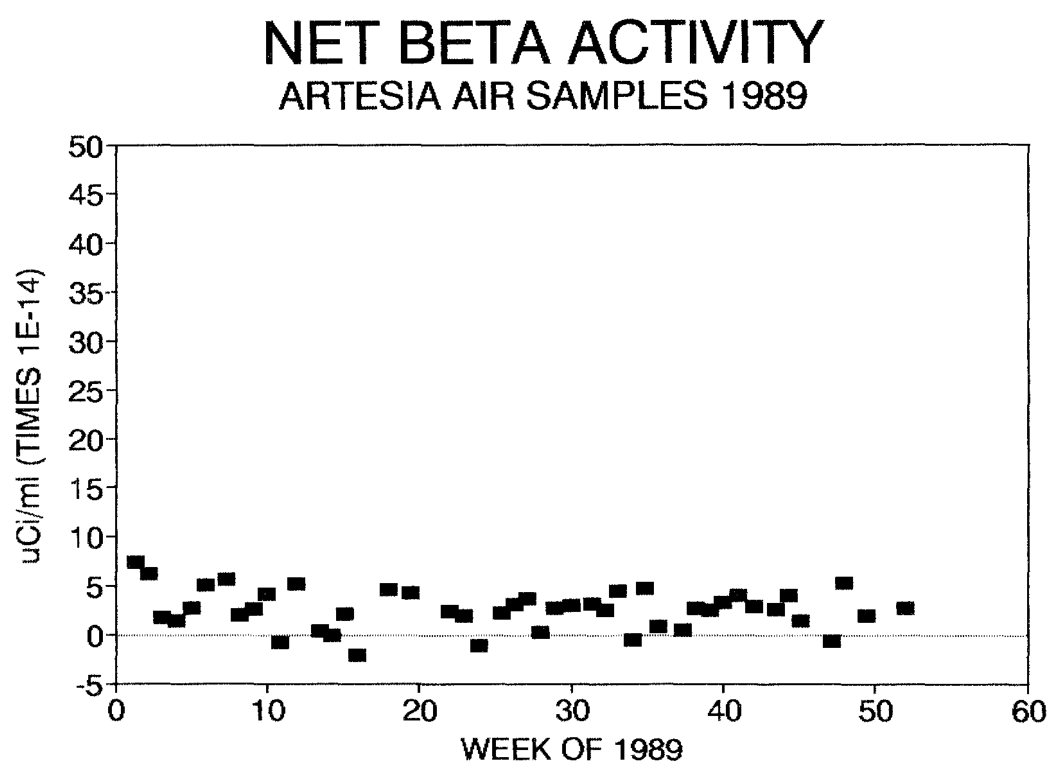
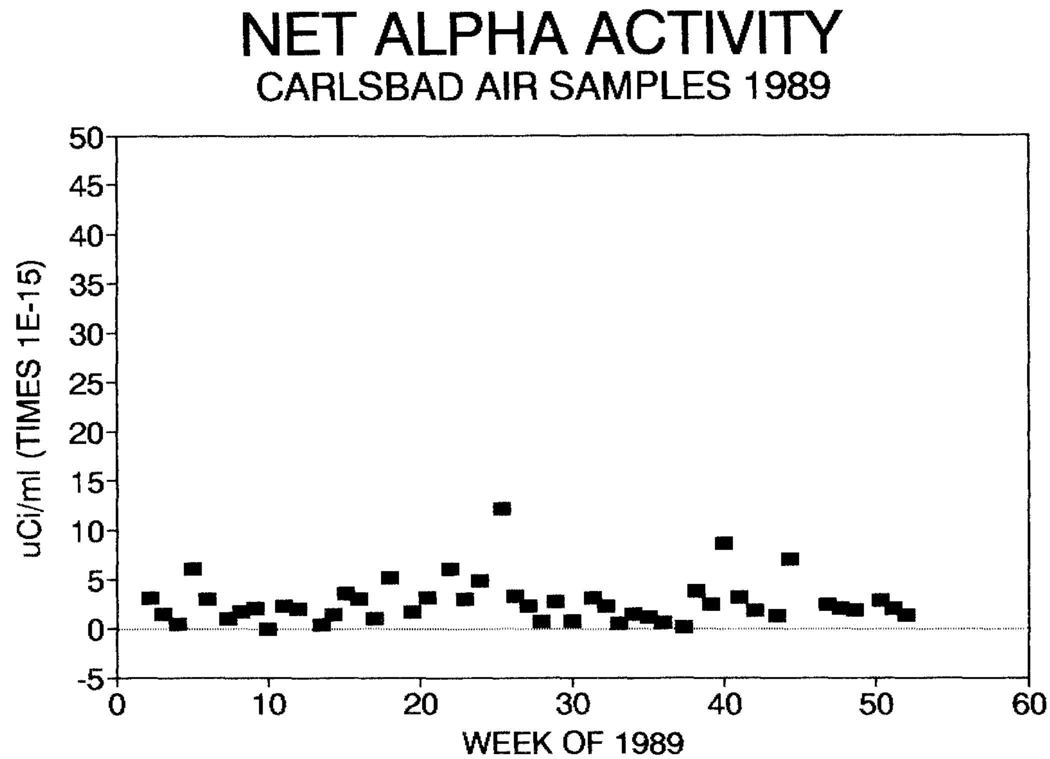


Figure B1. Net Alpha and Beta Activity-Air Samples-Artesia-1989



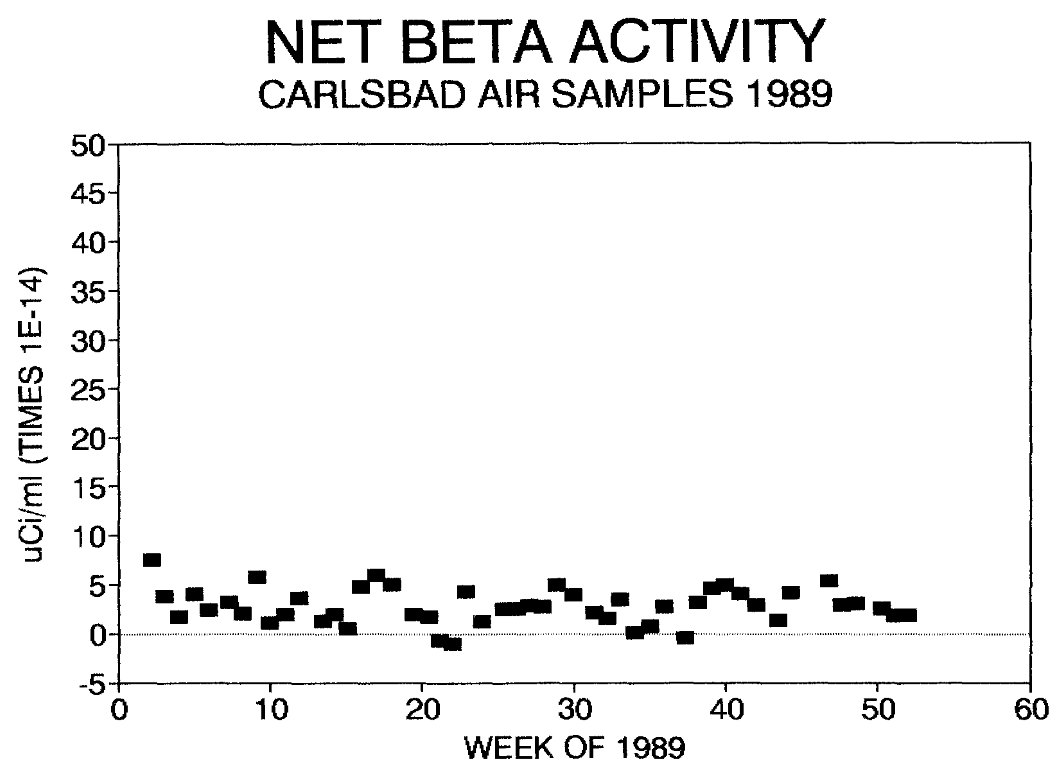
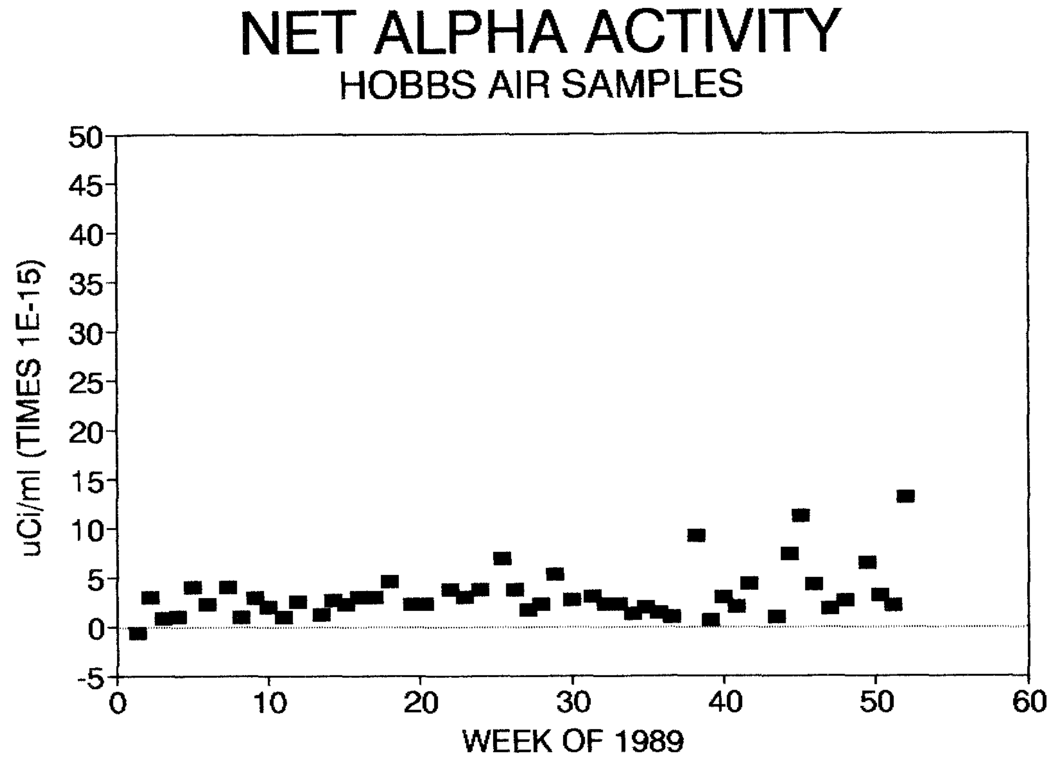


Figure B2. Net Alpha and Beta Activity-Air Samples-Carlsbad-1989



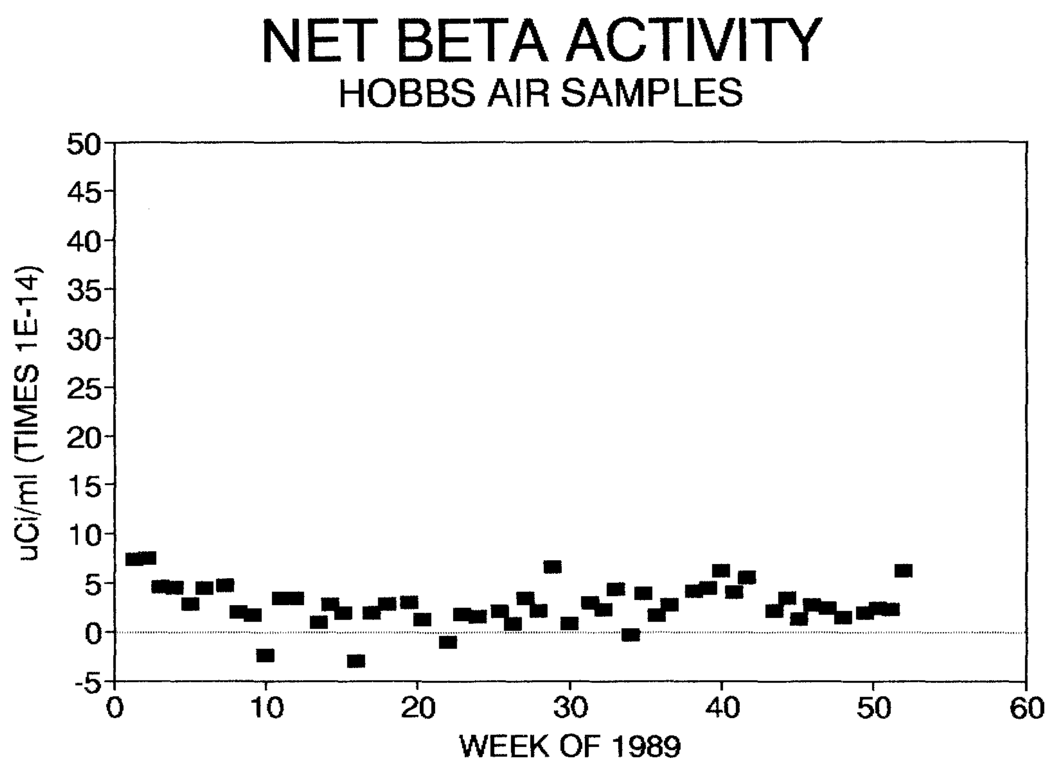
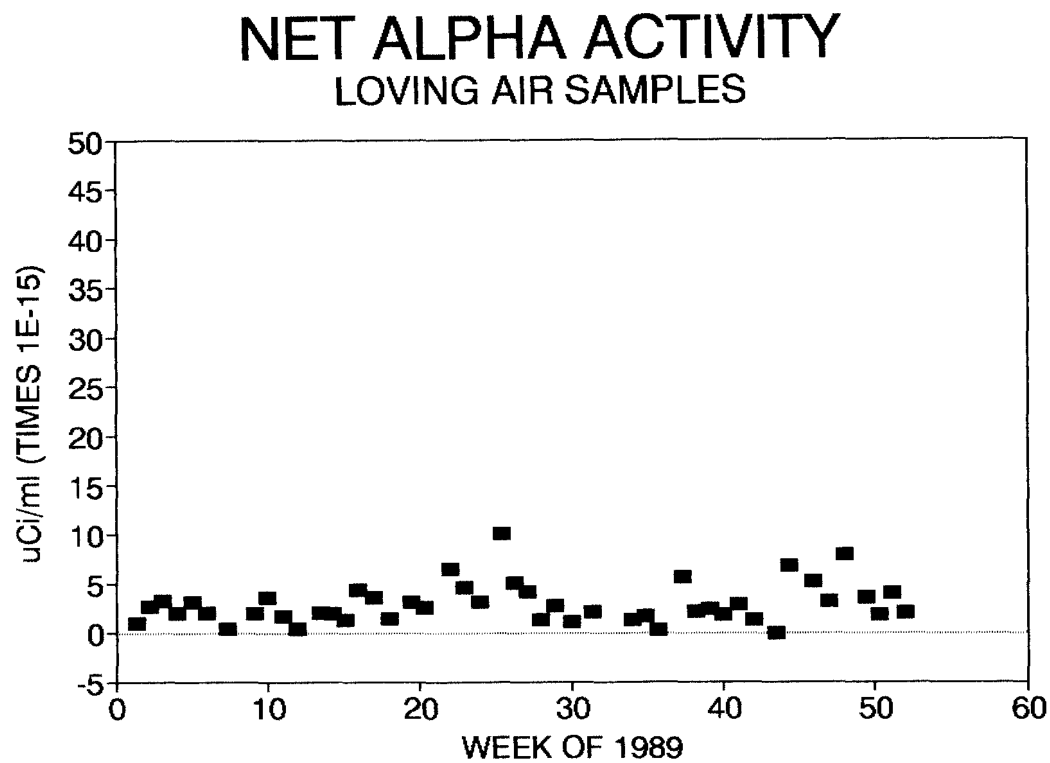


Figure B3. Net Alpha and Beta Activity-Air Samples-Hobbs-1989



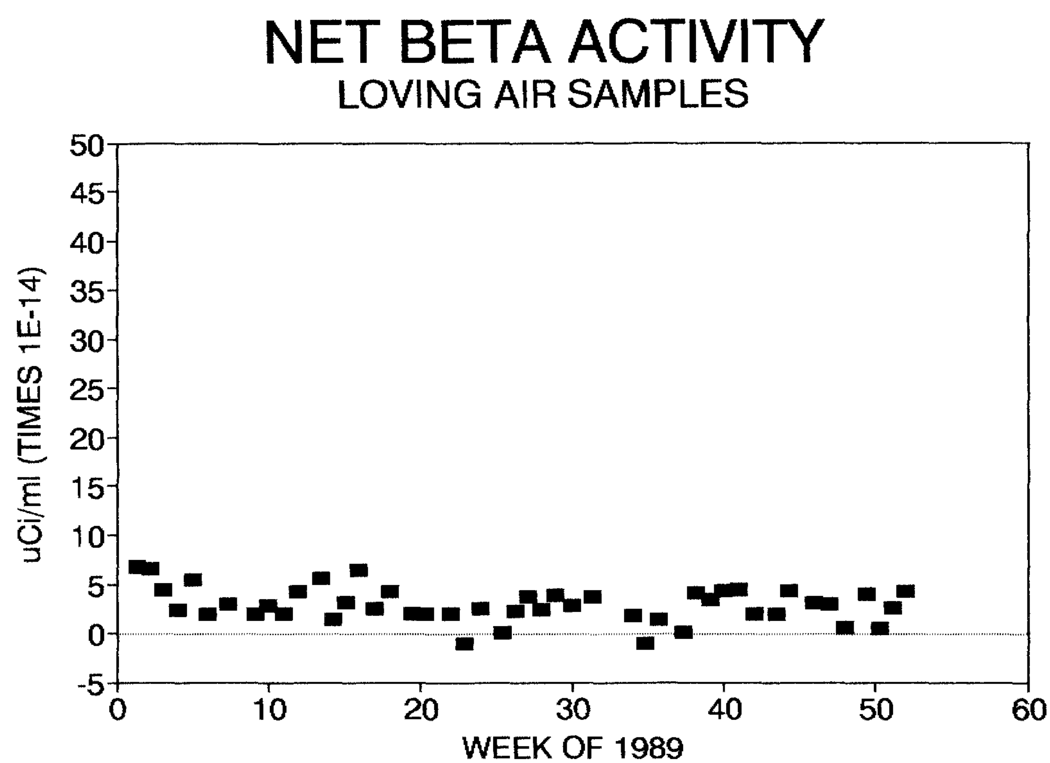
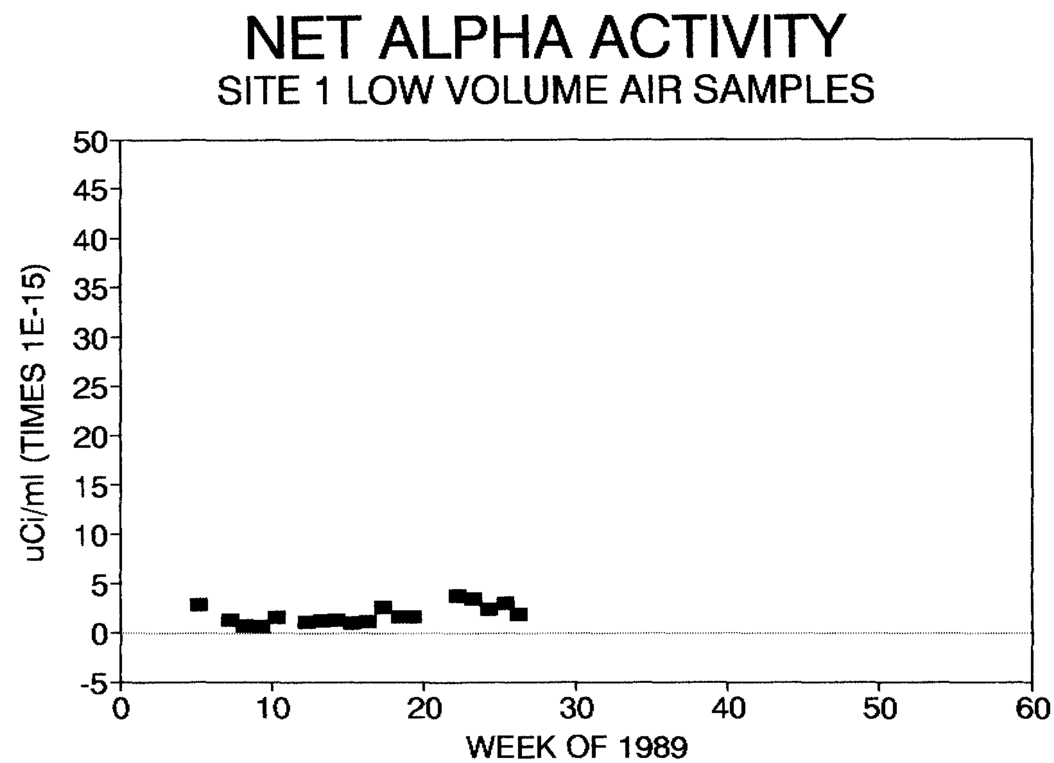


Figure B4. Net Alpha and Beta Activity-Air Samples-Loving-1989



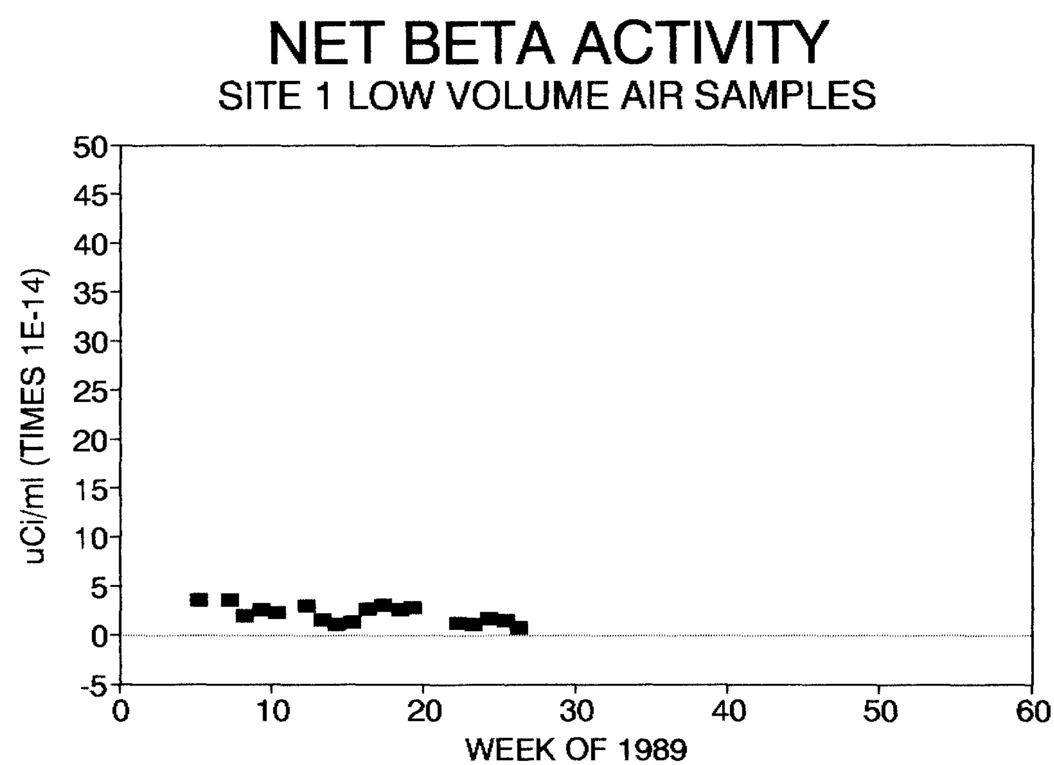
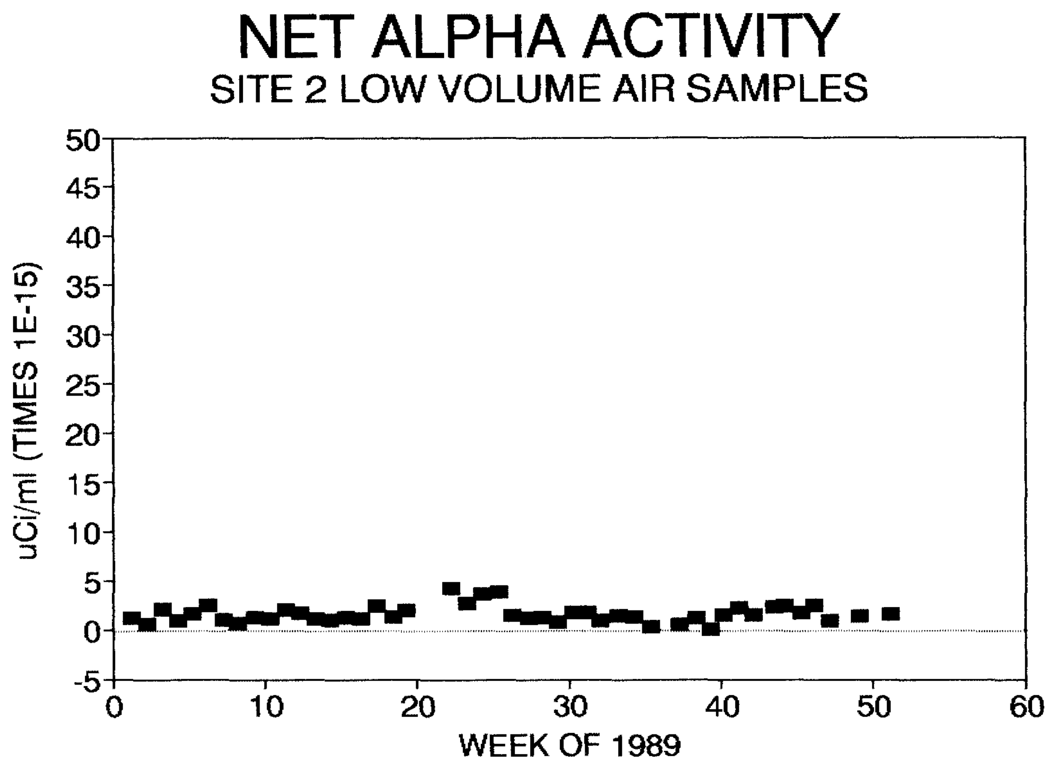


Figure B5. Net Alpha and Beta Activity-Air Samples-Site 1 WIPP-1989



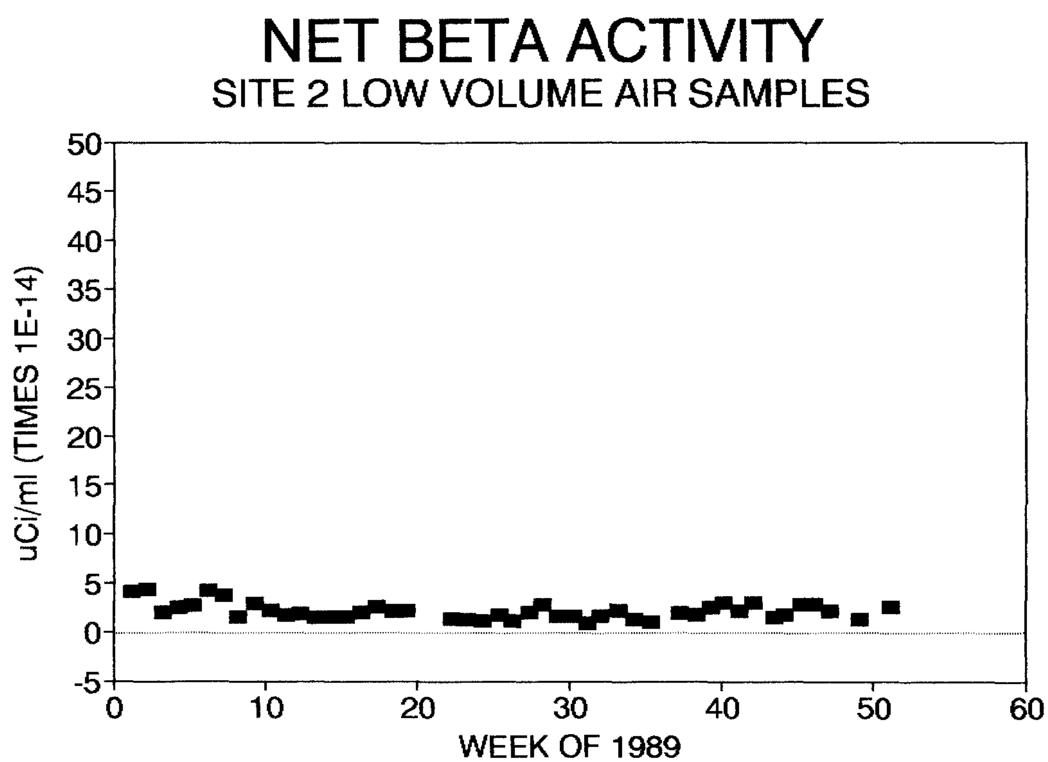
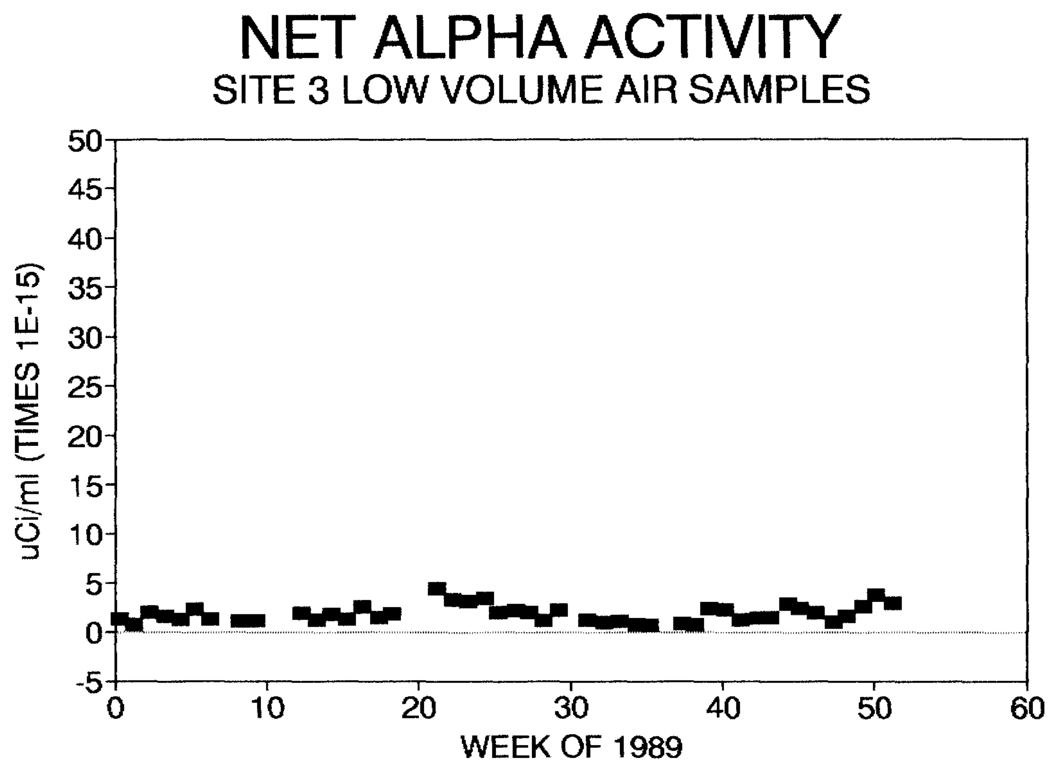


Figure B6. Net Alpha and Beta Activity-Air Samples-Site 2 WIPP-1989



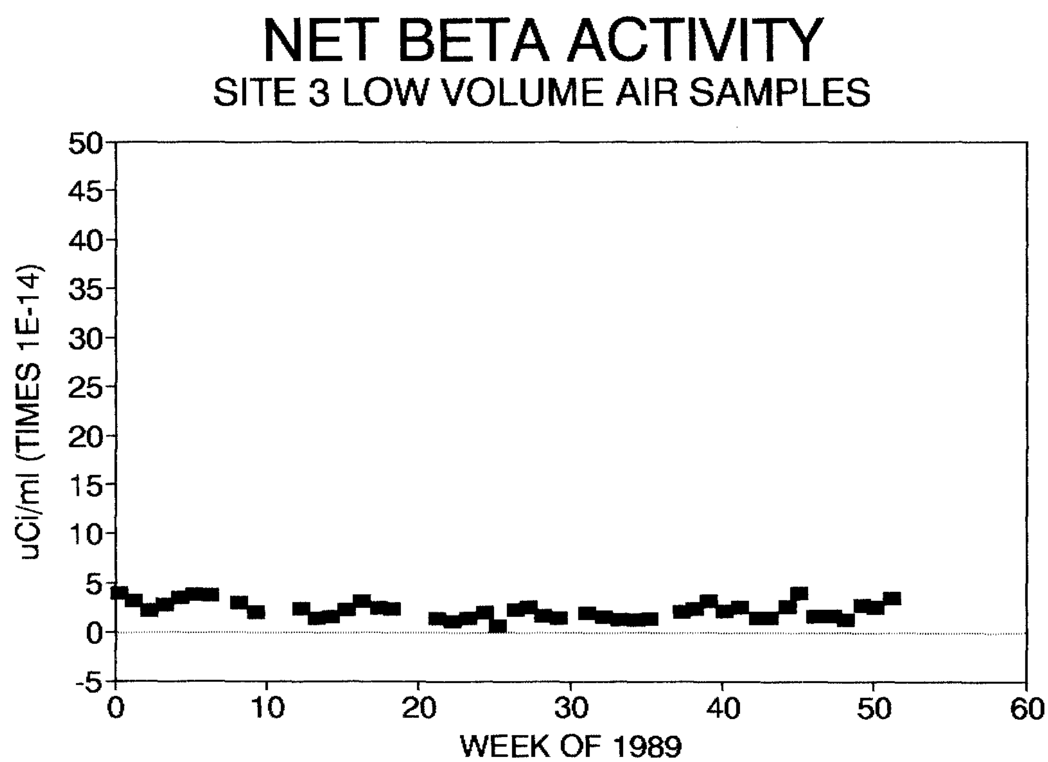


Figure B7. Net Alpha and Beta Activity-Air Samples-Site 3 WIPP-1989