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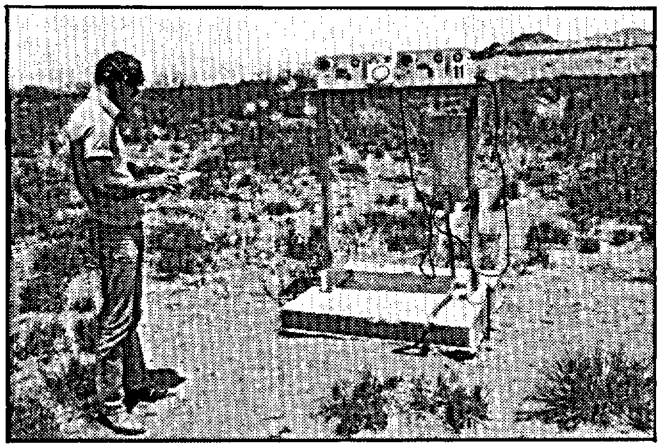
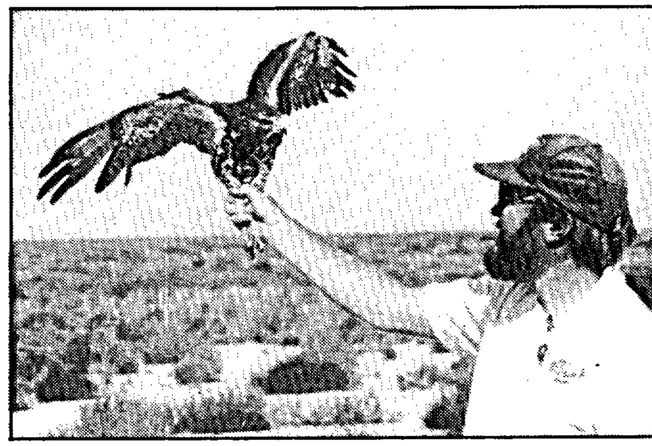
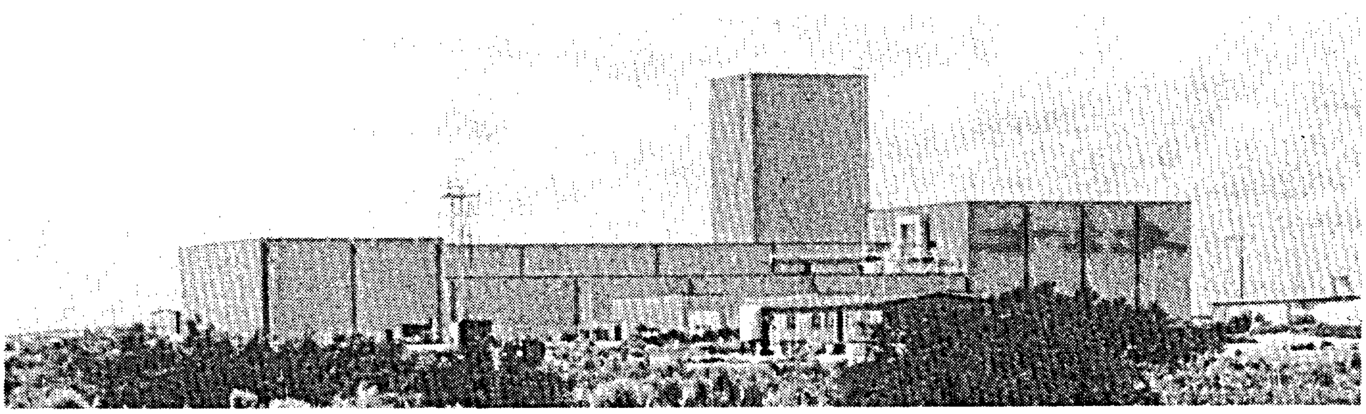
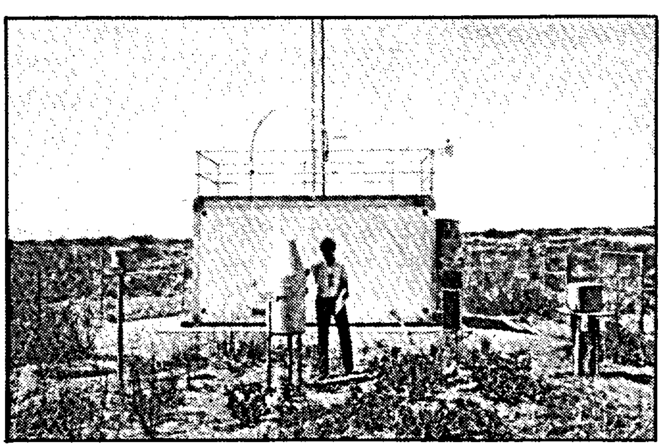
DOE/WIPP 90 - 003

Waste Isolation Pilot Plant Site Environmental Report For Calendar Year 1989









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ACRONYMS AND ABBREVIATIONS

ADM	Action Description Memoranda
AMS	Atmospheric Monitoring Station
ANOVA	Analysis of Variance
BLM	U. S. Bureau of Land Management
CAA	Clean Air Act
CFM	Cubic Feet per Minute
CH-TRU	Contact Handled Transuranic Waste
CWA	Clean Water Act
DOE	U. S. Department of Energy
DOT	U. S. Department of Transportation
EC	Electrical Conductivity
EEG	Environmental Evaluation Group
EID	New Mexico Environmental Improvement Division
EMP	Ecological Monitoring Program
EPA	U. S. Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FDA	Fluorescardiacetate Hydrolysis Assay
FSAR	Final Safety Analysis Report
GOCO	Government-Owned, Contractor Operated
HEPA	High Efficiency Particulate Air (filter)
HPIC	High Pressure Ionization Chamber
MOC	Management and Operating Contractor
MOU	Memorandum of Understanding
NCRP	National Council on Radiation Protection and Measurement
NEPA	National Environmental Policy Act

NES	Nonradiological Environmental Surveillance
NESHAP	National Emmissions Standards for Hazardous Air Pollutants
NMGF	New Mexico Department of Game and Fish
NMSA	New Mexico Statutes Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRC	Nuclear Regulatory Commission
OEMP	Operational Environmental Monitoring Program
OP	Optical Density
PCB	Polychlorinated Biphenyls
QA	Quality Assurance
QC	Quality Control
RBP	Radiological Baseline Program
RCRA	Resource Conservation and Recovery Act
REP	Regulatory and Environmental Programs
RES	Radiological Environmental Surveillance
RH-TRU	Remote Handled Transuranic Waste
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SEIS	Supplement Environmental Impact Statement
SER	Site Environmental Report
SNL	Sandia National Laboratories
SNK	Student-Newman-Keuls
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeters
TRU	Transuranic Waste

TRUPACT II	Transuranic Package Transporter
TSP	Total Suspended Particulate
TSS	Total Suspended Solids
UNC	United Nuclear Corporation
USC	United States Code
WAESD	Westinghouse Advanced Energy Systems Division
WEC	Westinghouse Electric Corporation
WID	Waste Isolation Division
WIPP	Waste Isolation Pilot Plant
WQSP	Water Quality Sampling Program
WTSD	Waste Technology Services Division
USGS	United States Geologic Survey

CHAPTER 1

INTRODUCTION

This is the 1989 Site Environmental Report (SER) for the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico. The WIPP is a government owned and contractor-operated facility. The WIPP project is operated by Westinghouse Electric Corporation for the U.S. Department of Energy (DOE). The mission of the WIPP is to provide a research and development facility to demonstrate the safe disposal of transuranic (TRU) waste generated by the defense activities of the U.S. Government. This document is prepared in accordance with the guidance contained in Order DOE 5400.1, General Environmental Protection Program Requirements (DOE, 1988a) and DOE/WIPP 90-001 Environmental Protection Implementation Plan for the Waste Isolation Pilot Plant, which requires DOE facilities to submit an SER to the Office of Operational Safety. This report provides a comprehensive description of environmental activities at the WIPP during calendar year 1989.

The WIPP facility will not receive waste until all concerns affecting opening the WIPP are addressed to the satisfaction of the Secretary of Energy. Therefore, this report describes the status of the preoperational activities of the Radiological Environmental Surveillance (RES) program, which are outlined in the Radiological Baseline Program for the Waste Isolation Pilot Plant (WTSD-TME-057). Since the WIPP is in a preoperational state, certain elements of Order DOE 5400.1 are not presented in this report. For example, no discussion of radionuclide emissions with subsequent estimates of doses to the public is included.

During March 1989, the monitoring activities of the Radiological Baseline Program (RBP) and the Ecological Monitoring Program (EMP) were combined into the Operational Environmental Monitoring Program (OEMP). This program is described in the "Operational Environmental Monitoring Plan for the Waste Isolation Pilot Plant" (DOE/WIPP 88-025). This plan defines the scope and extent of the WIPP effluent and environmental monitoring programs during the facility's operational life. The OEMP is the data base for all environmental monitoring programs during the operational life of the facility. The OEMP also discusses the quality assurance and quality control programs which ensure that samples collected and the resulting analytical data are representative of actual conditions at the WIPP site. The OEMP was prepared in accordance with the guidance contained in Order DOE 5400.1 and draft Order 5400.xx, Radiation Protection of the Public and the Environment (DOE, 1988b), which was subsequently issued as Order DOE 5400.5 in February, 1990. This plan also responds to the requirements and guidelines presented in draft Order DOE 5400.xy, Radiological Effluent Monitoring and Environmental Surveillance for U.S. DOE Operations (DOE, 1988c).

1.1 DESCRIPTION OF THE WIPP PROJECT

TRU wastes will be transported from 10 generator sites around the United States to the WIPP. These waste materials are contaminated with alpha emitting radionuclides having atomic numbers greater than 92 and half lives longer than 20 years. Also to be classified as a TRU waste, the specific activity of these radionuclides in TRU waste must be higher than 100 nCi/g. General criteria defining the various categories of radioactive waste, including TRU waste, appear in Order DOE 5820.2A (DOE, 1988d). Isotopes of plutonium, americium, and curium will be the predominant radionuclides contaminating TRU waste shipped to WIPP.

The TRU waste to be received from the 10 generator sites will be transported to the WIPP via trucks. Each truck can haul up to three TRUPACT IIs containing 14, 55 gallon drums or two standard waste boxes. The TRUPACT II is a durable, reuseable, container which has been approved by the Nuclear Regulatory Commission (NRC) to transport the Contact-handled transuranic waste to the WIPP. (The NRC is the nationally recognized governing agency that regulates safe handling and proper safety concerns pertaining to radiation exposure to the public and the environment).

Once these TRUPACT IIs have arrived at the WIPP and they are brought into the Waste Handling Building, waste containers will be removed from the TRUPACT II,placed on the waste handling hoist, and lowered to the repository level of 655 m (2,150 feet). Waste containers will then be removed from the hoist and emplaced in excavated storage rooms in the Salado formation, a thick sequence of salt beds deposited approximately 250 million years ago (Permian Age). After filling a storage area, specially designed seals and plugs will be placed in the excavated storage rooms and in the shafts. The plastic self healing nature of the salt formation will result in gradual creep closure, causing encapsulation and isolation of the waste within the Salado formation. Approximately the first five years of the WIPP operations will be a test phase period, during which time tests will be performed to support the WIPP design and long-term isolation performance.

During site operations, the underground area will be ventilated by ambient air which enters the Air Intake Shaft, the Salt Handling Shaft, the Waste Handling Shaft, and exits through the exhaust shaft. In the event of an underground accident involving radioactivity, exhaust air will be circulated at a reduced flow rate through the Exhaust Filter Building, which contains banks of high efficiency particulate air (HEPA) filters that remove potentially contaminated particulates. Exhaust ventilation from the Waste Handling Building is continuously HEPA filtered to the atmosphere, and air emissions are not expected to represent a significant effluent release point.

1.2 DESCRIPTION OF THE ENVIRONMENT

The WIPP site is located in Eddy county in southeastern New Mexico (Figure 1-1). The site is approximately 40 kilometers (26 miles) east-southeast of Carlsbad in an area known as Los Medanos (the dunes), which is a sparsely inhabited plateau with little water and limited land uses. The land is owned by the United States Department of Interior, Bureau of Land Management (BLM) and is leased to permittees for grazing livestock. Other land uses in the general area include mining for potash, exploring for and/or extracting oil and natural gas, recreational use such as hunting, trapping, birdwatching, or other uses as permitted by the BLM.

The WIPP site consists of 16 sections (6.48 ha) of Federal land in Township 22 South, Range 31 East. Except for the 2.75 square kilometers (1 square mile) encompassing the facility (known as the DOE Exclusive Use Area), surface land uses remain largely unchanged. Mining and drilling for purposes other than support of the WIPP project are restricted within this 16 section (6.48 ha) area.

The WIPP site is divided into zones as represented in Figure 1-1. Zone I, surrounded by a chain-link fence, includes all major surface facilities. The secured area boundary, bounded by a barbed wire fence, includes other facilities associated with construction. Zone II indicates the maximum extent of underground development. The WIPP site boundary extends at least 1.6 kilometers (1 mile) beyond any underground development and is defined on the surface by the 16 section (6.48 ha) land withdrawal area. This boundary provides a functional barrier of intact salt between the underground region defined by Zone II and the accessible environment.

The approximate distribution of the local population in 1985 within 80 kilometers (50 miles) of the WIPP site is illustrated in Figure 1-2. The nearest residents to the site include eight individuals living at the Mills Ranch, 5.8 kilometers (3.5 miles) south-southwest of the site, and 13 individuals living at the Smith Ranch, 11.7 kilometers (7 miles) west-northwest of the site. Both neighboring ranches have been and will continue to be, monitored as part of the environmental monitoring program. Also, the International Minerals and Chemical Corporation potash mine plant site is located 15 kilometers (9 miles) west-northwest of the site. Detailed demographic summaries and projections are in the WIPP Final Environmental Impact Statement (FEIS) (DOE, 1980), Supplement Final Environmental Impact Statement (SEIS) (DOE, 1990) and Final Safety Analysis Report (FSAR) (DOE, 1990).

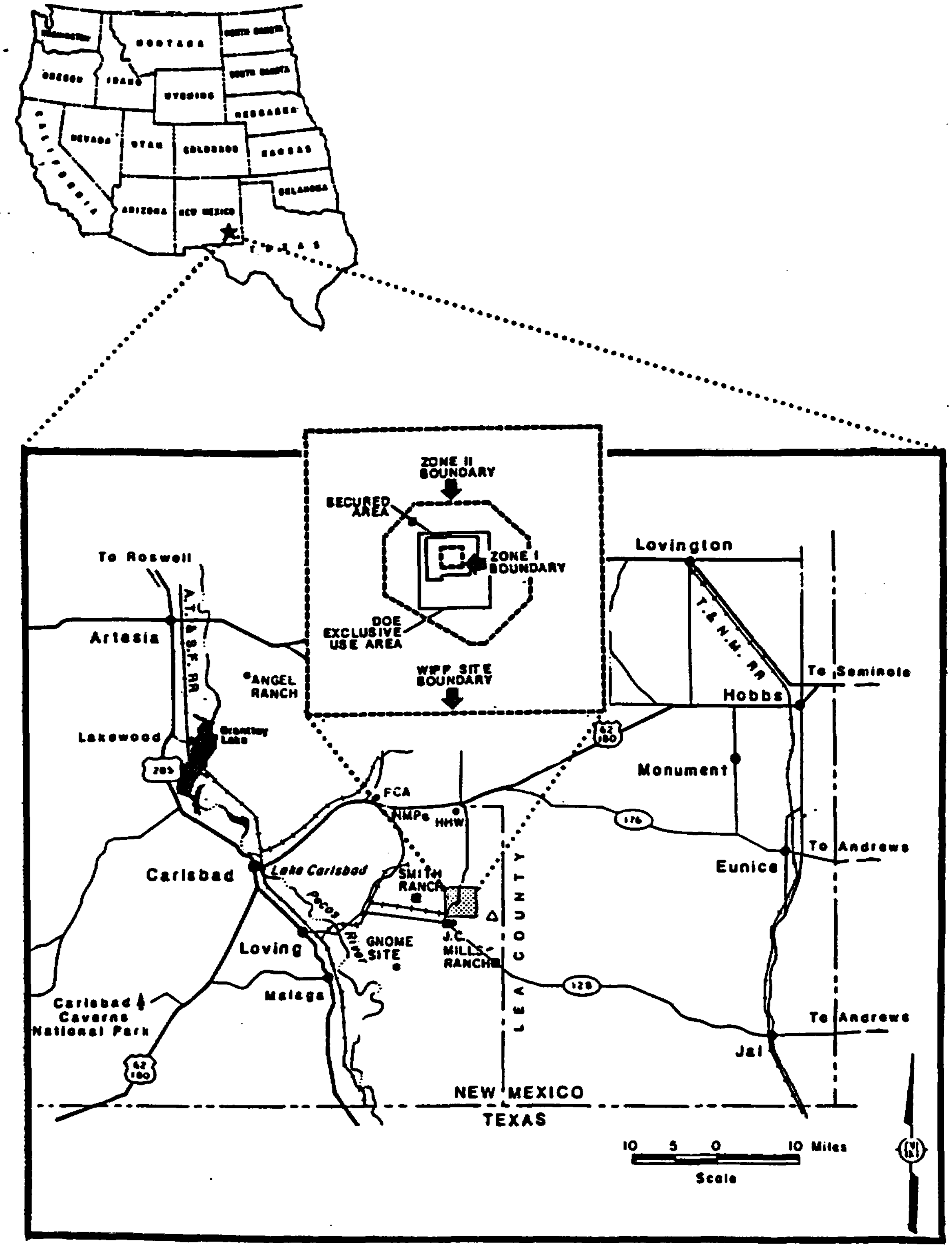

FIGURE 1-1 LOCATION OF THE WIPP SITE

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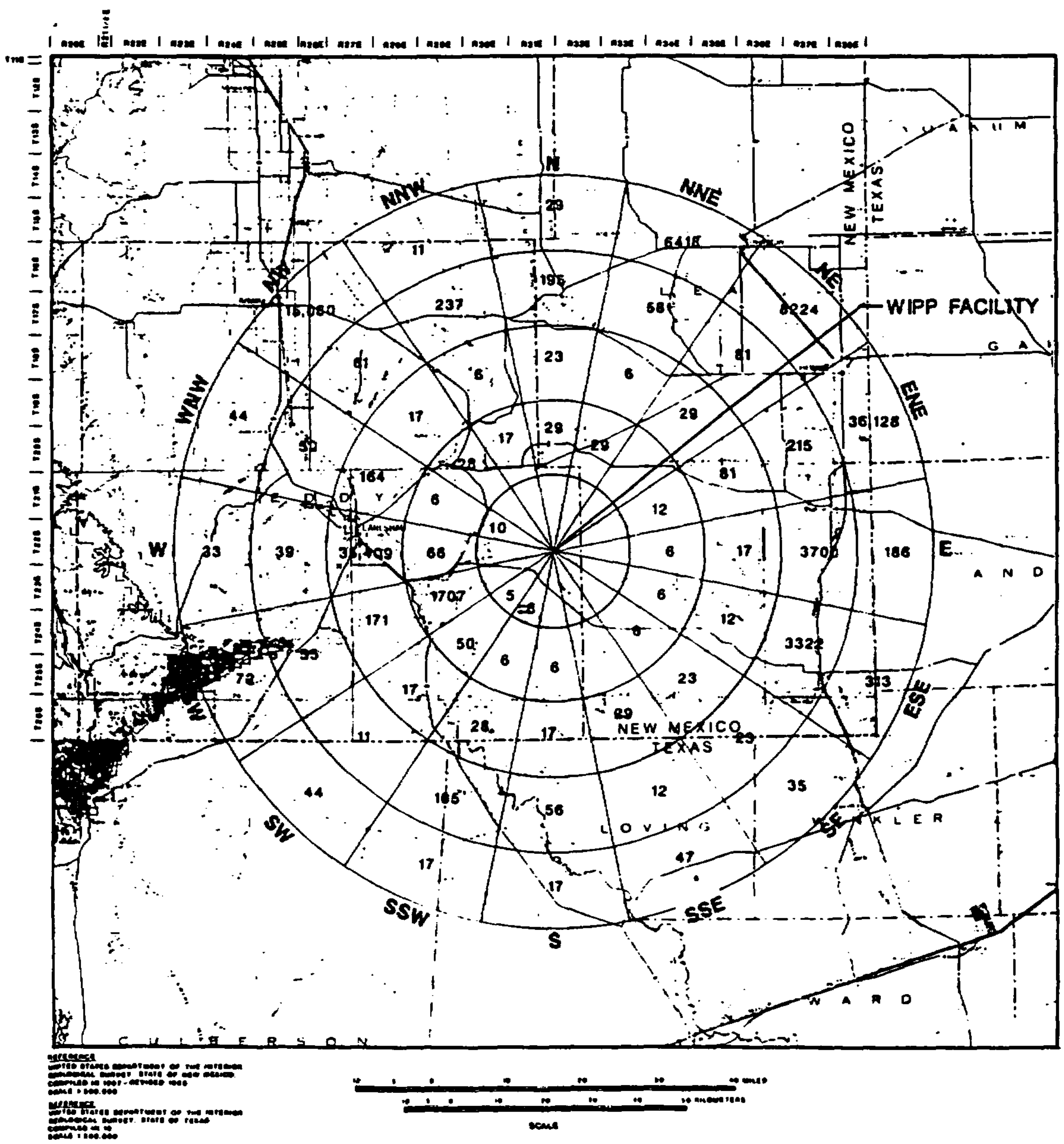

FIGURE 1-2
1985 POPULATION WITHIN 50 MILES OF THE WIPP FACILITY

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CHAPTER 2

SUMMARY OF ENVIRONMENTAL ACTIVITIES AT WIPP

The WIPP environmental program monitors a comprehensive set of parameters in order to detect any potential environmental impacts and establish baselines for future quantitative environmental impact evaluations. Measurements are taken of background radiation, meteorological conditions, water and air quality, soil properties, and the status of the local biological community. Ecological studies focus on the immediate area surrounding the site with emphasis on the salt storage pile, whereas baseline radiological surveillance covers a broader geographic area including nearby ranches, villages, and cities.

Since the WIPP is still in a preoperational state, no waste has been received, therefore, certain elements required by Order DOE 5400.1 are not presented in this report. For example, no discussion of radionuclide emissions with subsequent doses to the public is included. With the WIPP in a preoperational state discussions of radioactivity by radionuclides released as effluents is not discussed.

2.1 COMPLIANCE SUMMARY

In 1989, the WIPP complied with applicable Federal and State environmental regulations. The WIPP project maintains 15 active permits from the BLM and an Environmental Improvement Division (EID) permit for open burning. Additionally, the DOE has notified the EID of hazardous waste activities associated with the management of site-generated hazardous waste and has submitted the required Emergency and Hazardous Chemical Inventory Report. This report was submitted to satisfy the requirements of Title III of the Superfund Amendments and Reauthorization Act.

The No Migration Variance Petition was submitted to the Environmental Protection Agency (EPA) in accordance with 40 CFR 268.6. In October 1989, an addendum was also submitted. The EPA is currently reviewing this document to determine if untreated land-ban wastes can be received at the WIPP.

As a generator of hazardous waste, the DOE notified the EID in 1988 of hazardous waste activity at the WIPP. The WIPP has a hazardous waste management program in place which is in compliance with RCRA requirements.

In April 1989, the DOE issued a draft supplement to the Final Environmental Impact Statement (SEIS). The SEIS addressed several changes in the information and assumptions for calculating impacts reported in the Final Environmental Impact Statement (FEIS). A 90 day public comment period for the draft SEIS included nine public hearings at which nearly 1000 people provided oral testimony. In addition, over 1200 letters were received resulting in over 21,000 comments in the draft SEIS.

A National Emissions Standard for Hazardous Air Pollutants (NESHAPS) application was prepared and submitted to the DOE. This application was placed on hold pending final regulations for DOE facilities that emit radionuclides.

The only notification involved the New Mexico Department of Game and Fish (NMGF). The WIPP exceeded its permit to collect 20 catfish by 13 fish. The NMGF was notified of this deviation in December with an explanation. The collection permit has been increased from 20 catfish to 50 for 1990 and more stringent accountability of sample numbers has been implemented.

2.2 ENVIRONMENTAL PROGRAM INFORMATION

The effort to establish environmental baseline conditions at the WIPP Site before arrival of waste has been ongoing since 1975. These studies are continuing to characterize the local environment both radiologically and nonradiologically until the WIPP is operational. Once the WIPP is operational, these programs will transition into the operational phase and pertinent data collection will continue through the life of the project.

2.2.1 Operational Environmental Monitoring Program

The WIPP OEMP lists schedules and guidelines for monitoring a comprehensive set of parameters in order to detect and quantify any present or potential environmental impacts. Nonradiological portions of the program focus on the immediate area surrounding the site, whereas radiological surveillance generally covers a broader geographic area including nearby ranches, villages and cities. Environmental monitoring will continue at the site during project operations and through decommissioning activities. The sampling activities will continue to be performed at the established monitoring locations which are unchanged from earlier SERs.

2.2.2 Significant Environmental Activities

This section addresses significant environmental activities which occurred during 1989.

- Raptor Research Program

  In 1989, 62 raptor nests and 74 Chihuahuan raven nests were monitored. Reproductive success remains very low which is consistent with last year's poor nesting success. Harris and Swainson's hawks each fledged less than one young per nest over the total number of nests monitored. The poor nesting success rate continued to correlate with low numbers of prey species and below normal precipitation in the area.

- Reclamation of Disturbed Lands

  Total reclamation activities for calendar year 1989 included 8 km (5 miles) of caliche roads and 85 ha (21.25 acres) of disturbed areas (i.e., drill pads). At the reclamation sites, different reclamation techniques are being evaluated to produce the best plant germination success. Experimental parameters being evaluated include; single ripping, double ripping, differing direction of tillage, and forb and grass seeds that differ from the prescribed BLM mix. In conjunction with these experimental parameters, soil moisture, precipitation, and soil chemistry data were also collected in the study areas.

2.3 ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

The following subsections present monitoring topics for the subprograms of the OEMP. These programs are consistent with Draft Order DOE 5400.xy, Requirements for Radiological Effluent Monitoring and Environmental Surveillance for U.S. DOE Operations.

As specifically outlined in the OEMP, five subprograms are being conducted to document the background levels of possible radionuclide pathways leading from the WIPP to man.

2.3.1 External Radiation Monitoring

Involves the use of pressurized ionization chamber which supplies instantaneous readouts to a data logger. The external radiation monitoring measures only penetrating types of radiation.

2.3.2 Airborne Particulate and Effluent Monitoring

This subprogram involves the use of two different types of aerosol samplers to detect airborne background levels of radionuclides. One is a low volume continuous aerosol sampler which operates on a weekly basis at a sampling flow rate of two cubic feet per minute (CFM). The other type of aerosol sampler is a high volume intermittent aerosol sampler which operates one 24-hour day randomly during a month. The high volume sampler operates at 40 CFM. The filters for these two types of samplers are archived at the WIPP or counted in the WIPP low-level counting lab. Throughout the calendar year, every quarter (13 weeks) the filters are sent to the Waltz Mill laboratory for the quarterly composite of the aerosol filters. The data from these filters are presented in more detail in Chapter 5.

2.3.3 Soil and Sediment Sampling

In calendar year 1989 radiological soil samples were collected and archived for future analysis. With the WIPP still being in a preoperational state, it is not required that sediment samples be taken annually, thus there were no sediment samples collected in calendar year 1989.

2.3.4 Groundwater and Surface Water Monitoring

Groundwater monitoring continued routinely throughout calendar year 1989 with 19 wells sampled for water quality. Two were sampled for the first time, four were sampled for the third time, and 13 were sampled for the fourth time. Water level monitoring took place at 63 locations in the WIPP vicinity. The water level of the Culebra was measured at 48 locations and the Magenta water level was measured at 10 locations. The other five locations were completed in other zones of less interest to the WIPP.

Surface water samples were not collected in calendar year 1989. As with the sediment sampling, once background measurements have been established, annual collections of surface water is not required. However, periodic samples of surface water will be collected prior to the operational phase of the WIPP to further substantiate the background radiological data for the surface.

2.3.5 Vegetation, Beef, Game Animals, and Aquatic Fish Samples

In calendar year 1989, vegetation, game animals (quail, rabbits) and fish were collected as directed in the OEMP. Beef samples were not in 1989. The vegetation and other biotics collected were processed and archived for future radiological analysis.

2.4 NONRADIOLOGICAL MONITORING INFORMATION

Nonradiological environmental surveillance (NES) is conducted by the Regulatory and Environmental Program (REP) Department. This program was preceded by the WIPP Biology Program (1975-1982), which combined scientific and technical expertise from six universities. These universities developed an extensive baseline of information describing the major components of the Los Medanos ecosystem prior to the initiation of WIPP construction activities.

2.4.1 Meteorology

The WIPP NES includes a meteorological station that provides support for various programs at the WIPP. The primary function of this station is to generate data to aid in modeling atmospheric conditions for Radiological Environmental Surveillance (RES). The meteorological station documents (records) standard meteorological measurements of wind speed, wind direction, and temperature at 3, 10, and 40 meters (10, 32, and 130 ft), respectively, with dew point and precipitation monitored at ground level. These parameters are continuously measured and the data are stored as real time data.

The annual precipitation at the WIPP for 1989 was 25 cm (9.84 in), which is below the average for this area by 5.49 cm (2.16 in). This below normal amount of precipitation follows the previous year of below normal moisture and continues the detrimental effects of drought on the ecosystem of this geographical area.

In 1989 the predominate winds in the WIPP area were consistent with previous wind direction data with winds from the southeast 17 percent of the time and from the southeast sector (including south-southeast and east-southeast) a total of 40.4 percent of the time.

The average annual barometric pressure at the WIPP was 26.37 absolute (29.97 corrected for elevation) inches of mercury or 892.99 and 1014.90 millibars, respectively. Fluctuations of barometric pressure correlate to atmospheric pressure systems that moved through the WIPP area.

2.4.2 Environmental Photography

Aerial photographs of the WIPP site have been taken semiannually since 1982. In 1989, aerial photographs were taken in September and December. These photographs document surface disturbance, development, and reclamation activities at the WIPP site and surrounding BLM and DOE lands.

Surface photography has been conducted at seven ecological study plots since 1984. These photographs are used to document surface impacts at the study plots examined, and found to show very little surface impact.

2.4.3 Air Quality Monitoring

Seven classes of pollutant gases are monitored at the WIPP site on a continuous basis. These are: sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), hydrogen sulfide (H_2S), and oxides of nitrogen (NO_x). In addition, weekly measurements of Total Suspended Particulates (TSP) are made from the particulates collected by the low-volume continuous air sampler at the far-field air sampling location.

Initial data indicated that O_3 and H_2S were exceeding the state air quality standard with regular diurnal cyclic peaks in the reported values of O_3 and H_2S. This anomalous behavior led to an evaluation of the measuring instruments.

After an in-depth evaluation it was noted that the O_3 and H_2S analyzers had internal electronic and flow-rate deficiencies which allowed the instruments to report data values higher than what were actually present. After repair and recertification the data values detected by the instruments were typical for this area. Air pollutants above those that are typical for this area, and state standards, did not occur for any extended time in 1989.

2.4.4 Surface Water and Sediment Quality Monitoring

During 1989, no surface water or sediment quality monitoring was conducted since a baseline has been established. Preoperational monitoring to establish a baseline began in 1985 and continued through 1988 with samples collected annually. Surface water and sediment quality monitoring will be conducted biennially until the WIPP is operational.

2.4.5 Wildlife Population Monitoring

Population density measurements of breeding birds and small nocturnal mammals are preformed annually to assess the effects of WIPP activities on wildlife populations.

- Breeding Bird Densities

  In 1989 several species were found in lower numbers than in previous years. This is probably due to the very dry conditions in the environment during the winter and spring. Most notable was the absence of eastern meadowlarks from the sample. This species has been common in previous years.

  Overall, the patterns of species distribution between the WIPP transits and the Control transits follow that of previous years. More species and a higher total density were found in the WIPP transits, probably due to greater habitat diversity near the facility and perhaps more abundant food. Greater numbers of flycatchers account for the largest increase of birds near the facility.

- Small Nocturnal Mammal Population Densities

  In 1989, the Control and WIPP trap grids population densities of Ord's kangaroo rats were above average. This, in part, may be due to the earlier initiation of trapping in 1989 (approximately 3 weeks earlier than 1988), although a continued increase in the population of this species has occurred over the past two years. White-footed mice and southern plains woodrats also showed an increase this year in the WIPP grids, especially in the northwest grid. The northern grasshopper mouse and plains pocked mouse remained at a relatively low population size in all grids.

2.4.6 Surface and Subsurface Soil

Concentrations of major cations and chloride in the surface soils remained very low throughout the sampling period. This pattern continues to suggest that little windborne caliche and salt are deposited on surface soils immediately adjacent to site activities. The total input of ions was very small, and they were moved down through the soil profile during the rainy period. There was no indication that salts accumulate at the soil surface in any of the monitoring plots.

In the subsurface soils, there was no indication that windblown salts generated at the WIPP from the salt piles or from traffic are accumulating at any level in the soil profile. Rather, salts deposited at the soil surface are flushed through the soil to the underlying caliche layer. There is no indication of a buildup of ions in the soil above the caliche layer. If WIPP activities contribute to a long-term accumulation of salts in the soil, there should be progressively greater concentrations of salts at sampling points progressively closer to the salt piles and the site. This has not been demonstrated to date.

2.4.7 Vegetation Monitoring

The 1988 vegetation monitoring data showed a decline in several parameters with increasing proximity to the salt piles, indicating a detrimental effect of these storage piles on the surrounding ecosystem. However, the 1989 data do not show such an effect. The total coverages in all plots were relatively uniform over all distances from the piles. The densities of annuals and species richness were also relatively uniform across all plots. A pattern observed in the 1988 data that was also seen in the 1989 data is an increase in shrub cover with increasing proximity to the piles and an approximately equal decrease in perennial grass cover. The responses of these plots to higher rainfall in later years will reveal whether this pattern is reflecting the start of a significant change in the structure of the plant community or whether it is only a short-term effect caused by short-term weather conditions.

Of greatest significance in the 1989 vegetation monitoring data, was the observation that the drought conditions of this year have had a uniform effect on vegetation in all plots. A differential effect resulting from salt-induced physiological stress near the salt piles was not observed.

CHAPTER 3

COMPLIANCE SUMMARY

The WIPP is required to comply with all applicable federal and state laws and regulations such as those specified in Order DOE 5400.1, General Environmental Protection Program (DOE, 1988a). Documentation of required Federal and State permits, notifications, and approvals is maintained by the REP Department of the Management and Operating contractor. Regulatory requirements are implemented by incorporating them into facility plans and procedures.

Table 3-1 presents federal and New Mexico statutes applicable to the WIPP project. Table 3-2 presents DOE Orders and agreements affecting the WIPP environmental program. Table 3-3 is a summary of agreements between the DOE and the State of New Mexico that affect the environmental program. Appendix I presents details concerning active environmental permits for 1989.

3.1 COMPLIANCE ASSESSMENT FOR CALENDAR YEAR 1989

During 1989, compliance was maintained for applicable EPA regulations (i.e., Resource Conservation and Recovery Act (RCRA), Superfund Amendments and Reauthorization Act (SARA), the Clean Water Act (CWA), and the Clean Air Act (CAA)).

Compliance with all BLM and State of New Mexico permits and regulations was maintained with the exception of the New Mexico Department of Game and Fish, Permit Number 1775, for the collection of catfish. The limit for the total number of catfish collected under this permit was exceeded by 13 fish and the State of New Mexico was formally notified of this deviation on December 20, 1989. Programmatic adjustments have been made to prevent a similar occurance in the future.

The status of environmental requirements for 1989 are listed below:

- The 1989 Emergency and Hazardous Chemical Inventory Report was submitted as required for compliance with Title III of the SARA. In adhearance to SARA, 20 individuals thus far have been trained. This is a three-day training course with special emphasis for the emergency response technicians.
- The Environmental Evaluation Group (EEG)/EID correspondence data base was maintained to ensure tracking of all action items associated with communications between the WIPP Project and the EEG and the EID. This action has been taken in accordance with the DOE Management Directive Number 3.11.1.
- The status of all required environmental permits, as listed in Appendix I, are reviewed on a monthly basis and appropriate actions taken, as necessary.
- As a generator of hazardous waste, the DOE notified the EID in 1988 of hazardous waste activity at the WIPP. The WIPP has a hazardous waste management program in place which is in compliance with RCRA requirements. In addition, the DOE and EID were notified in 1986 of the presence of two underground fuel storage tanks. An underground storage tank fee is paid annually as required by the New Mexico Underground Storage Tank regulations.
- There were 17 shipments of hazardous waste handled at the WIPP. All shipments were in accordance with the RCRA requirements. The storage areas for hazardous waste at the WIPP are operated in accordance with WIPP procedure WP 02-601. In compliance with RCRA, routine inspections are conducted in the less than 90-day hazardous waste staging areas. Periodic inspections of satellite accumulation areas are conducted.
- All site-generated hazardous waste was shipped within the 90-day period specified in 40 CFR 262. Waste reports were submitted as required for compliance with the RCRA.

Table 3-1

FEDERAL AND NEW MEXICO STATUTES APPLICABLE TO THE WIPP PROJECT

NAME OF STATUTE	CITATION	ANNOTATION
Clean Air Act	42 U.S.C. §§ 7401 et seq.	Establishes a national regulatory strategy to protect and enhance the nation's air resources. Regulates "criteria" pollutants such as particulates, SO_2, CO, NOX_2, ozone, photochemical oxidants, and lead.
New Mexico Environmental Improvement Act	§§ 74-1-1 through 74-1-10 NMSA (1978)	Creates the Environmental Improvement Division with authority to regulate water supply, water pollution, liquid and solid waste, air quality, noise, low-level radioactive waste disposal, and sanitation.
New Mexico Air Quality Control Act	§§ 74-2-1 through 74-2-155 NMSA (1978)	Establishes a State regulatory strategy patterned after the Federal Clean Air Act. (Gives New Mexico primary jurisdiction for air quality regulations.)
Clean Water Act	33 U.S.C. §§ 1251 et seq.	Establishes a national regulatory strategy to restore and maintain the chemical, physical, and biological integrity of the nation's waters.
New Mexico Water Quality Act	§§ 74-6-1 through 74-6-13 NMSA (1978)	Establishes a State regulatory strategy patterned after the Federal Clean Water Act. (Gives the State "primacy" for water quality control regulation.)
National Historic Preservation Act of 1966	16 U.S. C. §§ 470 et seq.	Establishes the National Register of Historic Places and requires Federal agencies to consider the effect of any Federal undertaking on sites, structures, or objects included in the National Register.
New Mexico Cultural Properties Act	§§ 18-6-1 through 18-6-17 NMSA (1978)	Establishes a committee to review proposals for preservation of cultural properties. Requires permits for excavation of archeological sites. Establishes the State Historic Division and the State Historic Preservation Officer (SHPO).
Endangered Species of 1973	16 U.S.C. §§ 1531 et seq.	Authorizes determination of threatened and endangered plant and animal species and provides for Federal, State, and local conservation programs.
National Environmental Policy Act	42 U.S.C. 4321 et seq. (1970)	Establishes a broad national policy to encourage productive and enjoyable harmony between persons and their environment and to ensure that consideration is given to environmental values and factors in Federal decision making.
New Mexico Wildlife Conservation Act	§§ 17-2-37 through 178-2-46 NMSA (1978)	Empowers the State Game and Fish Commission to list endangered species, promulgate regulations, and enter into cooperative agreements with the U.S. Fish and Wildlife Service to protect such species.
Federal Land Policy and Management Act	16 U.S.C. §§ 1701 et seq.	Authorizes "administrative" public land withdrawals by the Secretary of Interior for a period not to exceed 20 years. Also authorizes exchanges of Federal for State or private lands where the "public interest will be well served." Applies to BLM lands.

Table 3-1 (continued)

FEDERAL AND NEW MEXICO STATUTES APPLICABLE TO THE WIPP PROJECT

NAME OF STATUTE	CITATION	ANNOTATION
Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980	Public Law (PL) 96-540 and PL 96-164; 42 U.S.C. §§ 7272 and 7273	Authorizes construction of the WIPP as a DOE defense R&D facility exempted from NRC regulation. Mandates DOE consultation and cooperation with the State of New Mexico.
New Mexico Emergency Management Act	§§ 74-3-1 through 74-3-16 NMSA (1978)	Provides for development of a comprehensive statewide hazardous materials emergency management plan covering hazardous and radioactive materials. Establishes a Hazardous Materials Safety Board.
New Mexico Radioactive Materials Act	§§ 74-4A-2 through 74-4A-14 NMSA (1978)	Establishes the Radioactive Waste Consultation Task Force, empowered to negotiate for the state with the federal government regarding federal facilities for disposal of high-level radioactive waste, transuranic waste, and low-level radioactive waste.
Hazardous Materials Transportation Act of 1976	49 U.S.C. §§ 1801 et seq.	Establishes authority of the Department of Transportation to uniformly regulate the transportation of hazardous materials which pose risks to life and property.
Resource Conservation and Recovery Act	PL 94-580 and amended by PL 95-609, PL 96-463, PL 96-482, PL 96-510, PL 97-272, PL 97-375, PL 98-48, PL 98-371, PL 98-616, PL 99-339, and PL 99-499	Provides cradle-to-grave regulation over hazardous waste. The DOE and the EPA have determined that radioactive mixed waste are regulated under both the Resource Conservation and Recovery Act and the Atomic Energy Act.
New Mexico Hazardous Waste Management Regulations	§§ 74-4-1 through 74-4-13 (1977, 1981, 1983, 1987, 1989)	Implements Hazardous Waste Management Program for the State of New Mexico.
Atomic Enerty Act	42 U.S.C. 2201/AEA 161	Requires the USEPA to promulgate generally applicable standards for the protection of the public and the environment with regards to radiation.
Safe Drinking Water Act	42 U.S.C. 300/SDWA 1412	Regulates the protection of primary drinking waters with regard to radionuclides.

Table 3-2

DOE ORDERS AND AGREEMENTS AFFECTING THE WIPP ENVIRONMENTAL PROGRAM

ORDERS

ORDER NO.	DATE	TITLE	ANNOTATION
DOE 5400.1	11/09/88	General Environmental Protection Program	Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for ensuring compliance with Federal and State environmental protection laws and regulations, Federal executive orders, and internal department policies.
DOE 5400.2A	01/31/89	Environmental Compliance Issue Coordination	Establishes DOE requirements for coordination of significant environmental compliance issues.
DOE 5400.3	02/22/89	Hazardous and Radioactive Mixed Waste Program	Establishes DOE hazardous and radioactive mixed waste policies and requirements for RCRA compliance.
DOE 5480.4	10/06/89	Comprehensive Environmental Response, Compensation, and Liability Act Requirements	Establishes basic requirements for implementation of the superfund at DOE facilities
DOE 5440.1C	04/09/85	National Environmental Policy Act	Establishes DOE policy for implementation of the National Environmental Policy Act of 1969 (PL 91-190).
DOE 5480.1B	09/23/86	Environmental Protection, Safety, and Health Protection Program for DOE Operations	Establishes an overall framework of program requirements for safety, environmental, and health protection, including criteria for radiation exposure and radioactive releases for operating facilities and sites.
DOE 5480.3	09/23/86	Safety Requirements for the Packaging of Fissile and Other Radioactive Materials	Establishes requirements for packaging and transportation of radioactive materials for DOE facilities.
DOE 5484.1*	11\06\87	Environmental Protection, Safety, and Health Protection Information Reporting Requirements	Establishes requirements and procedures for reporting information having environmental protection, safety, or health significance for DOE operations.
AL 5484.1	08/23/82	Environmental Protection, Safety and Health Protection Information Reporting Requirements	Albuquerque Operations Office implementation of 5484.1.
DOE 5820.2A	09/26/88	Radioactive Waste Management	Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactively contaminated surplus facilities.
DOE 5480.4	05/15/84	Environmental Protection, Safety, and Health Protection	To specify and provide requirements for the application of the mandatory Environmental Protection, Safety, and Health (ES&H) standards applicable to all DOE and DOE contractor operations; to provide a listing of reference ES&H standards; and to identify the sources of themandatory and reference ES&H standards.

Table 3-2 (continued)

DOE ORDERS AND AGREEMENTS AFFECTING THE WIPP ENVIRONMENTAL PROGRAM

ORDERS

ORDER NO.	DATE	TITLE	ANNOTATION
DOE 5481.1B AL 5481.1B	09/23/86 01/27/88	Safety Analysis and Review System	To establish uniform requirements for the preparation and review of safety analyses of DOE operations which include: identification of hazards, their elimination or control, assessment of the risk, and documented management authorization of the operation.
DOE 5482.1A	08/13/81	Environmental, Safety and Health Appraisal Program	To establish the Environmental Protection, Safety, and Health (ES&H) appraisal program for the DOE.
DOE 5500.3	08/13/81	Emergency Planning, Preparedness, and Response for Operations	To establish requirements for the development of DOE site-specific emergency plans and procedures for radiological emergencies occurring in existing or planned DOE reactors and nonreactor nuclear facilities. Furthermore, it requires that comprehensive emergency actions are planned, coordinated, and implemented to respond effectively to the on-site and off-site consequences of a radiological emergency at these facilities and it provides for appropriate coordination between DOE and off-site officials to ensure the protection of on-site personnel, public health and safety, and the environment.
DOE 5700.6B	09/23/86	Quality Assurance	To provide DOE policy, set forth principles, and assign responsibilities for establishing, implementing, and maintaining programs of plans and actions to ensure quality achievement in DOE programs.
DOE 6430.1A	04/06/89	General Design Criteria	To provide general design criteria for use in the acquisition of DOE facilities and to establish responsibilities and authorities for the development and maintenance of these criteria.

*DOE 5440.1C and 5820.2 of DOE 5484.1 are currently undergoing revision.

Table 3-3

SUMMARY OF AGREEMENTS BETWEEN DOE AND THE STATE OF NEW MEXICO THAT AFFECT THE ENVIRONMENTAL PROGRAM

Stipulated Agreement. This agreement, approved by the U.S. District Court when it stayed (held in abeyance) proceedings in the lawsuit against the DOE by the State, was executed on July 1, 1981. The eight-page agreement ensures that a binding, enforceable "consultation and cooperation" agreement will be entered into by the DOE and the State and that the DOE will make a "good faith effort" to resolve certain State off-site concerns (which are covered in the Supplemental Stipulated Agreement). The Stipulated Agreement also addresses a number of additional studies and experiments to be conducted by the DOE for the Site Preliminary Design Validation (SPDV) phase of the WIPP.

Agreement for Consultation and Cooperation. Usually referred to as the "C&C Agreement," this agreement is contained in Appendix A to the Stipulated Agreement. It affirms the intent of the Secretary of Energy to consult and cooperate with New Mexico with respect to State public health and safety concerns.

Working Agreement for Consultation and Cooperation. This agreement, Appendix B to the Stipulated Agreement, identifies in Article IV over 60 "key events" and "milestones" in the construction and operation of the WIPP that must be reviewed by the State before they are commenced. Many environmental items are included. (Article IV of the Working Agreement was revised on April 8, 1983.)

Supplemental Stipulated Agreement Resolving Certain State Off-Site Concerns over WIPP. This agreement, dated December 27, 1982, addresses five State concerns including the need for State "verification" of the WIPP operational environmental monitoring program. The concerns addressed are: State liability (for a nuclear incident), emergency response preparedness, transportation monitoring of the WIPP waste, WIPP environmental monitoring by the State, and upgrading of State highways.

First Modification to the Agreement for Consultation and Cooperation. Signed November 30, 1984, wherein the DOE and the State agreed to address certain concerns of the State regarding: (1) the specific mission of the WIPP, (2) a demonstration of irretrievably prior to waste emplacement, (3) post-closure control and responsibility, (4) completion of certain additional scientific testing and reports, (5) compliance with applicable Federal regulatory standards for waste repositories, and (6) a program for encouraging and reporting upon the hiring of New Mexico residents at the WIPP.

Second Modification to the Agreement for Consultation and Cooperation. Signed August 4, 1987, wherein the DOE and the state agree to address certain concerns of the state regarding: (1) surface and subsurface mining and drilling after closure of the WIPP site, (2) the disposal of salt tailings at the WIPP site, and (3) compliance with Environmental Protection Agency (EPA), Department of Transportation (DOT), and Nuclear Regulatory Commission (NRC) regulations.

1988 Modification to the Working Agreement of the Consultation and Cooperation Agreement between the Department of Energy and the State of New Mexico on the Waste Isolation Pilot Plant. Signed March 1988, this modification deleted the sorbing tracer test from the list of required reports and substituted additional tests. In addition, the State is allowed to operate a fixed air sampler in the mine ventilation effluent air stream.

- In early 1989, a No-Migration Variance Petition was submitted to the EPA in accordance with 40 CFR 268.6. An addendum to the petition was submitted to the EPA in October 1989. The EPA is currently reviewing the eight-volume petition to determine if untreated land-ban wastes can be disposed of at the WIPP. The EPA is expected to announce its decision in September 1990.
- The Underground Health and Safety Manual was prepared in support of the No-Migration Variance Petition.
- A notice of intent to discharge to the WIPP sewage lagoon system was filed with the EID in 1989. A discharge plan for the system was submitted to the EID in early 1990. This discharge plan was prepared as required by the New Mexico Water Quality Control Commission Regulation.
- In compliance with the NEPA requirement for public review, on April 21 1989, the DOE issued a draft Supplement Environmental Impact Statement (SEIS) for the WIPP. The purpose of this SEIS was to address several changes in the information and assumptions used in the FEIS, which was published in 1980 and to further the purpose of NEPA. The changes reviewed included the composition of the waste inventory, the transportation of waste to the WIPP, modification of the test phase, and the management of radioactive waste that contains hazardous chemical constituents (i.e., "mixed" wastes).

3.2 CURRENT ISSUES AND ACTIONS

The EID returned the RCRA Part A permit application in November 1989 with a request that the DOE resubmit the application when the State of New Mexico has received authorization to regulate mixed waste. The State is expected to receive this authorization in 1990, and plans are being made to file a Part A permit application during calendar year 1990.

In order to comply with the CAA, a NESHAPs application was prepared in 1989 and submitted to the DOE. The application was placed on hold pending promulgation of the final revised regulations for DOE facilities that emit radionuclides. The decision has recently been made that NESHAPs standards apply to the WIPP facility during the test phase only. (The EPA's nuclear waste management standards in 40 CFR 191 will apply when the WIPP is designated as a disposal facility.)

Reclamation of abandoned caliche pits, roads, and well pads, which is required by Public Land Order 6403 and the associated Memorandum of Understanding (MOU) between the DOE and the BLM, is under way. Land-Use Permit NM 067-LUP-237 for the construction landfill expired on February 9, 1990. Since the BLM no longer permits landfills, the landfill was closed and will be reclaimed in accordance with the permit conditions.

The WIPP must apply annually to the State of New Mexico, for a NMGF permit for the collection of biological samples. The 1989 permit allowed the collection of 20 catfish and 20 quail for radiological analysis. It should be noted that the WIPP permit (1775) from the NMGF to collect catfish was exceeded by 13 during 1989.

To ensure that sufficient numbers of specimens are collected for the biotic sampling program and that this amount does not exceed the permitted allowance, the catfish collection permit has been increased from 20 to 50 specimens, and the quail permit number has been increased from 20 to 25 specimens for 1990.

Exceeding the permit restrictions was a result of the simultaneous use of data sheets. Steps have been taken to limit the use of multiple data sheets to ensure that field sampling teams total the number of specimens taken on a given day. This daily accounting of the exact number of specimens collected will decrease the probability of exceeding the permit allowance specified in the NMGF permit.

3.3 PERMITS

The status of required permits is tracked on a monthly basis, and permits are renewed as necessary to comply with the BLM, the EID, the NMGF, the New Mexico Commissioner of Public Lands, and the New Mexico Department of Finance and Administration Planning Division (Historic Preservation Bureau).

The WIPP currently holds 15 active permits from the BLM. These permits are primarily land-use, free-use, and right-of-way permits. There were no noncompliances for BLM-administered permits in 1989.

The WIPP holds one New Mexico EID permit for open burning. The open burning permit is renewed annually for fire fighter training activities.

CHAPTER 4

ENVIRONMENTAL PROGRAM INFORMATION

The effort to establish environmental baseline conditions at the WIPP site before the arrival of radioactive waste has been ongoing since 1975. The WIPP is required by the DOE to have three years of preoperational baseline data prior to becoming an operational facility. The purpose of these studies is to characterize the local environment, to quantify environmental impacts of WIPP construction activities, and to ensure the protection of both the public and the environment.

The information acquired by these studies was used to develop the RBP, which measured environmental background radioactivity and radiation levels prior to waste emplacement, and the EMP, which monitored changes in ecosystem activities attributable to construction or salt handling activities. These two preoperational monitoring programs merged in 1988 into the OEMP for the WIPP (DOE/WIPP 88-025).

4.1 OPERATIONAL ENVIRONMENTAL MONITORING PROGRAM

The WIPP OEMP monitors a comprehensive set of parameters in order to detect and quantify any present or potential future environmental impacts. Nonradiological portions of the program focus on the immediate area surrounding the site, whereas radiological surveillance generally covers a broader geographic area including nearby ranches, villages, and cities. Environmental monitoring will continue at the site during project operations and through decommissioning activities.

The goal of the OEMP is to determine whether there are impacts during the operational phase of WIPP on the local ecosystem and, if so, to evaluate their severity, geographic extent, and environmental significance, and identify correctable actions and make every effort to minimize the environmental impacts of the WIPP. Table 4-1 summarizes the OEMP sampling schedule and sampling type, whereas Table 4-2 denotes the analytical array for the various sample types. The tables list the sample types, the number of sampling stations, the approximate sampling schedule, and the environmental/ecological parameters to be monitored or analyzed. Additional or different types of samples will be collected and analyzed as necessary to investigate and explain trends or anomalies that may have a bearing on environmental impacts.

As recommended in DOE/EP-0023 (Corley et al., 1981), the OEMP monitors levels of naturally occurring radionuclides and those associated with world-wide fallout, in addition to those expected in the WIPP waste. The geographic scope of radiological sampling is based on projections of potential release pathways (see Figure 4-1, Primary Pathway Exposure) and the types of radionuclides in WIPP waste. Also, the surrounding population centers are monitored even though release scenarios involving radiation dose to residents of those population centers are improbable due to the extended distances from the WIPP. Ecological sampling activities will continue to be performed at the permanent ecological monitoring plots, whose locations are unchanged from the earlier EMP.

4.2 SIGNIFICANT ENVIRONMENTAL ACTIVITIES

This section addresses significant environmental activities that occurred during 1989.

TABLE 4-1

OEMP SAMPLING SCHEDULE

TYPE OF SAMPLE	SAMPLING LOCATIONS	SAMPLING FREQUENCY
Liquid Influent	1	Semiannual
Liquid Effluent	1	Semiannual
Airborne Effluent	3	Continuous
Meteorology	2	Continuous
Exposure Rate Meter	1	Continuous
Atmospheric Particulate	7	Weekly
Air Quality	1	Continuous
Vegetation-Radioanalysis	4	Annual
Beef	2	Annual*
Game Birds	2	Annual
Rabbits	2	Annual
Soil-Radioanalysis	7	Biennial
Surface Water	8	Annual
Groundwater	14	Annual
Fish	2	Annual
Sediment	6	Biennial
Aerial Photography	Site Wide	Annual
Salt Impact Studies		
Surface Photography	7	Biannual
Soil Chemistry	7	Quarterly
Soil Microbiota	7	Semiannual
Vegetation Survey	7	Biannual
Wildlife Survey	4	Annual

TABLE 4-2

OEMP ANALYTICAL ARRAY

TYPE OF SAMPLE	ANALYSIS
Liquid Influent	Gross α, Gross β, pH, TSS, Specific Radionuclides
Liquid Effluent	Gross α, Gross β, pH, TSS, Specific Radionuclides, Chemical Constituents
Airborne Effluent	Gross α, Gross β, Specific Radionuclides
Meteorology	Temperature, Wind Speed, Wind Direction, Precipitation, Dew Point, Barometric Pressure
Exposure Rate Meter	Penetrating Radiation
Atmospheric Particulate	Gross α, Gross β, TSP, Specific Radionclide
Air Quality	O_3, CO, H_2S, SO_2, NO_x
Vegetation Radioanalysis	Specific Radionuclides
Beef	Specific Radionuclides
Game Birds	Specific Radionuclides
Rabbits	Specific Radionuclides
Soil Radioanalysis	Gross α, Gross β, Specific Radionuclides
Surface Water	Gross α, Gross β, Specific Radionuclides TSS, pH
Groundwater	Specific Radionuclides, pH
Fish	Specific Radionuclides
Sediment	Gross α, Gross β, Specific Radionuclides
Aerial Photography	Area of Land Disturbed

TABLE 4-2
(Continued)

OEMP ANALYTICAL ARRRAY

TYPE OF SAMPLE	ANALYSIS
Salt Impact Study	
Surface Photography	Visual Impacts
Soil Chemistry	pH, EC, Na, Cl, Mg, Ca, K
Soil Micorbiota	Microbial Activity, Litter Decomposition
Vegetation Survey	Foliar Coverage, Species Richness, Annual Plant Density
Wildlife Survey	Bird and Small Mammal Population Densities

TSS = Total Suspended Solids
TSP = Total Suspended Particulates
EC = Electrical Conductivity

Specific Radionulides = ^{238}Pu, $^{239/240}$Pu, ^{241}Pu, ^{233}U, ^{235}U, ^{241}Am, ^{232}Th, ^{226}Ra, ^{137}Cs, ^{90}Sr, ^{40}K, ^{7}Be, ^{60}Co, U_{nat}, Th_{nat}

Chemical Constituents = Chloride, iron, manganese, phenols, sodium, sulfate, pH, specific conductance, total organic cabon, total organic halogen, arsenic, barium, cadmium, chromium, fluoride, lead, mercury, nitrate, selenium, silver, endrin, methoxychlor, toxaphene, 2, 4-D, 2, 4, 5-T, silvex.

*In addition, surface water samples from Hill Tank and Red Tank will be analyzed for the above chemical constituents biannually.

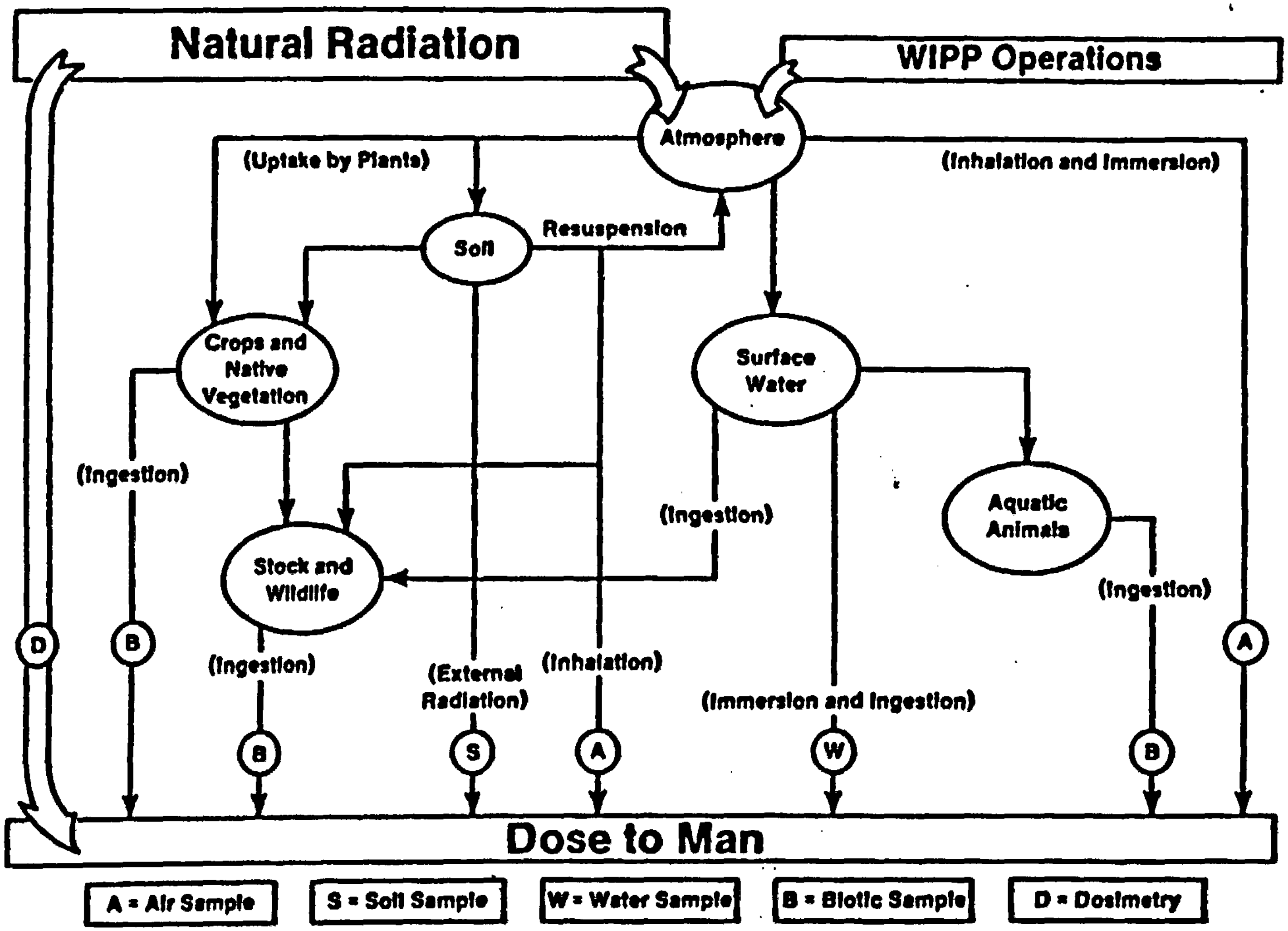

FIGURE 4-1

PRIMARY PATHWAYS TO MAN FOR RADIOACTIVE RELEASES FROM THE WIPP FACILITY

RE35

4.2.1 Cooperative Raptor Research and Management Program

In 1985, the Los Medanos Cooperative Raptor Research and Management Program was initiated under the sponsorship of the DOE with support from the BLM and the New Mexico Living Desert State Park. Part of the goal of this program, which is being conducted by researchers from the University of New Mexico, is to evaluate the impacts of WIPP activities on the breeding success of raptors (i.e., hawks and owls) that are found in great abundance in the area.

During 1989, 62 raptor nests and 74 Chihuahuan raven nests were located and monitored in the study area. Reproductive success was very low, especially for the Harris' and Swainson's hawks. The former fledged 0.67 young per nest, for a total recruitment of six birds into the population, while the latter fledged 0.68 young per nest out of 34 nests. The poor success rate is probably due to the continued low numbers of prey species, particularly rabbits.

The calendar year 1989 precipitation was 5.49cm (2.16in) below normal with a total precipitation amount of 25cm (9.84in). Typically the majority of precipitation occurs in July and August, however only 36 percent of the annual precipitation was received in these months.

With below normal precipitation occurring during a time of significant plant growth, less than normal new plant growth occurs. Thus, in raptor prey species such as rabbits and hares, which have a plant diet, there are below normal population levels due to a reduced food supply. This reduction in prey, leads to a decrease in the nesting success of the raptors.

4.2.2 Reclamation of Disturbed Lands

Reclamation activities conducted in 1989 repeated test designs that had been incorporated in 1988 on caliche roads. In addition, a briny reserve pit was included in the study. Also, demonstration plots of additional wildflower and grass species were implemented.

To date, the reclamation study includes three main study areas: caliche roads, dune soil, and a briny reserve pit. A number of smaller supporting studies are also being conducted (Table 4-3).

The current studies aim to answer the following questions relative to seed bed preparation and seed mix selection:

- Does single ripping the seed bed on caliche roads produce different results than double ripping?
- Does use of caliche as a top dressing produce different results on a reserve pit than not using it?
- Do different directions of tillage produce different results on a dune site?
- Do native forbs and grasses from commercial sources produce different results than a prescribed BLM mix?

In current studies a total of 30 native plant species including 10 grasses, 5 shrubs, and 15 forbs are examined.

Plots on roads, the reserve pit, and demonstration plots have been marked with permanent identification labels. These plot markers should allow for long-term identification of plot treatments in the field and facilitate a long-term monitoring schedule.

TABLE 4-3

RECLAMATION STUDY SITES

		AREA RECLAIMED	
		1988	1989
MAIN STUDY	Caliche Roads	3 miles	5 miles
	Dune Soil (Landfill)	4 acres	
	Reserve Pit		2.5 acres
RELATED STUDIES	Caliche Roads (ripped but not seeded)	1.3 miles	
	WIPP 16 Drill Pad		0.75 acres
	Caliche Borrow Pit		18 acres
	North Access Road Batch Plant (fenced)	4 acres	

CHAPTER 5

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

The following sections provide a description of the various subprograms constituting the OEMP at the WIPP.

5.1 RADIOACTIVE EFFLUENT MONITORING

During March 1989, the monitoring activities of the RBP were combined into the OEMP. This program is described in the OEMP for the WIPP, (DOE/WIPP 88-025). This plan defines the scope and extent of the WIPP effluent and environmental monitoring programs during the operational life of the facility. The OEMP is the database for all environmental comparisons once the WIPP is operational.

Draft Order DOE 5400.xy Requirements for Radiological Effluent Monitoring and Environmental Surveillance for U.S. DOE Operations (DOE,1988c), requires that monitoring of liquid waste effluent streams be adequate to demonstrate compliance with dose limits in Order DOE 5400.5, Radiation Protection of the Public and the Environment (DOE, 1990). This order also requires the monitoring of potential sources of contaminated airborne emissions. Since no radioactive waste was received at the WIPP site in 1989, no effluent sampling or release data are reported in this document.

5.2 ENVIRONMENTAL RADIOACTIVITY MONITORING

The following subsections present the monitoring results of the various subprograms of the OEMP for 1989. These include aerosol monitoring, ambient radiation, terrestrial radioactivity, hydrologic radioactivity, and biotic radioactivity baseline subprograms. Figures 5-1 through 5-4 summarize sample type and location for the WIPP and vicinity for the various subprograms.

5.2.1 The Atmospheric Radiation Baseline

Sampling airborne aerosol particulates is an important component of the OEMP. The draft Final Safety Analysis Report (FSAR) (DOE, 1990) identifies the atmospheric pathway as essentially the only release pathway resulting in a potential dose to the public. Continuous particulate aerosol samplers operate at seven locations, three within the Zone II boundary and four at local ranches and communities (Figure 5-1). The continuous aerosol samplers presently in use maintain a regulated flow rate of approximately 950 milliliters per second (two cubic feet per minute) of air through a 47-millimeter (1.9-inch) glass fiber filter for particulate collection.

Airborne particulate sampling was initiated in July 1985 at a few locations. Routine weekly filter collections and subsequent radiochemical analysis began in early 1986 for all locations except the far field location, where data collection began in October 1986. Particulate filters were collected weekly at all locations in 1989. These filters were analyzed at the Environmental Counting Lab at the WIPP, where a gross alpha and gross beta count of each weekly filter was completed prior to compositing filters from each location for each sampling quarter. Each quarterly composite of filters was transferred to the analytical laboratory where they were analyzed using gamma spectroscopy for representative gamma-emitting radionuclides typically present in the environment or expected to occur in the waste to be emplaced. Finally, the composite was analyzed for the specific alpha and beta emitters of interest.

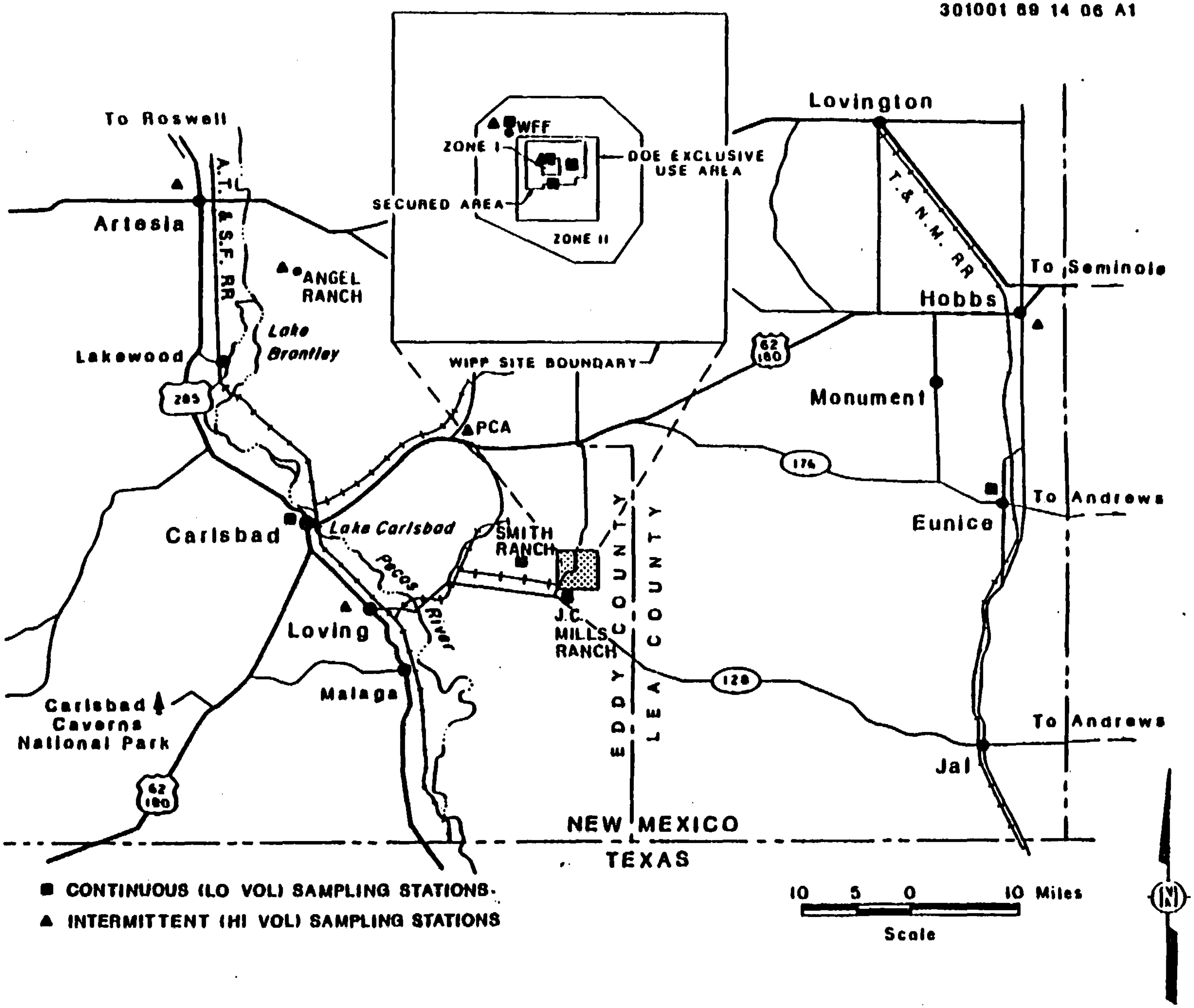

FIGURE 5-1 RBP AIRBORNE PARTICULATE SAMPLING STATIONS

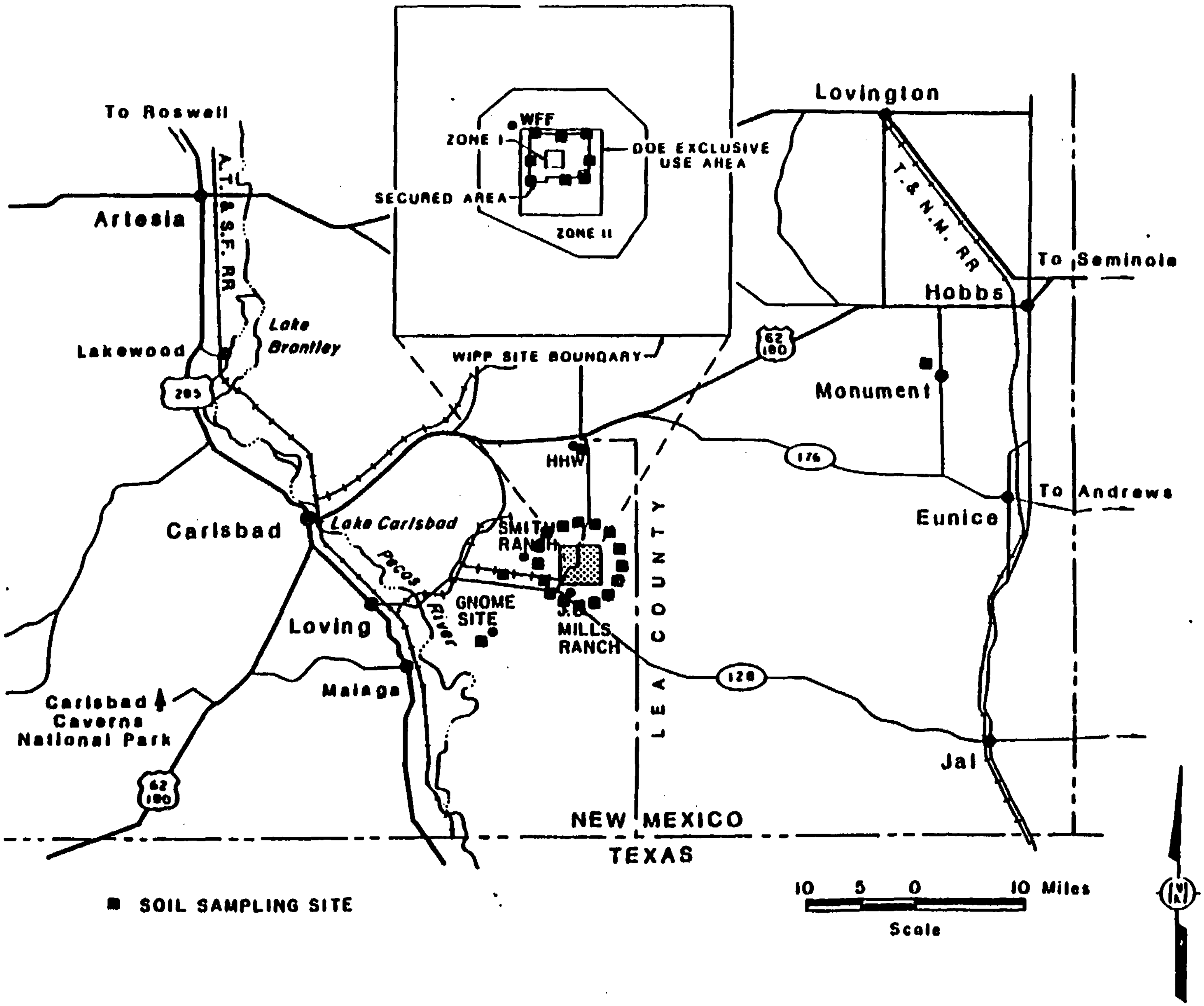

FIGURE 5-2 RBP SOIL SAMPLING LOCATIONS

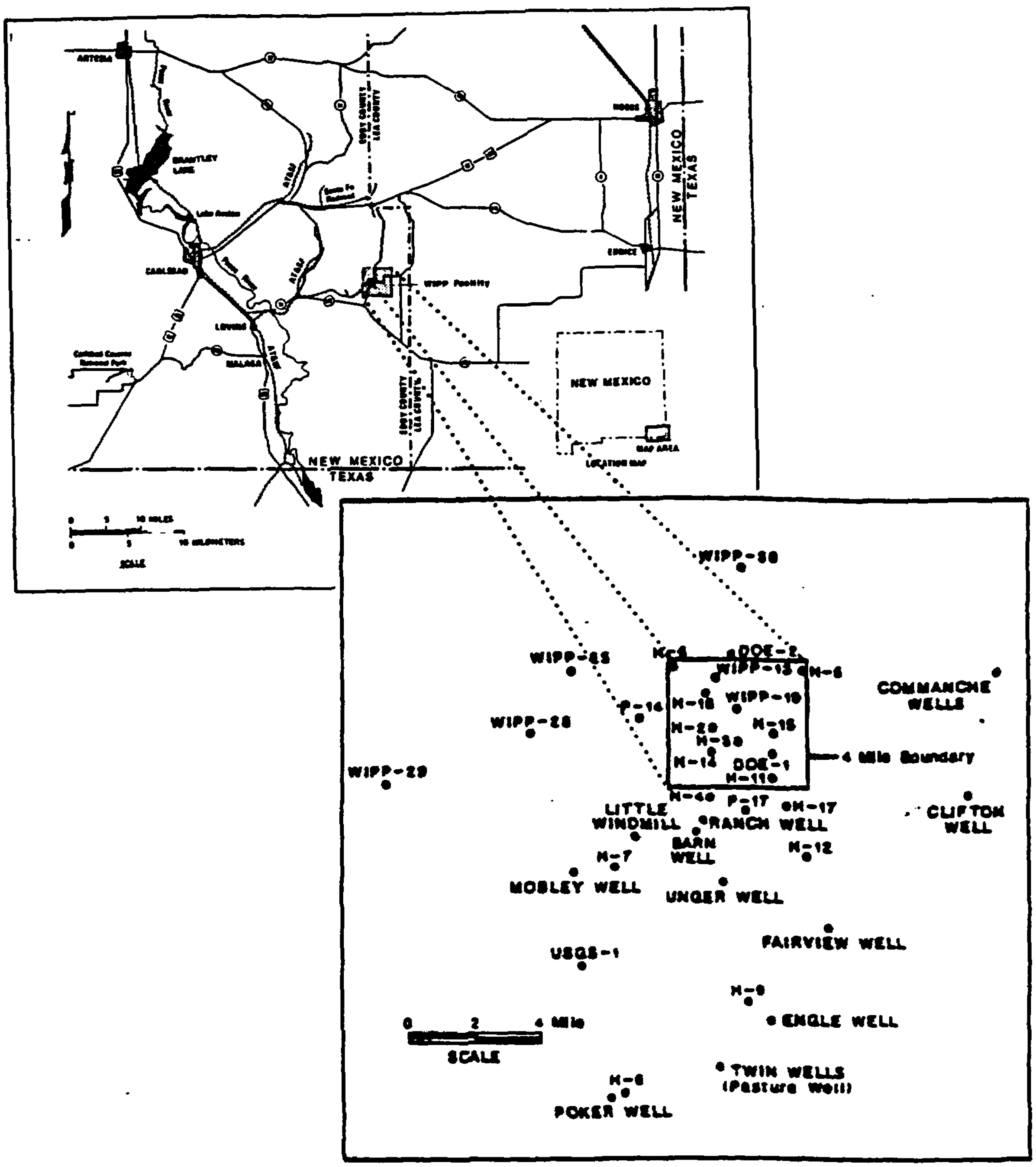

FIGURE 5-3 GROUNDWATER SAMPLING LOCATIONS

GG651

301001 89 14 06 A16

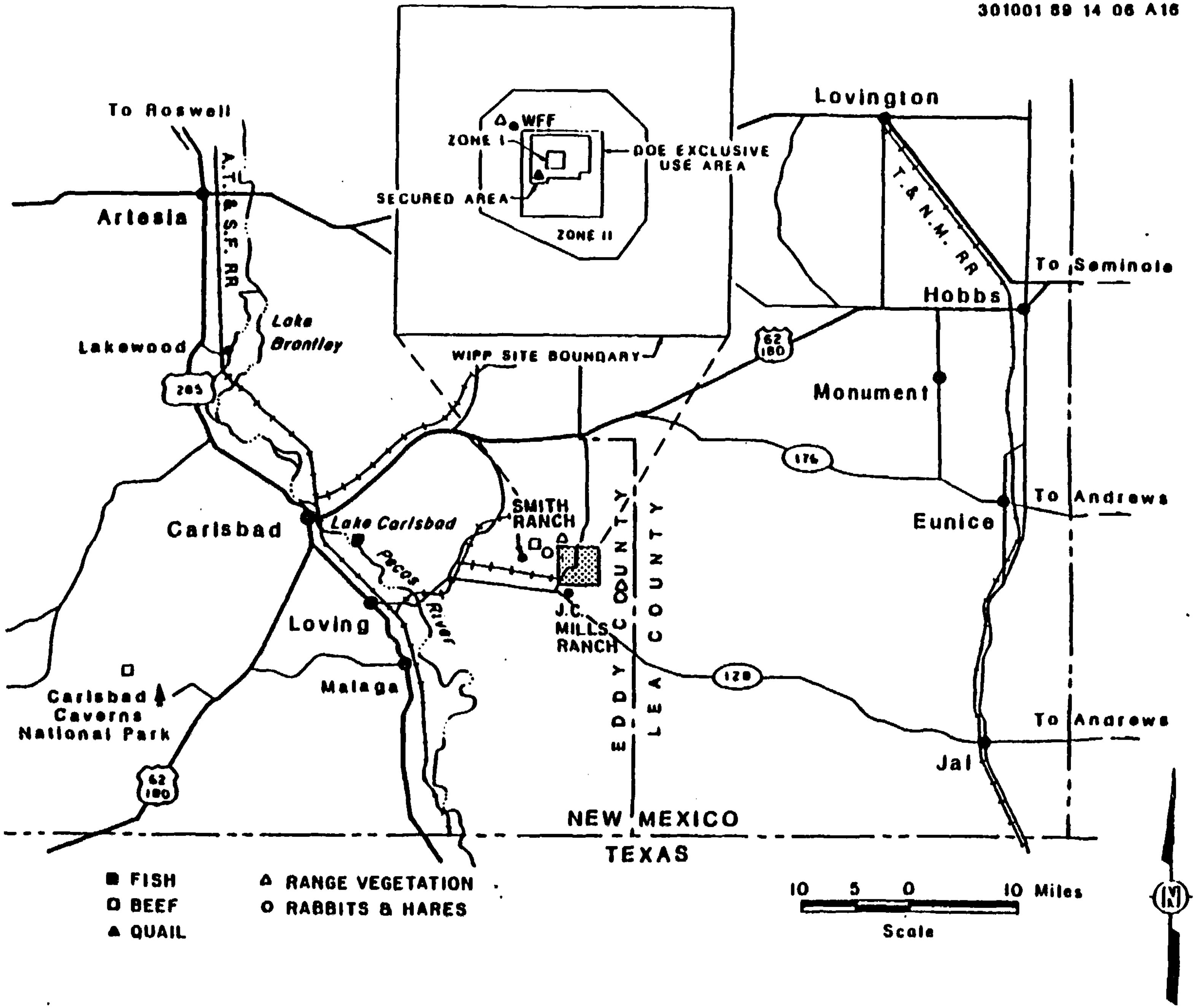

FIGURE 5-4 RBP BIOTIC BASELINE SAMPLING LOCATIONS

Figure 5-5 represents the mean gross alpha concentrations for all eight sampling locations. The individual gross alpha concentrations reported for each location are documented in Appendix II. The mean gross alpha concentrations in Figure 5-5 shows limited fluctuation throughout the year and are consistently less than 30 E-09 mCi/ml. These fluctuations appeared to be consistent among all sampling locations.

The mean gross beta concentrations listed in Figure 5-6, fluctuate throughout the year, typically within the range of 15 - 40 E-09 mCi/ml. Appendix III shows the 1989 gross beta concentration for each individual sampling location that was used to establish the mean.

Gross beta and gross alpha measurements provide an indication of total radionuclide concentration that may indicate changes in a specific radionuclide concentration. These measurements are also used for screening to ensure that important radionuclides are not overlooked when performing a specific measurement. However, gamma spectroscopy and specific radiochemical analysis are required to identify contributions from individual radionuclides and to define specific baseline environmental parameters.

Concentrations of specific radionuclides in quarterly composites of low volume air filters for all locations are summarized in Appendix IV. Levels of all TRU radionuclides are not significantly different from analytical sensitivity. Levels of other radionuclides are within the expected ranges. The fourth quarter data was not available from the laboratory for publishing in this report. The fourth quarter, quarterly composite data will be presented in the Site Environmental Report for calendar year 1990.

5.2.2 Ambient Radiation Baseline

A Reuter-Stokes High Pressure Ionization Chamber (HPIC), designed to monitor low levels of gamma radiation in the environment, was put into operation in May 1986. This unit is located at the WIPP far field location which is 1000 meters northwest of the site. The detector used to measure low levels of gamma radiation is a pressurized ion chamber and measures levels of radiation from 1 to 100 microroentgen per hour (μR/hr). Appendix V depicts the results from this program for 1989. Using the average rate of 7.4 μR/hr, the estimated annual dose is approximately 65 millirem. The fluctuations noted are primarily due to calibration of the system and meteorological events such as the high intensity thunderstorms that frequent this area in late summer.

The Reuter-Stokes shows a rise in the average radiation level for the fourth quarter. A seasonal rise in ambient radiation has been observed in the first and fourth quarters each year. As stated in previous reports, it is speculated that this fluctuation may be due to variations in the emission and dispersion of Radon-222 from the soil around the WIPP site. These variations can be caused by meteorological conditions, such as inversions, that would prevent the radon progeny from dispersing.

5.2.3 Terrestrial Radioactivity

Soil samples were collected in August 1988 at 37 locations (Figure 5-2). A template insert allows the collection of samples at three depths at each location: (1) a surface sample, 0 - 2 centimeters (0.8 inch deep); (2) an intermediate (middle) sample, 2 - 5 centimeters (0.8 - 2.0 inches); and (3) a deep sample, 5 - 10 centimeters (2.0 - 3.9 inches deep). Every sample was a composite of 10 randomly located subsamples, each delineated by a 10 by 10 centimeter (3.9 by

1989 Gross Alpha Concentration

Mean of all Locations

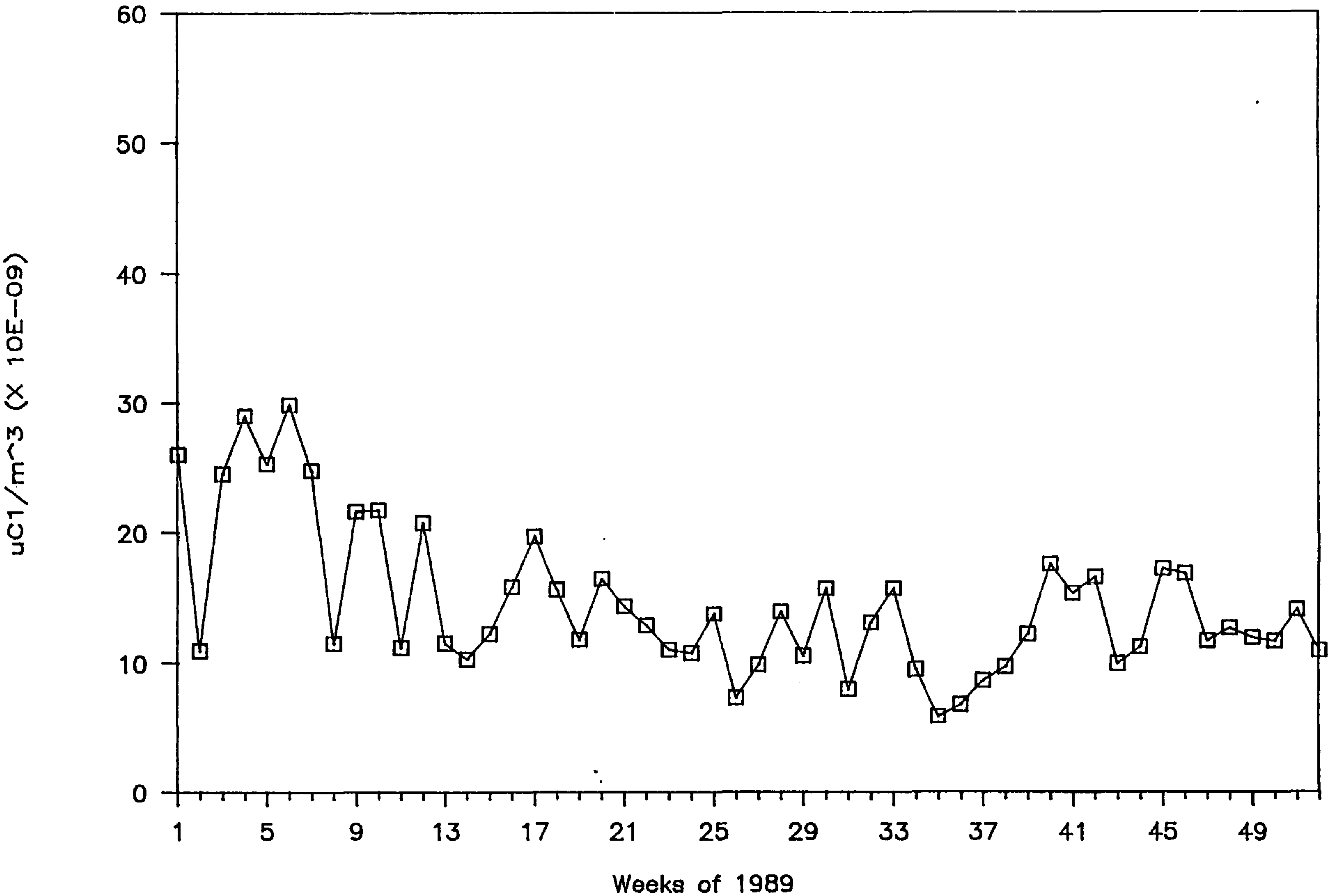

FIGURE 5-5

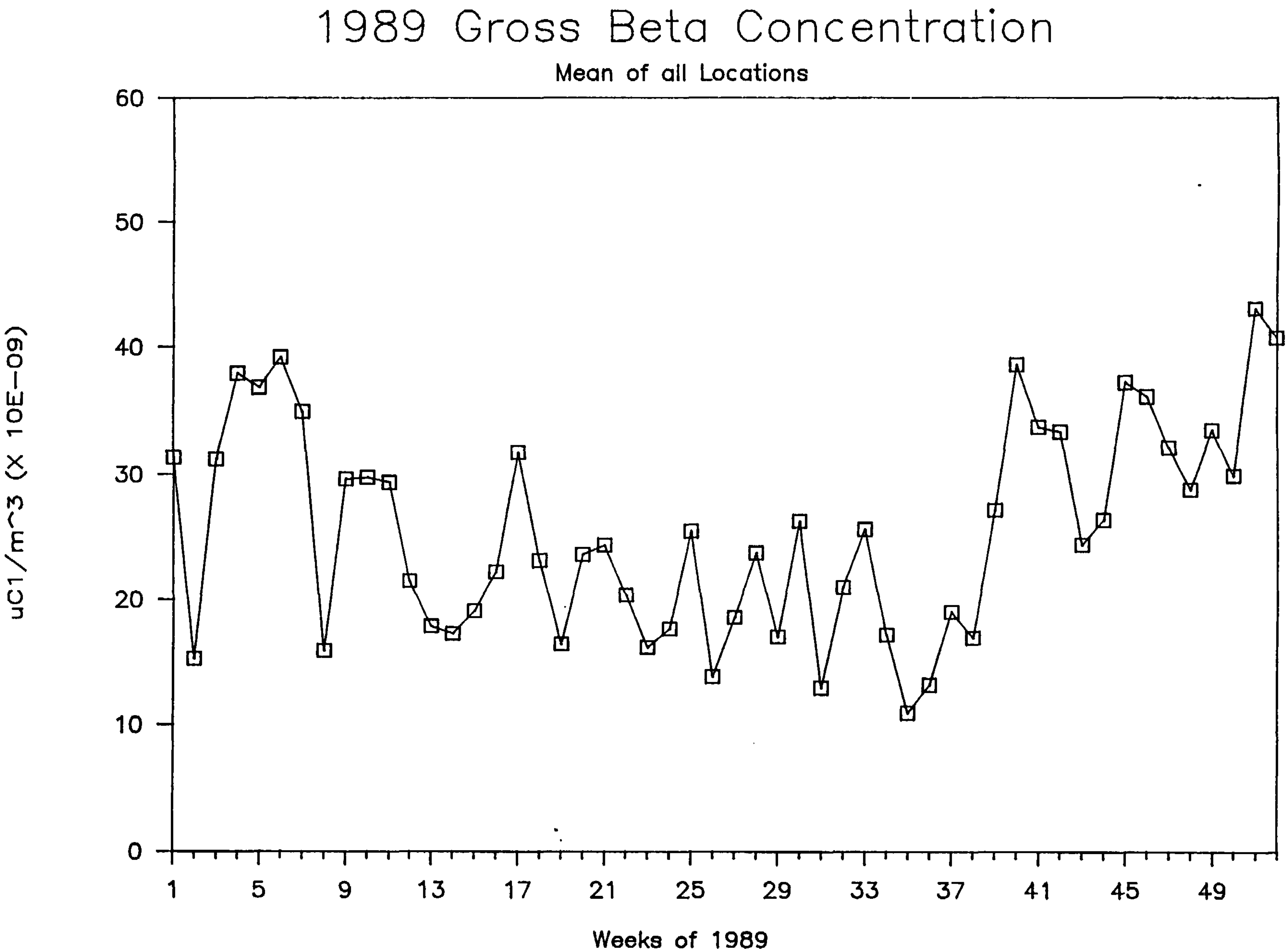
1989 Gross Beta Concentration
Mean of all Locations
uC1/m^3 (X 10E-09)
60
50
40
30
20
10
0
1
5
9
13
17
21
25
29
33
37
41
45
49
Weeks of 1989

FIGURE 5-6

3.9 inches) stainless steel template. Soil samples collected during 1989 were archived since the required number of baseline soil samples had already been collected and analyzed for the OEMP.

5.2.4 Hydrologic Radioactivity

This subprogram is designed to establish baseline radiation levels in surface water bodies, bottom sediments, and groundwater. The following discussion of the hydrologic program includes sampling locations, times and data collected during 1989, and refinements made to the program since the publication of the RBP Sampling Plan (Reith and Daer, 1985). Since data analysis lags behind sample collection, some samples have not yet been analyzed.

There were no surface water samples collected during calendar year 1989. However, groundwater samples were collected in accordance with the Water Quality Sampling Program (WQSP). The primary objective of the WQSP is to obtain representative and repeatable ground water quality data from selected wells under rigorous field and laboratory procedures and protocols. At each well site, the well is pumped and the ground water serially analyzed for specific field parameters. Once the field parameters have stabilized, denoting a chemical steady state with respect to those parameters analyzed, a final groundwater sample is collected to be analyzed for radionuclides. The controlling document for the WQSP is the WIPP Water Quality Sampling Manual (WP 07-2 of the Geotechnical and Geosciences Procedure Manual).

The primary water bearing units being evaluated by the WQSP are the Culebra and Magenta Dolomite members of the Rustler Formation. Samples have also been collected from the Dewey Lake Redbeds Formation at local ranches. A general discussion of local groundwater hydrology appears in Chapter 7.0, Groundwater Protection.

Figure 5-3 provides a map of the groundwater sampling locations. Approximately 23 wells are being monitored by the WQSP in support of the OEMP. In 1989, 16 Culebra and three Magenta wells were sampled for the full suite of radionuclides routinely analyzed for the OEMP. Due to pump failure, the H-01 and WIPP-30 samples were aborted. Four recently drilled wells were added to the WQSP and sampled for the first time in 1987. Wells H-14 and H-15 were drilled in 1986. Wells H-17 and H-18 were drilled in 1987. WIPP-19 was also sampled for the first time in 1987. All five wells are completed in the Culebra and are located to give the RBP and WQSP a more complete coverage of the area surrounding the WIPP site.

For the WQSP, groundwater was sampled at ten privately owned water wells that supply drinking water for livestock and human consumption. Of these ten wells, nine supply groundwater for livestock consumption and one (Barn Well) supplies groundwater for human consumption.

The groundwater samples collected in 1989 were archived. The required amount of baseline groundwater samples have been collected and analyzed as specified in the OEMP for the preoperational baseline.

5.2.5 Biotic Radioactivity

This subprogram characterizes background radioactivity levels in key organisms along possible food chain pathways to man. Vegetation, rabbits, quail, beef, and fish are sampled, and palatable tissues are analyzed for concentrations of transuranics and common naturally occurring radionuclides. During 1989, samples of fish, quail, and rabbits were collected and archived since the required number of baseline biotic samples had already been collected and analyzed for the OEMP. Representative sample locations are shown in Figure 5-4.

5.3 ASSESSMENT OF POTENTIAL DOSE TO THE PUBLIC

No waste has been received at the WIPP through 1989, therefore, there was no exposure of the public to radiation due to WIPP operations. Documentation of naturally occurring background radiation is discussed in Section 5.2.2, Ambient Radiation Baseline of this report.

CHAPTER 6

NONRADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

During March 1989, the monitoring activities of the EMP were combined into the OEMP. This program is described in DOE/WIPP 88-025 Operational Environmental Monitoring Plan for the Waste Isolation Pilot Plant. This plan defines the scope and extent of the WIPP effluent and environmental monitoring programs during the operational life of the facility. The OEMP is the data base for all environmental comparisons once the WIPP is operational. NES is conducted by the REP Department. This program was preceded by the WIPP Biology Program (1975-1982), which combined scientific and technical expertise from six universities to develop an extensive baseline of information describing the major components of the Los Medanos ecosystem prior to the initiation of WIPP construction activities. The principal functions of the NES are:

- To detect and quantify the impacts of construction and operational activities at the WIPP on the surrounding ecosystem
- To continue the development of the ecological data base for the Los Medanos Area which was initiated by the WIPP biology program
- To investigate unusual and unexpected elements in the ecological and radiological data bases
- To provide environmental data that are important to the mission of the WIPP project, but that have not or will not be acquired by other programs

This section of the SER presents and discusses data collected between January 1, 1989, and December 31, 1989, as part of the NES of the OEMP. Ecological monitoring at the WIPP includes five subprograms (1) meteorological monitoring, (2) air quality monitoring, (3) water quality monitoring, (4) wildlife population monitoring, and (5) surface disturbance monitoring through the analysis of aerial photographs. The salt impact studies include three subprograms: soil chemistry, soil microbial activity, and vegetation. The results of the environmental monitoring activities and discussions of significant findings are presented in this report.

Unless otherwise noted, all methods used in data collection are those described in the first Ecological Monitoring Program semiannual report (DOE/WIPP 86-002) and incorporating the modifications described in subsequent reports (Fisher et al., 1985; Fisher, 1987; Fisher, 1988).

6.1 METEOROLOGY

The WIPP NES includes a primary meteorological station that provides support for various programs at the WIPP. Its primary function is to generate data to aid in modeling atmospheric conditions for RES. The meteorological station documents standard meteorological measurements of wind speed, wind direction, and temperatures at 3, 10, and 40 meters (10, 32, and 130), respectively, with dew point, and precipitation monitored at ground level. These parameters are continuously measured and the data are stored as real time data in the central monitoring system.

In addition to the primary meteorological station, the WIPP is equipped with an atmospheric monitoring station (AMS) that monitors pollutant gases. At the AMS a secondary meteorological station measures and records temperature and barometric pressure, with wind speed and wind direction at 12.14 meters (30 ft).

6.1.1 Climatic Data Summary

The average annual temperature for the WIPP area in 1989 was 18 °C (64°F). The range for monthly mean temperatures (Figure 6-1) for the WIPP area was 7° to 28 ° C (38° to 82 ° F). (Daily maximum, minimum, and average temperature are presented in Appendix VI.) Maximum temperatures occur May through August and minimums occur in December through February.

The last freezing day of the 1988-89 winter season was March 4, with a temperature of -8° C (18° F). The first freezing day of the 1989-90 winter season occurred November 2 with -5 °C (23 ° F). The maximum temperature recorded was 43 °C (109 ° F) on July 2. The minimum temperature was -16 °C (3 ° F) on December 23, 1989.

The annual precipitation at the WIPP for 1989 was 25 cm (9.84in), which is below the average for this area by 5.49 cm (2.16 in). Typically, the majority of precipitation occurs in July and August, however only 36 percent of the annual precipitation was received in these months. The winter months remained dry with six months of the year receiving 0.15 cm (0.06 in) or less in precipitation. This low amount of precipitation continues the detrimental effects of drought on the ecosystem of this geographical area. Figure 6-1 also displays the monthly precipitation at the WIPP in 1989.

6.1.2 Wind Direction and Wind Speed

In 1989 the predominate winds in the WIPP area were from the southeast 17 percent of the time and from the southeast sector (including south-southeast and east-southeast) for a total of 40.4 percent of the time. This is illustrated in Figure 6-2, annual windrose for 1989. Wind speed noted as calm (less than 0.5 meters per second (mps)) occurred only 0.2 percent of the time. Winds of 1.4 through 6.3 mps were the most prevalent over 1989. Monthly windroses are presented in Appendix VII.

6.1.3 Barometric Pressure

The average annual barometric pressure at the WIPP was 26.37 absolute (29.97 corrected for elevation) inches of mercury or 892.99 and 1014.90 millibars, respectfully. Fluctuations of barometric pressure correlate to atmospheric pressure systems which move through the WIPP area.

6.2 ENVIRONMENTAL PHOTOGRAPHY

Aerial photographs of the WIPP site have been taken semi-annually since 1982. In 1989, photographs were taken in September and December. These photographs document surface disturbance, development, and reclamation activities at the WIPP site and surrounding BLM/DOE lands. Spot photographs and aerial flight lines are archived for future reference use. Beginning in 1990, aerial photographs will be taken on an annual basis with late summer as the time frame for the photographs.

Surface photography has been conducted at seven ecological study plots since 1984. These photographs are used to document surface impacts at the study plots. In 1989 these photographs were examined and found to show very little surface impact. There was evidence of trails developing from foot traffic in some of the plots.

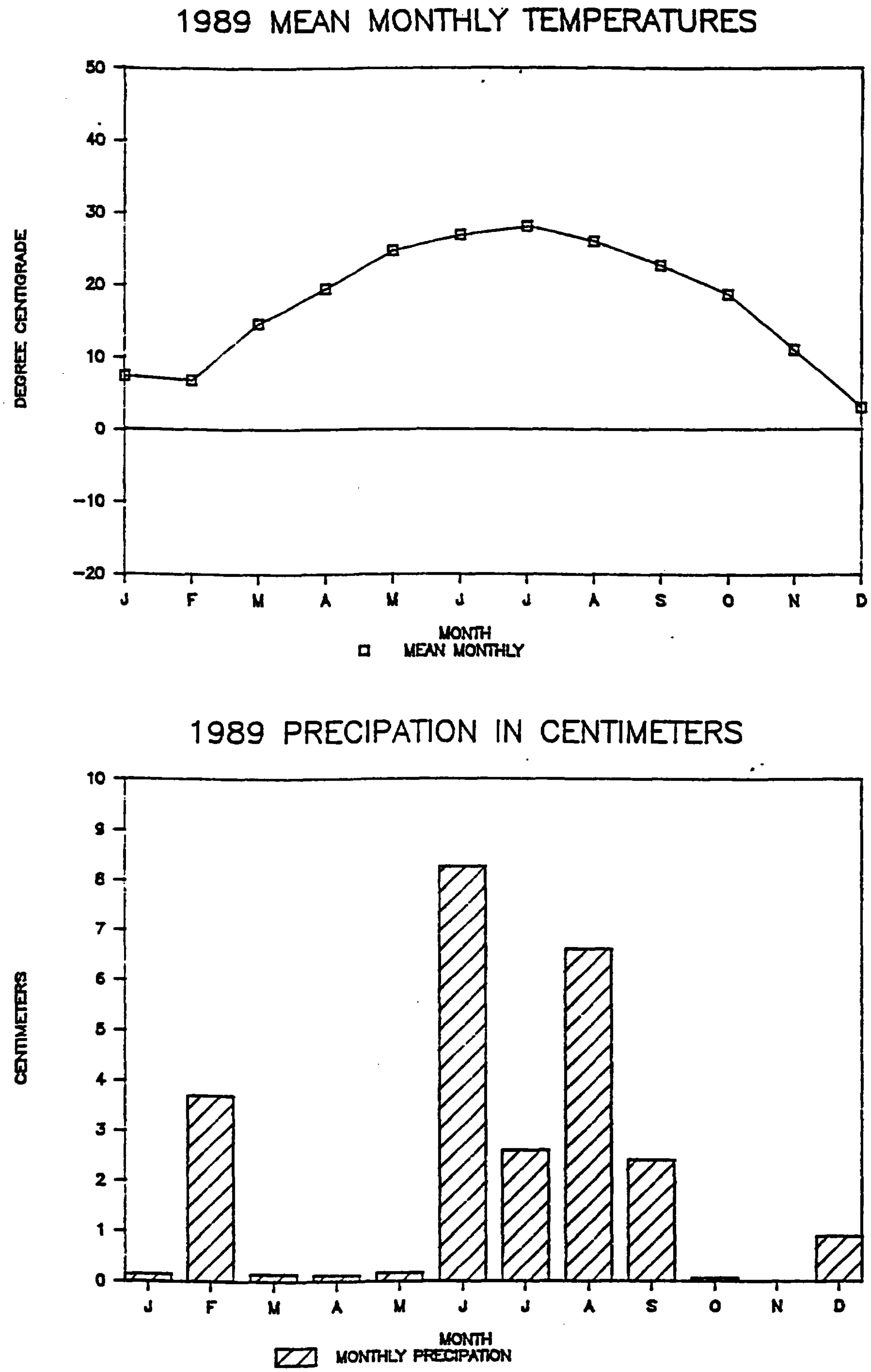
1989 MEAN MONTHLY TEMPERATURES
DEGREE CENTIGRADE
50
40
30
20
10
0
-10
-20
J F M A M J J A S O N D
MONTH
MEAN MONTHLY
1989 PRECIPATION IN CENTIMETERS
CENTIMETERS
10
9
8
7
6
5
4
3
2
1
0
J F M A M J J A S O N D
MONTH
MONTHLY PRECIPATION

FIGURE 6-1

1989 ANNUAL WINDROSE

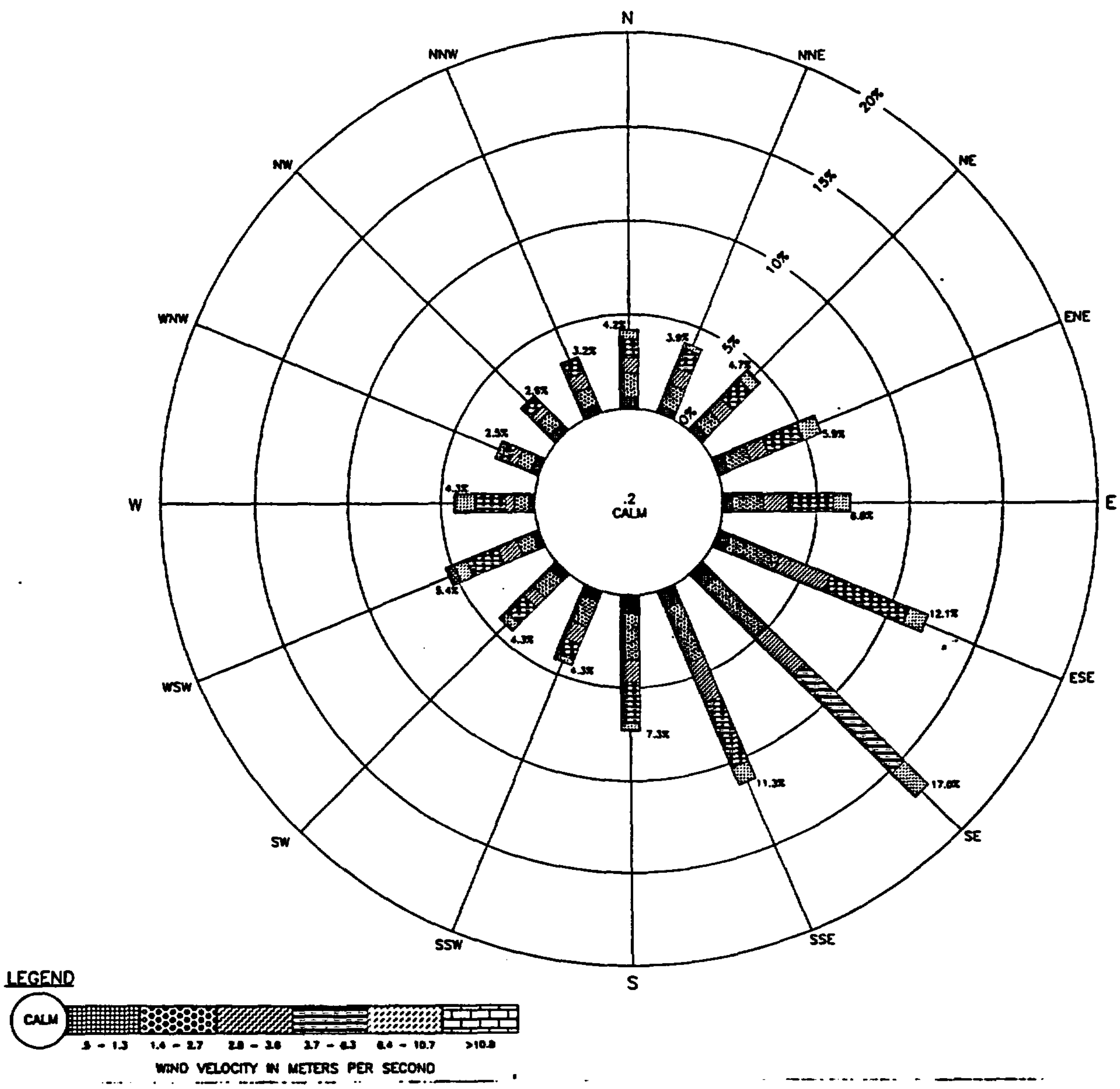

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FIGURE 6-2

6.3 AIR QUALITY MONITORING

Seven classes of pollutant gases are monitored 1000 meters northeast of the exhaust shaft at the WIPP site on a continuous basis. These are: sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), hydrogen sulfide (H_2S), and oxides of nitrogen (NO, NO_2, NO_x). In addition, weekly measurements of Total Suspended Particulates (TSP) are made from the particulates collected by the low-volume continuous air sampler at the far-field air sampling location.

There was a concern that O_3 and H_2S were exceeding the state air quality standard, .06 and .010 ppm respectively, during 1989, with regular diurnal cyclic peaks in the reported values of O_3 and H_2S, .180 and .084 maximum ppm recorded values. Due to this anomalous behavior an evaluation of the air quality monitoring instruments was performed. The evaluation showed that the O_3 and H_2S analyzers had internal electronic and operable deficiencies that allowed the instruments to report data values higher than what were actually present.

After repair and recertification the data values detected by the instruments were typical for this area. Air standards above those which are typical for this area, and state standards, did not occur for any extended time in 1989.

6.4 SURFACE WATER AND SEDIMENT QUALITY MONITORING

During 1989, no surface water or sediment quality monitoring was conducted. The OEMP requires annual collection and monitoring of these parameters when the WIPP is operational. However, with the WIPP being in a preoperational state during 1989, there is no requirement to sample annually, since a preoperational baseline has been established. Preoperational monitoring began in 1985 and continued through 1988 with samples collected annually. With three years of background data, continuing with annual monitoring is not required. However, surface water and sediment quality monitoring will be conducted biennially until the WIPP is operational.

6.5 WILDLIFE POPULATION MONITORING

Population density measurements of breeding birds and small nocturnal mammals are performed annually to assess the effects of the WIPP activities on wildlife populations. Two permanent study sites adjacent to the WIPP facility are used for each of these two classes of wildlife. The data are compared to two control sites for each class in order to assess the effects of WIPP on wildlife populations. Trap grids are used to measure small mammal populations, and 762 meters (2500 ft) Emlen-type transects are used to measure bird population densities.

6.5.1 Breeding Bird Densities

Table 6-1 presents the results of the 1989 breeding bird surveys for the Control and WIPP transects. Several species were found in lower numbers this year than previous years. This is probably due to the very dry conditions in the environment during the winter and spring. Most notable was the absence of eastern meadowlarks from the sample. This species has been common in previous years.

Overall, the patterns of species distribution between the WIPP transacts and the Control transacts follow that of previous years. More species and a higher total density were found in the WIPP transacts, probably due to greater habitat diversity near the facility and perhaps more abundant food. Greater numbers of flycatchers account for the largest increase of birds near the facility.

6.5.2 Small Nocturnal Mammal Population Densities

Table 6-2 summarizes the results of the 1989 small mammal surveys in the Control and WIPP trap grids. Population densities of Ord's kangaroo rats were above average. This, in part, may be due to the earlier initiation of trapping in 1989 (approximately three weeks earlier than 1988), although a continued increase in the population of this species has occurred over the past two years. White-footed mice and southern plains woodrats also showed an increase this year in the WIPP grids, especially in the northwest grid. The northern grasshopper mouse and plains pocket mouse remained at relatively low population size in all grids.

6.6 SOIL

The soil monitoring subprogram provides for the direct measurement of the concentration of selected ions at the soil surface and at two depths, 30 to 45 centimeters (11.8 to 17.7 in) and 60 to 75 centimeters (23.6 to 29.5 in), in the soil profile. Soil ion concentrations vary with input, deposition of windborne salts on the soil surface, and loss of salts through leaching to the caliche layer. Surface stockpiles of salt and general site activity are the sources of windblown salt in the immediate area. The site was paved with asphalt in 1988, decreasing to some degree the amount of caliche dust generated by traffic at the site.

Samples of surface soil are collected quarterly from the seven ecological monitoring plots and are analyzed for several soil parameters which may reflect salt-induced ecosystem impacts. The following patterns, when discerned in the analytical results, are of interest in identifying cause and effect relationships in the soil ecosystem.

- Consistent increases in concentrations of specific ions over time, indicating continual input of these ions
- Seasonal variation in soil parameters that are consistent in all plots, delineating normal cycles of change for those parameters affected by seasonal conditions, e.g., precipitation and wind direction
- Identification of patterns that may indicate interactions among components of the soil ecosystem

This section addresses the results of sampling conducted in calendar year 1989. Plot averages for each parameter measured quarterly are illustrated in Appendix VIII; letters denote statistically significant differences between plot means. Analytical results for subsurface soils are discussed in Section 6.6.3, Subsurface Soil.

6.6.1 Methods

Soil samples were analyzed for pH, electrical conductivity, and concentrations of chloride, calcium, magnesium, potassium, and sodium. Analytical results are evaluated statistically using an analysis of variance (ANOVA) procedure. All data except pH values are logarithems normally transformed prior to analysis to allow the use of parametric statistics. When the ANOVA indicates that a parameter varies significantly among plot means (0.05), a Student Newman-Keuls test is calculated to identify homogenous plots.

Control plots (CT1 and CT2) are located more than two kilometers (1.24 miles) from the facility (northeast and southwest) in the directions perpendicular to the prevailing wind (southeast and northwest). Near-field plots (SE 1, NW 1, and E 1) are adjacent to the two surface salt piles. The far-field plots (SE 2 and NW 2) are approximately 100 meters (328 ft) farther from the salt

TABLE 6-1

Summary of the 1989 breeding bird density measurments (in birds per 40ha)

	CONTROL TRANSECTS				WIPP TRANSECTS			
	CT1	CT2	AVERAGE 1989	AVERAGE 1984-1989	NW	SE	AVERAGE 1989	AVERAGE 1984-1989
- DOMINANT CONTROL SPECIES -								
BLACK-THROATED SPARROW	23.7	19.4	21.5	26.3	17.2	17.2	17.2	22.8
PYRRHULOXIA	17.2	23.7	20.4	18.1	15.1	23.7	19.4	15.6
NORTHERN MOCKINGBIRD	10.8	9.7	10.2	11.9	21.5	19.4	20.4	14.4
NORTHERN BOBWHITE	3.2	4.3	3.8	11.3	3.2	2.2	2.7	5.4
MOURNING DOVE	4.3	0.0	2.2	8.3	4.3	2.2	3.2	4.3
BROWN-HEADED COWBIRD	4.3	6.5	5.4	5.1	1.1	6.5	3.8	2.4
LOGGERHEAD SHRIKE	4.3	4.3	4.3	4.8	1.1	0.0	0.5	3.2
EASTERN MEADOWLARK	0.0	0.0	0.0	3.4	0.0	0.0	0.0	1.3
SCALED QUAIL	2.7	1.1	1.9	2.6	0.0	0.0	0.0	0.6
COMMON NIGHTHAWK	0.0	6.5	3.2	2.5	2.2	8.6	5.4	2.2
CACTUS WREN	1.1	1.1	1.1	2.0	8.6	4.3	6.5	6.7
CHIHUAHUAN RAVEN	8.6	2.2	5.4	1.2	0.5	4.3	2.4	1.2
- MINOR CONTROL SPECIES -								
CASSIN'S SPARROW	5.4	0.0	2.7	0.9	0.0	0.0	0.0	0.3
ASH-THROATED FLYCATCHER	4.3	0.0	2.2	0.9	4.3	4.3	4.3	3.2
POORWILL	4.3	0.0	2.2	0.9	0.0	0.0	0.0	0.3
SCISSOR-TAILED FLYCATCHER	8.6	0.0	4.3	0.7	0.0	2.2	1.1	0.6
CRISSAL THRASHER	0.0	4.3	2.2	0.7	0.0	0.0	0.0	0.0
WESTERN KINGBIRD	0.0	0.0	0.0	0.6	4.3	17.2	10.8	6.3
BREWER'S SPARROW	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
HOUSE FINCH	0.0	0.0	0.0	0.5	0.0	0.0	0.0	2.0
LARK BUNTING	0.0	0.0	0.0	0.2	0.0	4.3	2.2	0.4
YELLOW-HEADED BLACKBIRD	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.3
GREAT HORNED OWL	1.1	0.0	0.5	0.1	2.2	1.1	1.6	0.4
SWAINSON'S HAWK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
HARRIS' HAWK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- WIPP SPECIES -								
NORTHERN ORIOLE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
BARN SWALLOW	0.0	0.0	0.0	0.0	0.0	6.5	3.2	1.3
LADDER-BACKED WOODPECKER	0.0	0.0	0.0	0.0	2.2	2.2	2.2	0.9
GREATER ROADRUNNER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
LARK SPARROW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
LESSER GOLDFINCH	0.0	0.0	0.0	0.0	4.3	0.0	2.2	0.4
YELLOW WARBLER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
KILLDEER	0.0	0.0	0.0	0.0	0.0	1.1	0.5	0.3
TOTAL DENSITY	103.8	82.9	93.3	103.7	92.0	127.0	109.5	100.2
NUMBER OF SPECIES	15	11	17	23	15	17	19	31

TABLE 6-2

Summary of 1989 small nocturnal mammal density measurements (in individuals per trap grid)

	CONTROL GRIDS				WIPP GRIDS			
	CT1	CT2	AVERAGE 1989	AVERAGE 1985-1989	NW	SE	AVERAGE 1989	AVERAGE 1985-1989
ORD'S KANGAROO RAT	28	43	36	15	33	17	25	16
PLAINS POCKET MOUSE	3	2	3	13	3	1	2	5
NORTHERN GRASSHOPPER MOUSE	7	1	4	3	2	3	3	9
SOUTHERN PLAINS WOODRAT	0	0	0	2	2	3	3	1
WHITE-FOOTED MOUSE AND DEER MOUSE	0	0	0	0	8	2	5	3
TOTAL DENSITY	38	46	42	33	48	26	37	35

piles than the near-field plots. Therefore, when near-field or far-field plot means for a parameter do not differ significantly from one or the other control plot mean, the variations measured over time are believed to reflect normal cycles of change within the system.

6.6.2 Results and Discussion

For the sampling periods included in this report, ion concentrations in surface soils remain low. Total precipitation was low in 1989; very little measurable precipitation fell in the first half of the year. Generally, ion concentration in the sandy soil at the WIPP is a function of precipitation since there is little clay or organic material in the soil to retain the ions. They remain in the surface soil as long as it is dry but are easily moved down through the soil profile by percolation of precipitation. Soils are sampled annually to determine whether ions accumulate at any point in the soil profile above the caliche layer.

In the first quarter of 1989, conductivity values and magnesium and potassium concentrations did not differ significantly from values and concentrations in the control plots. Conductivity values and ion concentrations in the soil were low. Chloride concentrations were significantly higher in the control plots than in the near-field or far-field plots. Average surface soil pH in the near-field plots was slightly above neutral (neutral = 7.0), but the average fell below neutral in the far-field and control plots. This pattern of pH values has been seen consistently in the surface soils throughout the monitoring program. Calcium and sodium concentration means varied significantly among plots but did not follow the same pattern. Calcium concentrations were higher in the nearfield plots than in the far-field or control plots, whereas sodium concentrations in the near and farfield plots were relative to the average values in the control plots.

The second quarter 1989 sample results showed that chloride, magnesium, and potassium concentrations did not vary significantly among plots. Again, pH values were highest in the near-field plots; plot averages range between 6.3 and 7.5. Conductivity values were significantly higher in the near-field plots, following the same pattern as the first quarter. Calcium concentrations were similar to those measured first quarter and followed the same pattern. Sodium concentrations were highest in SE 1 and NW 1, but average concentrations in all plots were less than 5 mg/l.

In the third and fourth quarter of 1989 the pH values followed the same pattern found during the first two quarters. Calcium concentrations were highest in the NW 1 and E 1 plots, although values were lower than measured in the first two quarters. The third quarter sodium concentrations were at detection limits except in NW 1, where they were slightly above detection. Fourth quarter sodium concentrations were lower but continued to reflect a significantly higher concentration in the near field plot.

In summary, concentrations of major cations and chloride in the surface soils remained very low throughout the sampling period. The pattern continues to suggest that windborne caliche and salt are deposited on surface soils immediately adjacent to site activities. The total input of ions was very small, and they were moved down through the soil profile during the rainy period. There was an indication that salts accumulate at the soil surface in any of the monitoring plots.

6.6.3 Subsurface Soil

Intermediate and deep soils have been sampled annually in the ecological monitoring plots to monitor for the possible accumulation of deposited ions at several levels in the soil profile. To date, results indicate that materials deposited at the soil surface are leached at least 75 cm (29.5 in.) through the soil profile. The stabilized dune sand is underlain by a caliche layer at a depth of two to four meters (6.5 to 13 ft).

During the second quarter sampling period each year, three intermediate soil samples from each plot are collected 25 to 45 cm (9.84 to 17.7 in) below the surface from each plot and are analyzed for the same parameters as the surface samples. Analytical results of the intermediate soil samples are presented in Appendix IX. An ANOVA was calculated for each parameter to determine differences between plot means. All data except pH values were logarithems normally transformed prior to analysis to allow the use of parametric statistics.

Ion concentrations and conductivity levels are very low. Average pH values at this depth range from 6.5 to 7.5. The pH values vary significantly between plots, but mean values from all plots are statistically equal to one or the other control plots. Sodium concentrations vary significantly between plots. Concentrations are higher in NW2 and E1 than in the control plots, and are highest in SE1 and NW1.

Deep soil samples are collected at 60 to 75 centimeters (23.6 to 29.5 in) at the same locations and on the same schedule as the intermediate samples. Analytical results of the deep soil samples are presented in Appendix XI. An ANOVA was calculated for each parameter to identify significant differences between plots. All data except pH values were logarithems normally transformed prior to analysis to allow the use of parametric statistics.

Ion concentrations and conductivity values were very low in the deep soils. Average pH values ranged from 6.3 to 7.4. The pH values varied significantly among plots, but all plots were statistically equal to one or the other control plots. Sodium concentrations varied significantly among plots. Concentrations were significantly higher in NW 1 than in either of the control plots.

These results indicate that there was input of windblown salt, composed at least inpart of sodium chloride (NaCl) from the salt pile, to adjacent soil. Sodium ions appear to be leaching through the sandy soil profile. The rate of salt input to the near field plots is slow and the concentrations of accumulated ions, though measurable, are well below levels that would pose a potential threat to the surrounding ecosystem.

In conclusion, there is no indication that windblown salts generated at the WIPP from the salt piles or from traffic are accumulating at any level in the soil profile. Rather, salts deposited at the soil surface are flushed through the soil to the underlying caliche layer. There is no indication of a build-up of ions in the soil above the caliche layer. If WIPP activities contribute to a long-term accumulation of salts in the soil, there should be progressively greater concentrations of salts at sampling points progressively closer to the salt piles and the site. This has not been demonstrated.

6.7 SOIL MICROBIOTA

The soil microbial sampling subprogram is designed to monitor an important portion of the biological community that can be affected by changes in chemical properties at the soil surface. The normal cycle of microbial activity is generally influenced by climatic factors as well as the physical and chemical nature of the substrate, which in this study is plant litter. Microbial activity levels and the rate at which the surface litter is decomposed by the microbial community in the control plots are compared to those in the near-field and far-field plots to detect any effect of salt deposition on these biological processes.

6.7.1 Methods

A litter sample is composed of two nylon mesh bags fastened together with a nylon tie, each containing ten grams of oven-dried shinier oak leaves (Quercus havardii) which are collected at the time of leaf fall. In February, six samples of litter are placed at random locations in each of the ecological monitoring plots. Each sample is attached to the base of a shinier oak stem. Three samples are collected from each plot every six months.

Two parameters are measured for each litter sample collected: the level of microbial activity and the rate at which organic matter is lost from the sample via decomposition. Microbial activity levels are measured indirectly using the fluorescein diacetate hydrolysis assay (FDA), described by Schnurer and Rosswall (1982). The assayed enzymes are produced in small quantities in dormant organisms and spores relative to the quantity produced by active colonies. Therefore, the optical density of the sample, which is a measure of the amount of breakdown product produced from a known quantity of fluorescein diacetate substrate, is proportional to the total microbial respiration in the sample. Activity levels measured at a given time are affected by the immediate chemical and physical conditions in the environment, (i.e., moisture, temperature, and nutrient availability).

The rate at which plant litter is broken down by microbial action is another indirect measure of a biotic soil process. The amount of organic matter lost from the litter over time is determined using the ashing technique described by Santos, et al. (1984). Decomposition rates reflect to a greater degree than microbial activity levels, the long-term impacts of the physical and chemical environment.

Results of the FDA assay are analyzed using the ANOVA method. To determine decomposition rates, an arcsine transformation is applied to the percentage values prior to the ANOVA use. When the ANOVA indicates that significant differences exist between plot means, a SNK test is performed to identify homogeneous means.

Due to the unavailability of required laboratory equipment for decomposition measurement in 1988, the third and fourth quarter samples from that year were retained in dry storage until the equipment was again available in June 1, 1989. At this time, the fourth quarter samples were measured for decomposition; however, the third quarter samples were analyzed for microbial activity using the FDA assay. This was done to check the assumption that dry storage significantly reduces microbial activity. The results of these analyses are presented in Table 6-3). The FDA assay showed very low activity. In the stored samples indicating that the fourth quarter data are comparable.

In February 1989, six litter samples were placed in each of the ecological monitoring plots. Three samples were collected from each plot in August. The second set was collected in February 1990. The results from the analyses of these samples are presented in (Table 6-4). No significant differences were found in either the rate of decomposition or the microbial activity between plots in 1989.

6.8 VEGETATION MONITORING

The vegetation in each of the seven ecological monitoring plots was measured in the early summer (June and July) and again in the early fall (September and October) to assess the effect of proximity to the salt piles on plant community structure. Due to the extremely dry conditions in the spring, the spring vegetation monitoring was delayed to allow for the late germination of the annual species. In each plot, foilage of each species, density of annual species, and species diversity are measured using the methods described in Reith, et al; (1985) and Fischer et al; (1985). The frequency of each species in the sample of 20 quadrat frames ($1m^2$) was also calculated. The frequency of a species is defined as the proportion (as percent) of the quadrats containing that species.

Summaries of the data for the spring and fall sampling periods are presented in Table 6-5 and 6-6, respectively. The calendar year of 1989 was marked by severe drought conditions in the Los Medanos area, which is reflected in the results of the vegetation monitoring. This is especially apparent in the densities of annuals. Species that were common or abundant in previous years, such as telegraph plant (Heterotheca psammophila), bluets (Houstonia humifusa), and spotted horsemint (Monarda punctata), were extremely rare in the plots and did not occur in the sample. The effects of the drought are also seen in nearly all parameters measured in 1989.

The 1988 vegetation monitoring data showed a decline in several parameters with increasing proximity to the salt piles, indicating a detrimental effect of these storage piles on the surrounding ecosystem. However, the 1989 data do not show such an effect. The total coverages in all plots were relatively uniform over all distances from the piles. The densities of annuals and species richness were also relatively uniform across all plots. A pattern observed in the 1988 data which was also seen in the 1989 data is an increase in shrub cover with increasing proximity to the piles and an approximately equal decrease in perennial grass cover. The responses of these plots to higher rainfall in later years will reveal whether this pattern is reflecting the start of a significant change in the structure of the plant community or whether it is only a short-term effect was caused by short-term weather conditions.

Of greatest significance in the 1989 vegetation monitoring data was the observation that the drought conditions of this year have had a uniform effect on vegetation in all plots. A differential effect resulting from salt-induced physiological stress near the salt piles was not observed.

TABLE 6-3

PERCENTAGE MICROBIAL DECOMPOSITION BY PLOT
4TH QUARTER 1988, FIRST AND SECOND HALF OF 1989

4TH QUARTER, 1988

	CT1	CT2	SE1	SE2	NW1	NW2	E1
A	23.66	24.20	24.62	25.05	26.02	31.48	30.08
B	30.94	20.66	26.12	29.66	26.60	27.09	32.12
C	17.66	18.84	20.13	31.16	31.69	14.13	28.16
AVG	24.09	21.23	23.62	28.62	28.10	24.23	30.12

FIRST HALF, 1989

	CT1	CT2	SE1	SE2	NW1	NW2	E1
A	12.08	17.69	17.16	18.67	11.97	25.00	15.78
B	13.98	13.14	20.02	17.37	16.00	12.39	21.50
C	9.00	12.82	3.60	15.15	15.78	18.33	22.25
AVG	11.69	14.55	13.59	17.06	14.58	18.57	19.84

SECOND HALF, 1989

	CT1	CT2	SE1	SE2	NW1	NW2	E1
A	22.78	25.11	27.12	30.09	30.09	22.14	31.67
B	21.93	26.38	35.17	30.40	19.17	19.92	30.09
C	29.60	19.70	23.41	21.61	28.81	29.03	27.97
AVG	24.77	23.73	28.57	27.37	26.02	23.70	29.91

TABLE 6-4

AVERAGE OPTICAL DENSITY (MICROBIAL ACTIVITY LEVEL) BY PLOT

	CT1	CT2	SE1	SE2	NW1	NW2	E1
1ST Half 1989	0.238	0.162	0.138	0.175	0.196	0.147	0.124
2ND Half 1989	0.27	0.272	0.204	0.225	0.243	0.237	0.205
Stored Samples (1)	0.061	0.073	0.043	0.077	0.075	0.099	0.052

(1) Samples from the third quarter 1988 used to check the effectiveness of dry storage in suppressing microbial activity

TABLE 6-5

Summary of the Spring 1989 vegetation measurements from seven monitoring plots grouped as three relative distances from the salt storage piles

	CONTROL PLOTS (1)			FAR FIELD PLOTS (2)			NEAR FIELD PLOTS (3)		
--- SHRUBS ---	COVER(4)	FREQ.(5)	DENS.(6)	COVER	FREQ.	DENS.	COVER	FREQ.	DENS.
SHINNERY OAK	10.06	85	--	12.05	88	--	13.03	87	--
SAND SAGE	2.25	35	--	2.70	55	--	3.96	87	--
YUCCA	1.42	23	--	1.46	18	--	0.73	13	--
HARTWEG PRIMROSE	0.00	0	--	0.05	5	--	0.15	8	--
CROTON	0.12	10	--	0.08	3	--	0.03	2	--
SMALLHEAD SNAKEWEED	0.00	0	--	0.00	0	--	0.40	5	--
SOUTHWEST RABBITBRUSH	0.00	0	--	0.19	3	--	0.00	0	--
HONEY MESQUITE	1.27	5	--	2.78	5	--	2.86	15	--
--- PERENNIAL FORBS ---									
LEAF-FLOWER	0.03	8	--	0.13	25	--	0.06	12	--
LONGLOBED GROUNDSEL	0.33	8	--	0.04	8	--	0.06	7	--
HOG POTATO	0.00	0	--	0.02	5	--	0.01	3	--
SMOOTH OXYBAPHUS	0.00	0	--	0.03	5	--	0.01	2	--
WOOLLY DALEA	0:01	3	--	0.01	3	--	0.03	2	--
ELEGANT NIGHTSHADE	0.01	5	--	0.00	0	--	0.00	0	--
FLATSEDGE	0.00	0	--	0.01	3	--	0.00	0	--
COTTA	0.01	3	--	0.00	0	--	0.00	0	--
SPINY YELLOW ASTER	0.01	3	--	0.00	0	--	0.00	0	--
CLIMBING MILKWEED	0.01	3	--	0.00	0	--	0.00	0	--
--- ANNUAL FORBS ---									
LACE SPURGE	0.01	5	0.05	0.02	8	0.08	0.04	13	0.38
FETID MARIGOLD	0.00	0	0.00	0.01	3	0.03	0.02	5	0.50
ANNUAL BUCKWHEAT	0.00	0	0.00	0.01	3	0.03	0.01	3	0.03
PRAIRIE SUNFLOWER	0.00	0	0.00	0.01	3	0.03	0.00	0	0.00
ARIZONA DOZE DAISY	0.01	3	0.03	0.00	0	0.00	0.00	0	0.00
RUSSIAN THISTLE	0.00	0	0.00	0.00	0	0.00	0.00	2	0.02
--- PERENNIAL GRASSES ---									
THREE-AWN	1.93	80	--	1.09	55	--	0.87	33	--
SAND MUHLY	0.40	38	--	0.59	50	--	0.20	23	--
SANDBUR	0.33	30	--	0.55	35	--	0.34	28	--
GIANT DROPSEED	0.16	23	--	0.29	35	--	0.37	25	--
SAND DROPSEED	0.19	23	--	0.13	23	--	0.24	23	--
SPIKE DROPSEED	0.07	13	--	0.06	10	--	0.14	15	--
FALL WITCHGRASS	0.16	18	--	0.03	10	--	0.00	2	--
SANDHILL GRASS	0.01	3	--	0.09	18	--	0.01	2	--
KNOTGRASS	0.09	8	--	0.08	8	--	0.08	5	--
PLAINS BRISTLEGRASS	0.00	0	--	0.00	0	--	0.00	2	--
HAIRY GRAMA	0.03	3	--	0.00	0	--	0.00	0	--
INTERMEDIATE LOVEGRASS	0.00	0	--	0.00	0	--	0.02	2	--
--- ANNUAL GRASSES ---									
GRASS SEEDLING	0.01	3	0.03	0.00	0	0.00	0.02	8	0.17
PURPLE SANDGRASS	0.00	0	0.00	0.00	0	0.00	0.01	5	0.07

TOTALS BY GROUP

--- SPECIES GROUP ---	COVER	DENS.	No. SPECIES	COVER	DENS.	No. SPECIES	COVER	DENS.	No. SPECIES
SHRUBS (7)	13.85	--	5	16.53	--	7	18.30	--	7
PERENNIAL FORBS	0.40	--	7	0.23	--	6	0.17	--	5
ANNUAL FORBS	0.03	0.08	2	0.04	0.15	4	0.07	0.93	4
PERENNIAL GRASSES	3.35	--	10	2.90	--	9	2.26	--	11
ANNUAL GRASSES (8)	0.01	0.03	0	0.00	0.00	0	0.03	0.23	1
TOTAL	17.63	0.10	24	19.69	0.15	26	20.83	1.17	28

(1) Control Plots include plots CT1 and CT2, more than 2km from the salt piles
(2) Far Field Plots include plots NW2 and SE2, approximately 200m from the salt piles
(3) Near Field Plots include plots NW1, SE1 and E1, which are adjacent to the salt piles
(4) Foliar cover, in percent
(5) Frequency in the sample, in percent
(6) Density of annual species only, in plants per square meter
(7) Coverage does not include honey mesquite
(8) Number of species does not include grass seedlings

TABLE 6-6

Summary of the Fall 1989 vegetation measurements from seven monitoring plots grouped as three relative distances from the salt storage piles

	CONTROL PLOTS (1)			FAR FIELD PLOTS (2)			NEAR FIELD PLOTS (3)		
--- SHRUBS ---	COVER(4)	FREQ.(5)	DENS.(6)	COVER	FREQ.	DENS.	COVER	FREQ.	DENS.
SHINNERY OAK	9.31	85	--	7.41	95	--	9.73	87	--
SAND SAGE	1.15	38	--	2.59	65	--	2.77	52	--
YUCCA	0.61	13	--	0.56	10	--	0.68	15	--
SMALLHEAD SNAKEWEED	0.05	8	--	0.00	0	--	0.09	7	--
HARTWEG PRIMROSE	0.00	0	--	0.03	5	--	0.00	0	--
SOUTHWEST RABBITBRUSH	0.00	0	--	0.01	3	--	0.05	2	--
CROTON	0.06	5	--	0.00	0	--	0.00	0	--
CHRISTMAS CHOLLA	0.01	3	--	0.00	0	--	0.00	0	--
PRICKLY PEAR	0.02	3	--	0.00	0	--	0.00	0	--
HONEY MESQUITE	1.04	8	--	2.04	10	--	1.79	8	--
--- PERENNIAL FORBS ---									
LEAF-FLOWER	0.04	8	--	0.13	23	--	0.11	18	--
FLATSEDGE	0.06	5	--	0.06	8	--	0.03	3	--
MILKWEED	0.00	0	--	0.01	3	--	0.02	3	--
SMOOTH OXYBAPHUS	0.04	5	--	0.00	0	--	0.01	2	--
HOG POTATO	0.00	0	--	0.01	3	--	0.01	2	--
PLAINS BLACKFOOT	0.02	3	--	0.00	0	--	0.07	2	--
CLIMBING MILKWEED	0.00	0	--	0.02	3	--	0.00	0	--
LONGLOBED GROUNDSEL	0.00	0	--	0.01	3	--	0.00	0	--
GAURA	0.00	0	--	0.02	3	--	0.00	0	--
SPINY YELLOW ASTER	0.04	3	--	0.00	0	--	0.00	0	--
COTTA	0.01	3	--	0.00	0	--	0.00	0	--
--- ANNUAL FORBS ---									
FETID MARIGOLD	0.03	5	0.10	0.03	8	0.08	0.09	13	0.23
LACE SPURGE	0.06	15	0.28	0.03	5	0.03	0.01	5	0.05
PALAFOXIA	0.01	5	0.03	0.00	0	0.00	0.02	3	0.03
RAGWEED	0.21	8	0.73	0.00	0	0.00	0.00	0	0.00
--- PERENNIAL GRASSES ---									
THREE-AWN	3.28	80	--	2.39	80	--	1.71	57	--
SAND DROPSEED	0.67	53	--	0.41	60	--	0.49	45	--
SAND MUHLY	0.61	38	--	2.10	58	--	1.13	28	--
SANDBUR	0.77	38	--	0.94	45	--	0.39	22	--
SPIKE DROPSEED	0.13	18	--	0.16	18	--	0.23	22	--
KNOTGRASS	0.36	20	--	0.15	10	--	0.35	13	--
MESA DROPSEED	0.04	3	--	0.01	5	--	0.31	18	--
FALL WITCHGRASS	0.50	20	--	0.13	5	--	0.13	5	--
GIANT DROPSEED	0.34	15	--	0.02	5	--	0.15	8	--
MEXICAN LOVEGRASS	0.07	8	--	0.09	5	--	0.00	0	--
SANDHILL GRASS	0.15	8	--	0.00	0	--	0.04	2	--
HAIRY GRAMA	0.20	8	--	0.00	0	--	0.05	2	--
BLACK GRAMA	0.00	0	--	0.06	5	--	0.00	0	--
PLAINS BRISTLEGRASS	0.01	3	--	0.00	0	--	0.01	2	--
--- ANNUAL GRASSES ---									
FALSE BUFFALOGRASS	0.04	10	0.13	0.11	10	0.15	0.10	17	0.27
GRASS SEEDLING	0.02	8	0.13	0.00	0	0.00	0.01	3	0.23
PURPLE SANDGRASS	0.02	3	0.03	0.03	5	0.03	0.01	2	0.02

TOTALS BY GROUP

--- SPECIES GROUP ---	COVER	DENS.	No. SPECIES	COVER	DENS.	No. SPECIES	COVER	DENS.	No. SPECIES
SHRUBS (7)	11.21	--	8	10.59	--	6	13.31	--	6
PERENNIAL FORBS	0.21	--	6	0.26	--	7	0.24	--	6
ANNUAL FORBS	0.31	1.13	4	0.06	0.10	2	0.12	0.32	3
PERENNIAL GRASSES	7.13	--	13	6.44	--	11	4.99	--	12
ANNUAL GRASSES (8)	0.08	0.28	2	0.14	0.18	2	0.12	0.52	2
TOTAL	18.93	1.40	33	17.49	0.28	28	18.78	0.83	29

(1) Control Plots include plots CT1 and CT2, more than 2km from the salt piles
(2) Far Field Plots include plots NW2 and SE2, approximately 200m from the salt piles
(3) Near Field Plots include plots NW1, SE1 and E1, which are adjacent to the salt piles
(4) Foliar cover, in percent
(5) Frequency in the sample, in percent
(6) Density of annual species only, in plants per square meter
(7) Coverage does not include honey mesquite
(8) Number of species does not include grass seedlings

CHAPTER 7

GROUNDWATER PROTECTION

Current groundwater protection activities at the WIPP are outlined in the WIPP Water Level Monitoring Program WP 07-1, Water Quality Sampling Program WP 07-2, and Pressure/Density Survey Program WP 07-6. Groundwater monitoring activities are also defined in the OEMP.

The objective of those programs is to monitor the characteristics of the groundwater surrounding the WIPP facility, both before and throughout the operational lifetime of the facility. Baseline water quality data collected prior to the start of operations will be compared to water quality data collected after TRU waste is placed in the WIPP facility. Any statistically significant evidence of groundwater contamination noted will be used to initiate corrective actions. Water quality data is collected at specific wells as identified in Table 7-1.

A Water Quality Sampling Program (WQSP) has been conducted at the WIPP since January 1985. The goal of this program was to establish a pre-operational baseline of groundwater parameters data from water bearing zones in the vicinity of the WIPP.

In October of 1988 the WQSP program was placed under the direction of the REPs department in preparation for the receipt of waste. The objective of the program shifted from water characterization to water monitoring. With receipt of waste delayed, 1989 was spent collecting an additional year's worth of pre-operational groundwater data and in developing a WIPP Groundwater Monitoring Program Plan and Procedure Manual, WP 02-1, which will be issued in June 1990.

The water quality data obtained by the WQSP in 1989 supported three major programs at the WIPP: (1) Site Characterization; (2) Performance Assessment (in compliance with 40 CFR 191); (3) The OEMP. Each of these programs requires a unique set of analyses and data, but overlap of analytical needs does occur. Particular sample needs are defined by each program. In addition, water samples from each 1989 sampling location were provided to the EEG for independent analysis.

7.1 HYDROLOGIC SETTING

The WIPP is located within the Pecos Valley section of the Southern Great Plains physiographic province (Powers et. al., 1978). Geologically, the WIPP is located in the northern portion of the Delaware Basin, the western most subsection of the Permian Basin. The northern Delaware Basin is bounded by the Capitan Limestone, a Permian Age reef which is the only major source of potable groundwater in the basin. Interior to the basin, eight rock units make up the stratigraphic column in the vicinity of the WIPP. In ascending order, these units are the Delaware Mountain group (consists of the Brushy Canyon, Cherry Canyon and the Bell Canyon Formations), the Castile Formation, the Salado Formation, the Rustler Formation, the Dewey Lake RedBeds, and the Triassic Dockum Group, Figure 7-1.

The rock units which were sampled in 1989 are in descending order; The Dewey Lake Redbeds, the Magenta Dolomite, and the Culebra Dolomite, Figure 7-2. Fluids from these rock units have been collected either from monitoring wells at the WIPP or from privately owned wells (windmills). A brief description of these geological formations and their hydrology follows.

The Dewey Lake Redbeds are comprised of a deltaic sequence of alternating thin, even beds of orange red siltstone and mudstone with lenticular interbeds of fine grained sandstone. Geologic data for the area around the WIPP facility indicate that the sands are lenticular, and pinch out laterally. Hydrologic investigations at and near the WIPP facility have not identified a continuous zone of

TABLE 7-1

WATER QUALITY SAMPLING SCHEDULE

WIPP DESIGNATED MONITORING WELLS SAMPLED ONCE EACH YEAR

1.	H-06b	CULEBRA
2.	H-06c	MAGENTA
3.	H-05b	CULEBRA
4.	H-05c	MAGENTA
5.	WIPP-19	CULEBRA
6.	H-02	CULEBRA
7.	H-02	MAGENTA
8.	H-03b3	CULEBRA
9.	H-03b1	MAGENTA
10.	H-11b3	CULEBRA
11.	H-04b	CULEBRA
12.	H-04c	MAGENTA
13.	H-7b	CULEBRA

WIPP DESIGNATED MONITORING WELLS, SAMPLED ONCE EVERY 3 YEARS

1.	WIPP-25	CULEBRA
2.	H-18	CULEBRA
3.	P-14	CULEBRA
4.	H-15	CULEBRA
5.	H-14	CULEBRA
6.	P-17	CULEBRA
7.	H-12	CULEBRA
8.	H-09b	CULEBRA

PRIVATE WELLS SAMPLED ONCE EACH YEAR

1.	RANCH WELL	DEWEY LAKE
2.	BARN WELL	DEWEY LAKE
3.	TWIN WELLS	(PASTURE) DEWEY LAKE

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
RECENT	RECENT		SURFICIAL DEPOSITS	
QUATERNARY	PLEISTOCENE		MESCALERO CALICHE	
			GATUNA	
TRIASSIC		DOCKUM	UNDIVIDED	
PERMIAN	OCHOAN		DEWEY LAKE RED BEDS	
			RUSTLER	Forty-niner
				Magenta
				Tamarisk
				Culebra
				Unnamed
			SALADO	Upper
				McNutt
				Lower
			CASTILE	
	GUADALUPIAN	DELAWARE MOUNTAIN	BELL CANYON	
			CHERRY CANYON	
			BRUSHY CANYON	

FIGURE 7-1

STATIGRAPHIC COLUMN

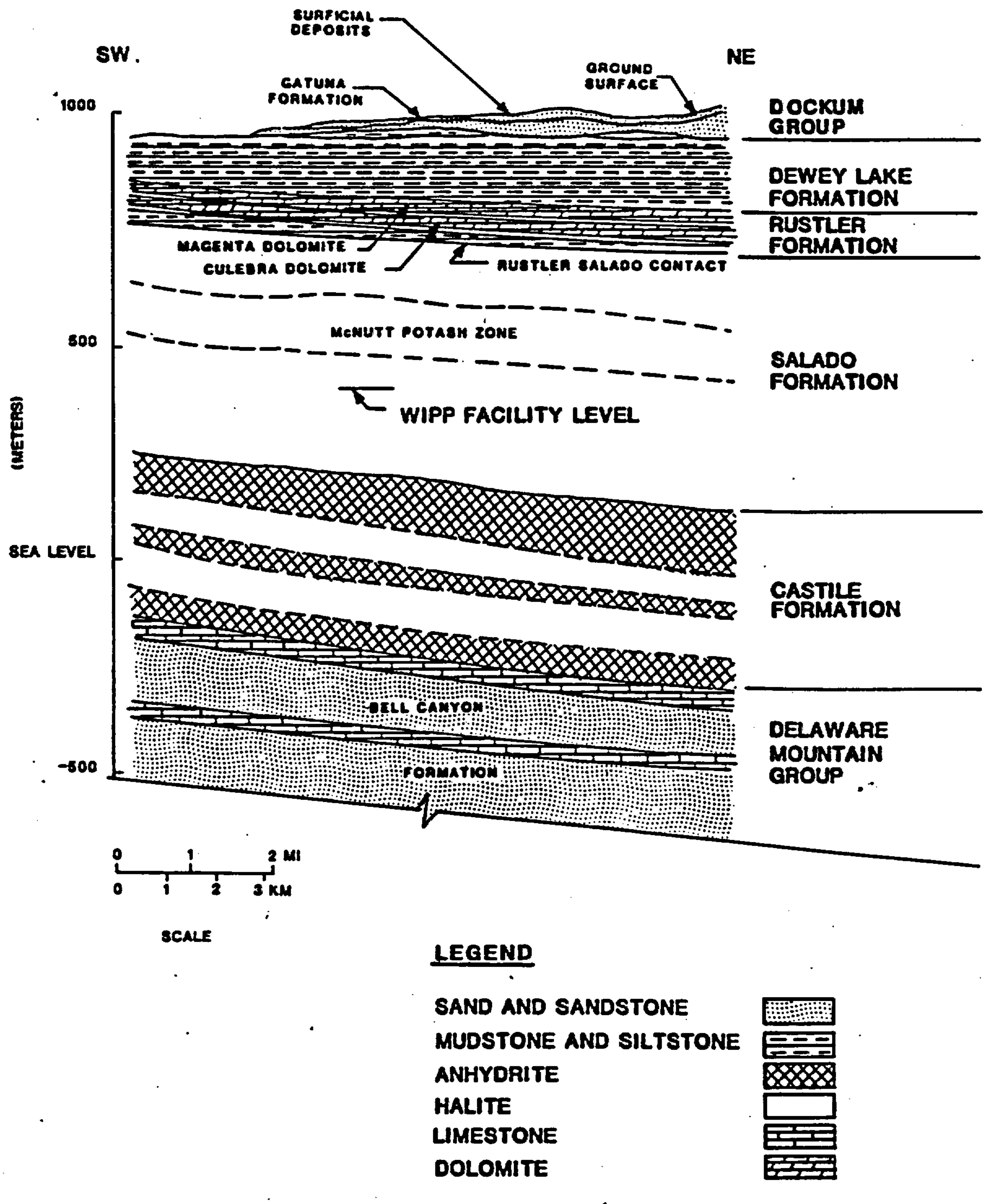

FIGURE 7-2

GENERALIZED STRATIGRAPHIC CROSS SECTION

GG12.1

saturation within the Dewey Lake Redbeds. Several private wells (located approximately five miles south of the WIPP site) are completed in the Dewey Lake. These wells appear to be producing from thin lenticular sands that are locally recharged (Mercer, 1983). Four private wells in this area have been sampled by WIPP (Barn Well, Fairview Well, Unger Well, and Ranch Well), and the data are reported in Randall et al., 1988, and Lyon, 1989. The Fairview, Unger, and Ranch wells supply water for livestock. The Barn well supplies water to a local rancher for human consumption.

The Rustler Formation underlies the Dewey Lake RedBeds and consists of interbeded anhydrite, gypsum, halite, polyhalite, dolomite, and limestone. The Rustler formation is divided into five lithologic units. These units are, in descending order; the Forty-niner Member, the Magenta Dolomite, the Tamarisk Member, the Culebra Dolomite, and an unnamed lower member consisting of reddish-brown siltstone interbedded with gypsum or anhydrite, and halite. The Forty-niner and Tamarisk Members are primarily anhydrite and include some halite and potash minerals. Where dissolution has occurred, the anhydrite has altered to gypsum, and halite salts are absent. The Magenta and Culebra Dolomites are aerially extensive and are the significant water-bearing units in the WIPP vicinity. Water from the Magenta and the Culebra has undergone five years of sampling, (Broberg et. al., 1990, Lyon, 1989, Randall et al., 1988, Uhland et al., 1987, and Uhland et al., 1986).

The Magenta Dolomite is the uppermost significant water-bearing stratum in the Rustler Formation, and consists of a clastic carbonate bed with thin laminae of anhydrite. The unit ranges in thickness from six to nine meters (20 to 30 feet) in the WIPP vicinity. Water under confined conditions has been sampled from four wells completed in the Magenta Dolomite (H-06c, H-05c, H-03b1, and H-04c).

The Culebra Dolomite is the first continuous water-bearing unit above the Salado Formation (waste facility horizon) and is the most transmissive hydrologic unit in the WIPP area. In the WIPP vicinity, the Culebra Dolomite ranges from 7.6 to 9 meters (25 to 30 feet) in thickness and is a vuggy, finely crystalline dolomite. The formation contains water (under confined conditions) of variable density ranging from brackish to brine. Hydrologic testing has shown the Culebra Dolomite to be a heterogeneous, fractured unit with transmissivities varying locally from (0.07 to greater than 200 square feet) per day (Mercer, 1983). The high transmissivity values in the Culebra have been reported from well locations south and west of the WIPP facility. In this area near the WIPP, the Culebra fluids exhibit relatively low concentrations of total disolved solids (TDS). South of the WIPP site (Engle, H-08b) a few wells that are completed in the Culebra are used by local ranchers for watering livestock. In areas lying east of the WIPP, transmissivities in the Culebra are quite low, and fluid samples show TDS concentrations. Based on actual formation measurements, Crawely 1988 estimated regional groundwater flow directions near the WIPP site are towards the south and southeast. It has been suggested ,since the water flow in the Culebra Dolomite is affected by fractures, variable fluid densities, and heterogeneity of the rock, that regional flow directions may have little, if any, relationship to localized flow paths.

7.2 GROUNDWATER MONITORING PROGRAM

Groundwater sampling at WIPP focuses on the Magenta and Culebra Dolomite Members of the Rustler Formation. The Magenta and Culebra Dolomites are the most significant water-bearing units within the vicinity of the WIPP. No known hydrologic connection exists between the repository horizon and these rock units. Monitoring the characteristics of the water contained in both the Culebra and the Magenta Dolomite is benefitial to the WIPP project because it provides data which can be used to determine if the characteristics of the water in either the Culebra or Magenta is changing. It also provides additional data for use in hydrologic models designed to predict long term performance of the repository environment (i.e., performance assessment).

Long term monitoring of physical, chemical and radionuclide parameters within Culebra and Magenta groundwater is currently planned for 20 WIPP designated monitoring locations. Twelve locations will be sampled annually, and eight of the locations will be sampled once every three years, Table 7-1. Three private wells, ranch, barn and twin pasture wells, completed in the Dewey Lake Red Beds will also be sampled annually. Other Private wells completed in the Dewey Lake Redbeds and the Culebra will be sampled periodically on an as needed basis. The sampling schedule is subject to change pending changing project needs.

The water quality sampling process has been developed around the logistics of using groundwater wells that were not originally constructed for water monitoring activities. The wells that are available were constructed for site characterization efforts and later transformed into monitoring wells. Their designs did not consider the Geochemistry of the area, anticipated lifetime of the monitoring program, and the chemical parameters to be monitored. Most of the wells are constructed with J-55 or K-55 iron casing. A serial sampling process is utilized to decrease the sampling bias created by these well construction deficiencies.

The serial sampling process involves two types of water samples: (1) serial samples, and (2) final samples. Serial samples are taken once a day, while a well is being pumped continuously, until key physical and chemical parameters have stabilized (hereafter referred to as field parameters). Stabilization of these field parameters indicates that the pumped groundwater is representative of the zone being sampled. A final sample is collected, once the pumped groundwater has achieved a representative state, and is sent off site to a contract laboratory for analysis.

Water level monitoring is conducted at 63 locations in the vicinity of the WIPP, Table 7-2. The water level of the Culebra is measured at 48 of these locations and the water level of the Magenta is measured at ten of these locations. The other five locations are completed in other zones of lesser interest to the WIPP project, (i.e., the Rustler/Salado contact).

Water level measurements are conducted by lowering an electronic water-level conductance probe to the water level. When the probe contacts water it trips a buzzer alarm at the surface. The graduated tape on the conductance probe is read, adjusted to the top of the casing and recorded. The probe is then brought to the surface, rinsed with fresh water and wiped clean with a cloth or disposable towel.

7.2.1 Sampling Activities and Results

In 1989 the water quality was tested at 11 Culebra locations, 5 Magenta locations and three Dewey Lake locations. All of the Culebra and Magenta locations were serially sampled prior to final sampling, but the three Dewey Lake locations were private wells and could not be serially sampled. Of the 19 sampling efforts, 18 were successful. The attempt to develop a new Magenta monitoring well on the H-02 well pad failed because the formation at that location would not yield adequate amounts of water for sampling. Table 7-3 outlines which wells were sampled in 1989, the zones that were tested, the dates that pumping took place, the approximate number of gallons pumped at each well, the depth of the pump in each well, and the type of pump used.

Each well was tested for the following field parameters: pH, temperature, specific conductivity, specific conductance, alkalinity, chlorides, divalent cations, total iron and ferrous iron. A mobile field lab was utilized to determine when field parameters had stabilized.

Private wells were not serially sampled, only final sampled. The International Technology Analytical Services Lab in Export, Pennsylvania, tested 1989 groundwater samples for general chemistry and major anions, major cations and trace metals, hazardous substances, and polycholrinated biphenyls (PCBs). The Westinghouse Advanced Energy Systems Analytical

TABLE 7-2
WATER LEVEL MONITORING SCHEDULE

CULEBRA MONITORING LOCATIONS		MAGENTA MONITORING LOCATIONS		OTHER MONITORING LOCATIONS		
WELL NAMES	MEASUREMENT FREQUENCY	WELL NAMES	MEASUREMENT FREQUENCY	WELL NAMES	UNIT MONITORED	MEASUREMENT FREQUENCY
AEC-7	MONTHLY	H-01	QUARTERLY	H-08c	RUSTLER/SALADO	MONTHLY
CABIN BABY	MONTHLY	H-02b1	MONTHLY	WIPP-28	RUSTLER/SALADO	MONTHLY
D-268	MONTHLY	H-03b1	MONTHLY	AEC-8	BELL CANYON	MONTHLY
DOE-1	MONTHLY	H-04c	MONTHLY	H-03d	FORTY NINER	MONTHLY
DOE-2	MONTHLY	H-05c	MONTHLY	H-03d1	DEWEY LAKE	MONTHLY
ERDA-9	MONTHLY	H-06c	MONTHLY			
H-01	MONTHLY	H-08a	MONTHLY			
H-02a	QUARTERLY	WIPP-25	MONTHLY			
H-0-2b1	QUARTERLY	WIPP-27	MONTHLY			
H-02b2	MONTHLY	WIPP-30	MONTHLY			
H-02c	QUARTERLY					
H-03b2	MONTHLY					
H-03b3	QUARTERLY					
H-04b	MONTHLY					
H-05a	QUARTERLY					
H-05b	MONTHLY					
H-06a	QUARTERLY					
H-06b	MONTHLY					
H-07b1	MONTHLY					
H-07b2	QUARTERLY					
H-08b	MONTHLY					
H-09a	QUARTERLY					
H-09b	MONTHLY					
H-09c	QUARTERLY					
H-11b1	QUARTERLY					
H-11b2	MONTHLY					
H-11b3	QUARTERLY					
H-11b4	QUARTERLY					
H-12	MONTHLY					
H-14	MONTHLY					
H-15	MONTHLY					
H-17	MONTHLY					
H-18	MONTHLY					
P-14	MONTHLY					
P-15	MONTHLY					
P-17	MONTHLY					
P-18	MONTHLY					
WIPP-12	MONTHLY					
WIPP-13	MONTHLY					
WIPP-18	MONTHLY					
WIPP-19	MONTHLY					
WIPP-21	MONTHLY					
WIPP-22	MONTHLY					
WIPP-25	MONTHLY					
WIPP-26	MONTHLY					
WIPP-27	MONTHLY					
WIPP-29	MONTHLY					
WIPP-30	MONTHLY					

TABLE 7-3
SUMMARY OF 1989 SAMPLING PROGRAM

WELL NAME	UNIT SAMPLED	ROUND	1989 DATES SAMPLED START	FINISH	APPROX. GALLONS PUMPED	NUMBER OF SS	FEET BTOC TO PUMP INTAKE	PUMP TYPE	FINAL SAMPLE TEST PROGRAM
H-02a	CULEBRA	3	01-04-89	01-19-89	4778.00	9	581.33	ADP	GC, M, ORG, GASES, REDOX
H-14	CULEBRA	3	01-25-89	02-14-89	5588.00	12	532.00	ADP	GC, M, ORG, GASES, REDOX
H-03b3	CULEBRA	4	02-14-89	03-02-89	101919.00	8	664.90	ES	GC, M, ORG, GASES, REDOX
H-03b1	MAGENTA	4	03-07-89	03-16-89	2280.00	6	558.00	ADP	GC, M, ORG, GASES, REDOX
H-04b	CULEBRA	4	04-03-89	04-06-89	1048.00	3	478.00	ADP	GC, M, ORG, GASES, REDOX
H-04c	MAGENTA	4	04-17-89	04-21-89	450.00	4	378.00	ADP	GC, M, ORG, GASES, REDOX
H-07B1	CULEBRA	4	05-15-89	05-19-89	3909.00	4	198.00	ADP	GC, M
WIPP-25	CULEBRA	4	06-15-89	06-27-89	10213.00	7	432.00	ADP	GC, M
RANCH	DEWEY LAKE	4	NA	07-12-89	NA	NA	NA	NA *	GC, M
BARN	DEWEY LAKE	3	NA	07-13-89	NA	NA	NA	NA *	GC, M
H-06b	CULEBRA	4	07-17-89	07-24-89	5142.00	6	588.88	ADP	GC, M
H-06c	MAGENTA	4	07-31-89	08-04-89	2391.00	4	483.00	ADP	GC, M
H-05b	CULEBRA	4	08-14-89	08-23-89	1996.00	9	875.00	ADP	GC, M
H-05c	MAGENTA	4	09-06-89	09-14-89	1997.00	4	784.00	ADP	GC, M
TWIN	DEWEY LAKE	3	NA	09-28-89	NA	NA	NA	NA *	GC, M
WIPP-19	CULEBRA	4	10-05-89	10-18-89	6292.00	3	734.00	ADP	GC, M
H-11b3	CULEBRA	4	10-22-89	10-25-89	4751.00	3	733.00	ADP	GC, M
H-02b1	MAGENTA	1	10-30-89	11-02-89	NA	0	507.00	ADP	FLOURESCEIN
H-02c	CULEBRA	1	11-06-89	12-13-89	6660.00	10	613.00	ADP	GC, M, ORG, GASES, REDOX

ADP Air Driven Piston
BTOC Below Top Of Casing
ES Electric Submersible
NA Not Applicable

SS Serial Sample
GC General Chemistry
M Metals
ORG Organics (VOA, BNA, PCB)
* Private Windmill (not serially sampled)

Lab at Waltz Mill, Pennsylvania, tested 1989 groundwater samples for radionuclides. The United Nuclear Corporation Lab in Grand Junction, Colorado, tested a few of the 1989 groundwater samples for dissolved gases and redox couples. Gas and redox-couple data was needed to complete a study being performed by Sandia National Laboratories (SNL).

The analytical program chosen for each location varied, depending upon project needs (see Table 7.3). The final sample suite is outlined in Table 7-4. Final samples were also provided to the SNL in Albuquerque, New Mexico, and to the EEG for independent analysis.

A goal of the WIPP Groundwater Monitoring Program is to make the data public. In the past all non-radiological groundwater data has been reported yearly in the Annual Water Quality Data Report, Uhland & Randall, (1986), Uhland et. al., (1987), Randall et. al., (1988), Lyon (1989). For 1989 data, this will be continued. All non-radiological Groundwater data collected in 1989 can be found in The , Broberg et. al., 1990. Radiological data though, collected during 1989 from groundwater samples, is reported in Chapter 5 of this document.

With completion of the 1989 sampling year, approximately 119 groundwater samples have been successfully accomplished since January, 1985. This total includes four sampling rounds at twelve locations. Non-radiological groundwater data from previous years of sampling were published in the following Annual Water Quality Data Reports: Uhland and Randall (1986), Uhland et. al., (1987), Randall et. al., (1988), Lyon, (1989). Non-radiological groundwater data collected in 1989 will be published in July in the 1990 Annual Water Quality Report. Radiological data collected during 1989 from groundwater samples is reported in Section 5 of this document. All field data sheets, data books, analytical laboratory data, reports, and records pertaining to the WQSP are on file at the Regulatory and Environmental Programs Department, Waste Isolation Pilot Plant, near Carlsbad, New Mexico. Data collected to date serves as the basis for a preoperational water quality baseline at the WIPP.

Table 7-5 lists the results obtained on the last day of serial sampling for each well tested in 1989. Private wells were only tested once, they were not serially sampled. With the exception of H-02b1, all samplings were successful. The chemical parameters listed in Table 7-5 are averaged from a sample and a duplicate analysis. Total iron and ferrous iron was not sampled in the Dewey Lake windmills.

Analysis from two sampling locations showed traces of organics. However, in both instances the source can be traced to handling or shipping errors (see Table 7-6). Field and laboratory personnel are working closely to minimize occurrences of this nature in the future.

7.2.2 Comparative Water Quality Data

Data collected during 1989 represents preoperational data, and will be combined with data collected previously to formulate a preoperational water quality baseline. This preoperational baseline can be used once the WIPP receives waste to help determine statistically if the WIPP operations are effecting the quality of the groundwater. Appendix X which presents data (with graphical comparisons) compares the average final days serial sample field paramenter values (alkalinity, chloride, dications, and total iron) for Culebra wells sampled in 1989 that were not sampled for the first time. The average, standard deviation and the coefficient of variance has been calculated for each location using the data which has been collected to date. Appendix XI compares the average final days serial sample field paramenters values (alkalinity, chloride, dications, and total iron) for Magenta and Dewey Lake wells sampled in 1989 that were not sampled for the first time. The average, standard deviation and the coefficient of variance has been calculated for each location using data which has been collected to date.

Table 7-4

Final Sample Analytical Suite

General Chemistry	Metals	Gases	Redox Couples	Radionuclides	Organics
Alkalinity	Alminium	Argon	Ammonia	Am-243	Volatiles (Hazardous subatance list)
Bromide	Antimony	Oxygen	Nitrate	Pu-242	Semi-Volatiles (Hazardous substance list)
Chloride	Arsenic	Nitrogen	Total Iron	Am-241	PCB's
Cyanide	Barium	Carbon Monoxide	Ferrous Iron	Pu-241	
Flouride	Beryllium	Carbon Dioxide	Arsenic (III)	Pu-239/Pu-240	
Iodide	Boron	Methane	Arsenic (Total)	Pu-238	
Nitrate	Cadmium	Ethane	Iodide	U-238	
pH	Calcium	C-3	Iodate	U-235	
Phenolics	Cesium	C-4	Selenium (IV)	U-234	
Phosphate, Total	Chromium	C-5	Selenium (Total)	U-233	
Residue, Filterable	Cobalt	C-6		Th-232	
Residue, Nonfilterable	Copper	Sum of CO_2		Th-230	
Specific Conductance	Iron	Total Gas		Th-228	
Sulfate	Lead			Ra-228	
Total Organic Carbon	Lithium			Ra-226	
Total Organic Halogen	Magnesium			Np-237	
	Manganese			Cm-244	
	Mercury			Pb-210	
	Molybdenum			Cs-137	
	Nickel			Co-60	
	Potassium			Po-210	
	Selenium				
	Silica				
	Silver				
	Sodium				
	Strontium				
	Thallium				
	Tin				
	Titanium				
	Zinc				

TABLE 7-5
LAST DAY SAMPLING RESULTS FOR EACH WELL
SAMPLED IN 1989

WELL	ZONE	ROUND	DATE SAMPLED	Eh (mv)	pH (S.U.)	TEMP (C)	SPECIFIC GRAVITY	SPECIFIC CONDUCTANCE (umhos)	ALKALINITY (mg/l)	CHLORIDES (mg/l)	DICATIONS (meq/l)	TOTAL IRON (mg/l)	FERROUS IRON (mg/l)
H-02a	Culebra	3	01-19-89	83.90	7.88	19.2	1.0142 @ 19.4 C	14100	56.9	4129	50.4	1.15	0.99
H-14	Culebra	3	02-14-89	270.00	7.76	20.5	1.0142 @ 20.5 C	24300	38.1	8502	132.9	0.44	0.37
H-03b3	Culebra	4	03-02-89	362.00	7.46	22.2	1.036 @ 22.2 C	68100	50.4	27639	139.1	0.15	0.13
H-04B	Culebra	4	04-06-89	194.00	7.81	21.5	1.0160 @ 21.4 C	24500	68.1	7403	72.5	0.48	0.43
H-07b1	Culebra	4	05-19-89	233.00	7.28	22.0	1.0030 @ 22.0 C	3640	117.8	290	40.6	0.14	0.09
WIPP-25	Culebra	4	06-27-89	188.00	7.28	22.4	1.0110 @ 22.7 C	22000	129.8	6933	89.3	0.72	0.63
H-06b	Culebra	4	07-24-89	284.00	7.01	22.2	1.0444 @ 22.3 C	75000	97.4	31615	188.6	0.44	0.38
H-05b	Culebra	4	08-23-89	182.00	7.35	22.3	1.1022 @ 23.0 C	153000	52.5	84385	258.5	3.06	2.88
WIPP-19	Culebra	4	10-18-89	168.00	7.28	21.2	1.0564 @ 20.9 C	92400	61.1	40440	187.2	1.71	1.49
H-11b3	Culebra	4	10-25-89	187.00	7.34	23.1	1.0804 @ 23.1 C	128900	58.5	63473	192.4	0.46	0.31
H-02c	Culebra	1	12-13-89	173.00	7.84	18.4	1.0202 @ 22.0 C	13500	58.3	3836	52.4	0.79	0.57
H-03b1	Magenta	4	03-16-89	24.00	7.93	22.4	1.0085 @ 21.4 C	12204	46.6	3299	73.9	0.03	< 0.02
H-04c	Magenta	4	04-21-89	-63.00	7.95	19.8	1.0200 @ 26.8 C	30400	79.7	8407	68.9	0.2	0.14
H-06c	Magenta	4	08-04-89	209.00	7.81	22.7	1.0046 @ 22.6 C	5230	52.5	404	40.6	0.31	0.21
H-05c	Magenta	4	09-14-89	206.00	7.95	22.0	1.0080 @ 22.1 C	8460	57.2	1023	42.8	0.21	0.18
Barn Well	Dewey Lake	3	07-13-89	NT	7.71	22.4	1.008 @ 27.8 C	1113	283.4	46.8	6.5	NT	NT
Ranch Well	Dewey Lake	4	07-12-89	NT	7.42	21.2	1.0018 @ 27.8 C	3550	250.8	328	31.8	NT	NT
Twin Wells Pasture	Dewey Lake	3	09-28-89	NT	7.71	NT	1.0016 @ 23.6 C	612	221.0	38.5	4.1	NT	NT

NOTE: DEWEY LAKE WELLS WERE NOT SERIALLY SAMPLED.
ALKALINITY, CHLORIDE, DICATIONS, TOTAL IRON AND FERROUS IRON ARE AVG. VALUES

TABLE 7-6
ORGANIC PARAMETERS GREATER THAN THE LIMIT OF DETECTION
FOR WELLS TESTED IN 1989

WELL	ZONE	ROUND	DATE	PARAMETER	VALUE	DUPLICATE VALUE	TRIP BLANK	DUPLICATE TRIP BLANK	UNITS
H-02c	CULEBRA	1	12-13-89	ACETONE	2800	2100	LD 10	LD 10	ug/l
H-02a	CULEBRA	3	01-19-89	ACETONE	27	1200	1200	17	ug/l
H-03b1	MAGENTA	4	03-16-89	BIS(2-ETHYLHEXL)PHTHALATE	11	NA	NA	NA	ug/l
H-02a	CULEBRA	3	01-19-89	BIS(2-ETHYLHEXL)PHTHALATE	20	NA	NA	NA	ug/l
H-02a	CULEBRA	3	01-19-89	METHYLENE CHLORIDE	16	45	LD 5	30	ug/l
H-02c	CULEBRA	1	12-13-89	1-3-DICHLOROBENZENE	11	NA	NA	NA	ug/l
H-02c	CULEBRA	1	12-13-89	1-4-DICHLOROBENZENE	23	NA	NA	NA	ug/l

(NA) NOT APPLICABLE/NOT ANALYZED (LD) LIMIT OF DETECTION

Ending serial sample values for 1989 are often within a few percent of values obtained in previous years. This indicates successful reproducibility of field results over four rounds of sampling at many locations. A coefficient of variance less than 1.00 indication of non-normality in the data is the chloride parameter for Twin Wells. The round two chloride measurement (400 mg/l) is an order of magnitude above round one (44.1 mg/l) and round three (38.5 mg/l). The round two serial sample field parameter for chloride is suspect. Iron values exhibit a high degree of scatter across the four rounds of sampling. Iron concentrations in the field most likely reflect deteriorating well casing and not groundwater chemistry.

In October of 1988, long-term monitoring of water levels in the Culebra and the Magenta members was initiated by the REP department. There are 63 wellbores included in the program. The three months of data collected in 1988 will be reported with the 1989 data in the Annual Water Quality Data Report for 1990 (Broberg et. al., 1990). Of the 63 wells, 50 wells were monitored on a monthly basis and 13 additional wells were monitored on a quarterly basis. Of the 50, 48 were from Culebra, 10 were from Magenta, two from the Rustler/Salado contact, one from Bell Canyon, one from a Forty-niner, and one from Dewey Lake (see Table 7-2).

Although some water-level trends can be noted from the data, the data base is not large enough at this time to offer any conclusive evidence on water level fluctuations. The data has been supplied to SNL and incorporated into their data base which extends back several years.

CHAPTER 8

QUALITY ASSURANCE

Quality Assurance (QA) comprises all planned and systematic actions (programmed events) undertaken to ensure the validity of the results of a monitoring program. QA includes Quality Control (QC), which is task specific and provides a context for assessing the performance of equipment, instruments, and procedures. The QA/QC program for the WIPP environmental programs is established within the framework of the overall Quality Program Manual of the Westinghouse Electric Corporation.

A comprehensive QA program has been implemented to ensure that the data collected reflects actual concentrations in the environment and has been obtained prior to commencement of operations in order to provide sound baseline data for comparison with potential impacts of the WIPP. The focus of this program includes:

- Sample collection at all locations, according to procedures based on accepted practices and widely recognized methodologies and criteria
- Procedure review and revision as appropriate to minimize uncertainty due to sampling error while maintaining comparability and continuity between past and future data
- Data verification through a continuing program of analytical laboratory quality control, including participation in inter-laboratory cross-checks; duplicate sample analysis, and, for radiological samples, splits provided to the EEG for analysis

Adherence to policies set forth by federal QA regulations including: ANSI NQA-1, Quality Assurance Program Requirements for Nuclear Facilities, (ANSI, 1986) and EPA, QAMS-005/80, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, (EPA, 1980), fulfills the requirements of the QA plan specified in DOE Orders 5400.1 (DOE, 1988d), 5400.3 (DOE, 1988e), 5700.6B (DOE, 1986c) and DOE 5400.xy (DOE, 1988f).

8.1 BASELINE DATA

There are four environmental programs currently in place at the WIPP: the Nonradiological Environmental Surveillance program (NES) (formerly the Environmental Monitoring Program), the Radiological Environmental Surveillance Program (RES) (formerly the Radiological Baseline Program), the Cooperative Raptor Research Program, and the WIPP Groundwater Monitoring Program. Their purpose is to collect the data needed to detect and quantify any impacts that construction and operational activities at the WIPP site may have on the surrounding ecosystem. A baseline data base spanning several years prior to operations at the WIPP can provide objective evidence of location-specific anomalies in the test results.

Preliminary studies are important when considering WIPP environmental monitoring efforts since they contribute to the baseline data useful during the construction phase, and because they are the predecessors to the long-term monitoring programs. These studies include:

- WIPP Site Characterization Program - instituted in 1976 by SNL to monitor air quality, background radiation levels, and groundwater quality (Pocalujka et al., 1979; 1980a, b, c; 1981a, b; Powers et al., 1978; Lappin, 1989)
- WIPP Biology Program - begun in 1975 with baseline studies of climate, soils, vegetation, arthropods, and vertebrates (Best, 1980)

- Investigations of the site geohydrology - conducted by the U.S. Geological Survey (USGS) at the request of the DOE. In addition, the Nuclear Regulatory Commission issued a contract to Columbia University to perform a study of radionuclide mobility in the highly saline groundwaters of the Delaware Basin (U.S. Geological Survey, 1983)
- Radiological monitoring of air, water, and biological media - conducted by the Atomic Energy Commission before and after the Project Gnome nuclear detonation (USAEC, 1962a,b,c,d)

8.2 SAMPLE COLLECTION METHODOLOGIES

Written procedures provide guidance to field personnel for every sample taken and form the basis of an auditable program. The QA Department of the Westinghouse, WID periodically conducts overviews, surveillances, and internal audits to ensure compliance with established procedures. An overview surveys personnel performance in one activity. A surveillance assesses a procedure from data collection through data management. Surveillances are conducted according to WP 13-011. An internal audit, a more comprehensive investigation, evaluates the adequacy and effectiveness of the QA program implementation and related procedures and practices. An audit may include procedure review, file management, and test equipment. Audits are conducted according to WP 13-005. Results of each audit, surveillance, and overview are kept on file at the WIPP. In 1989, Westinghouse QA/QC conducted 17 overviews, three surveillances, and one internal audit. Problems identified (i.e., labeling of samples) are resolved by correcting the techniques of the field personnel and by formally refining the sampling procedures. Corrective actions are implemented as directed in WP 13, Waste Isolation Pilot Plant, Waste Isolation, Division Quality Assurance Program Manual.

Sampling procedures are contained in the following documents:

- WIPP Environmental Procedures Manual (WP 02-03)
- WIPP Groundwater Monitoring Program Plan and Procedure Manual (WP 02-1)
- Geotechnical and Geosciences Procedure Manual (WP 07-2)
- Ecological Monitoring Program Semiannual Report (Reith et al., 1985)
- Radiation Safety Manual (WP 12-5)
- Management and Operating Contractor - WIPP Quality Program Manual (WP 13-1)

The sampling procedures describe the methods for sample location determination; timing of collection; equipment calibration; specific steps for sample collection, analysis, and shipment preparation; and the shipment method. The sampling procedures also provide program requirements for data entry, sample tracking, and record-keeping; this ensures data collected and entered becomes a quality record. Standard sample location codes are used for reporting results. The OEMP, the current guiding document for all environmental programs, provides details on the sampling procedures and cites the document containing those procedures. Chapter 11 of the OEMP defines the policies and practices that are applied to provide confidence in the quality of the data.

The data collected in the NES monitoring programs are analyzed statistically each year. The goal of statistical analyses is twofold: (1) to provide an objective and reliable means for interpreting data in relation to the stated objectives of the data collection program and (2) to provide a means for concise summarization and management recommendations. WIPP preoperational data provides a standard for comparison with postoperational data. The basic requirements for data analysis are stated in guidance documents, DOE/EH-0023 (Corley et al., 1981) and DOE/EH-XXX (DOE, 1987). Section 8.0 of the OEMP discusses at length the procedures used to analyze the data statistically.

8.3 REVISION OF PROCEDURES

One of the responsibilities of data collection personnel is to assess the performance of collection and analysis methodologies. Sample collection field procedures, analysis preparation, and the laboratory analysis methodology are periodically reviewed and updated and continually scrutinized for adequacy. The method for modifying procedures is set forth in WP 15-101. Additionally, cooperative sampling efforts and radiological samples split with the EEG act as a check that procedures are adequate and that data results are comparable between WIPP and EEG samples. All procedures manuals are reviewed regularly and updated and expanded as necessary.

8.4 LABORATORY QUALITY CONTROL

The WIPP has contract analytical support for the environmental programs from Westinghouse Advanced Energy Systems Division (WAESD), Waltz Mill, Pennsylvania; Eberline Analytical Corporation, Santa Fe, New Mexico; the University of New Mexico, Alburquerque, New Mexico; International Technology Corporation Laboratories (Export, Pennsylvania, and Cerritos, California); and United Nuclear Corporation (UNC), Grand Junction, Colorado. Table 8-1 lists the 1989 intercomparison cross check of samples. This support includes:

- Routine calibration of instruments
- Frequent source and background counts (as appropriate)
- Routine yield determinations of radiochemical procedures
- Replicate/duplicate analyses to check precision
- Analyses of reagents to ensure chemical purity that could affect the results of the analytical process

Each laboratory has a written and implemented QA program that utilizes standard analysis methods for each parameter studied. These methods are listed in detail in the OEMP.

Participation in inter-laboratory cross-checks can reveal outdated, previously acceptable lab procedures that are currently unsuitable or inadequate. Steps are then taken to find updated methodologies. The four laboratories providing chemical analytical services for the WIPP are required to participate in inter-laboratory cross-checks conducted by the EPA.

There is no cross-check procedure currently available for the litter microbiota analyses conducted at the University of New Mexico in Albuquerque since the process is unique. However, litter decomposition studies are conducted concurrent with enzyme activity studies on the same samples. The two sets of data can be correlated. Spearman's correlation coefficient was conducted on the four data sets from 1989 with a resultant coefficient of 0.98 or 0.85. With a high coefficient approaching 1.0 and with values very similar this means sample results corresponded very closely.

8.5 RECORD KEEPING

Records generated in support of the OEMP are controlled and maintained in accordance with DOE Order 1324.2 (DOE, 1982a), WIPP Records Management Procedures (WP 15-030), and WIPP Document Control Procedures (WP 15-006). All original records are maintained in a fire resistant file cabinet at the WIPP until they are transmitted to the WIPP Master Records Center for permanent filing (WP 15-030). All records, including raw data, calculations, computer programs or other data manipulation, are subject to review and verification under the WIPP Quality Assurance Program.

Records (such as reports of analyses and sample receipt forms transmitted by contract analytical laboratories) are dated upon receipt and a copy made for QC review as specified in NES/RES QA/QC Implementation Procedures (WP 02-302). Specific record and data management procedures including the recording and referencing of data manipulations are implemented according to the Water Quality Sampling Manual (WP 7-2), RES Data Management Procedure (WP 02-305), and NES Data Management Procedure (WP 02-334).

The WIPP will voluntarily comply with record-keeping requirements as promulgated under 40 CFR Part 61, Subpart H (EPA, 1985b), which pertain to atmospheric radionuclide emissions (WP 02-301). In addition, unless regulations are amended in the future, records development pursuant to these criteria will be maintained at least 30 years, as specified in DOE 1324.2 (DOE, 1982a), Chapter V, Attachment 1, Schedule 25 (Medical, Health and Safety Records).

Consistent record keeping in all aspects of the Environmental Monitoring Programs are a part of QA requirements. Section 10.0 of the OEMP (DOE, 1989) includes a listing of the required records and reports and the laws, regulations, or DOE Orders that contain the requirements. Records are maintained in accordance with WP 15-030, Records Management.

Table 8-1
Analytical Lab - Waltz Mill Site
EPA Intercomparison Study Cross Check Samples

1989			pCi/Liter		
		Known	(Control Limits)		Lab
Date	Analysis	Value	From	To	Measured
06-Jan-89	Sr-89	40.00	31.34	48.66	50.00
06-Jan-89	Sr-90	25.00	22.40	27.60	12.00
13-Jan-89	Pu-239	4.20	3.51	4.89	4.10
20-Jan-89	Alpha	8.00	0.00	16.66	10.00
20-Jan-89	Beta	4.00	0.00	12.66	5.00
10-Feb-89	Cr-51	235.00	193.43	276.57	174.00
10-Feb-89	Co-60	10.00	1.34	18.66	7.33
10-Feb-89	Zn-65	159.00	131.29	186.71	128.00
10-Feb-89	Ru-106	178.00	146.82	209.18	72.33
10-Feb-89	Cs-134	10.00	1.34	18.66	6.67
10-Feb-89	Cs-137	10.00	1.34	18.66	7.67
24-Feb-89	Tritium	2754.00	2137.39	3370.61	2384.00
10-Mar-89	Ra-226	4.90	3.69	6.11	2.30
10-Mar-89	Ra-228	1.70	1.18	2.22	3.77
18-Apr-89 Mixed	Alpha	-	-	-	-
18-Apr-89 Mixed	Beta	-	-	-	-
18-Apr-89 Mixed	U(Nat)	3	0	13.39	3
18-Apr-89 Mixed	Sr-89	8.00	0.00	16.66	5.00
18-Apr-89 Mixed	Sr-90	8.00	5.40	10.60	8.00
18-Apr-89 Mixed	Cs-134	20.00	11.34	28.66	14.00
18-Apr-89 Mixed	Cs-137	20.00	11.34	28.66	16.00
18-Apr-89 Mixed	Ra-226	3.50	2.63	4.37	2.47
18-Apr-89 Mixed	Ra-228	3.60	2.73	4.47	3.53
05-May-89	Sr-89	6.00	0.00	14.66	6.00
05-May-89	Sr-90	6.00	3.40	8.60	4.67
12-May-89	Alpha	30.00	16.14	43.86	35.33
12-May-89	Beta	50.00	41.34	58.66	41.00
09-Jun-89	Ba-133	49.00	40.34	57.66	36.33
09-Jun-89	Co-60	31.00	22.34	39.66	25.67
09-Jun-89	Zn-65	165.00	135.56	194.44	149.00
09-Jun-89	Ru-106	128.00	105.48	150.52	87.33
09-Jun-89	Cs-134	39.00	30.34	47.66	27.67

Table 8-1
Analytical Lab - Waltz Mill Site
EPA Intercomparison Study Cross Check Samples
(Continued)

1989			pCi/Liter		
		Known	(Control Limits)		Lab
Date	Analysis	Value	From	To	Measured
09-Jun-89	Cs-137	20.00	11.34	28.66	16.33
23-Jun-89	Tritium	4503	3723.58	5282.42	5085
14-Jul-89	Ra-226	17.7	13.02	22.38	12.30
14-Jul-89	Ra-228	18.3	13.62	22.98	14.53
22-Sep-89	Alpha	4	0	12.66	5.00
22-Sep-89	Beta	6	0	14.66	5.67
06-Oct-89	Ba-133	59.00	48.61	69.39	44.33
06-Oct-89	Co-60	30.00	21.34	38.66	27.00
06-Oct-89	Zn-65	129.00	106.48	151.52	124.00
06-Oct-89	Ru-106	161.00	133.29	188.71	127.67
06-Oct-89	Cs-134	29.00	20.34	37.66	22.00
06-Oct-89	Cs-137	59.00	50.34	67.66	54.33
20-Oct-89	Tritium	3496	2865.53	4126.47	3305

CHAPTER 9

COMPLIANCE SELF ASSESSMENT COVER MEMORANDUM JANUARY - MAY 1990

Compliance Summary

The applicable environmental requirements and permits and the status of each are listed in Table 9-1, Environmental Permit Matrix for January - May 1990.

9.1 COMPLIANCE ASSESSMENT FOR JANUARY-MAY 1990

During the period January - May 1990, compliance was maintained for applicable EPA regulations (i.e., RCRA, SARA, the CWA, and the CAA).

Compliance with all BLM and State of New Mexico permits and regulations was also maintained during this period.

The status of environmental requirements for 1990 are listed below:

- In order to comply with OSHA and SARA an ongoing training program is being conducted to train Hazardous Material Area Representatives. This is a three-day training course with special emphasis for the emergency response technicians.
- The EEG/EID correspondence data base is continuing to be maintained to ensure tracking of all action items resulting from correspondence between the WIPP project and the EEG or the EID. This action has been taken in accordance with the DOE Management Directive Number 3.11.1.
- The updated status of all required environmental permits, as listed in Appendix I of the Annual Site Environmental Report is reviewed on a monthly basis and renewed, as necessary.
- The WIPP has a hazardous waste management program in place which is in compliance with RCRA requirements and in accordance with this program the Hazardous Waste Biennial report was submitted in March 1990.
- Site-generated hazardous waste was shipped within the 90-day period allowable for non-permitted RCRA facilities, and waste reports were submitted as needed for compliance with RCRA.
- There were 10 shipments of hazardous waste handled at the WIPP. WIPP is in 100 percent compliance with the RCRA requirements at the WIPP. The storage areas for hazardous materials at the WIPP are operated in accordance with the WIPP procedure WP 02-601. Routine inspections of the 90-day hazardous waste staging area are conducted in accordance with RCRA and satellite accumulation areas are inspected periodically.
- Area-specific Material Safety Data Sheet (MSDS) books have been prepared, and personnel are being trained to use them for compliance with OSHA.
- A discharge plan for the sewage lagoon system was submitted to the EID in early 1990. This discharge plan was prepared as required by the New Mexico Water Quality Control Commission Regulation.

9.2 CURRENT ISSUES AND ACTIONS

In order to comply with the Clean Air Act, a National Emissions Standard for Hazardous Air Pollutants (NESHAPs) application was prepared in 1989 and submitted to the DOE. The application was placed on hold pending promulgation of the final revised regulations for DOE facilities that emit radionuclides.

Land-Use Permit NM 067-LUP-237 for the construction landfill expired on February 9, 1990. Since the BLM no longer permits landfills, the landfill was closed and covered in February and will be reclaimed in accordance with the permit conditions.

The WIPP in January 1990, was issued biotic sampling permit number 1894, from the State of New Mexico, Department of Game and Fish which allows the collection of 50 catfish and 25 quail for radiological analysis.

9.3 PERMITS

The status of required permits is tracked on a monthly basis, and they are renewed as necessary to comply with the Bureau of Land Management (BLM), the New Mexico Environmental Improvement Division (EID), the New Mexico Department of Game and Fish, the New Mexico Commissioner of Public Lands, and the New Mexico Department of Finance and Administration Planning Division (Historic Preservation Bureau).

The WIPP currently holds 15 active permits from the BLM. These permits are primarily land-use, free-use, and right-of-way permits. There were no noncompliances for BLM-administered permits in 1990.

The WIPP holds one New Mexico EID permit for open burning. The open burning permit is renewed annually for fire fighter training activities.

The Final SEIS was issued in February 1990 as DOE/EIS-0026-FS (SEIS). It is expected that the Record of Decision will be issued in June 1990.

TABLE 9-1

ENVIRONMENTAL PERMIT MATRIX FOR JANUARY - MAY 1990

Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired
Department of the Interior, Bureau of Land Management (BLM)	Approval to Drill 2 New Test Wells on Existing Pads At P-1 and P-2	NA	9/18/86	NA
BLM	Right-of-way For water Pipeline	NM53809	8/17/83	NA
BLM	Right-of-way For North Access Road	NM55676	8/24/83	NA
BLM	Right-of-way For Railroad	NM55699	9/27/83	NA
BLM	Right-of-way For Dosimetry And Aerosol Sampling Sites	NM63136	7/3/86	NA
BLM	Right-of-way For Seven Subsidence Monuments	NM65801	11/7/86	NA
BLM	Two Additional Subsidence Monuments	NM82245	12/13/89	NA
BLM	Raptor Platforms	NM82212	9/12/89	9/12/92
BLM	Right-of-way For Aerosol Sampling Site	NM77921	8/18/89	8/18/90
New Mexico Department of Game and Fish	Permit to Collect Biological Samples	1894	1/8/90	12/31/90

TABLE 9-1
(Continued)

ENVIRONMENTAL PERMIT MATRIX FOR JANUARY - MAY 1990

Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired
New Mexico Department of Game and Fish	Concurrence That Construction of WIPP Will Have No Significant Adverse Impact Upon Threatened or Endangered Species	NA	4/7/80	NA
New Mexico Commissioner of Public Lands	Right-of-Way For High Volume Air Sampler	RW-22789	10/3/85	10/3/90
New Mexico Department of Finance and Administration Planning Division, Historic Preservation	Concurrence That the Archaeo-logical Resource Protection Plan Prepared by the DOE DOE is Adequate To Mitigate any Adverse Impacts Upon Cultural Resources Resulting from Construction of the Full WIPP Facility	NA	7/25/83	NA
U.S. Environ-mental Pro-tection Agency (EPA)	Acknowledge-ment of Notification Of Hazardous Waste Activity (Trupact II)	NMD982283566	10/87	NA
EPA	Acknowledge-ment of Notification of Hazardous Waste Activity (WIPP)	NM4890139088	1/88	NA
EPA	Submittal of Part A RCRA Permit Application		7/88	NA

TABLE 9-1
(Continued)

ENVIRONMENTAL PERMIT MATRIX FOR JANUARY - MAY 1990

Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired
New Mexico Environmental Improvement Division (EID)	Open Burning Permit to Train Fire Control Crews	NA	3/17/89	3/17/90 (Extension)
EID	Notification of Presence of 2 Underground Fuel Storage Tanks At WIPP	NA	4/15/86	NA

CHAPTER 10

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CHAPTER 11

DISTRIBUTION LIST

Clarence R. Allen
Seismologic Laboratory
California Institute of Tech.
Pasadena, CA 91125

Dr. Roger E. Batzel, Dir.
University of California
Lawrence Linermor National Lab.
P.O. Box 808
Livermore. CA 94550

Mr. Jim Bednarz
Hawk Mountain Sanctuary Assn.
Route 2
Kempton, PA 19529

Mr. Michael Bell
U.S. Nuclear Regulatory Comm.
Division of Waste Management
Mail Stop 697-SS
Washington, DC 20555

Dr. Robert Bernstein, F.A.C.P
Commissioner of Health
Texas Department of Health
1100 W. 49th
Austin, TX 78756

Maxwell Blanchard
DOE-NWTS Program Office
505 King Avenue
Columbus, OH 43201

Dr. John O. Blomeke
Oak Ridge National Lab.
P.O. Box X
Oak Ridge, TN 37830

Dr. John D. Bredehoeft
Western Region Hydrologist
Water Resources Division
U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

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Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Comm.
Washington, DC 20555

George D. Carpenter
Manager, Operational Safety
Westinghouse Hanford Co.
P.O. Box 1970
Drop: W/A--43
Richland, WA 99352

Dr. Jerry Cohen
Manager of Energy & Envir. Evaluation
1811 Santa Rita Road, Suite 104
Pleasanton, CA 94566

Dr. Sanford Cohen
8200 Riding Ridge Place
McLean, VA 22102

Dr. Carl P. Cohen
Consultant
928 N. California Av.
Palo Alto, CA 94303

E. William Colglazier
Energy, Environment and Resources Center
University of Tennessee
327 S. Stadium Hall
Knoxville, TN 37996-0710

Dr. Neville G. W. Cook
Department of Material Sciences
University of California at Berkeley
Hearst Mining Building, #320
Berkeley, CA 94720

Mr. Charles L. Cox
Assistant to the Dir.
Bureau of Radiological Health
Food and Drug Administration
5600 Fishers Lane
Rockville, MD 20857

Mr. Cliff Crawford
Department of Biology
University of New Mexico
Albuquerque, NM 87131

Mr. Gary Cunningham
Department of Biology
New Mexico State University
Las Cruces, NM 88003

Gary Daer
Science Applications International Corp.
Valley Bank Center
Suite 407
101 Convention Drive
Las Vegas, NV 89109

Dr. Harold Daw
Associate Academic V.P.
New Mexico State University
P.O. Box 3004
Las Cruces, NM 88003

Manager
Regulatory Compliance
Westinghouse Materials Co.
P.O. Box 398704
Cincinnati, OH 45239

Mr. John D'Mura
Department of Science
New Mexico State University
1500 University Drive
Carlsbad, NM 88220

Mr. David L. Duncan
Regional Radiation Rep.
U.S. Environmental Protection Agency
215 Fremont St.
San Francisco, CA 94105

D. W. Duszynski, Chairman
Department of Biology
University of New Mexico
Albuquerque, NM 87131

Dr. Bruce Erdal
Los Alamos National Lab.
University of California
P.O. Box 1663
Los Alamos, NM 87545

Dr. Fred M. Ernsberger
1325 NW Tenth Avenue
Gainesville, FL 32601

Dr. Rodney C. Ewing
Department of Geology
University of New Mexico
Albuquerque, NM 87131

Dr. Charles Fairhurst
Department of Civil
Mineral Engineering
University of Minnesota
Minneapolis, MN 55455

A. G. Fremling, Manager
Richland Operations Office
P.O. Box 550
Richland, WA 99352

Tony Gennaro
Department of Biology
Eastern NM University
Portales, NM 88130

J. R. Goodin
Department of Biology Sciences
Texas Tech University
Lubbock, TX 79409

J. T. Granaghan, Plant Manager
Savannah River Plant
P.O. Box A
Aiken, SC 29801

John W. Healy
51 Grand Canyon Drive
Los Alamos, NM 87544

Dr. Moses Greenfield
Professor and Chief
Department of Radiological Sciences
Medical Physics Division, BL-428 CHS
University of California
Los Angeles, CA 90024

Dr. Wayne Hanson
Mail Stop 490-Group-H
Los Alamos National Laboratory
Los Alamos, NM 87545

Mr. Saul Harris
Principal Health Physicist
Union Electric Co.
P.O. Box 149-Code 470
St. Louis, MO 63166

Ms. Francis Harshaw
Radiological Physicist
Radiation Safety Office
Box U-97
University of Connecticut
Storrs, CT 06268

Rep. Robert M. Hawk
1005 Washington St., SE
Albuquerque, NM 87108

John W. Healy
51 Grand Canyon Drive
Los Alamos, NM 87544

G. Ross Heath, Dean
College of Ocean & Fishery Sciences
University of Washington
Seattle, WA 98195

Mr. Wylie B. Hogeman
President, MRC
Director, Mound
P.O. Box 32
Miamisburg, OH 45342

Mr. George Holeman
314 WNSL West
Wright Nuclear Structure Lab.
Yale University
260 Whitney Avenue
New Haven, CT 06520

Mr. Harold L. James
1617 Washington Street
Port Townsend, WA 98368

Mr. Harry Jordan
Assistant Division of Leader
Environmental Concerns
Health Division Office
Los Alamos National Laboratory
Los Alamos, NM 87544

Mr. Jess Juen
Bureau of Land Man.
101 E. Mermod
Carlsbad NM 88220

Dr. Roger Kasperson
Center for Technology
Environment and Dev.
Clark University
Worchester, MA 01610

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Reference Center
School of Public Health
University of Illinois
P.O. Box 69998
Chicago, IL 60680

Dr. Charles Kelsey, Chief
Bio-Medical Physics
Cancer Research
And Treatment Center
Room 219
900 Camino De La Sierra, NE
Albuquerque, NM 87131

Dr. Donald M. Kerr, Dir.
Los Alamos National Lab.
P.O. Box 1663
Los Alamos, NM 87545

Mr. Alan Krause
Bureau of Land Man.
101 E. Mermod
Carlsbad, NM 88220

Dr. Konrad B. Krauskopf, Chairman
Department of Geology
Stanford University
Stanford, CA 94305

Jan Kronenburg, Ad. Assist.
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418

J. LaGrone, Manager
Oak Ridge Operations Office
P.O. Box E
Oak Ridge, TN 37830

LATA
1650 Trinity Avenue
Los Alamos, NM 87545

Robert E. Lawrence
Manager, D&D Operations
West Valley Nuclear Services (WVNS)
P.O. Box 191
West Valley, NY 14171

Kai N. Lee
Northwest Power Planning Council
217 Pine Street, Suite 700
Seattle, WA 98195

Librarian
Westinghouse Hanford
Peoples Bank Building
Richland, WA 99352

Robert B. Lyon
Whiteshell Nuclear Reasearch
Establishment
Pinawha, Manitoba Canada

Frederick T. Mackenzie
Marine Sciences Building 525
University of Hawaii
1000 Pope Road
Honolulu, Hawaii 96822

O. D. Markham
Radiological and Envir. Sciences
Laboratory
U.S. Department of Energy
550 Second Street
Idaho Falls, ID 83401

Ms. Vijila Markunas, Librarian
Transportation and Tecnology Dep.
Prg. 4550-A
Sandia National Labs
Albuquerque, NM 87138

Martin Speare Memorial Library
New Mexico Tech
Campus Station
Socorro, NM 87801

Dr. James E. Martin
University of Michigan
School of Public Health
Radiological Health Dep.
109 Observatory
Ann Arbor, MI 48109

A. J. (Tony) Matule
Manager, Environmental Eng.
Westinghouse Idaho Nuclear Co.
P.O. Box 4000, CPP-630
Idaho Falls, ID 83403

John M. Matuszek, Jr.
Radiologic Sciences Lab.
New York State
Department of Health
Empire State Plaza
Albany, NY 12201

Mrs. Helen Melton
Carlsbad Public Library
Public Document Room
101 S. Halagueno
Carlsbad, NM 88220

Dr. Wade W. Moeller, Chairman
Department of Environmental & Health
Sciences
School of Public Health
55 Shattuck
Harvard University
Boston, MA 02115

Dr. Robert Mosley, Chairman
Department of Radiology
School of Medicine
University of New Mexico
Albuquerque, NM 87131

Dr. William R. Muehlberger
Department of Geological Sciences
University of Texas
Austin, TX 78712

Dr. Peter B. Myers, Staff Director
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418

Dr. Kenneth H. Olsen
Los Alamos National Lab.
Group G-2, Mail Stop 676
P.O. Box 1663
Los Alamos, NM 87554

Dr. Richard R. Parizek
Department of Hydrology
Pennsylvania State University
University Park, PA 16802

Dr. Frank L. Parker
Department of Envir. Eng.
108 New Engineering Building
Vanderbilt University
24th Avenue, South
Nashville, TN 37235

F. David Pierce
Manager, Safety, Sec. & Envir.
Western Zirconium
P.O. Box 3208
Ogden, UT 84409

Dr. Thomas H. Pigford
Department of Nuclear Engin.
University of California
Berkely, CA 94720

Mr. Bill Pike
Department of Science
New Mexico State University
1500 University Drive
Carlsbad, NM 88220

Sam Pitts
Director, Environmental Affairs
Gateway Center
1558 Westinghouse Building
Pittsburgh, PA 15222

Dr. Roy G. Post, Professor
Department of Nuclear Energy
Tucson, AZ 85721

Mr. Loren Potter
Department of Biology
University of New Mexico
Albuquerque, NM 87131

Radioactive Waste Consultation Committee
Room 334
State Capitol
Santa Fe, NM 87503

Dr. Court Randall, Director
Energy Education Division
Oak Ridge Operations Office
P.O. Box E
Oak Ridge, TN 37830

Mr. H. J. Rauch, Manager
U.S. Department of Energy
Chicago Operations Office
9800 S. Cass Avenue
Argonne, IL 60439

Dr. Charles Reith
Jacobs Engineering Group, Inc.
5301 Central Ave., NE, Suite 1700
Albuquerque, NM 87108

Mr. Mark Rosacker
Living Desert State Park
P.O. Box 100
Carlsbad, NM 88220

RUTGERS
Library of Science and Medicine
Goverment Documents Dep.
P.O. Box 1029
Piscataway, NJ 08854

Dr. Benard Schleien
Bureau of Radiological Health
Food and Drug Administration
5600 Fishers Lane
Rockville, MD 20857

Mr. D'Arcy A. Shock, Consultant
233 Virginia
Ponca City, OK 74601

Dr. Glen Sjoblom, Director
Office of Radiation Problems, ANR 458
Christal Mall #2 216
U.S. Envir. Protection Agency
401 M. Street, SW
Washington, DC 20460

M. C. Skriba
Westinghouse Science & Technology Center
P.O. Box 2728
Pittsburgh, PA 15230-2728

Ms. Kim Stuart
Thomas Brannigan Library
200 E. Piacho
Las Cruces, NM 88001

Diasah E. Taylor
Wildlife Biologist
White Sands Missile Range
STEWS-EL-N
WSMR, NM 88002-5076

Ms. Elsa Taylor
Department of Biology
University of New Mexico
Albuquerque, NM 87131

Mr. Al Topp
Health Programs Manager 2A
Radiation Protection Burearu
Environmental Improvement Div.
P.O. Box 968
Santa Fe, NM 87503

Walter Gregson Vaux, P.E.
Principal Engineer
Facilitator, Waste & Envir.
R & D Center-501-3022

Mr. John C. Villforth, Dir.
Bureau of Radiological Health
Food and Drug Administration
5600 Fishers Lane
Rockville, MD 20857

Ms. Ingrid Vollnhofer
New Mexico State Library
325 Don Gasper
Santa Fe, NM 87503

Jim Walters
Resources Management Specialist
Natural Park Service Headquarters
3225 National Parks Highway
Carlsbad, NM 88220

Ms. Judi Ward
Roswell Public Library
301 N. Pennsylvania
Roswell, NM 88201

Dr. Glenn Whan
Chemical and Nuclear Engin.
Farris Engineering Center
University of New Mexico
Albuquerque, NM 87131

Christopher G. Whipple
Electric Power Research Inst.
3412 Hillview Avenue
Palo Alto, CA 94303

Walt Whitford
Department of Biology
New Mexico State University
Las Cruces, NM 88001

Susan M. Wiltshire
JK Associates
77 Fox Run Road
P.O. Box 2219
S. Hamilton, MA 01982

Dr. John W. Winchester
Department of Oceanography
Florida State University
Tallahassee, FL 32307

Richard C. Winter, Ph.D.
Energy and Environmental Systems Div.
Argonne National Laboratory
Argonne, IL 60439

Mr. Harold C. Wyckoff
4108 Montpelier Road
Rockville, MD 20853

ACTIVE ENVIRONMENTAL PERMITS FOR 1989

Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired	Permit Status
Department of The Interior, Bureau of Land Management (BLM)	Land Use Permit for Placement of Raptor Platforms	NM-060-LUP-235	9/12/86	9/12/89	Active
BLM	Land Use Permit to Dispose of Construction Debris	NM-067-LUP-237	2/9/87	2/9/90	Active
BLM	Free Use Permit	NM-060-FU9-7020	1/31/89	1/23/90	Active
BLM	Free Use Permit	NM-060-FU9-7030	6/8/89	6/8/90	Active
BLM	Approval to Drill 2 New Test Wells on Existing Pads At P-1 and P-2	NA	9/18/86	NA	Active
BLM	Right-of-way For water Pipeline	NM53809	8/17/83	NA	Active
BLM	Right-of-way For North Access Road	NM55676	8/24/83	NA	Active
BLM	Right-of-way For Railroad	NM55699	9/27/83	NA	Active
BLM	Right-of-way For Dosimetry And Aerosol Sampling Sites	NM63136	7/3/86	NA	Active
BLM	Right-of-way For Seven Subsidence Monuments	NM65801	11/7/86	NA	Active

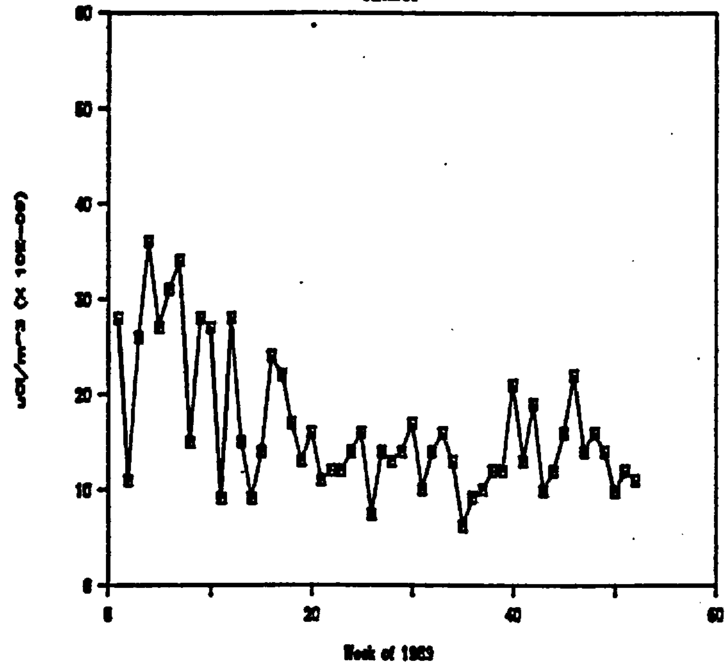
Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired	Permit Status
BLM	Right-of-way For Aerosol Sampling Site	NM77921	8/18/89	8/18/90	Active
New Mexico Department of Game and Fish	Permit to Collect Biological Samples	1775	2/15/89	12/31/89	Active
New Mexico Department of Game and Fish	Concurrence That Construction of WIPP Will Have No Significant Adverse Impact Upon Threatened or Endangered Species	NA	4/7/80	NA	Active
New Mexico Commissioner of Public Lands	Right-of-Way For High Volume Air Sampler	RW-22789	10/3/85	10/3/90	Active
New Mexico Department of Finance and Administration Planning Division, Historic Preservation	Concurrence That the Archaeo-logical Resource Protection Plan Prepared by the DOE DOE is Adequate To Mitigate any Adverse Impacts	NA	7/25/83	NA	Active
New Mexico Historic Preservation Bureau	Upon Cultural Resources Resulting from Construction of the Full WIPP Facility				
New Mexico Environmental Improvement Division (EID)	Open Burning Permit to Train Fire Control Crews	NA	3/17/89	3/17/90 (Extension)	Active
U.S. Environ-mental Pro-tection Agency (EPA)	Acknowledge-ment of Notification	NMD982283566	10/87	NA	Active
EPA	Of Hazardous Waste Activity (Trupact II)				

Granting Agency	Type of Permit/Approval	Permit Number	Date Granted	Date Expired	Permit Status
EPA	Acknowledgement of Notification of Hazardous Waste Activity (WIPP)	NM4890139088	1/88	NA	Active
EID	Notification of Presence of 2 Underground Fuel Storage Tanks At WIPP	NA	4/15/86	NA	Active
EPA	Submittal of Part A RCRA Permit Application		7/88	NA	Active

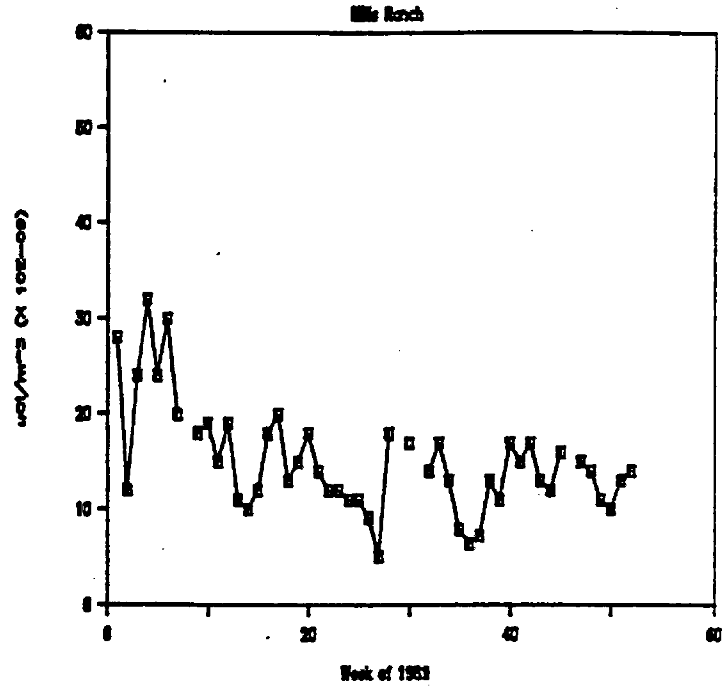
APPENDIX II

Gross Alpha Concentrations for Ranch and City Sampling Locations

1989 Gross Alpha Concentration
Carlsbad



1989 Gross Alpha Concentration
Mills Ranch



1989 Gross Alpha Concentration
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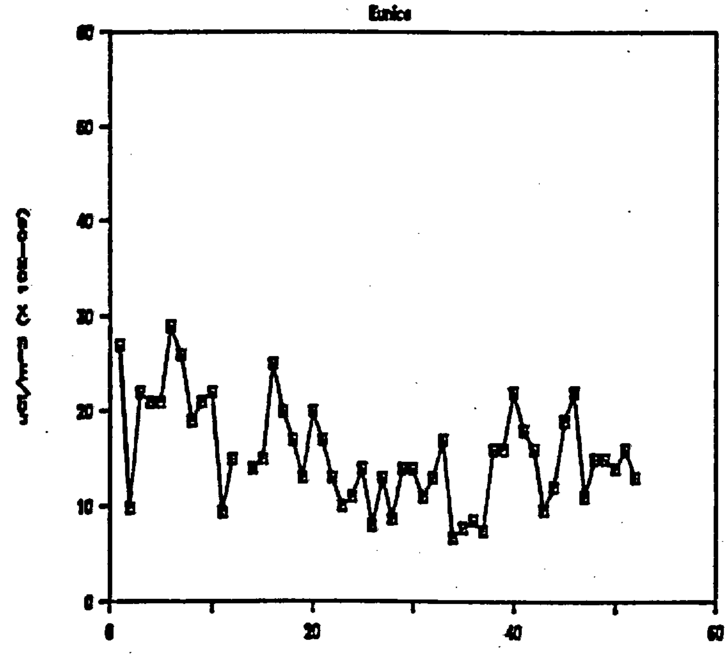
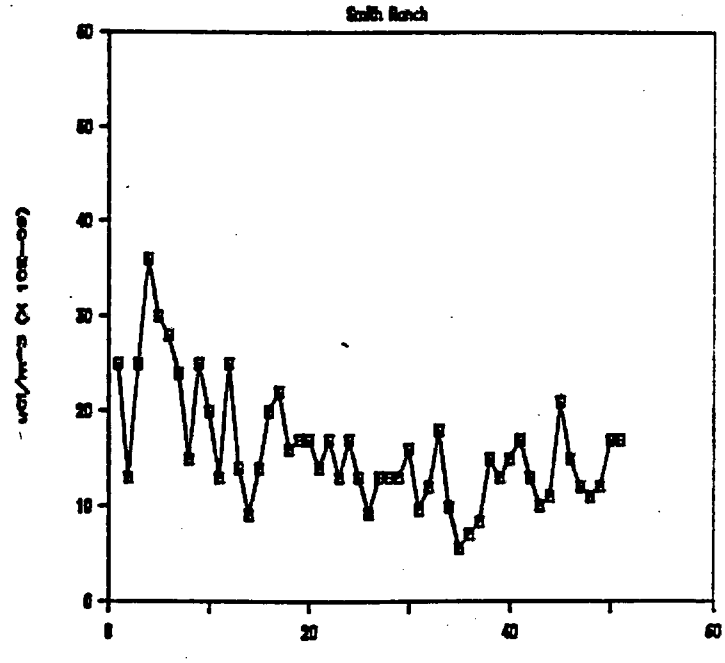
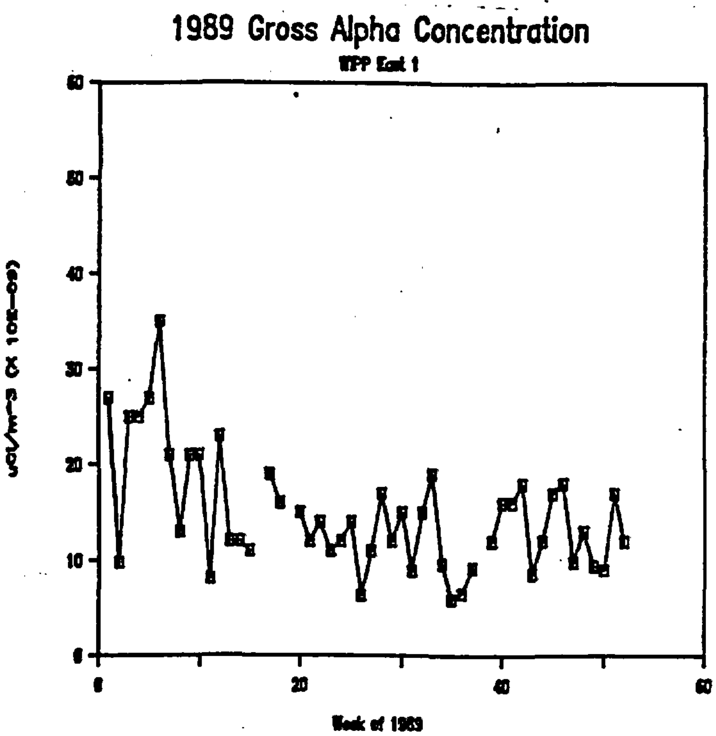


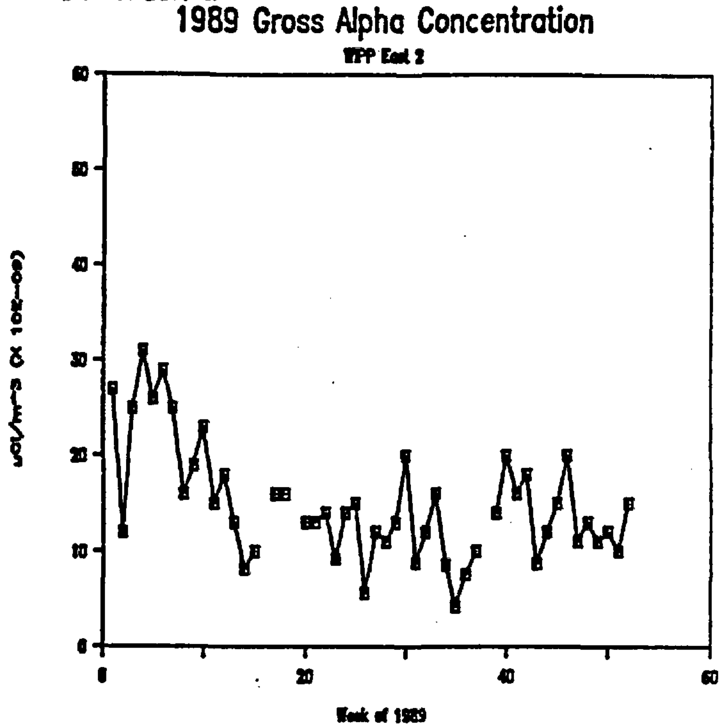
1989 Gross Alpha Concentration
Smith Ranch

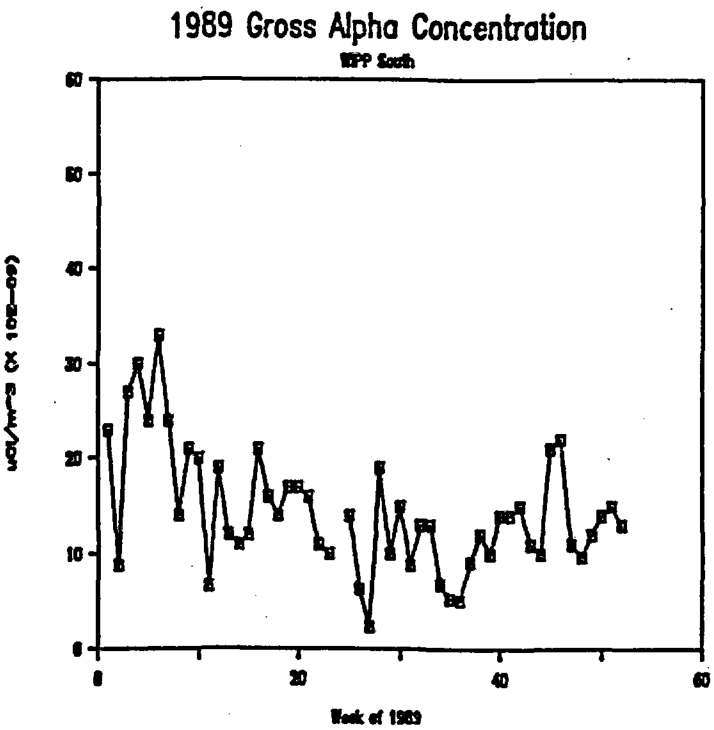


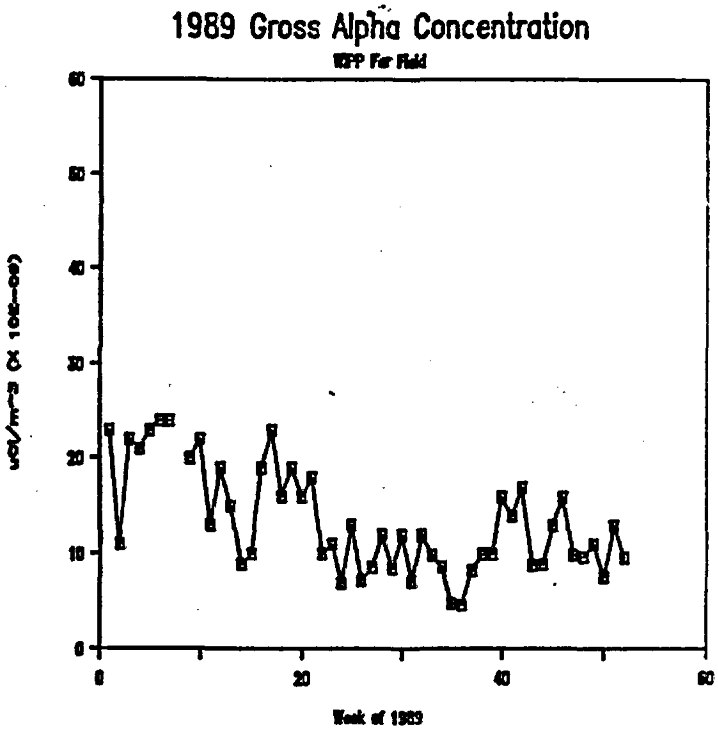
APPENDIX II

Gross Alpha Concentrations for Ranch and City Sampling Locations



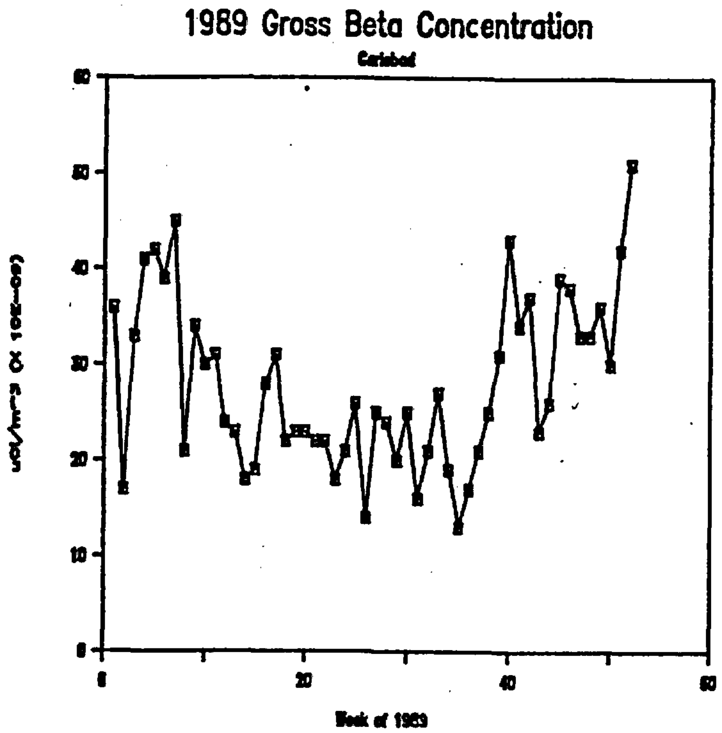


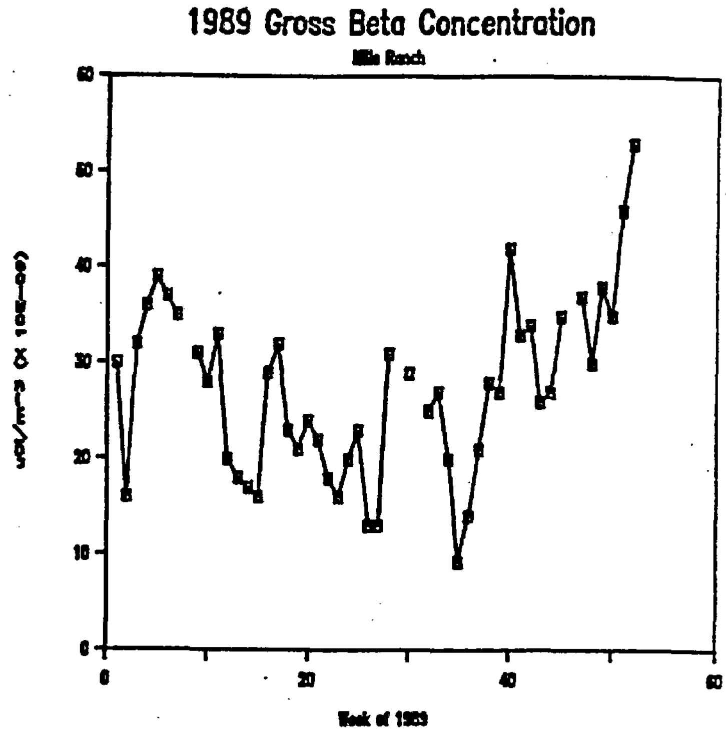


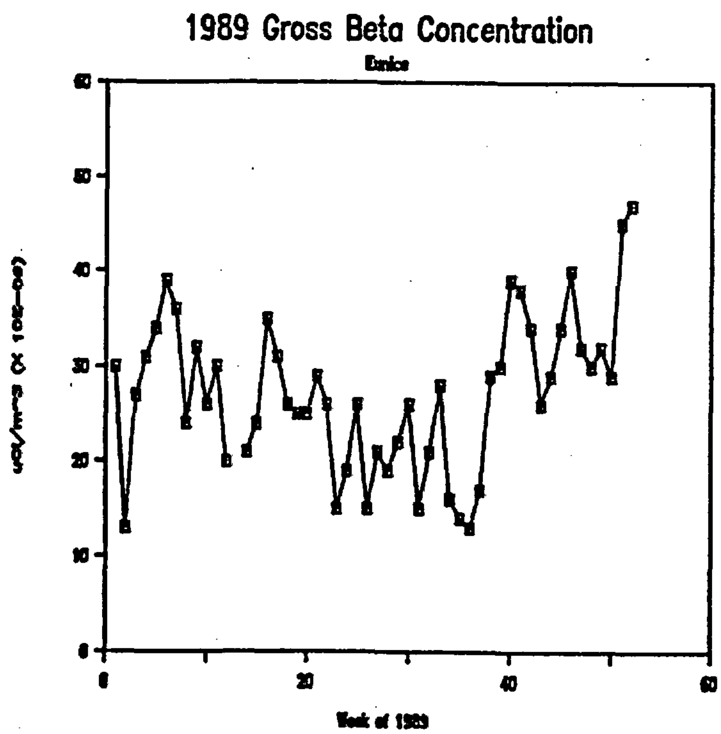


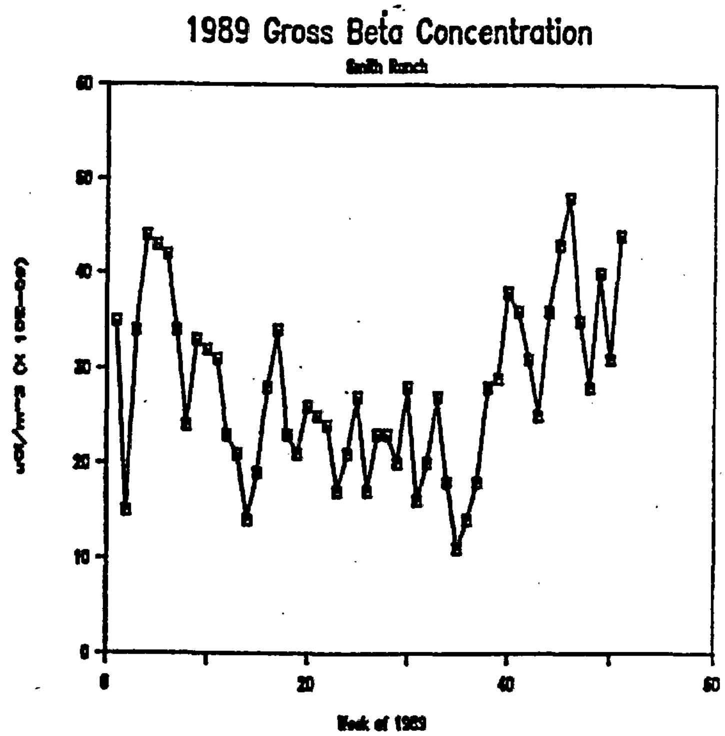
APPENDIX III

Gross Beta Concentrations for Ranch and City Sampling Locations







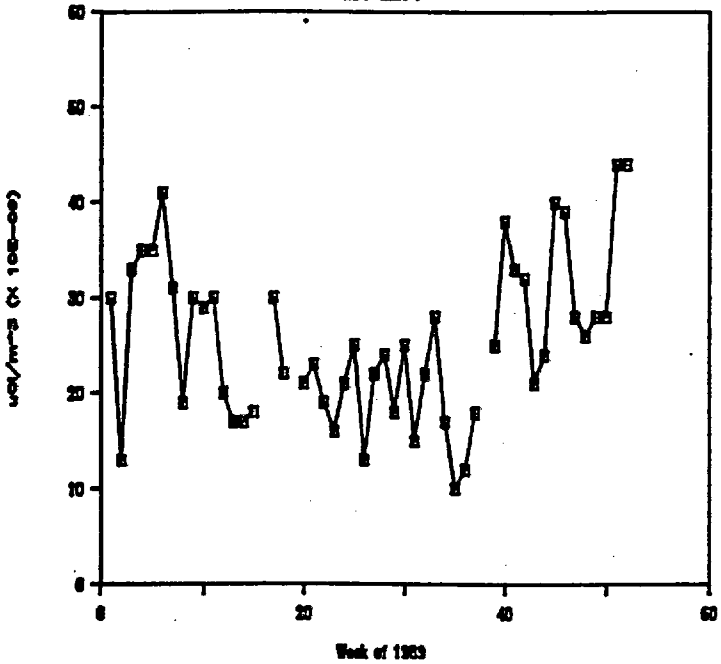


APPENDIX III

Gross Beta Concentrations for Ranch and City Sampling Locations

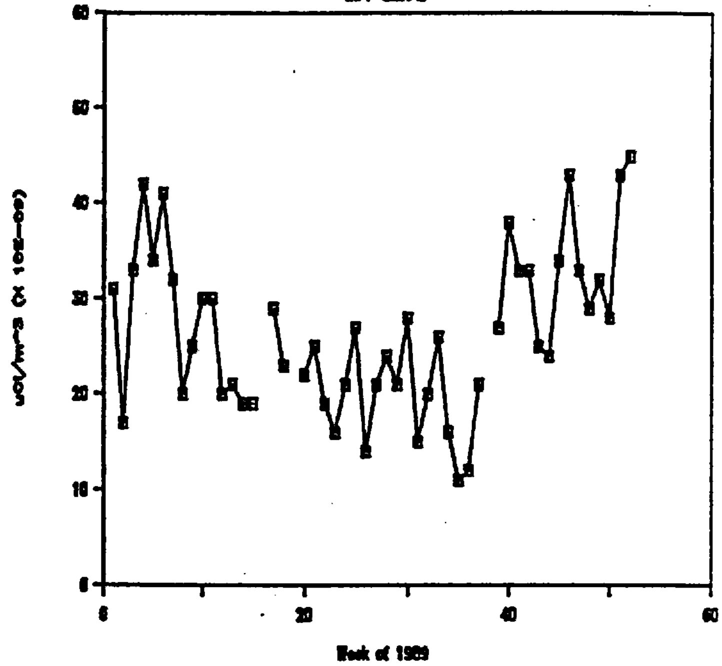
1989 Gross Beta Concentration

WIPP East 1



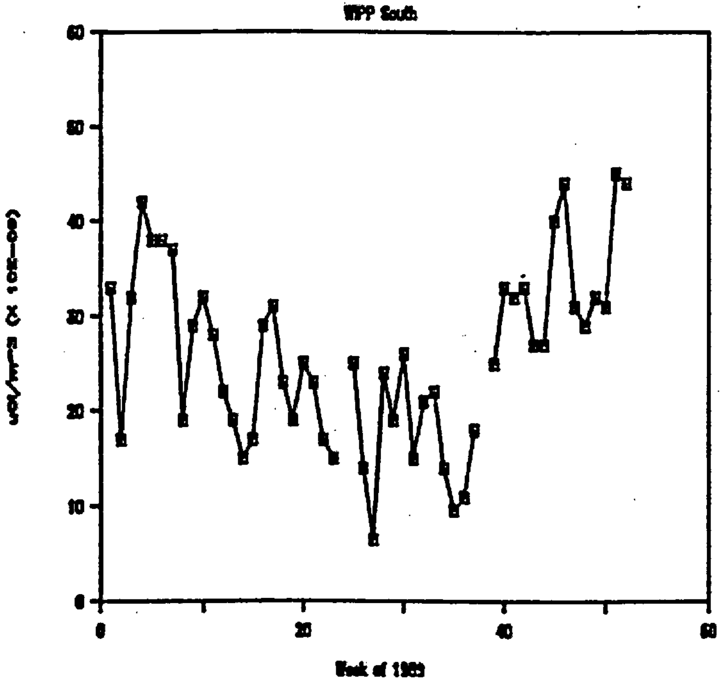
1989 Gross Beta Concentration

WIPP East 2



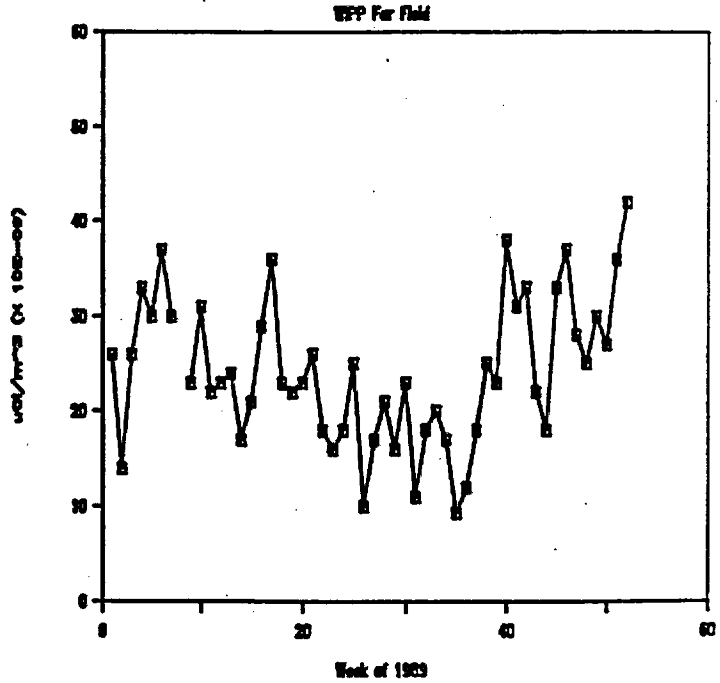
1989 Gross Beta Concentration

WIPP South



1989 Gross Beta Concentration

WIPP Far Field



RADIONUCLIDE CONCENTRATIONS IN QUARTERLY COMPOSITES
FIRST QUARTER 1989
(uCi/ml)

LOCATION CODE	Be-7 (E-13)	K-40 (E-15)	Co-60 (E-16)	Sr-90 (E-16)	Cs-137 (E-17)	Pb-210 (E-14)
CBD	1.6	8.1	3.4	8.1	0.18	2.5
EUN	1.3	6.0	3.8	6.2	1.8	2.1
MLR	1.7	5.2	3.8	0.61	0.22	2.9
SMR	2.1	3.3	3.5	13.0	2.0	2.0
WEE 1.2	1.2	4.0	3.4	8.0	2.1	2.0
WEE 2.2	1.6	5.4	3.5	-2.6	0.61	1.8
WFF	1.4	6.8	3.8	2.0	79.0	2.2
WSS	1.4	5.7	3.4	17.0	1.8	2.7

LOCATION CODE	Ra-226 (E-16)	Ra-228 (E-15)	Th-228 (E-16)	U-233 (E-17)	U-234 (E-16)	U-235 (E-17)
CBD	2.5	1.0	1.7	-1.7	1.5	0.0
EUN	1.5	1.1	1.2	-1.7	3.4	2.9
MLR	2.1	1.0	2.0	-0.58	0.74	1.2
SMR	3.3	26.0	1.7	3.8	2.0	0.0
WEE 1.2	0.81	1.0	0.35	-1.8	1.4	0.0
WEE 2.2	2.8	18.0	0.94	-1.7	2.2	60.0
WFF	4.0	1.1	1.5	-26.0	56.0	-68.0
WSS	2.4	3.4	1.8	-30.0	1.6	3.3

LOCATION CODE	U-238 (E-17)	Pu-238 (E-15)	Pu-239/240 (E-17)	Pu-241 (E-15)	(E-14)	(E-17)
CBD	0.12	7.5	8.5	0.0		
EUN	0.11	-3.8	4.1	0.0		
MLR	6.7	-5.6	-4.0	0.74	1.2	
SMR	5.3	0.26	1.7	0.51	3.4	2.9
WEE 1.2	8.6	1.0	0.35	-0.26	0.56	-0.68
WFF 2.2	8.5	0.18	0.94	-0.30	1.6	3.3
WSS	7.1	0.34	1.8	-1.7	2.2	0.6

RADIONUCLIDE CONCENTRATIONS IN QUARTERLY COMPOSITES
SECOND QUARTER 1989
(uCi/ml)

LOCATION CODE	Be-7 (E-13)	K-40 (E-15)	Co-60 (E-16)	Sr-90 (E-16)	Cs-137 (E-17)	Pb-210 (E-14)
CBD	1.3	4.3	3.4	No	2.0	1.4
EUN	1.7	8.7	3.3	Data	2.0	1.6
MLR	1.7	2.6	3.6		2.0	1.8
SMR	1.6	8.9	5.9		-1.2	1.4
WEE 1.2	1.6	6.2	4.2		2.3	1.8
WEE 2.2	1.7	3.3	4.1		6.0	1.4
WFF	1.4	5.1	2.6		2.0	1.2
WSS	1.4	6.0	3.6		2.2	1.7

LOCATION CODE	Ra-226 (E-16)	Ra-228 (E-15)	Th-228 (E-16)	U-233 (E-17)	U-234 (E-16)	U-235 (E-17)
CBD	1.9	4.4	2.0	0.0	1.4	9.8
EUN	3.3	8.0	2.0	2.8	6.8	6.7
MLR	9.8	1.0	5.2	0.0	1.0	2.5
SMR	1.6	1.5	1.9	9.2	-1.8	-2.2
WEE 1.2	1.1	2.0	9.2	0.0	8.9	0.0
WEE 2.2	3.1	4.7	1.4	6.0	9.7	0.0
WFF	1.2	1.7	1.4	0.0	1.2	9.8
WSS	2.1	2.5	4.1	5.9	7.1	0.0

LOCATION CODE	U-238 (E-17)	Pu-238 (E-15)	Pu-239/240 (E-17)	Pu-241 (E-15)	(E-14)	(E-17)
CBD	-1.2	-3.9	1.7	-3.5		
EUN	6.2	-3.5	3.3	-5.2		
MLR	4.0	6.5	-1.5	5.8		
SMR	-1.1	-1.8	7.6	-3.3		
WEE 1.2	6.9	-4.2	8.5	3.2		
WEE 2.2	1.8	-3.7	5.5	-6.6		
WFF	2.0	1.0	6.6	4.9		
WSS	6.9	-6.2	1.0	1.2		

RADIONUCLIDE CONCENTRATIONS IN QUARTERLY COMPOSITES
THIRD QUARTER 1989
(uCi/ml)

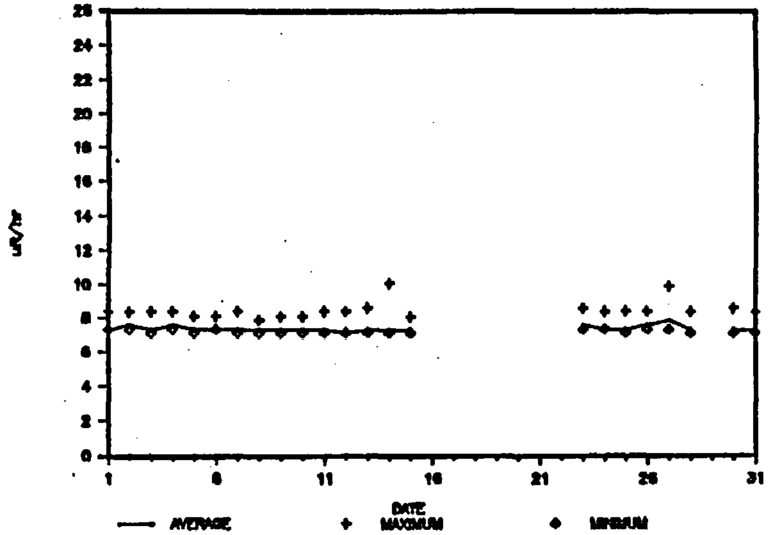
LOCATION CODE	Be-7-OK (E-13)	K-40-ok (E-15)	Co-60-ok (E-16)	Sr-90ok (E-16)	Cs-137 (E-17)	Pb-210 (E-14)
CBD	1.2	4.2	3.5	No	2.0	1.4
EUN	1.9	3.4	3.2	Data	2.0	1.6
MLR	1.2	6.6	4.3		2.0	1.8
SMR	1.1	5.3	3.3		1.2	1.4
WEE 1.2	1.3	2.4	3.8		2.3	1.8
WEE 2.2	1.3	3.1	3.6		6.0	1.4
WFF	1.0	5.4	3.8		2.0	1.2
WSS	1.1	4.4	3.3		2.2	1.7

LOCATION CODE	Ra-226 (E-16)	Ra-228 (E-15)	Th-228 (E-16)	U-233 (E-17)	U-234 (E-16)	U-235 E-17)
CBD	1.9	4.4	2.0	0.0	1.4	9.8
EUN	3.3	8.0	2.0	2.8	6.8	6.7
MLR	9.8	1.0	5.2	0.0	1.0	2.5
SMR	1.6	1.5	1.9	9.2	-1.8	-2.2
WEE 1.2	1.1	2.0	9.2	0.0	8.9	0.0
WEE 2.2	3.1	4.7	1.4	6.0	9.7	0.0
WFF	1.2	1.7	1.4	0.0	1.2	9.8
WSS	2.1	2.5	4.1	5.9	7.1	0.0

LOCATION CODE	U-238 (E-17)	Pu-238 (E-15)	Pu-239/240 (E-17)	Pu-241 (E-15)	(E-14)	(E-17)
CBD	-1.2	-3.9	1.7	-3.5		
EUN	6.2	-3.5	3.3	-5.2		
MLR	4.0	6.5	-1.5	5.8		
SMR	-1.1	-1.8	7.6	-3.3		
WEE 1.2	6.9	-4.2	8.5	3.2		
WEE 2.2	1.8	-3.7	5.5	-6.6		
WFF	2.0	1.0	6.6	4.9		
WSS	6.9	-6.2	1.0	1.2		

Background Gamma Radiation for 1989

JANUARY 1989



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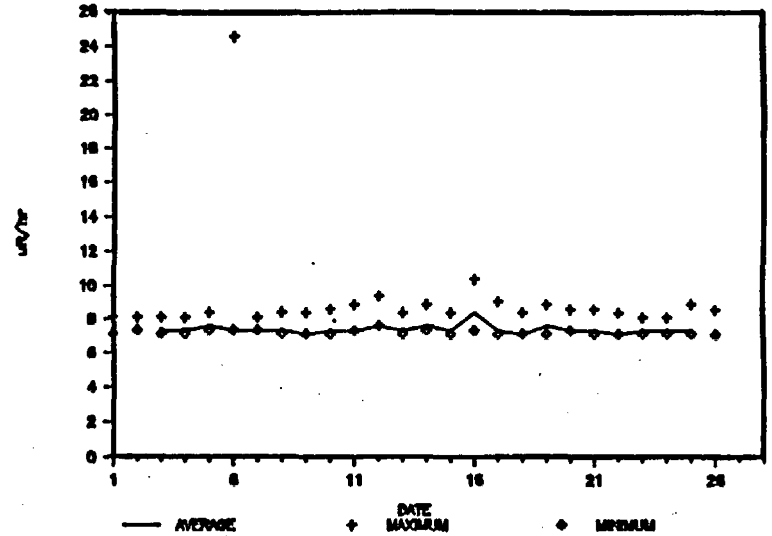
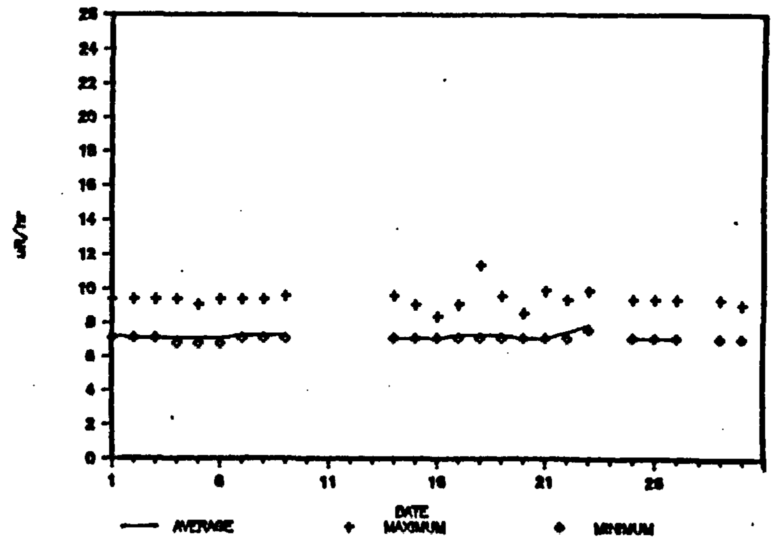
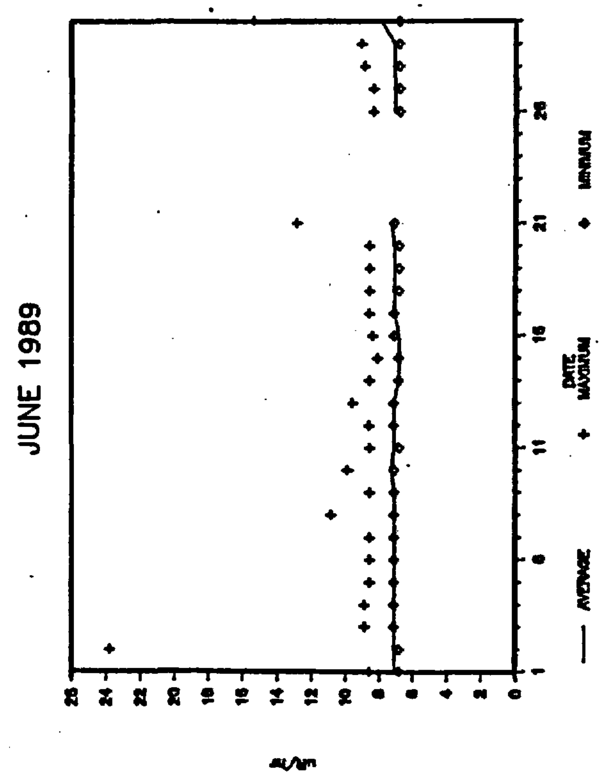


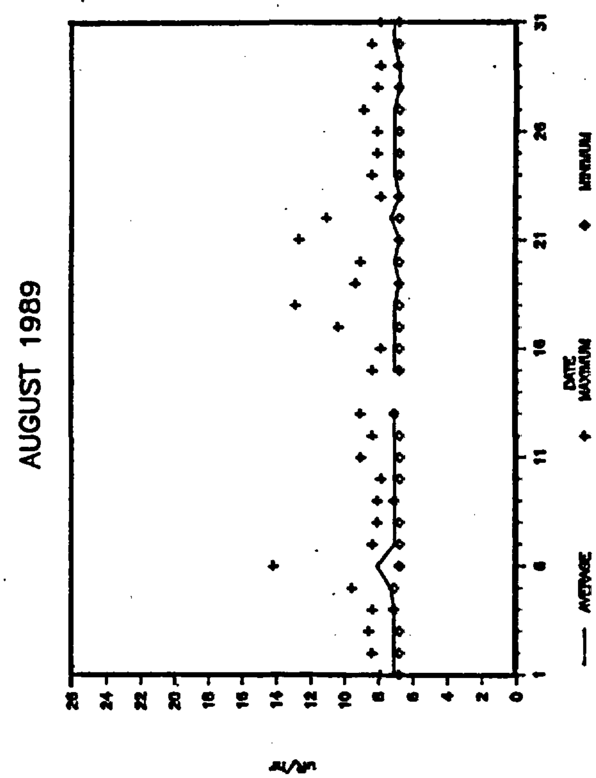
MARCH DATA INCOMPLETE
FOR MONTHLY SUMMARY

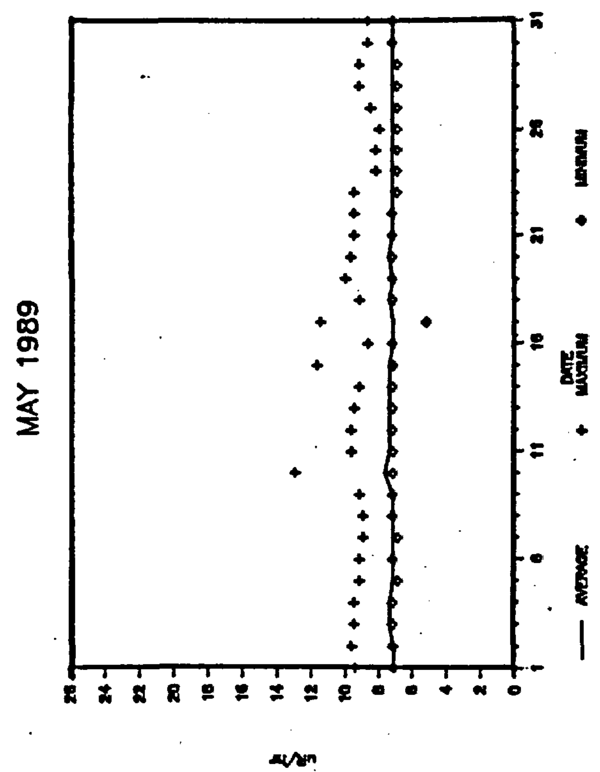
APRIL 1989

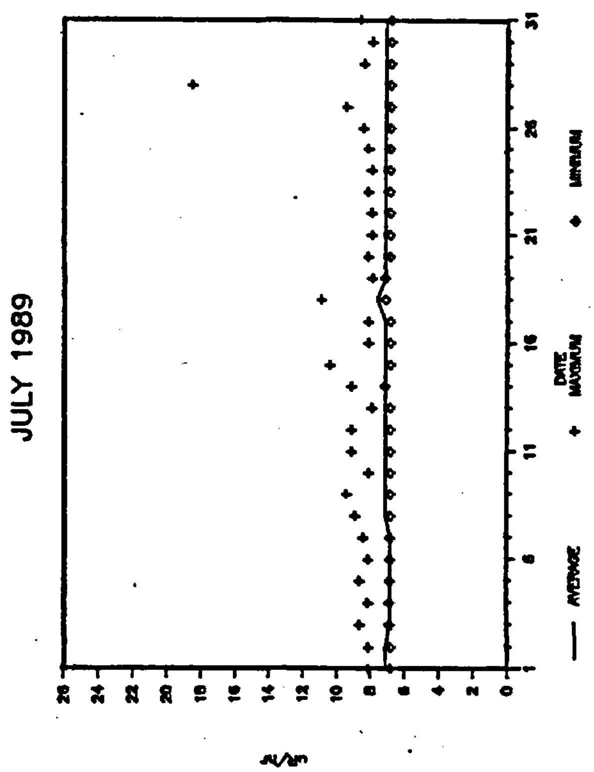


Background Gamma Radiation for 1989





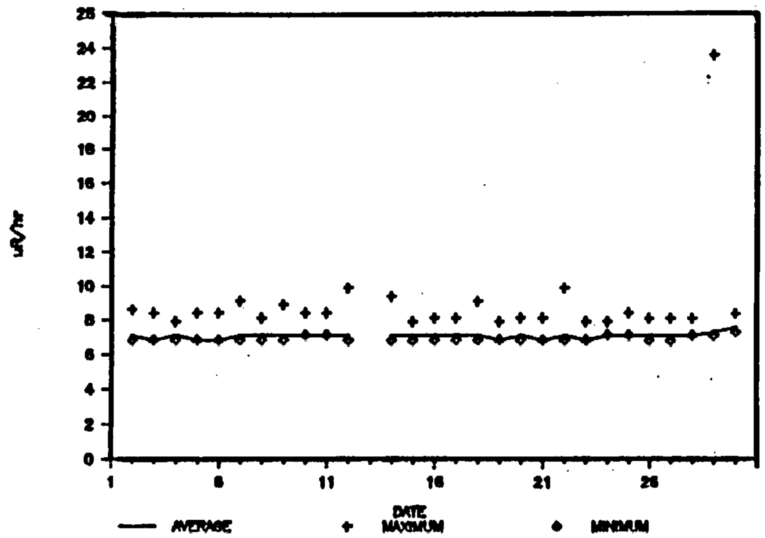




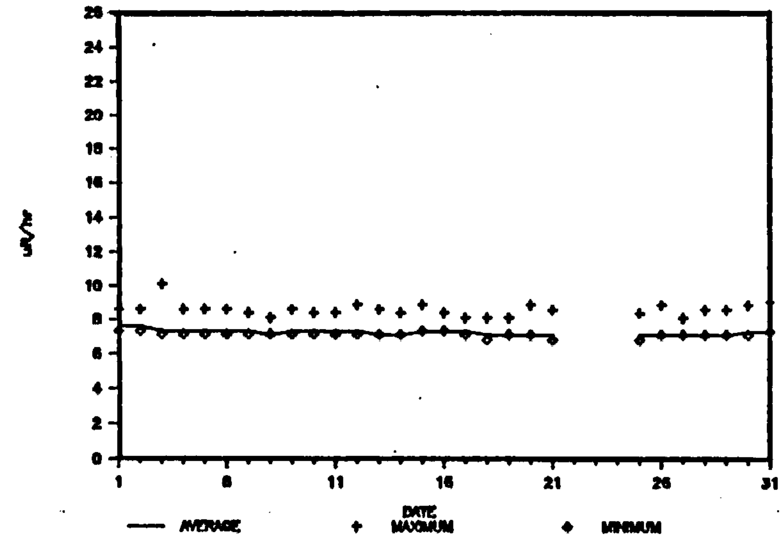
APPENDIX V

Background Gamma Radiation for 1989

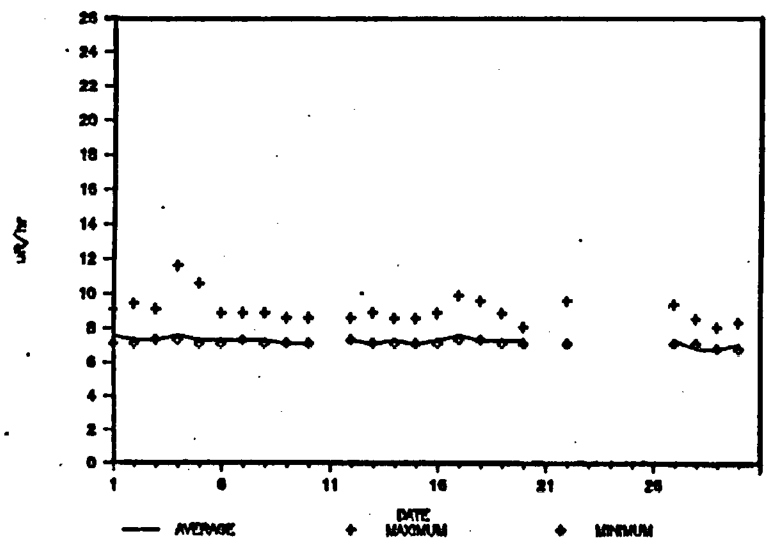
SEPTEMBER 1989



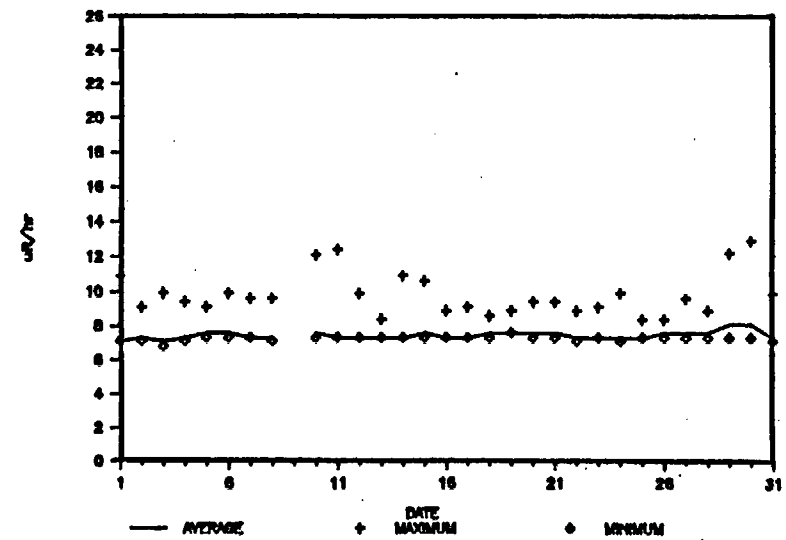
OCTOBER 1989



NOVEMBER 1989



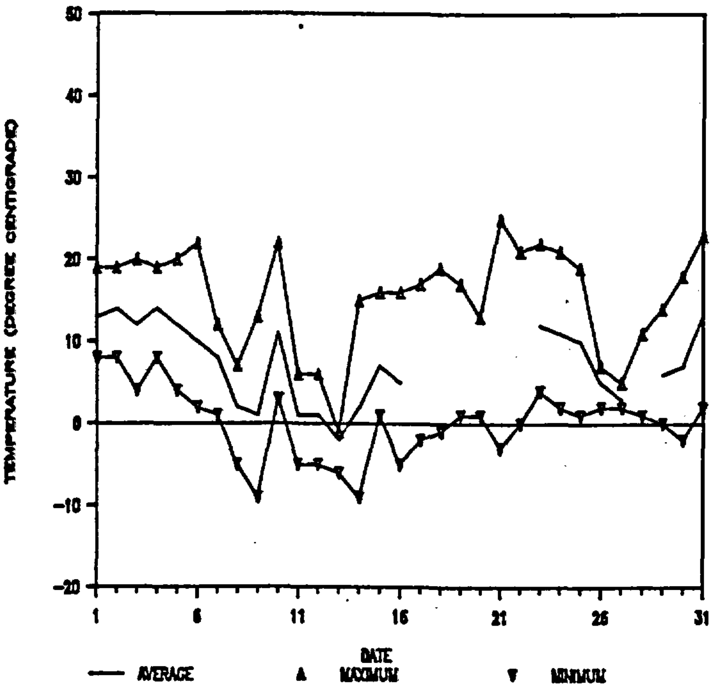
DECEMBER 1989



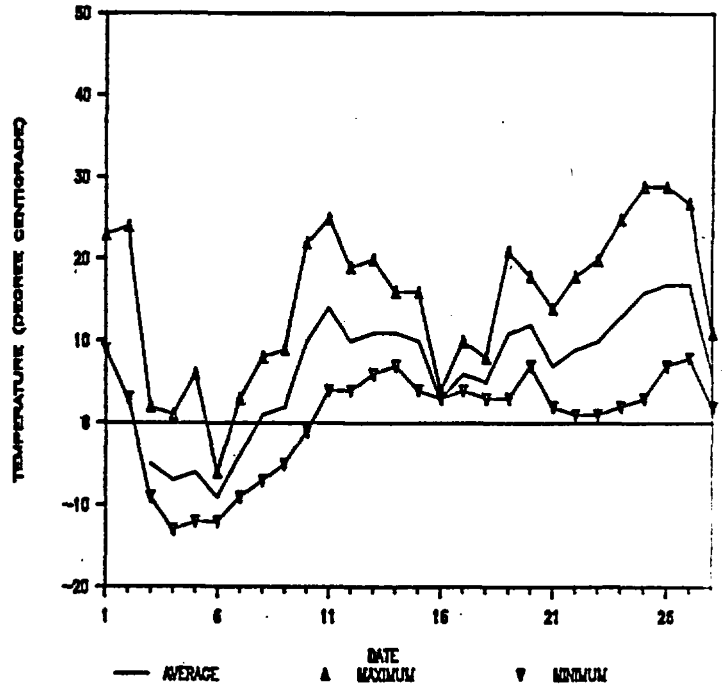
APPENDIX VI

Daily Maximum, Minimum, and Average Temperature

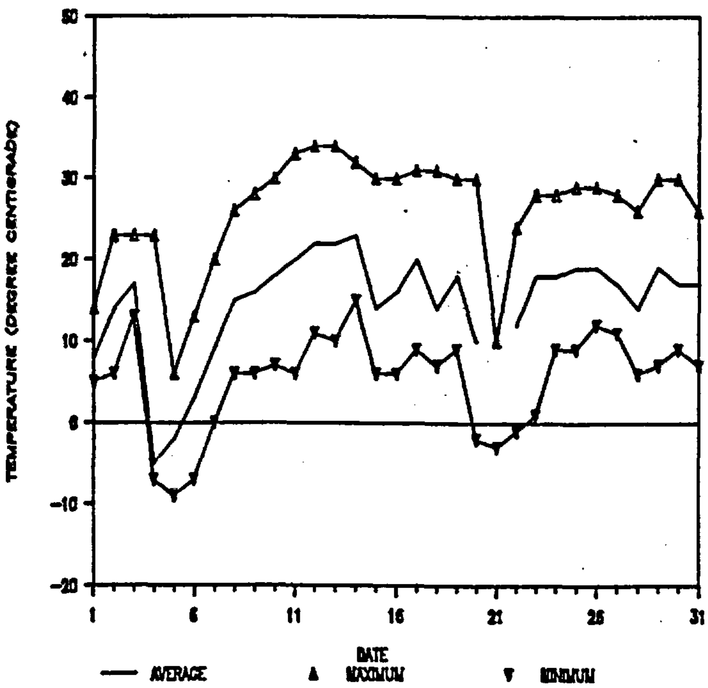
JANUARY 1989



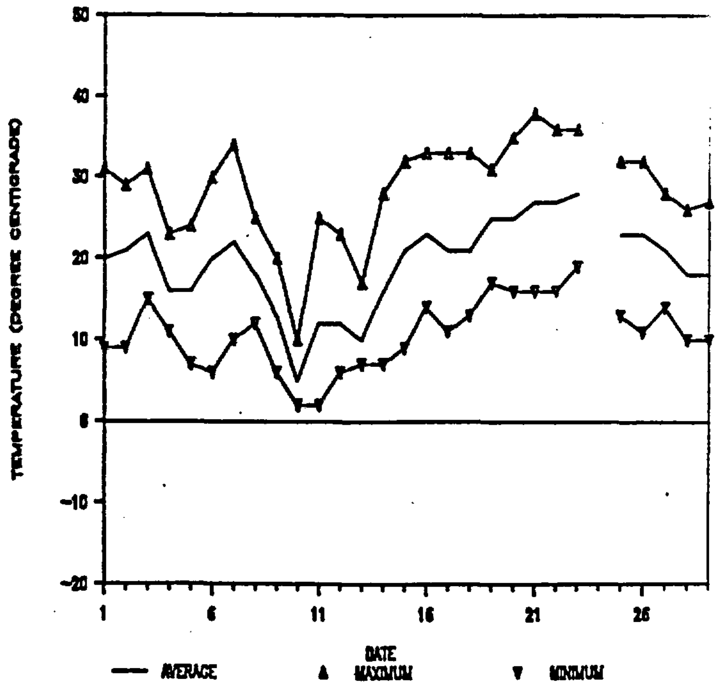
FEBRUARY 1989



MARCH 1989



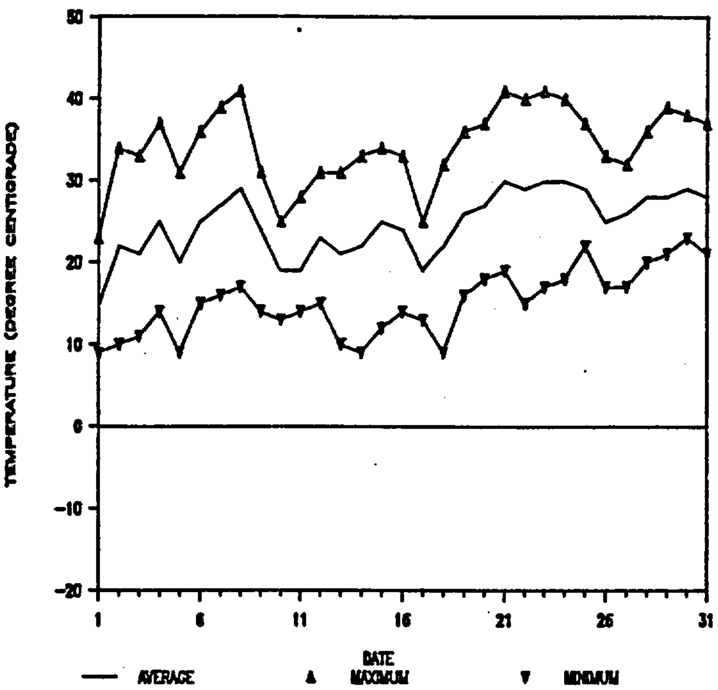
APRIL 1989



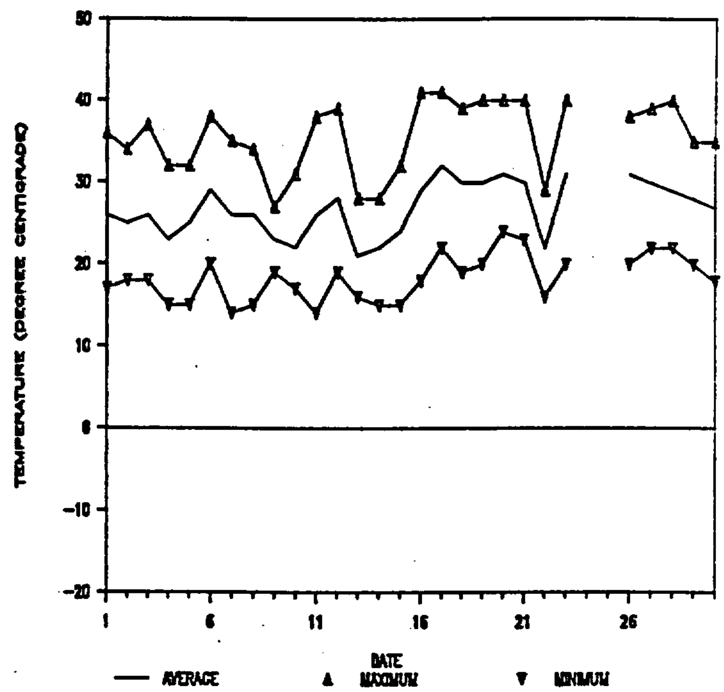
APPENDIX VI

Daily Maximum, Minimum, and Average Temperature

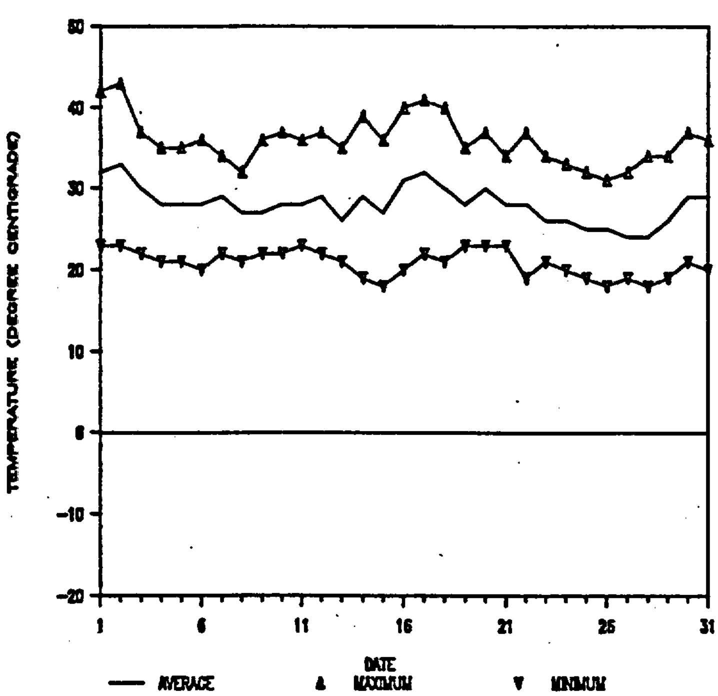
MAY 1989



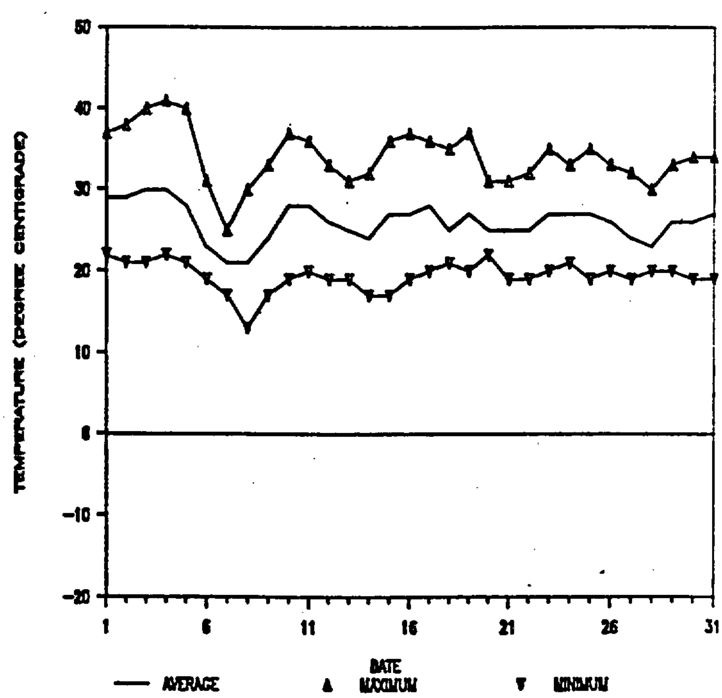
JUNE 1989



JULY 1989

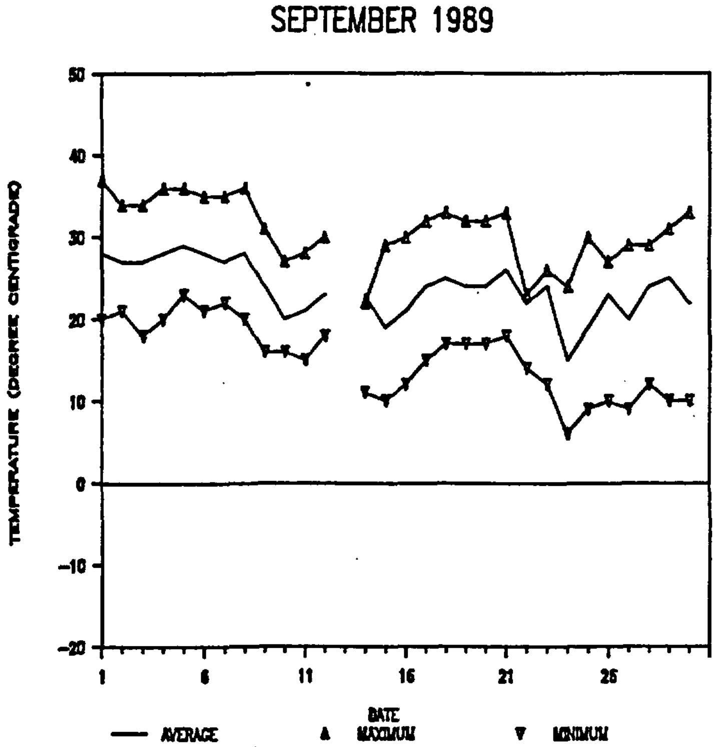


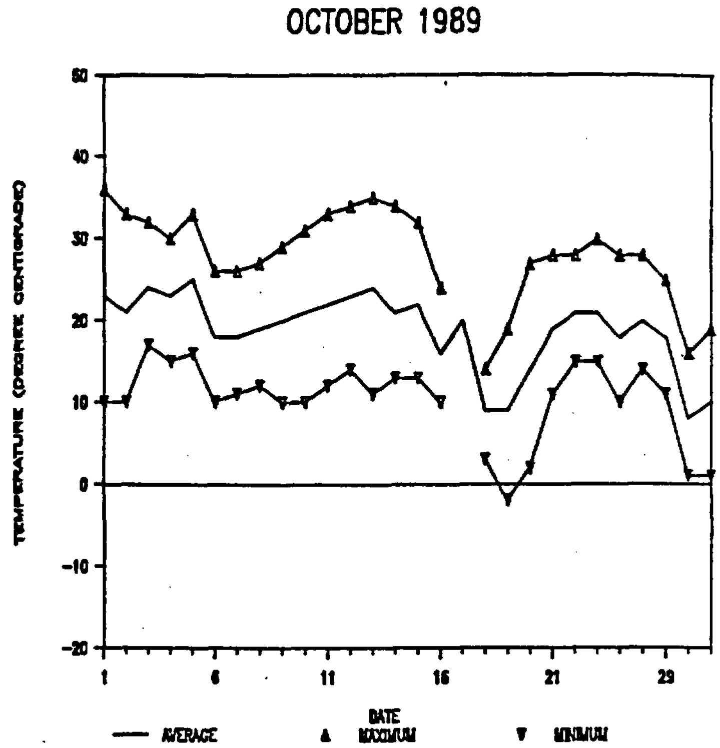
AUGUST 1989

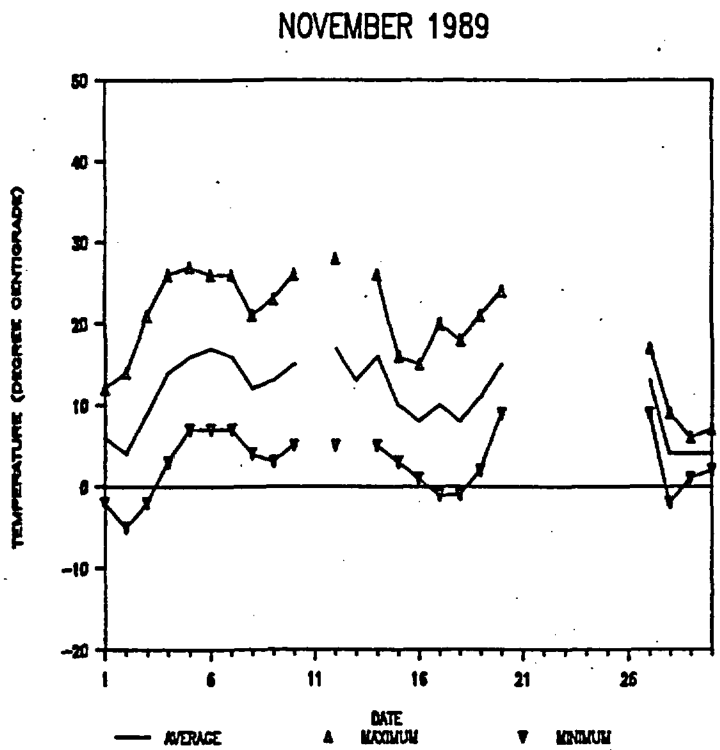


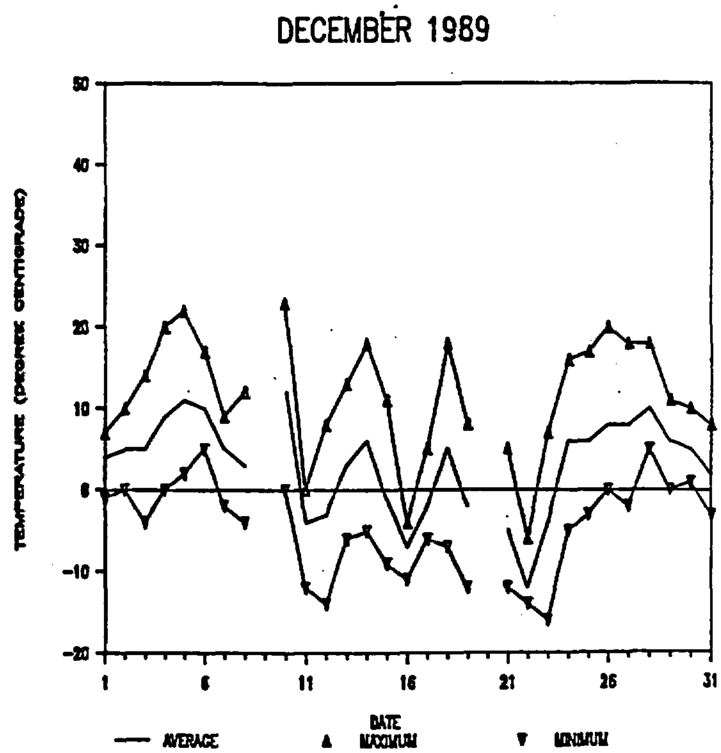
APPENDIX VI

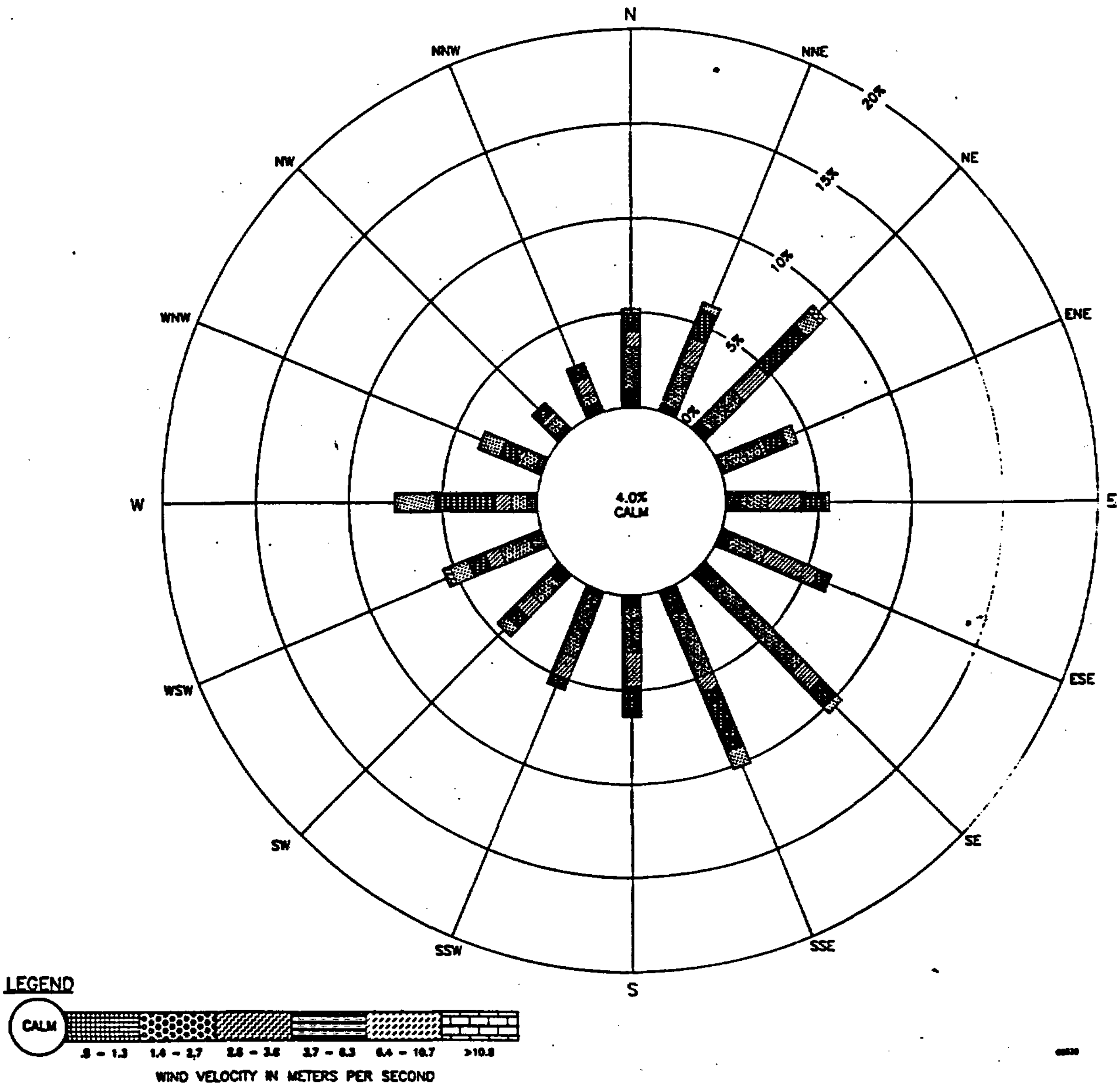
Daily Maximum, Minimum, and Average Temperature





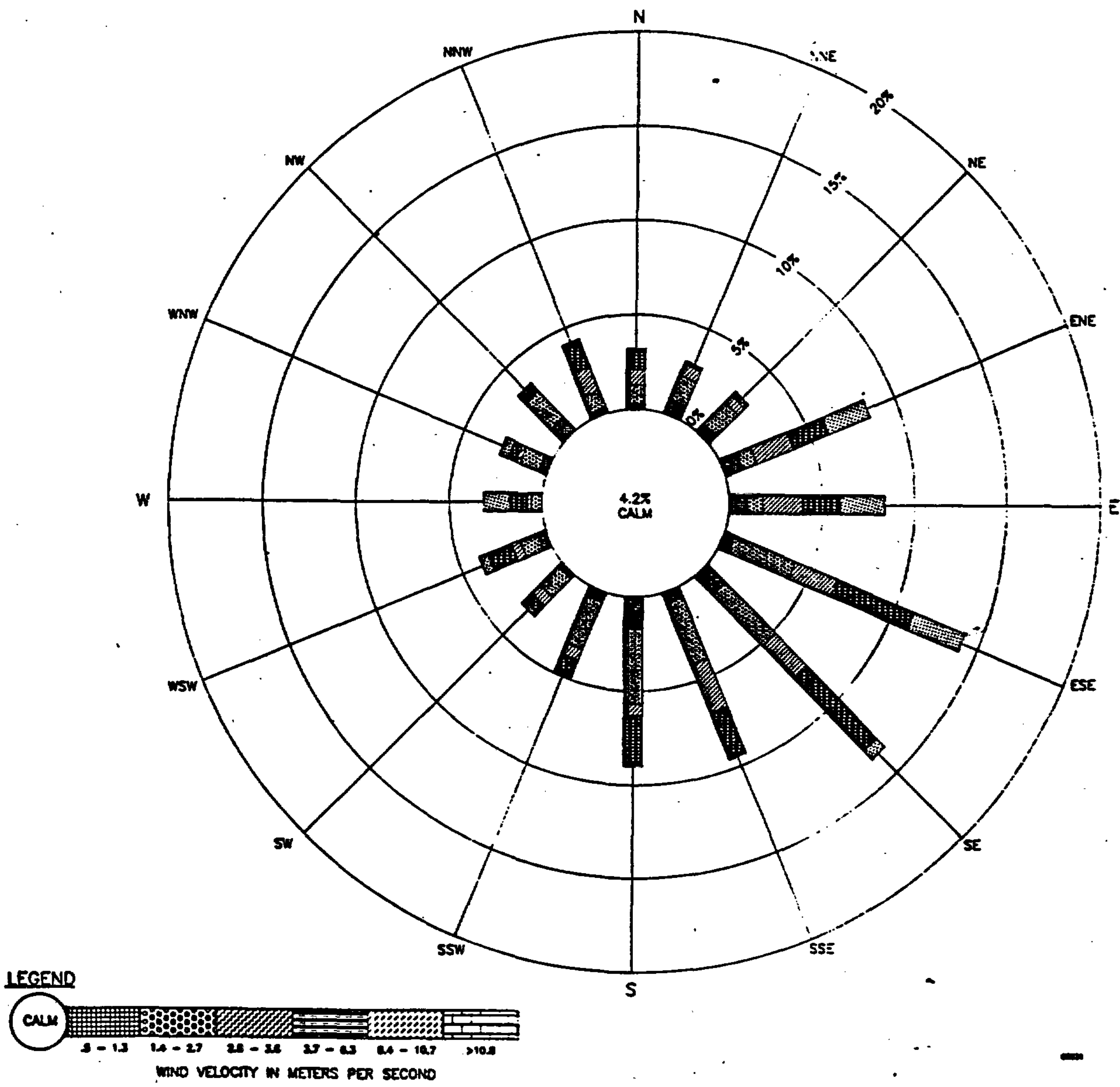






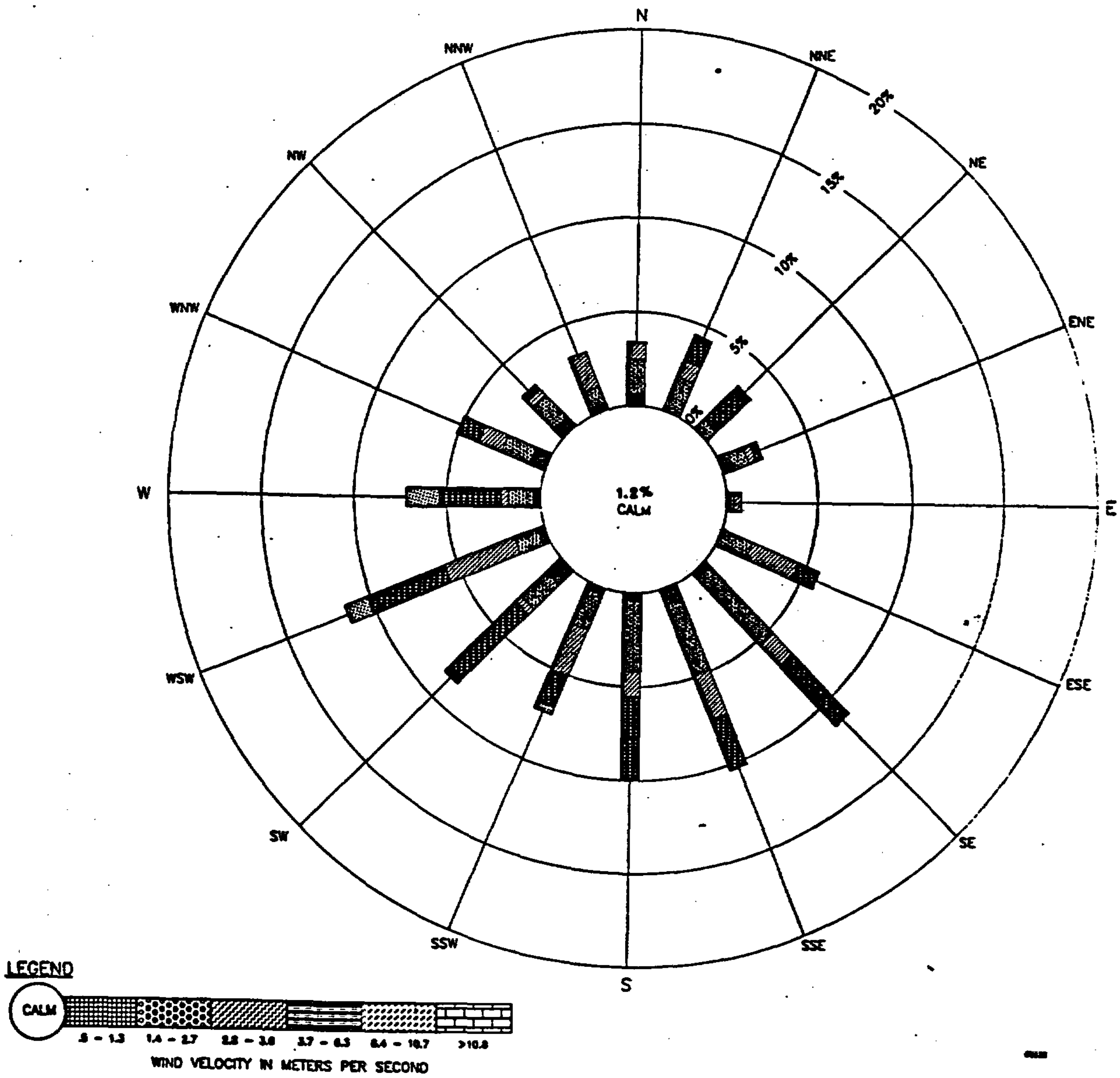
1989 MONTHLY WINDROSE
MONTH OF JANUARY

GG630



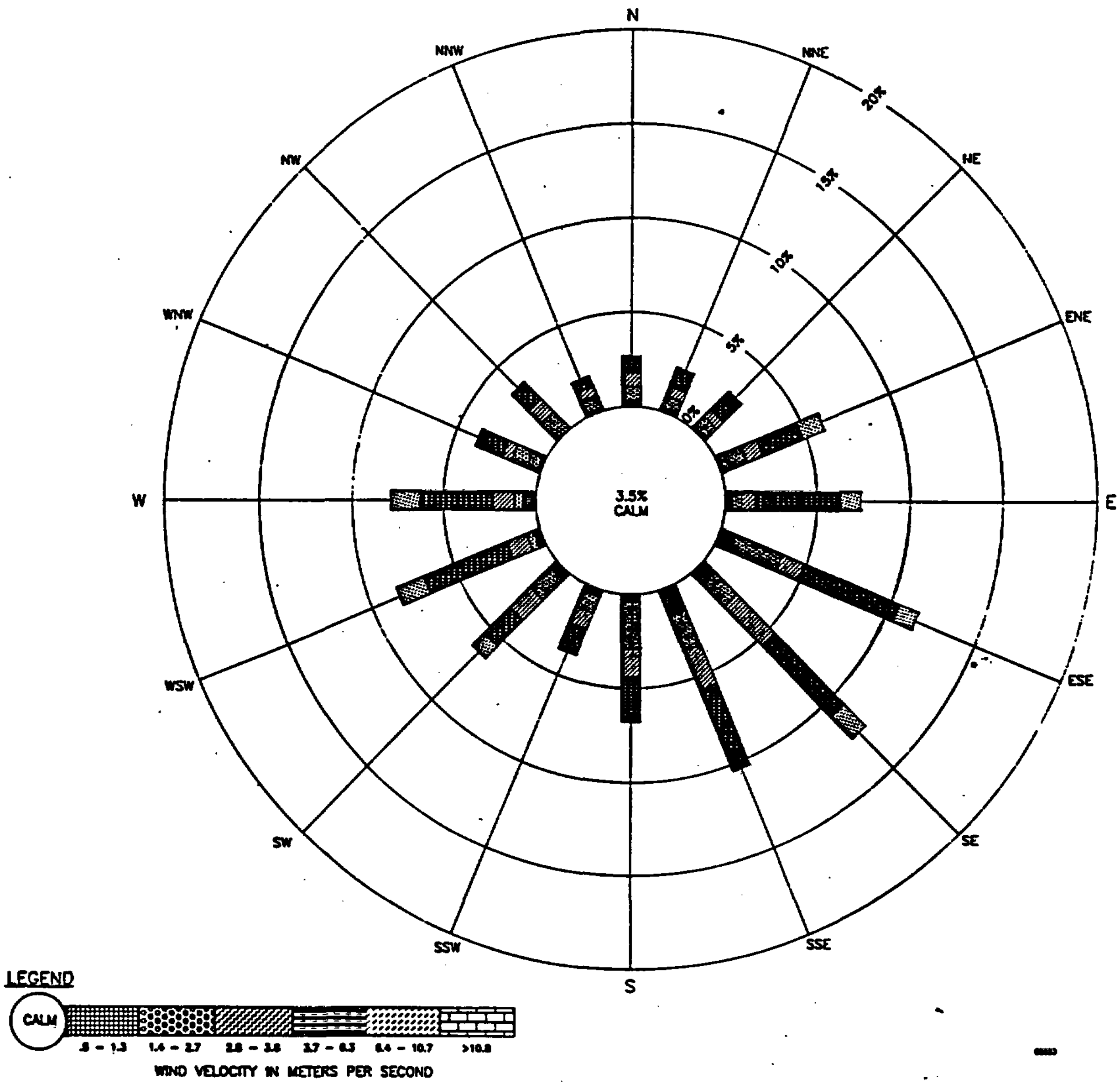
1989 MONTHLY WINDROSE
MONTH OF FEBRUARY

GG631



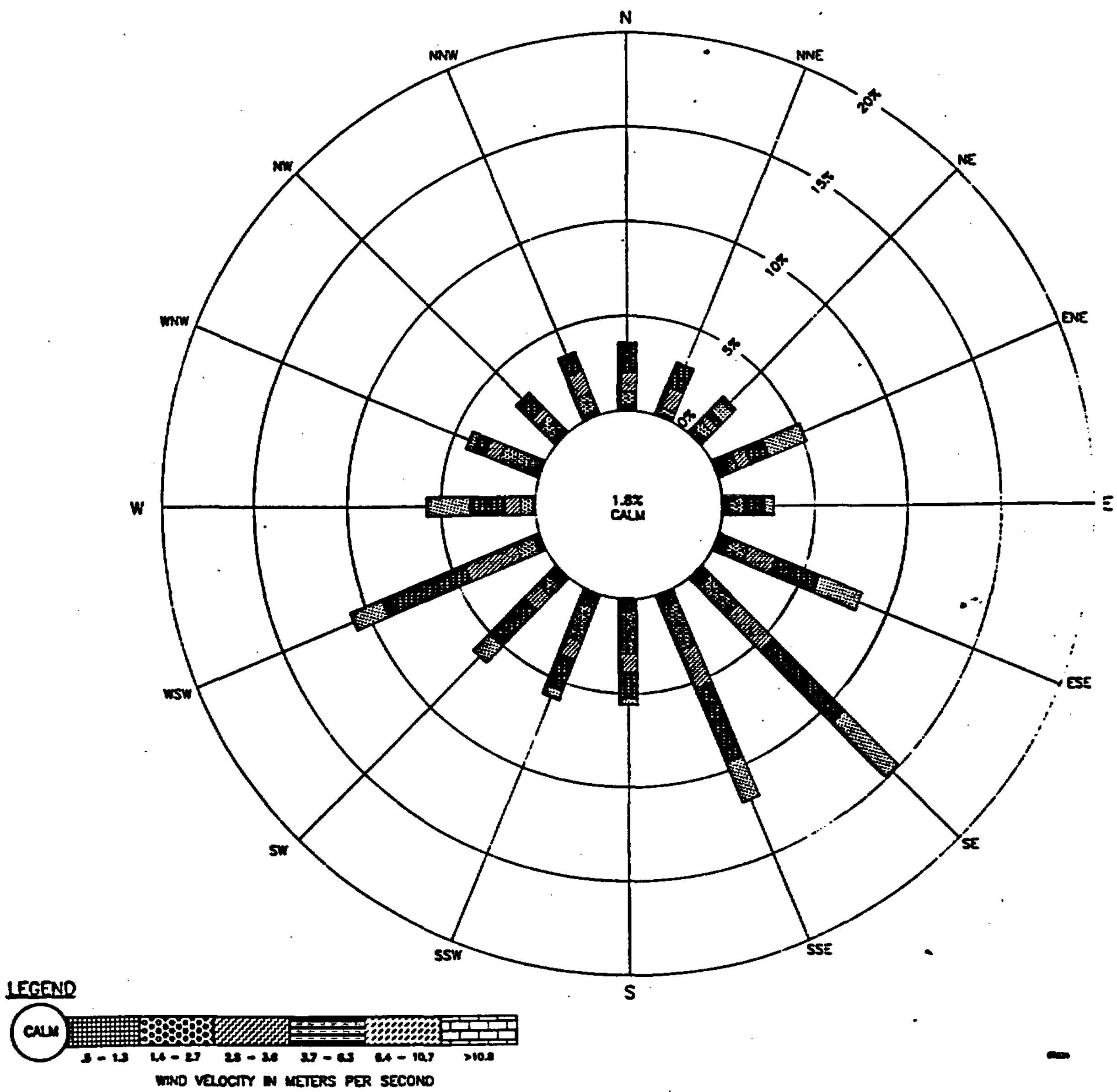
1989 MONTHLY WINDROSE
MONTH OF MARCH

GG632



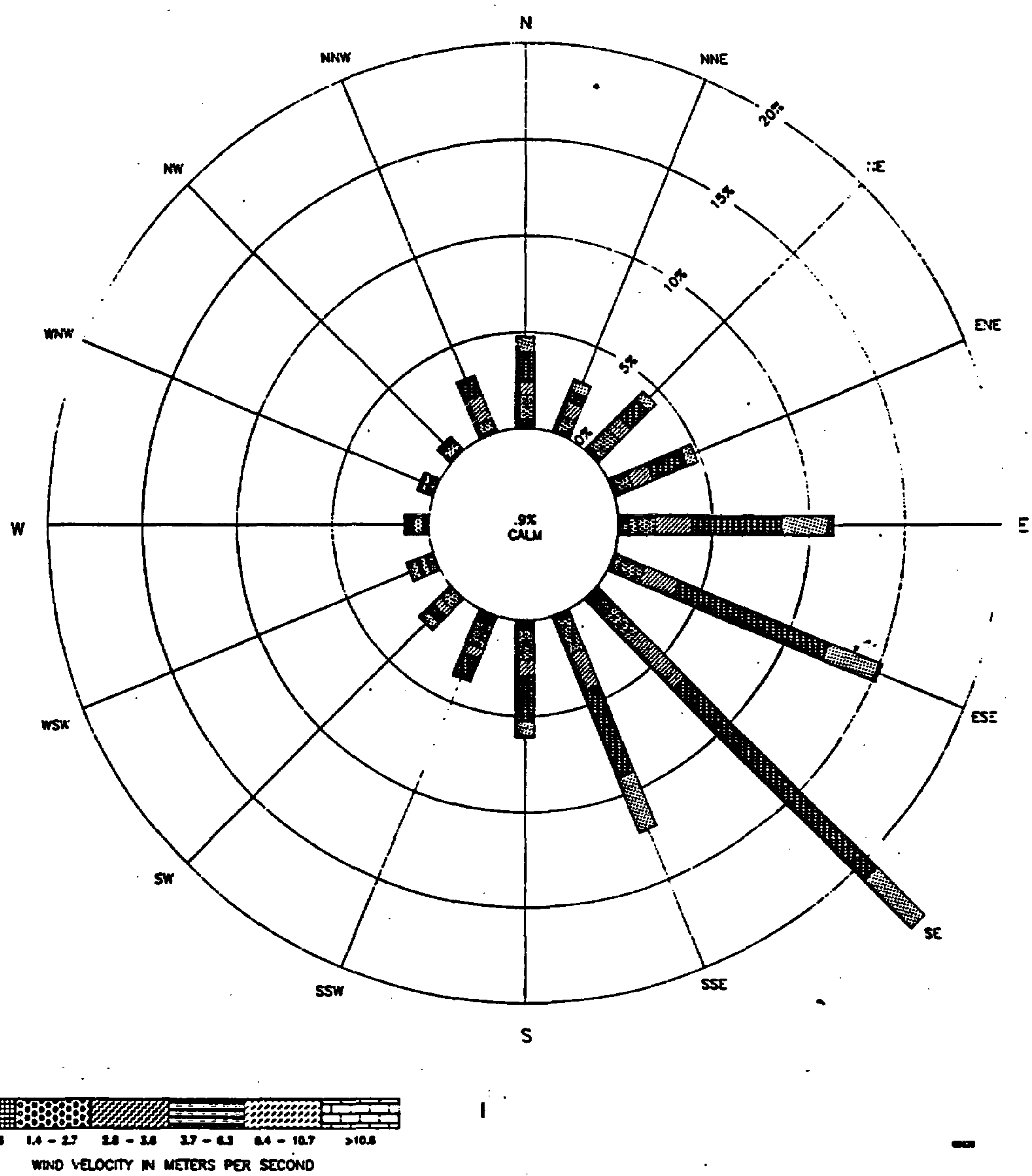
1989 MONTHLY WINDROSE
MONTH OF APRIL

GG633



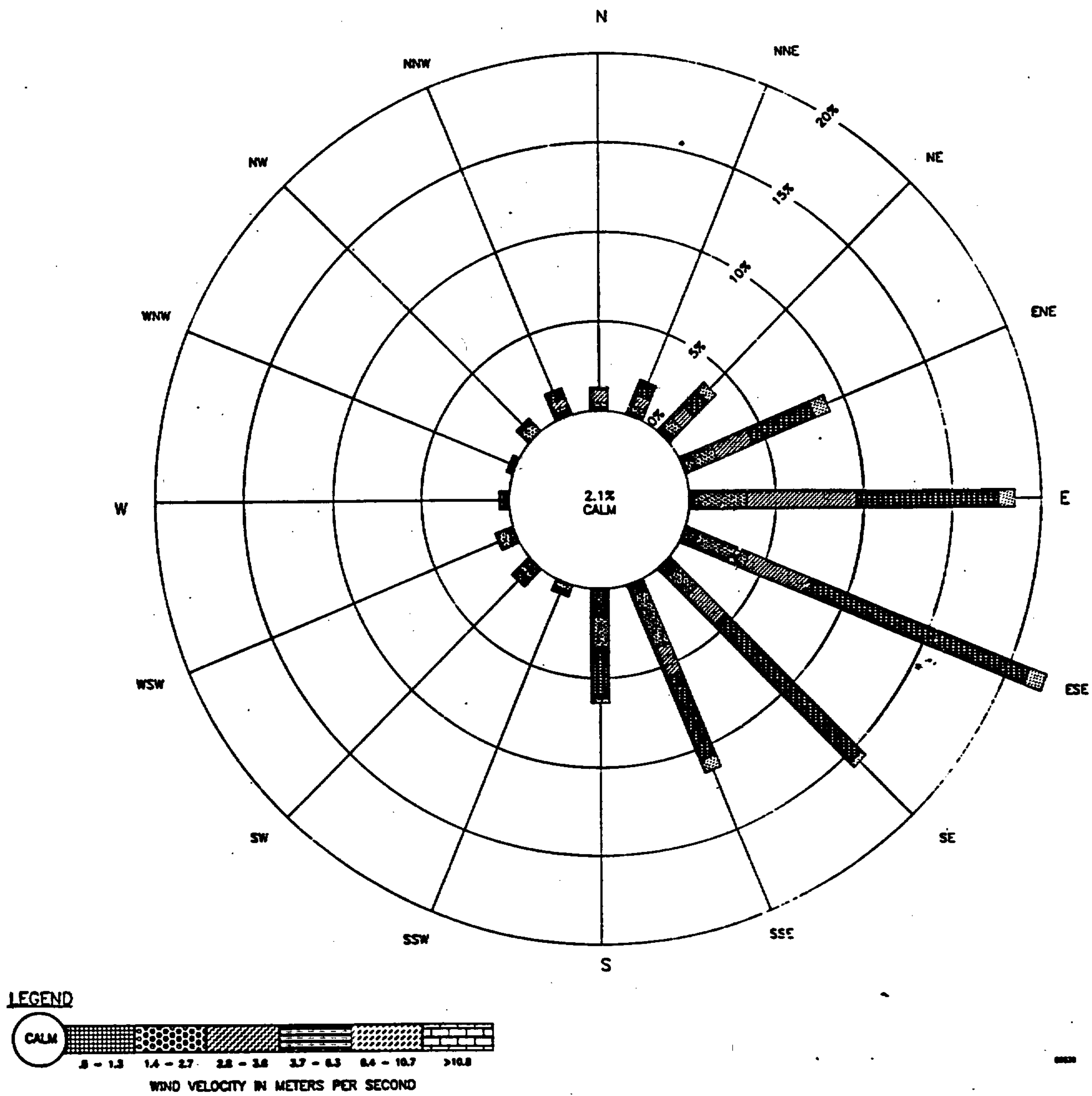
1989 MONTHLY WINDROSE
MONTH OF MAY

GG634



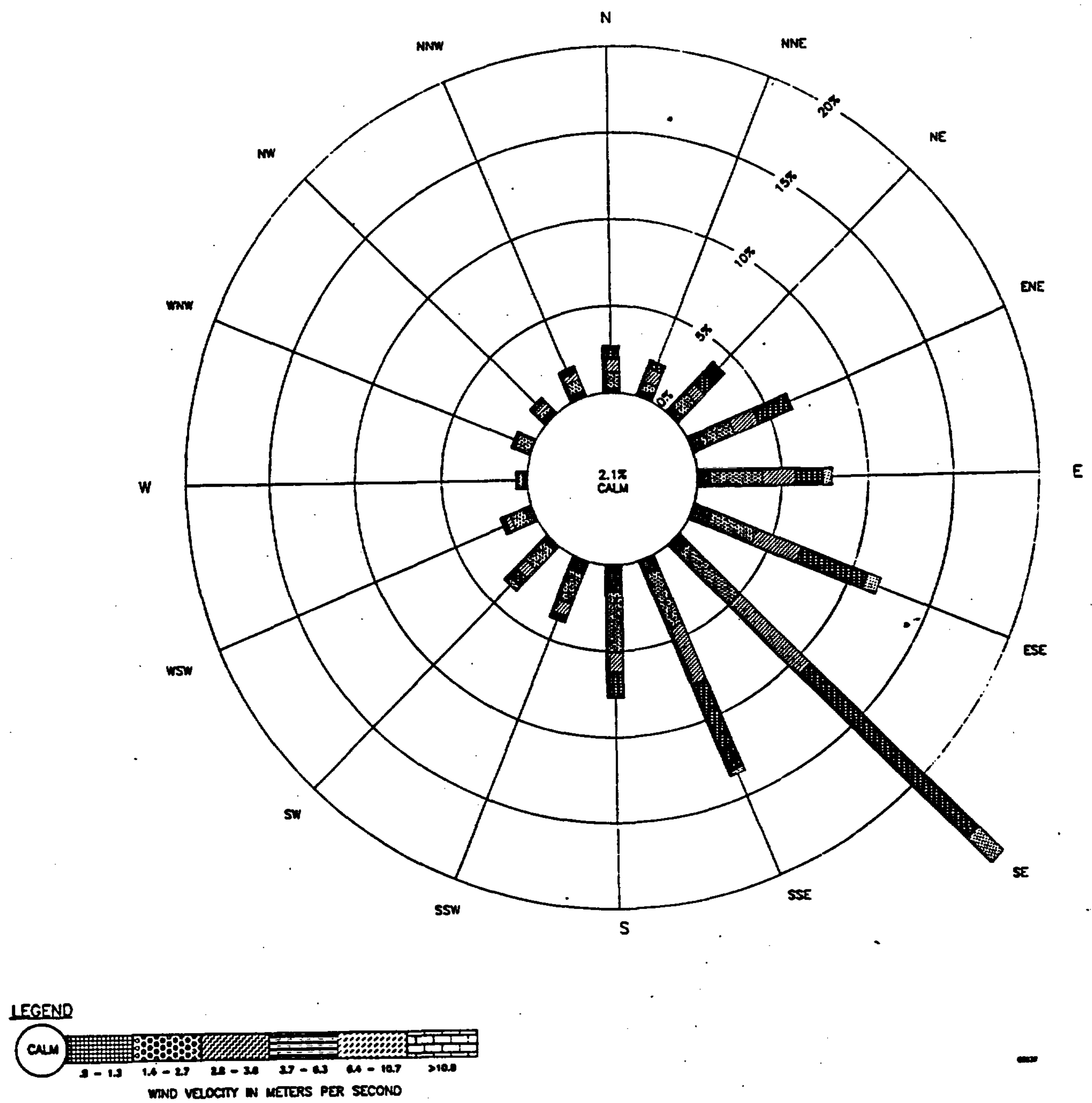
1989 MONTHLY WINDROSE
MONTH OF JUNE

GG635



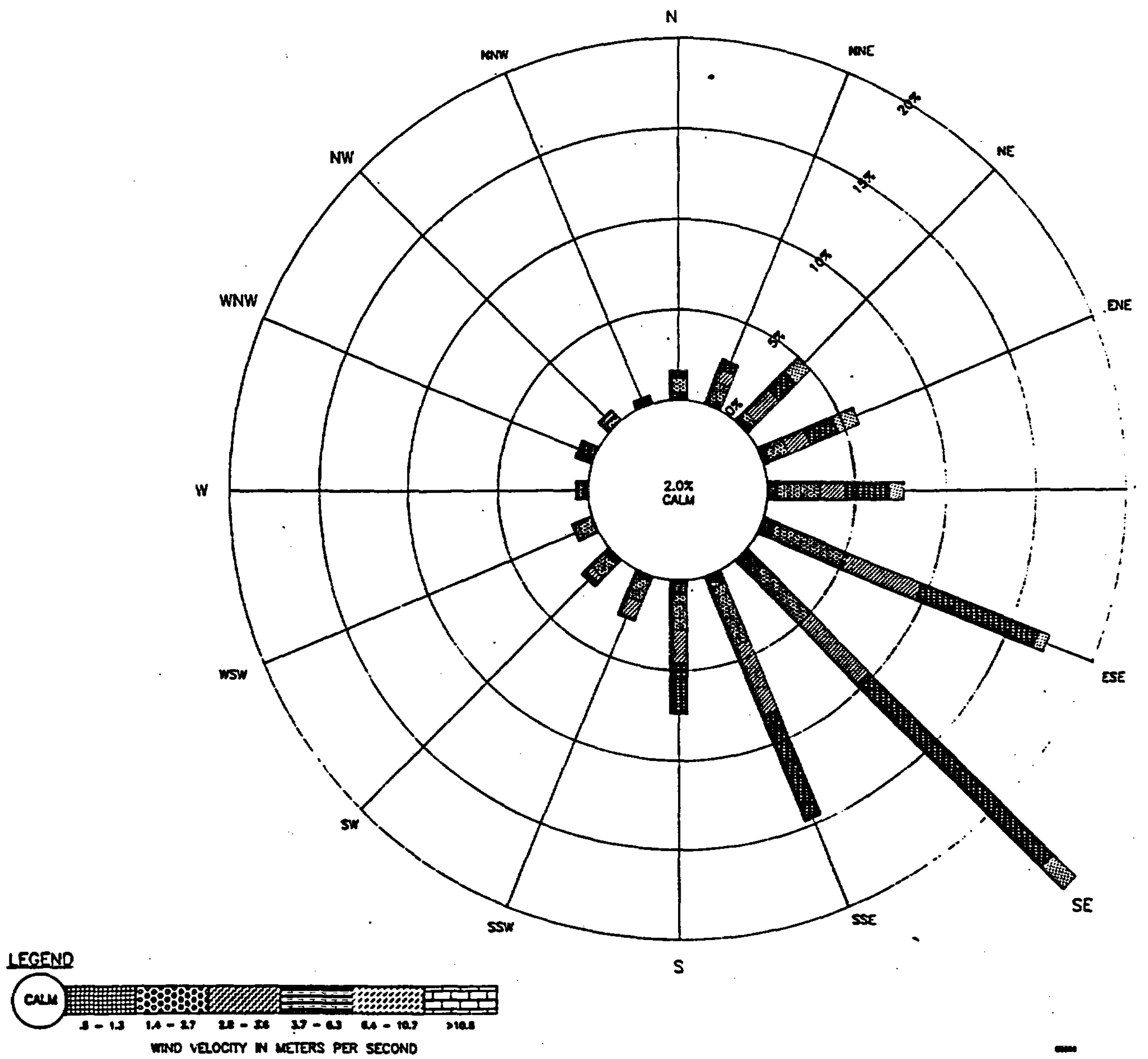
1989 MONTHLY WINDROSE
MONTH OF JULY

GG636



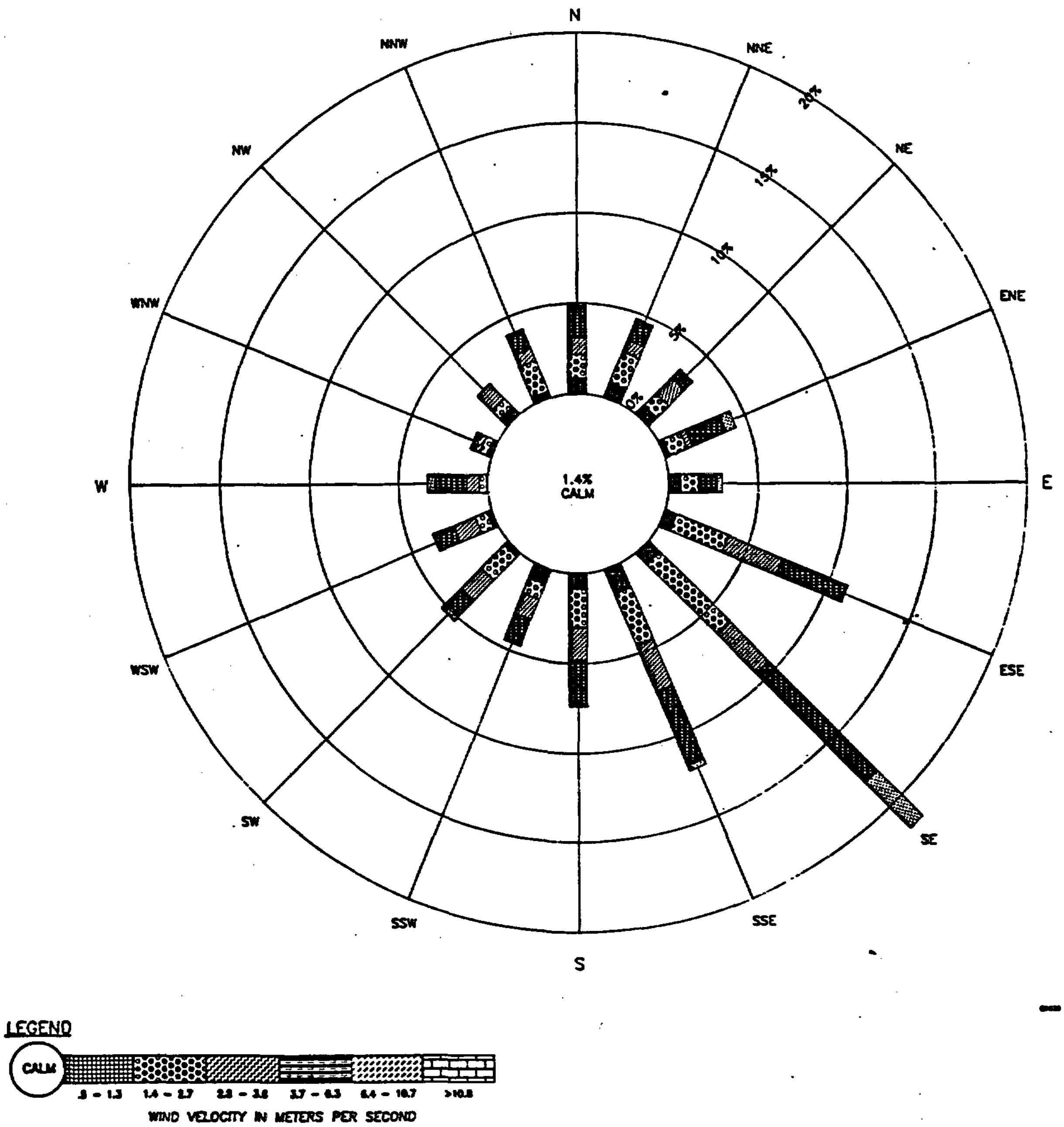
1989 MONTHLY WINDROSE
MONTH OF AUGUST

GG637



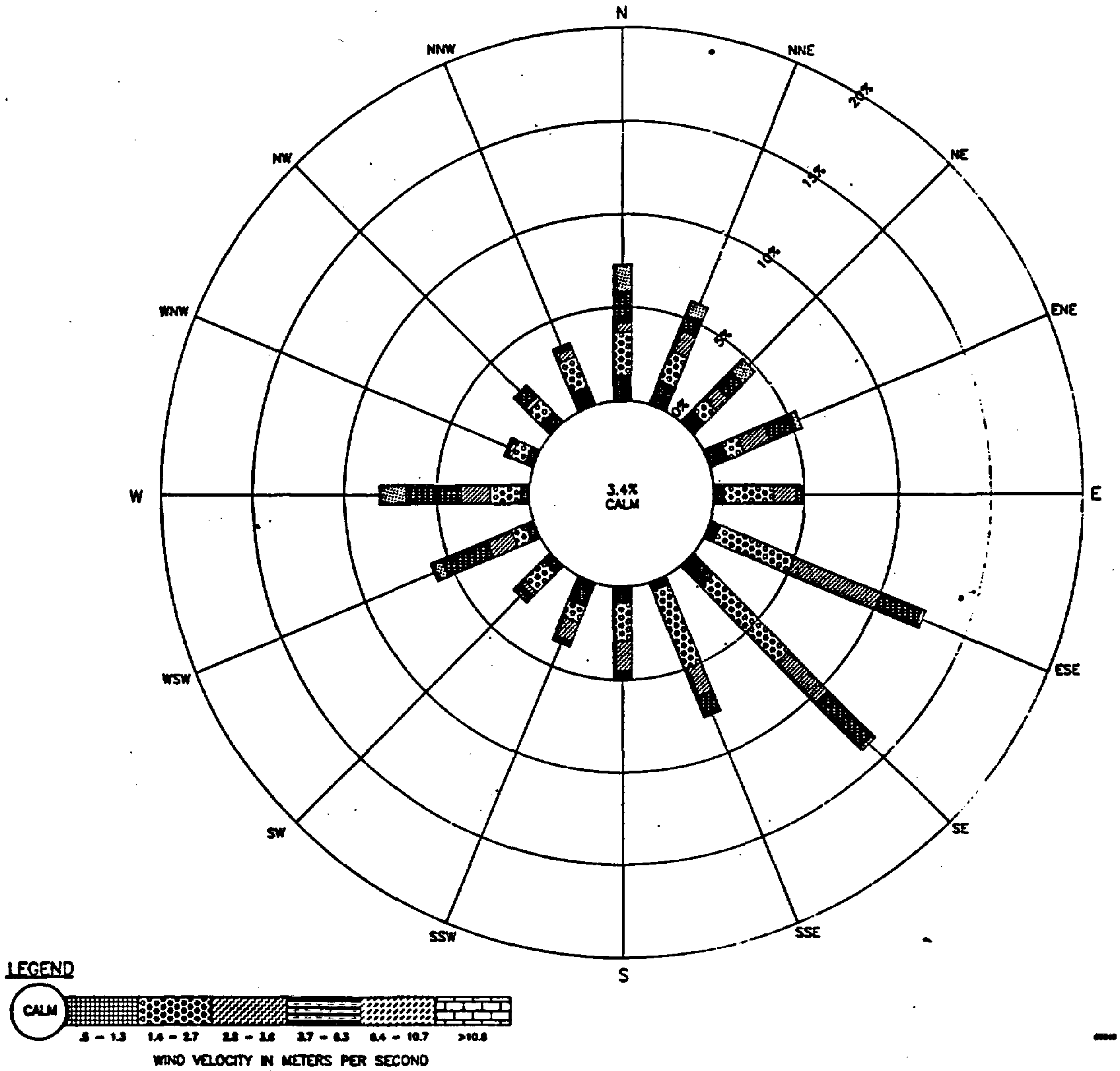
1989 MONTHLY WINDROSE
MONTH OF SEPTEMBER

GG638



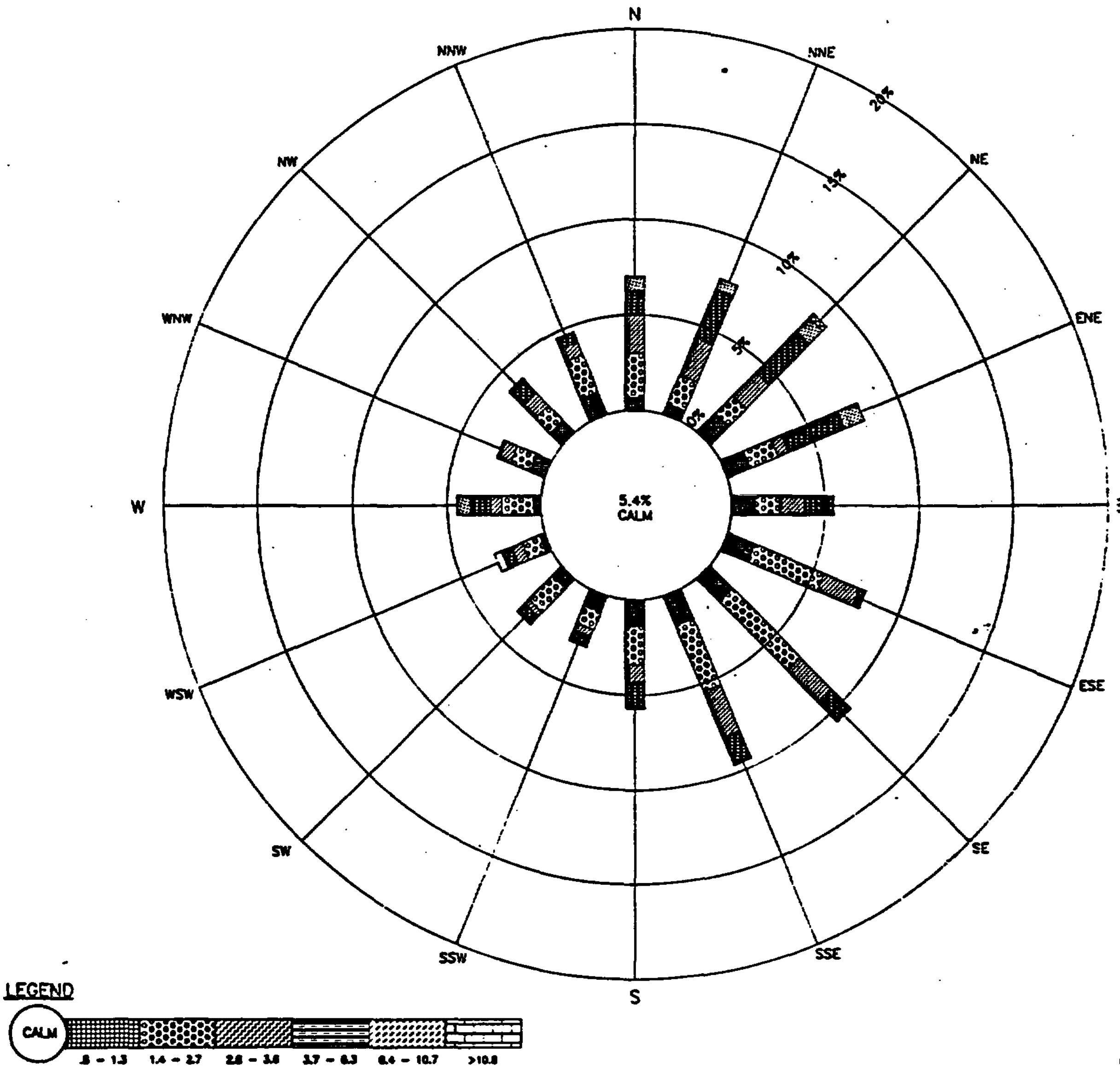
1989 MONTHLY WINDROSE
MONTH OF OCTOBER

GG639



1989 MONTHLY WINDROSE
MONTH OF NOVEMBER

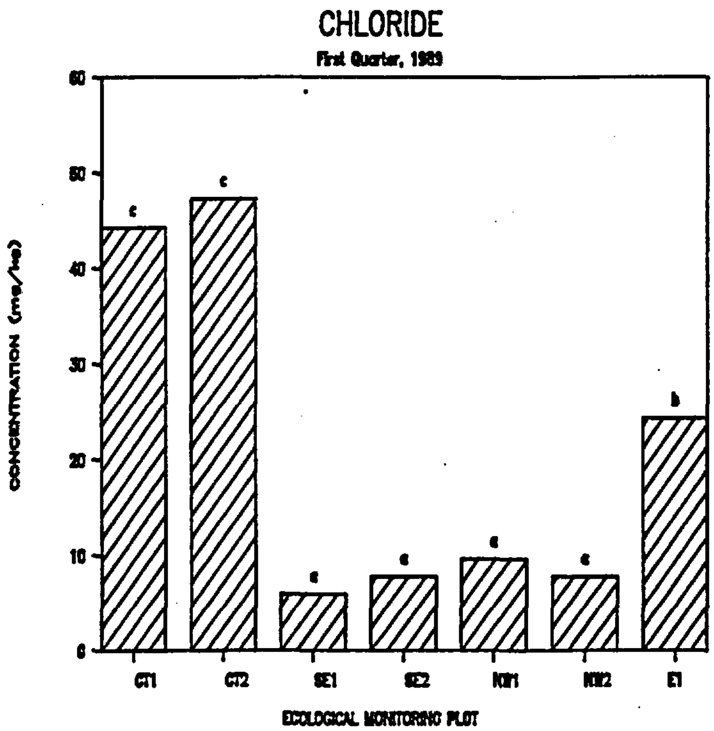
GG640

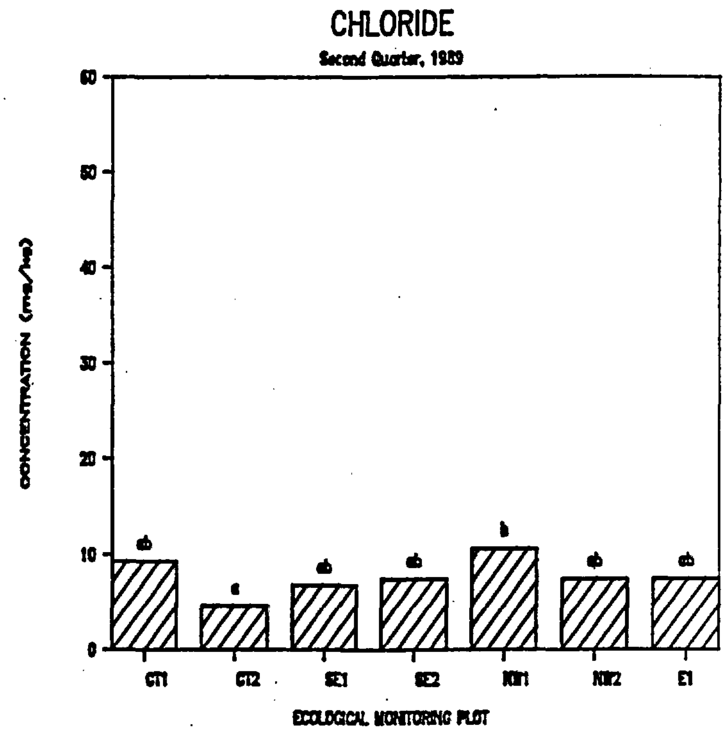


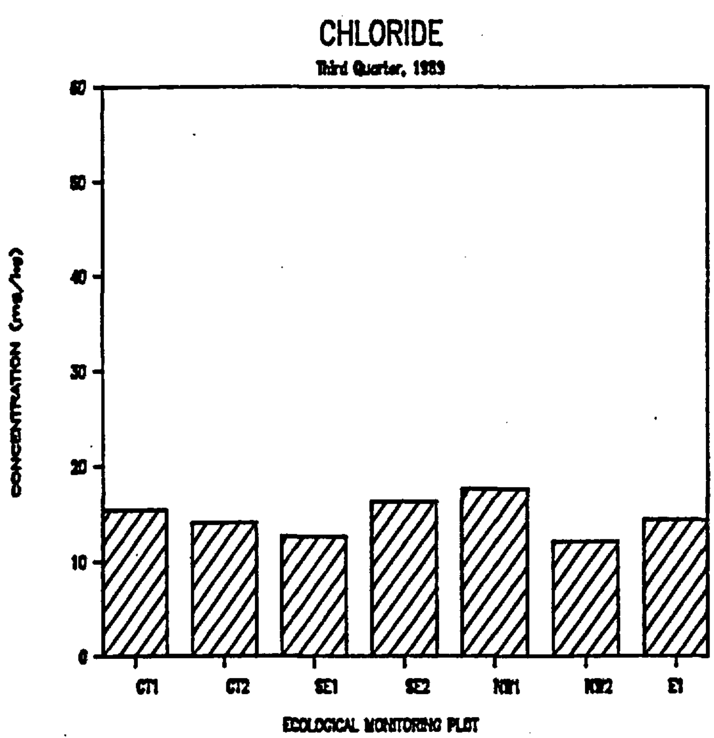
1989 MONTHLY WINDROSE
MONTH OF DECEMBER

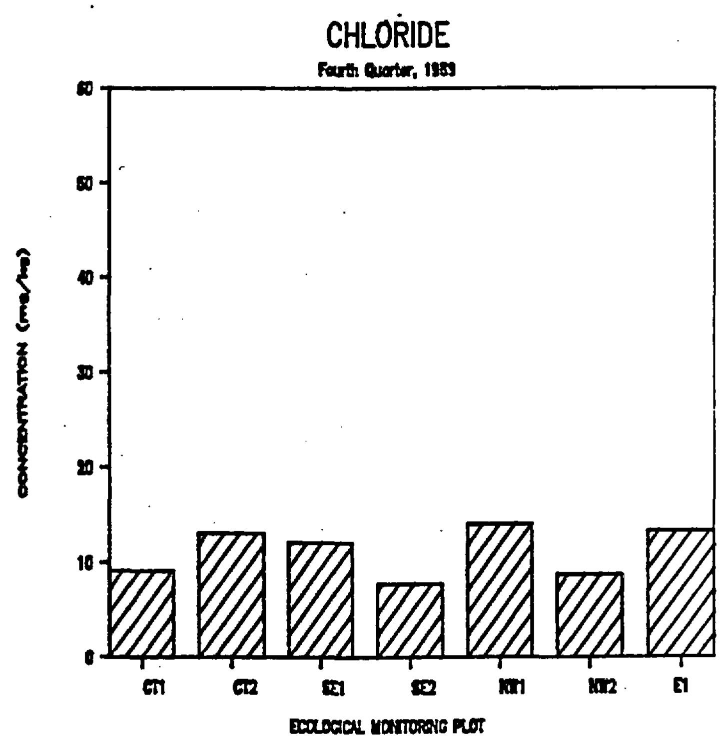
GG641

Soil Chemistry Parameters



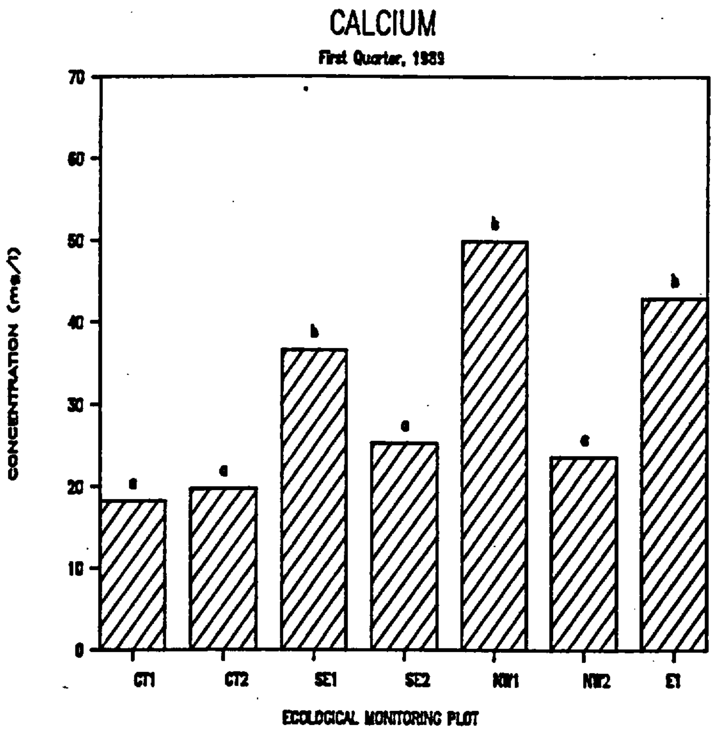


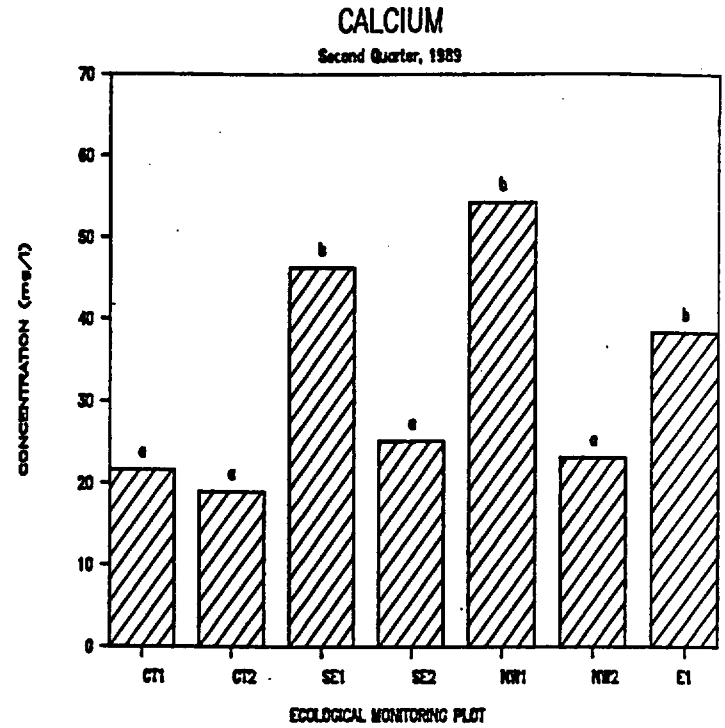


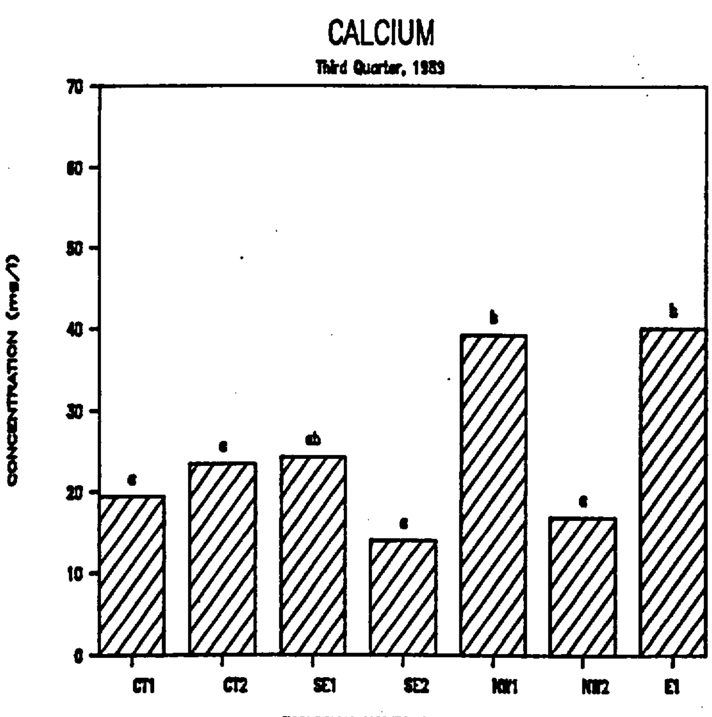


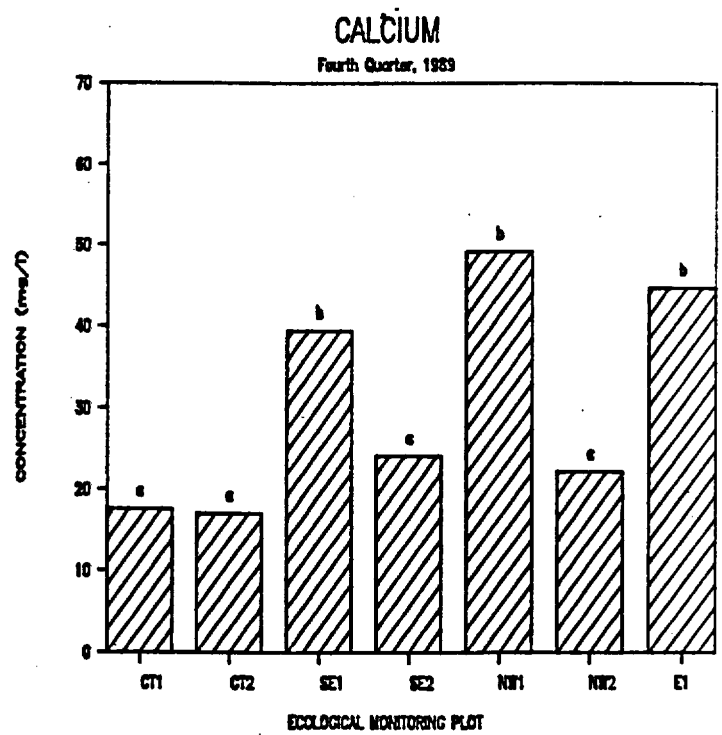
APPENDIX VIII

Soil Chemistry Parameters



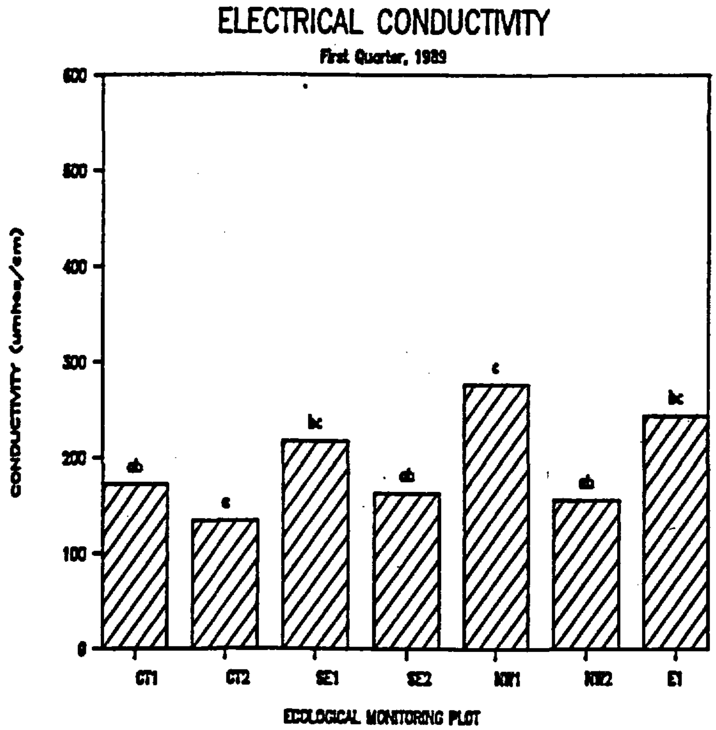


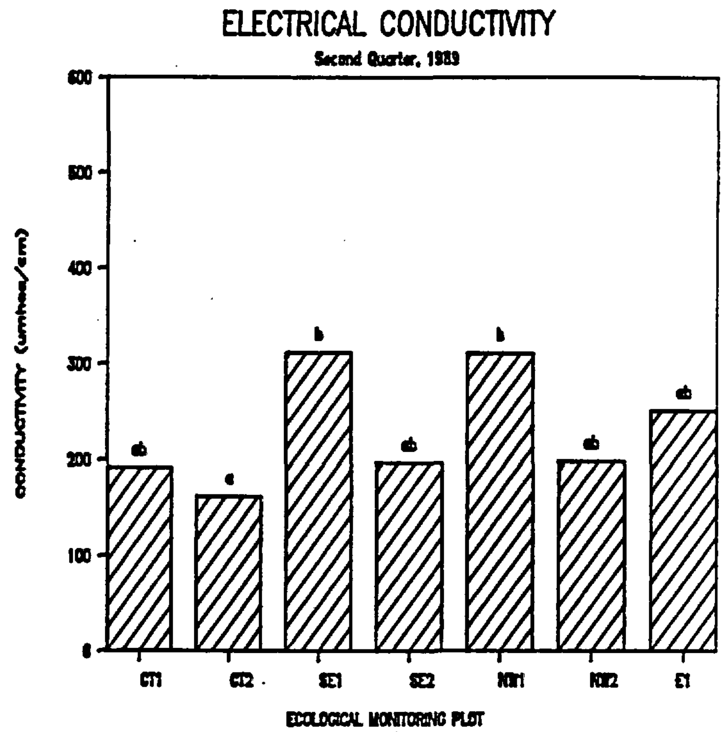


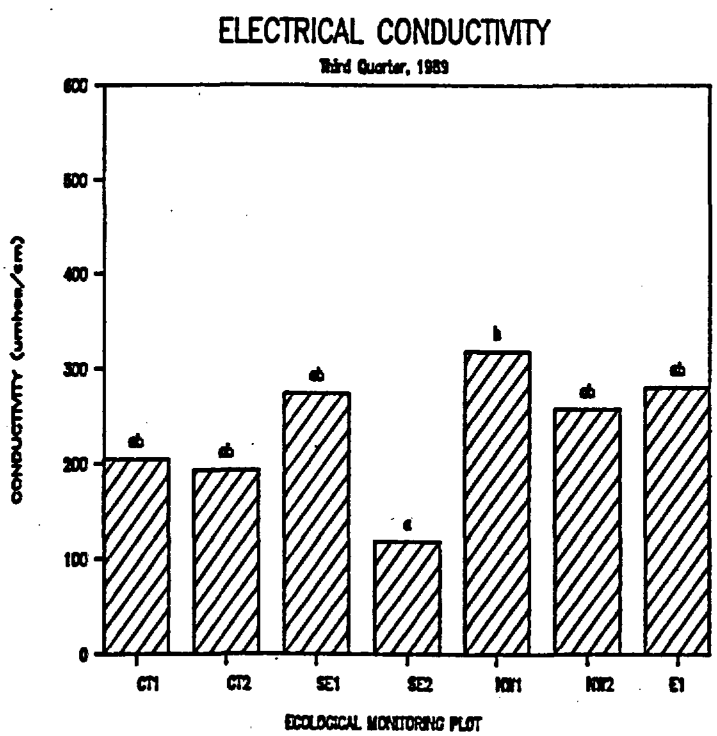


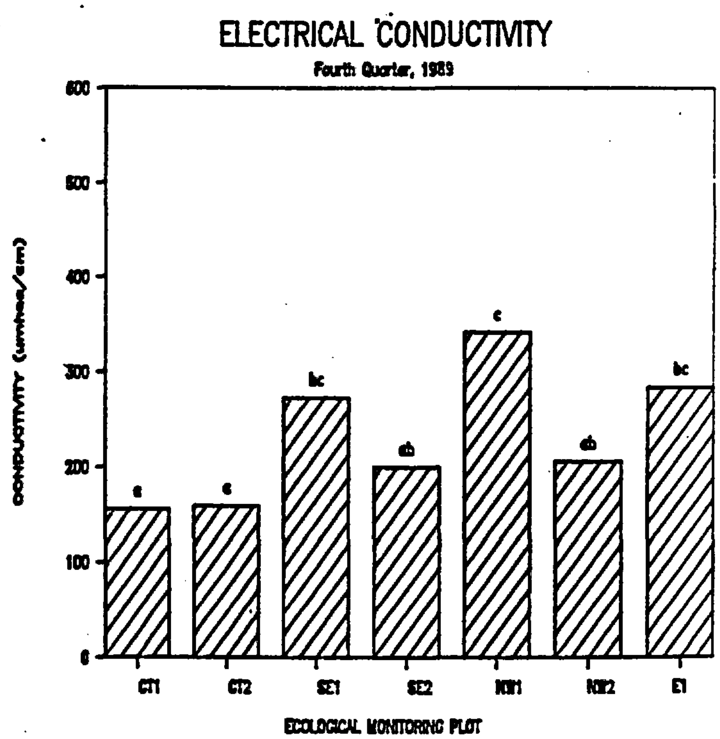
APPENDIX VIII

Soil Chemistry Parameters

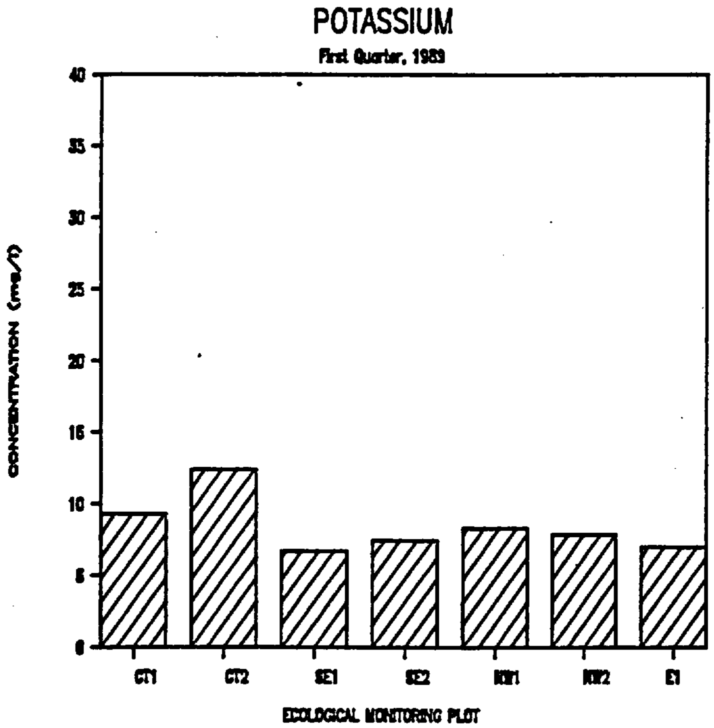


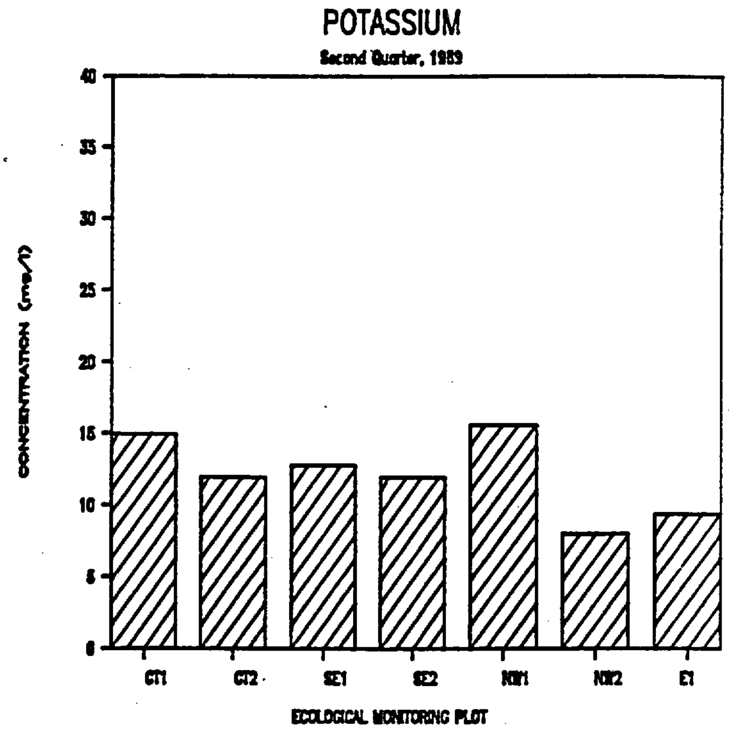


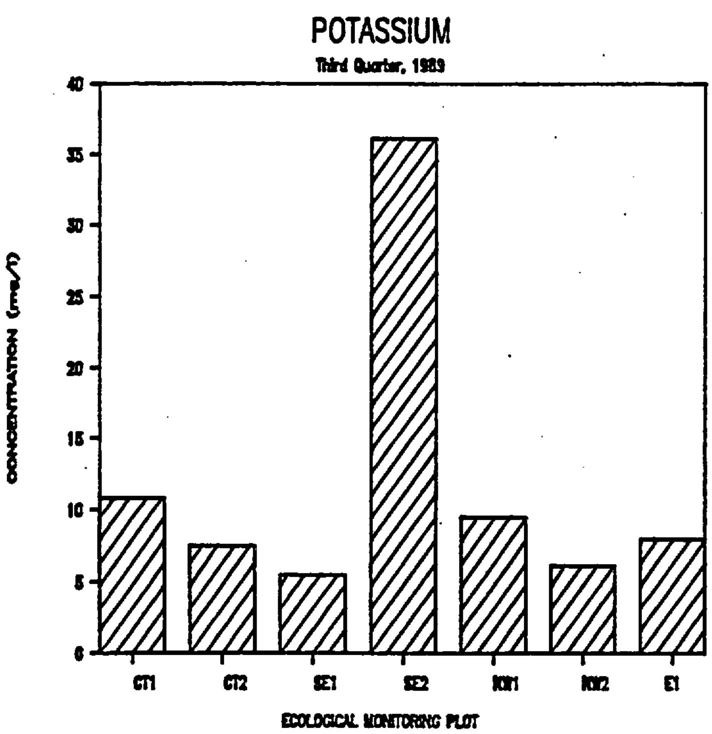


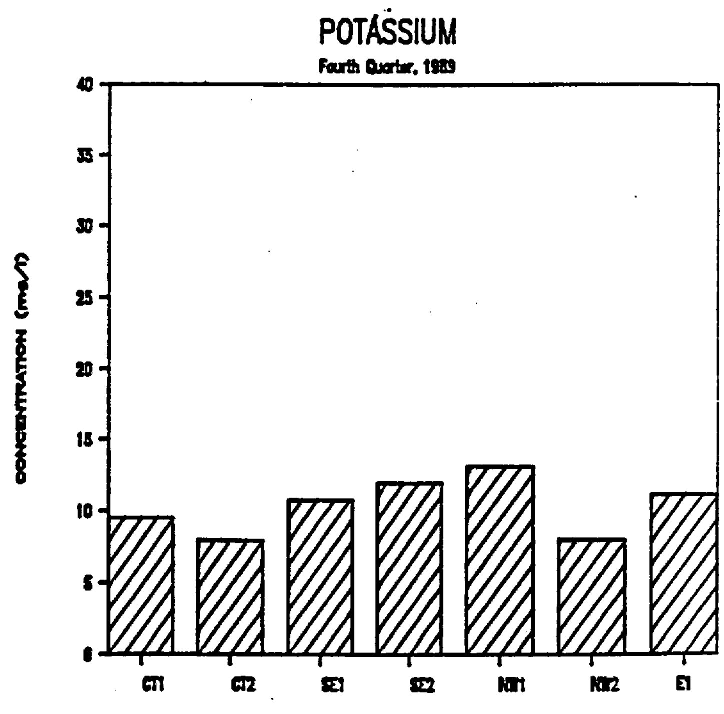


Soil Chemistry Parameters

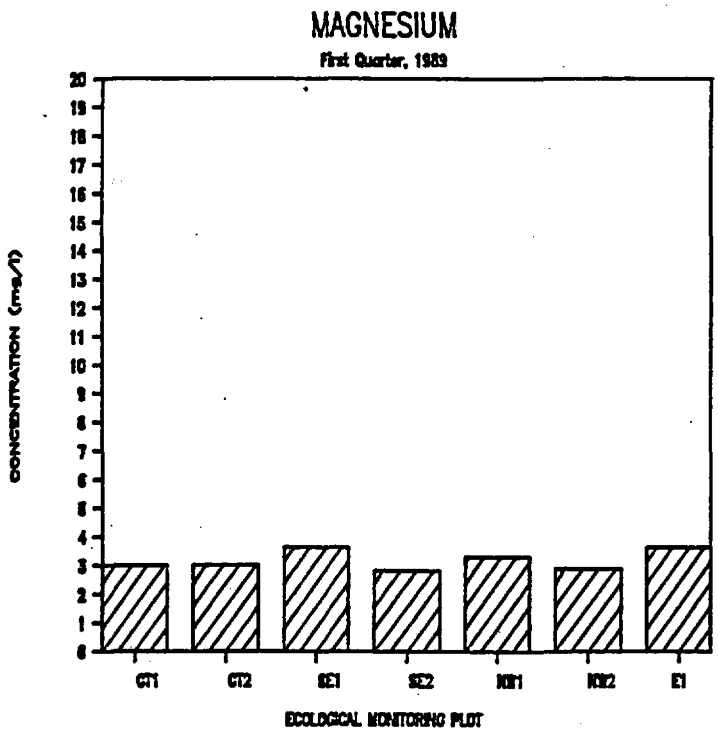


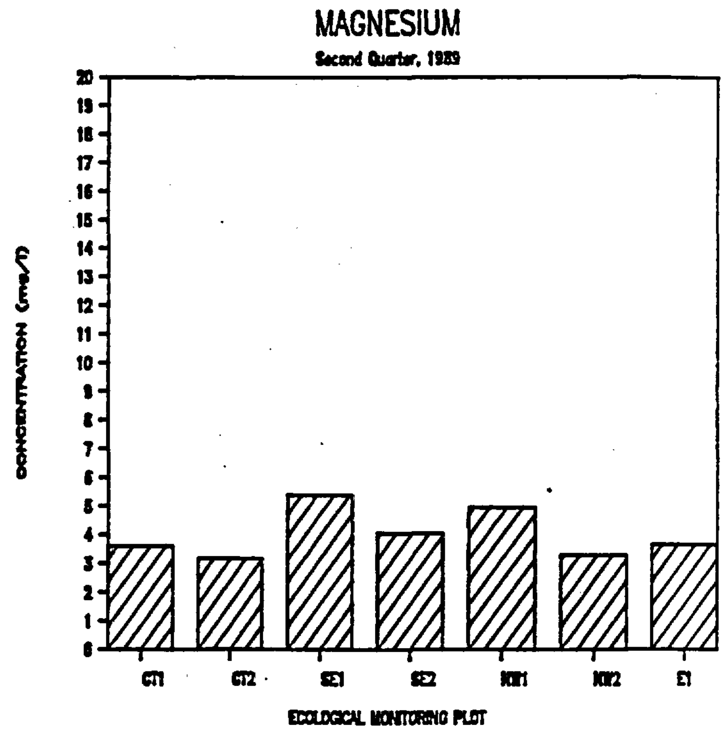


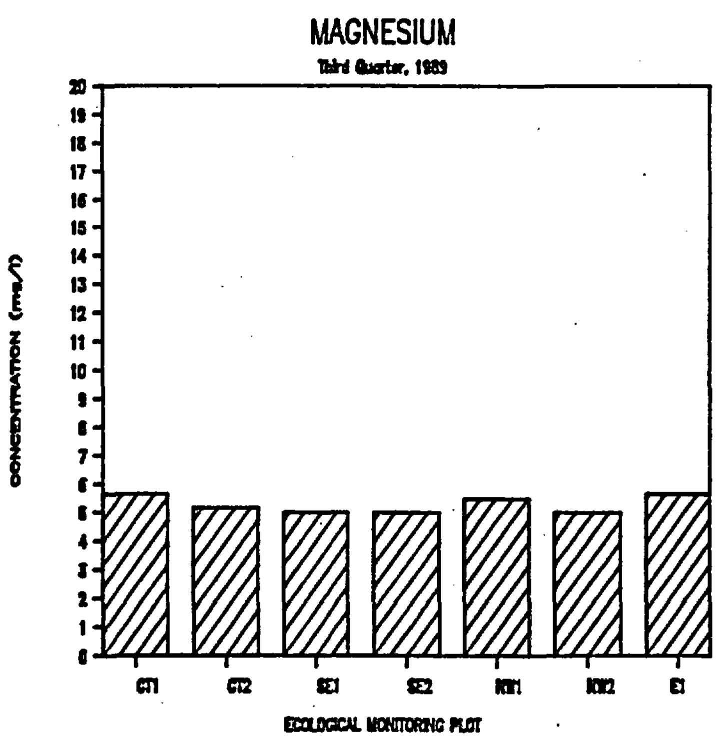


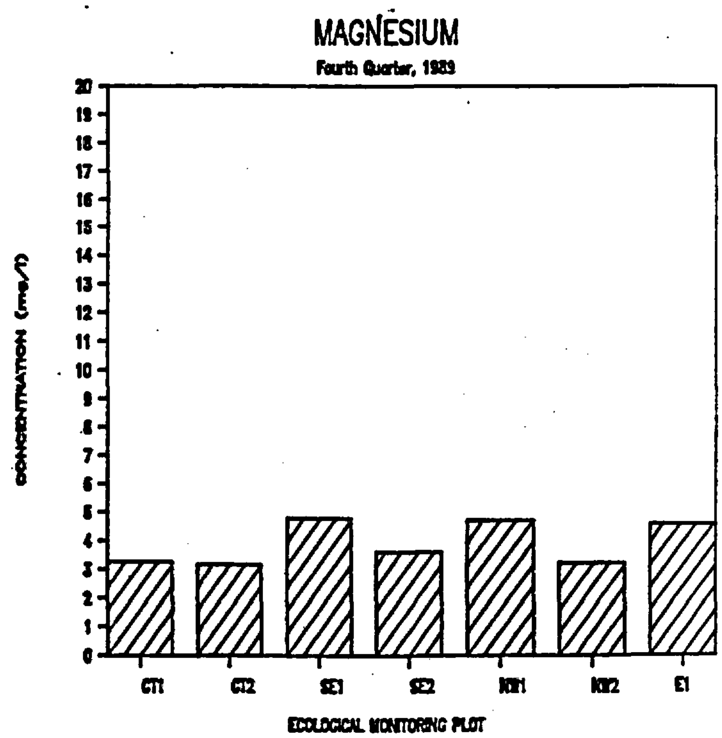


Soil Chemistry Parameters

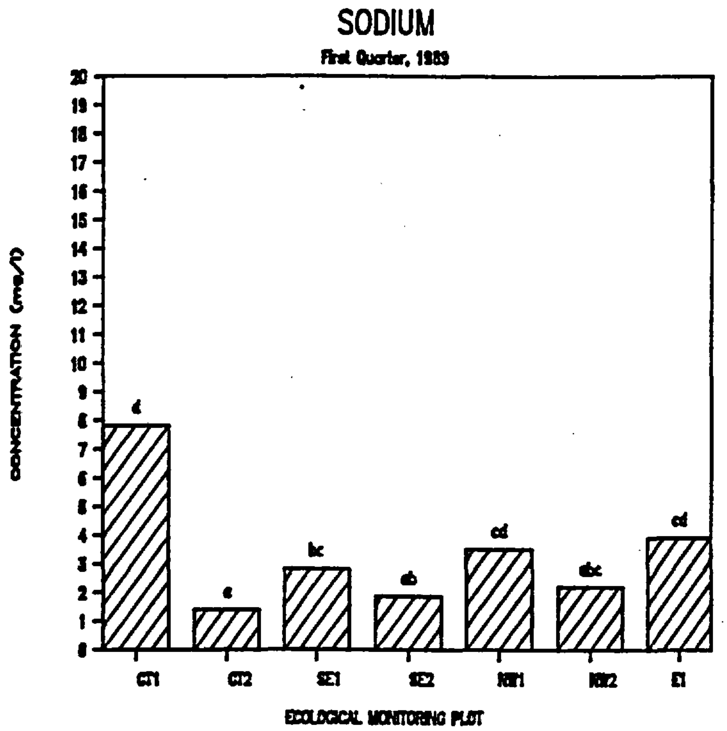


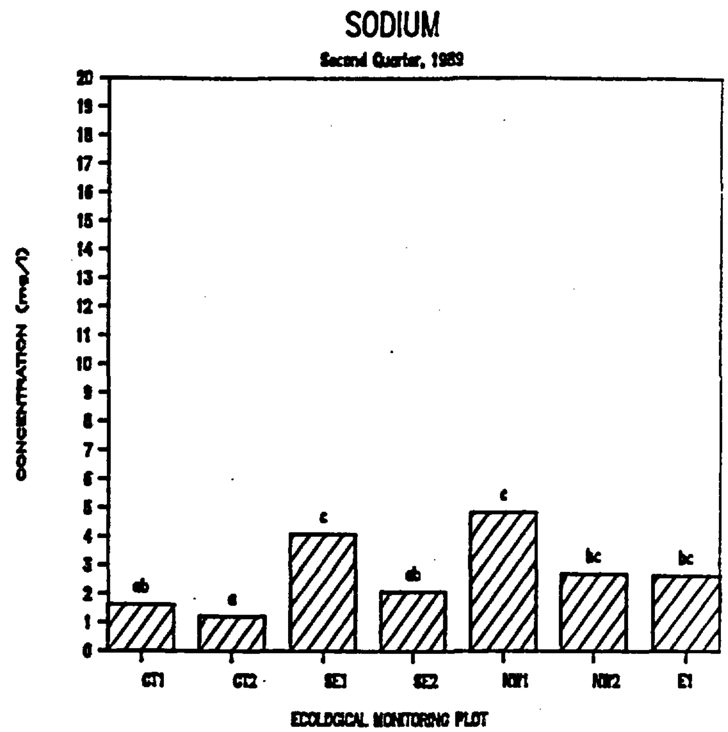


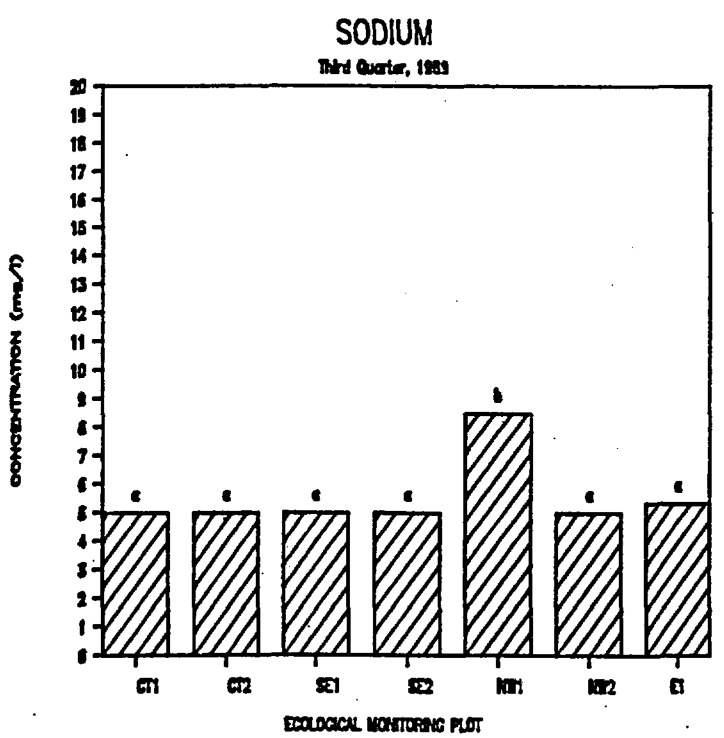


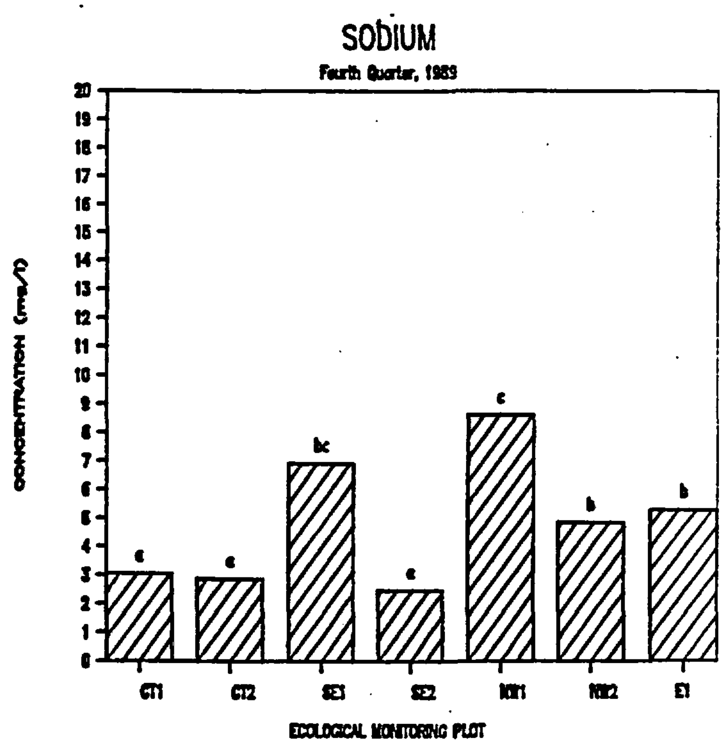


Soil Chemistry Parameters

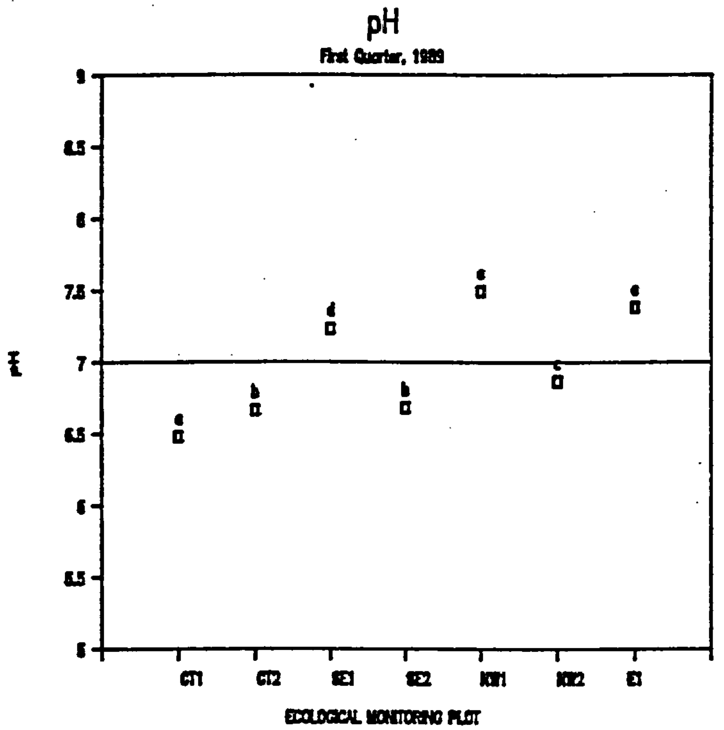


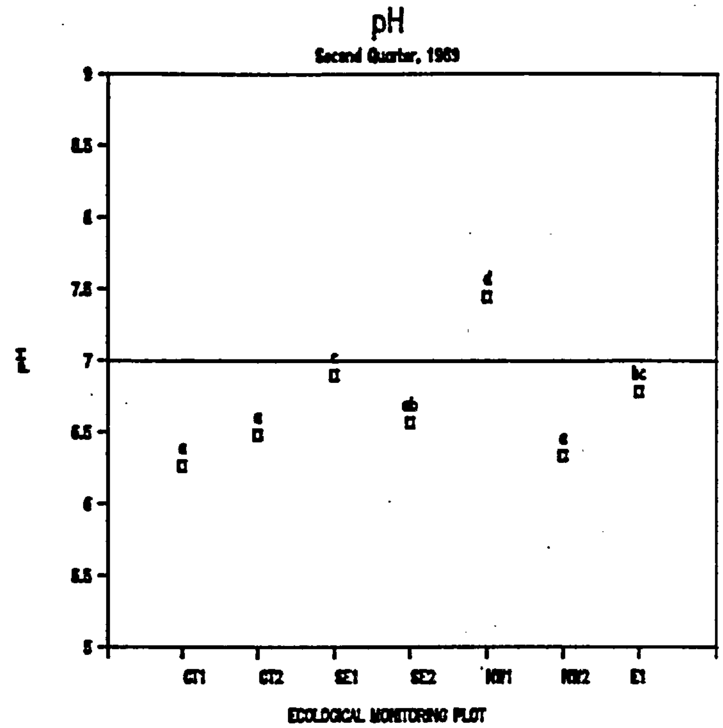


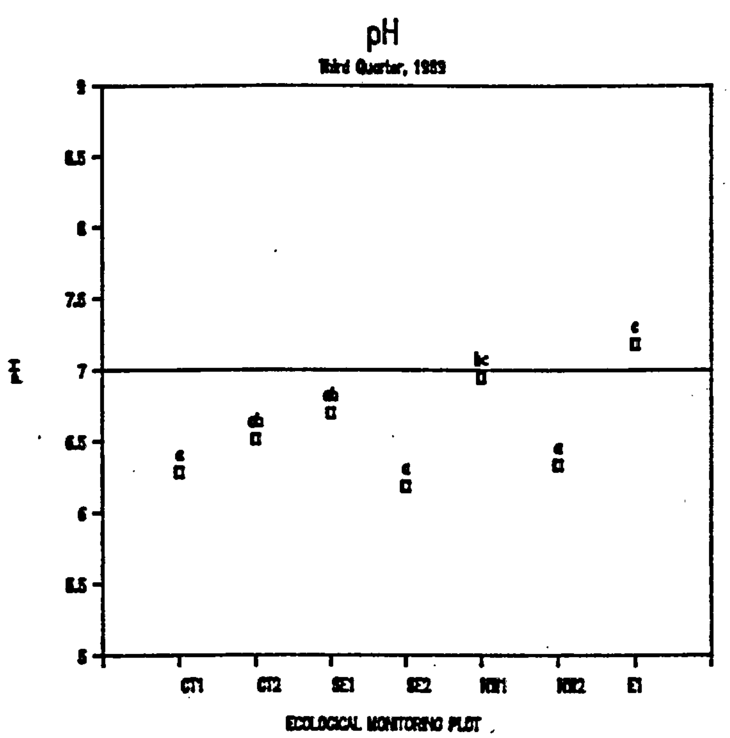


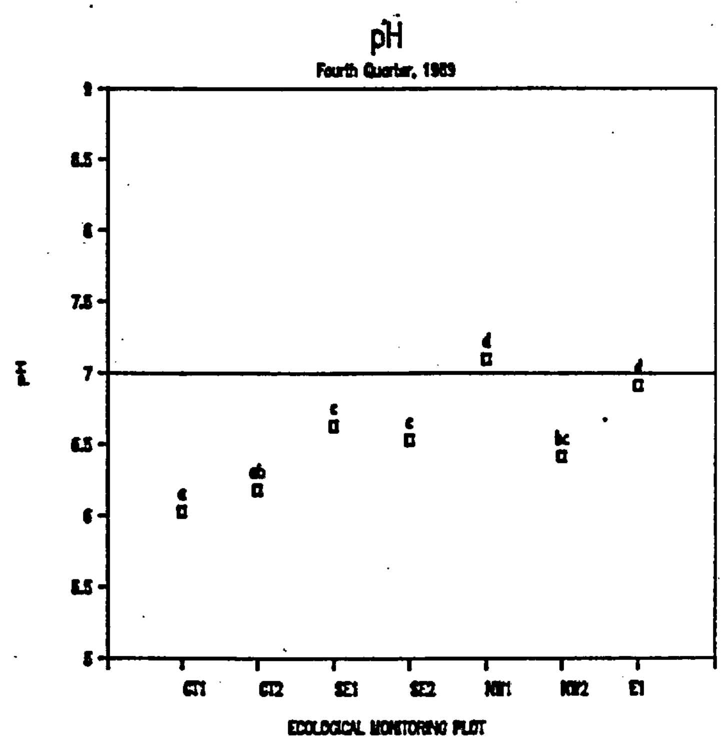


Soil Chemistry Parameters



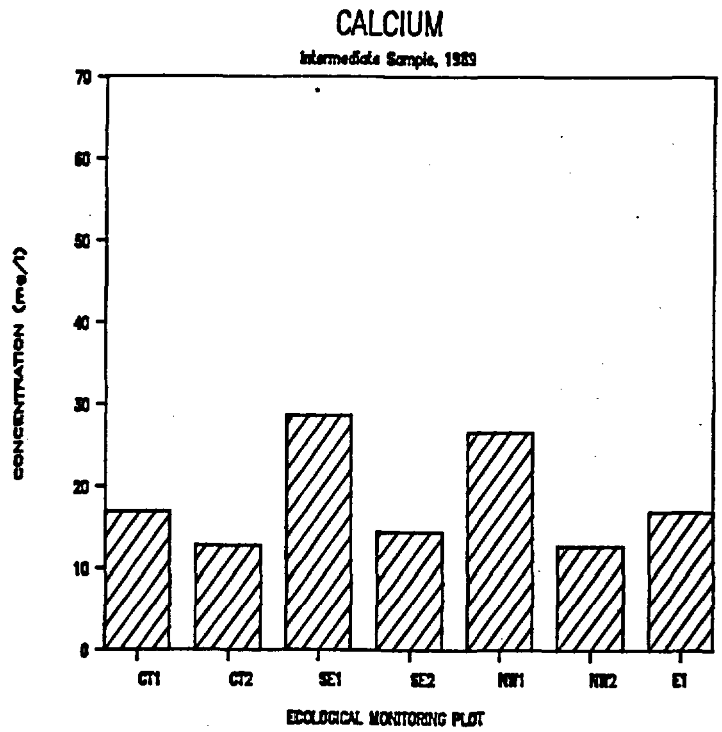


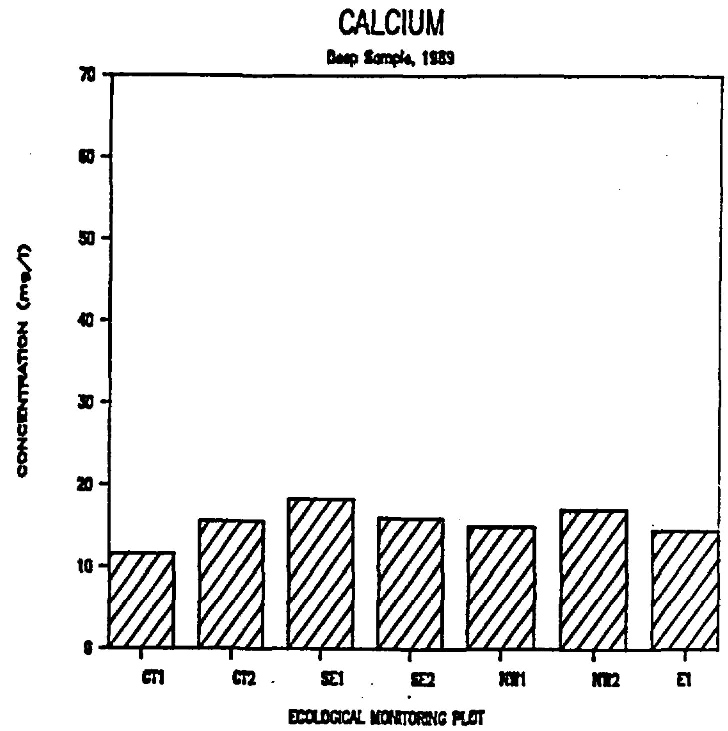


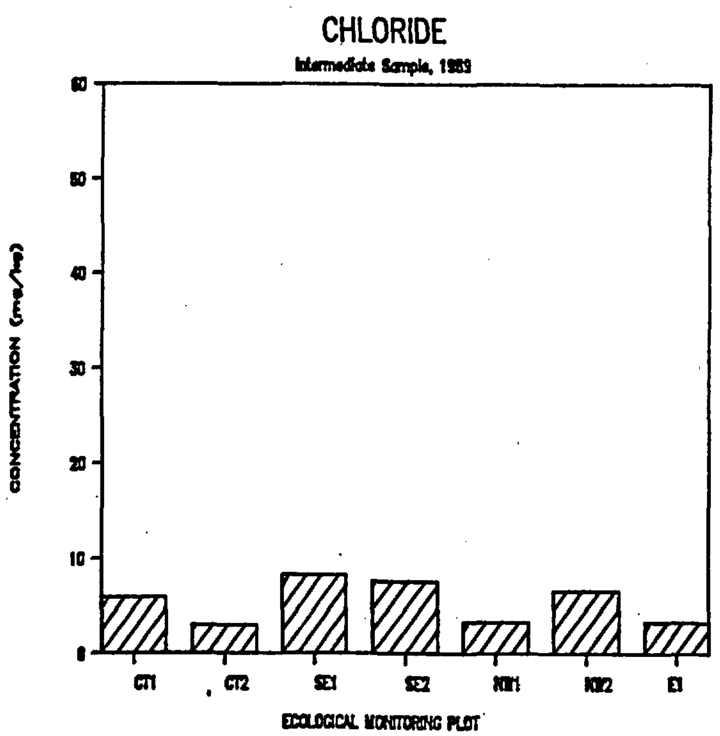


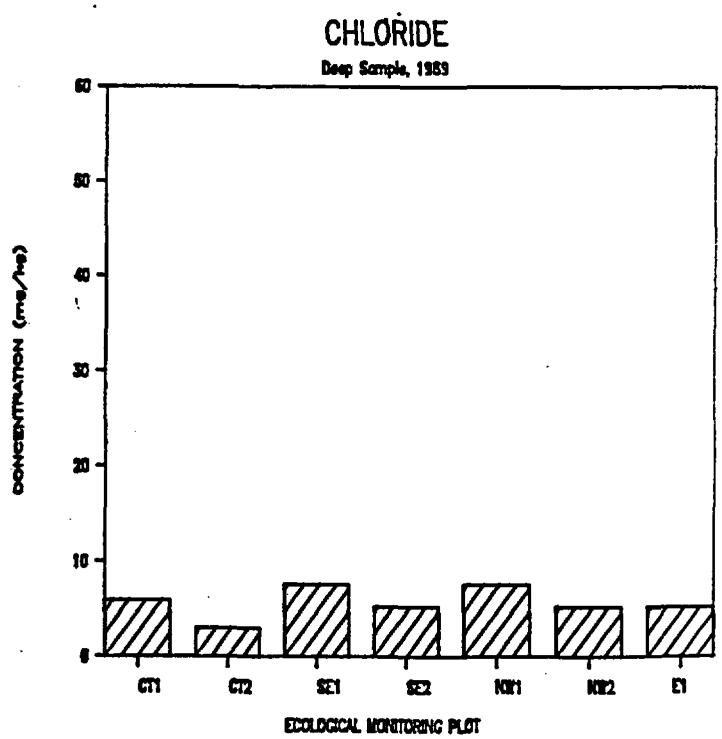
APPENDIX IX

Average Plot Concentrations of Soil Parameters, Intermediate, and Deep Soils



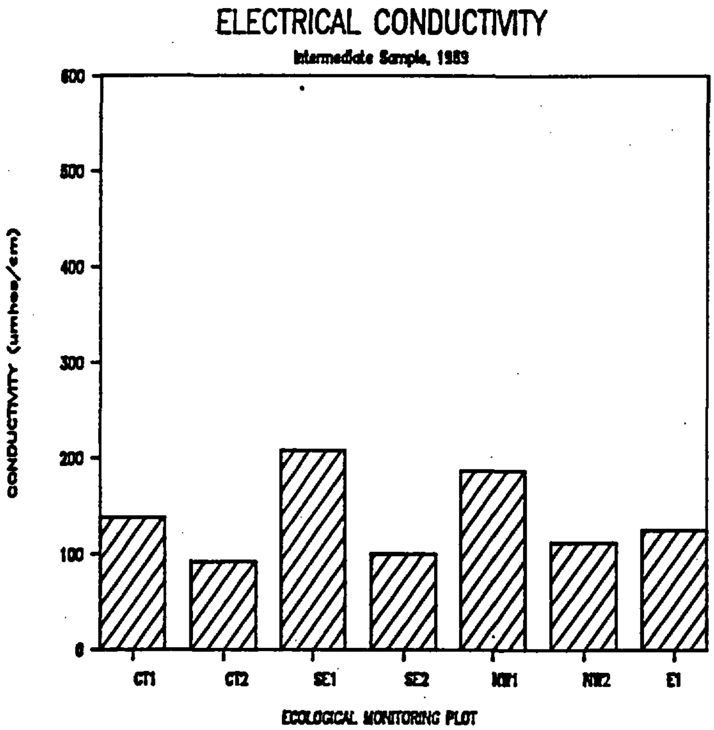


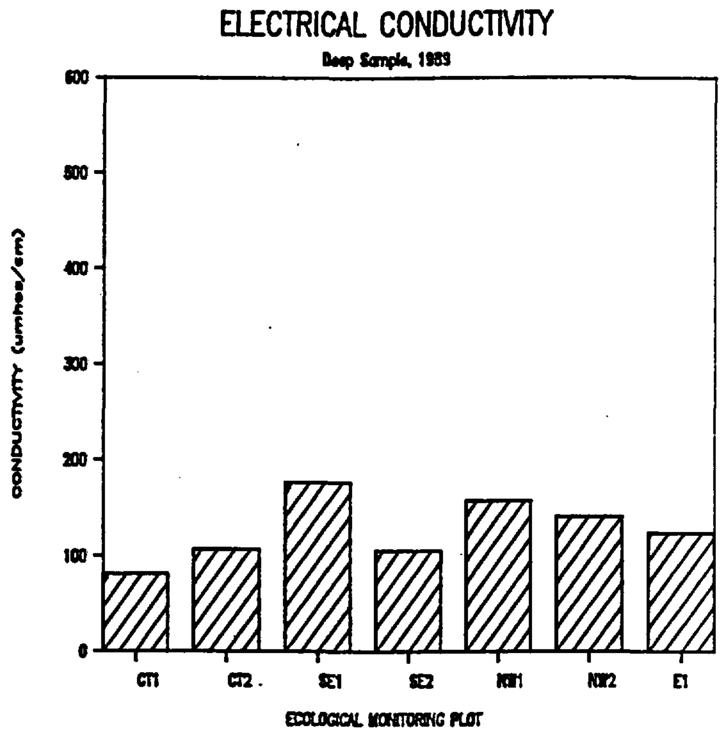


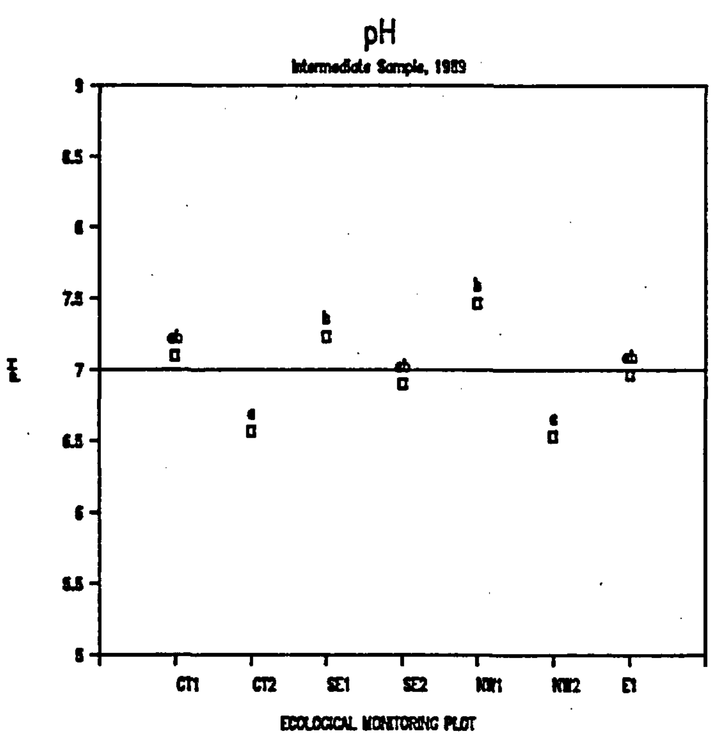


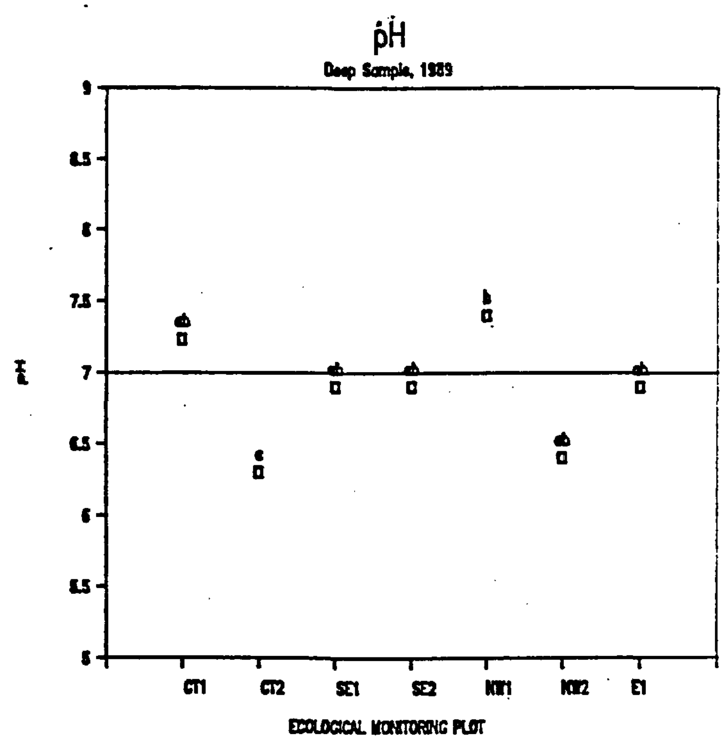
APPENDIX IX

Average Plot Concentrations of Soil Parameters, Intermediate, and Deep Soils



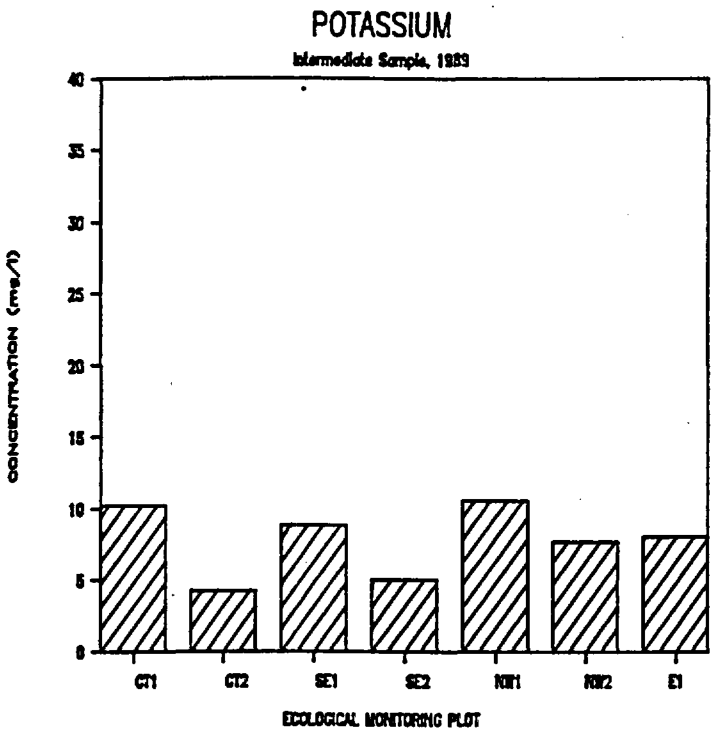


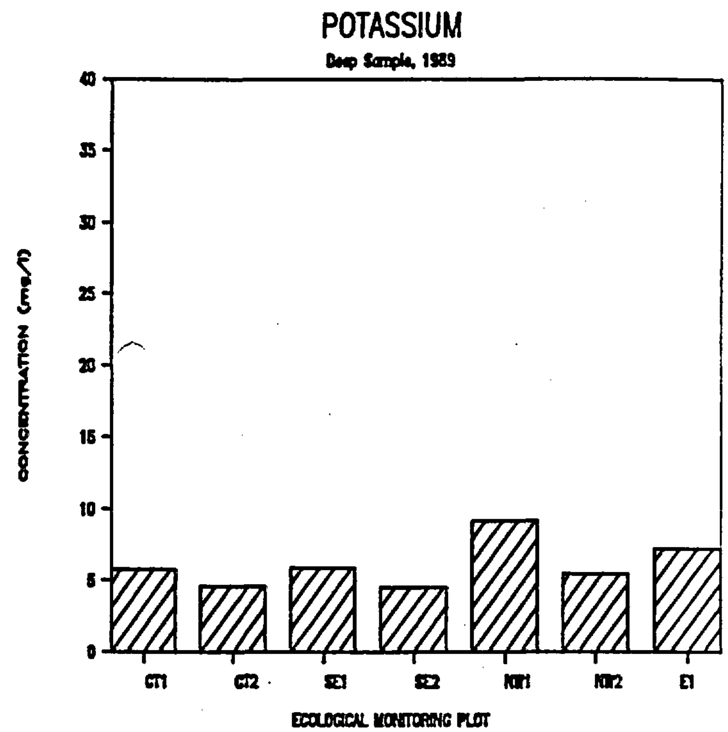


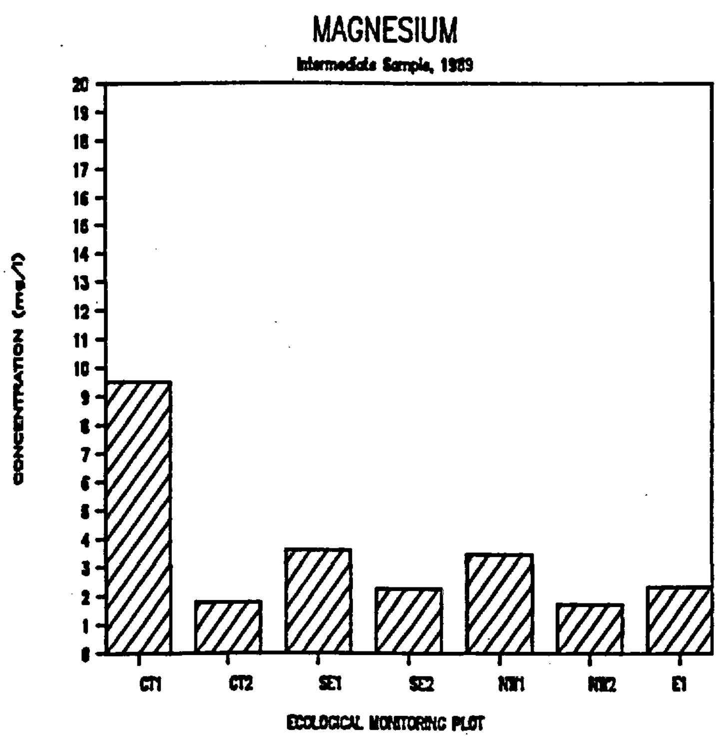


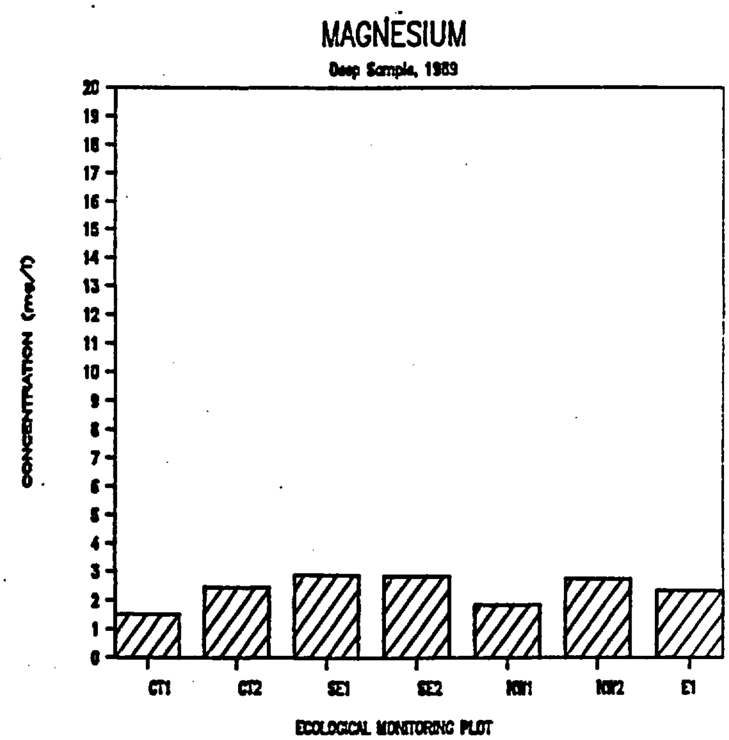
APPENDIX IX

Average Plot Concentrations of Soil Parameters, Intermediate, and Deep Soils



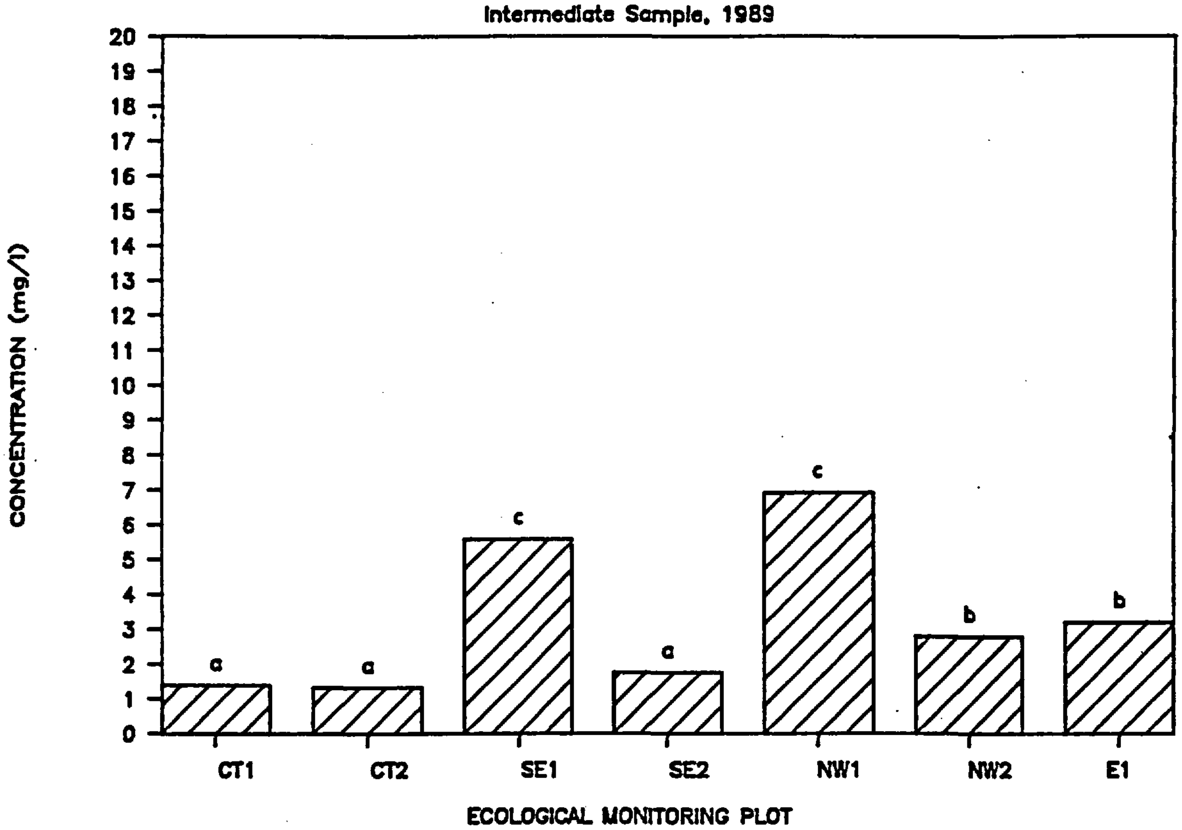




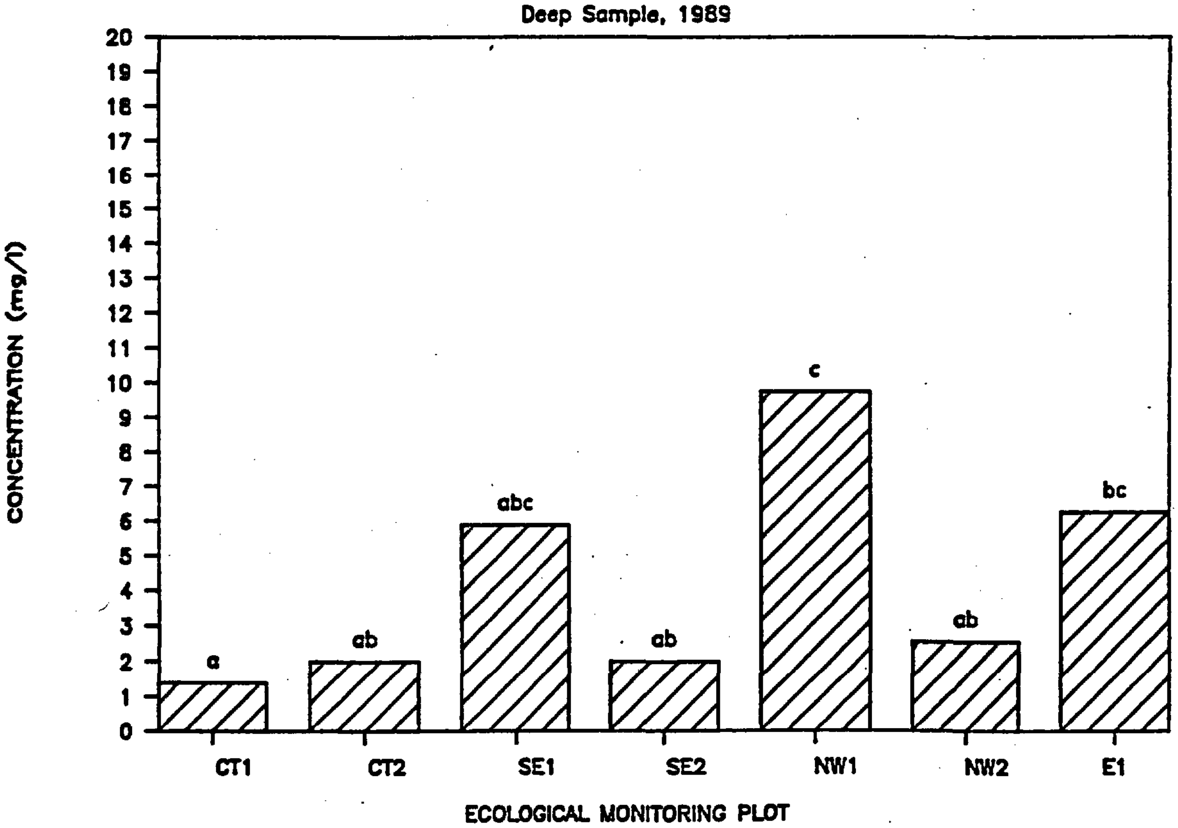


Average Plot Concentrations of Soil Parameters, Intermediate, and Deep Soils

SODIUM
Intermediate Sample, 1989



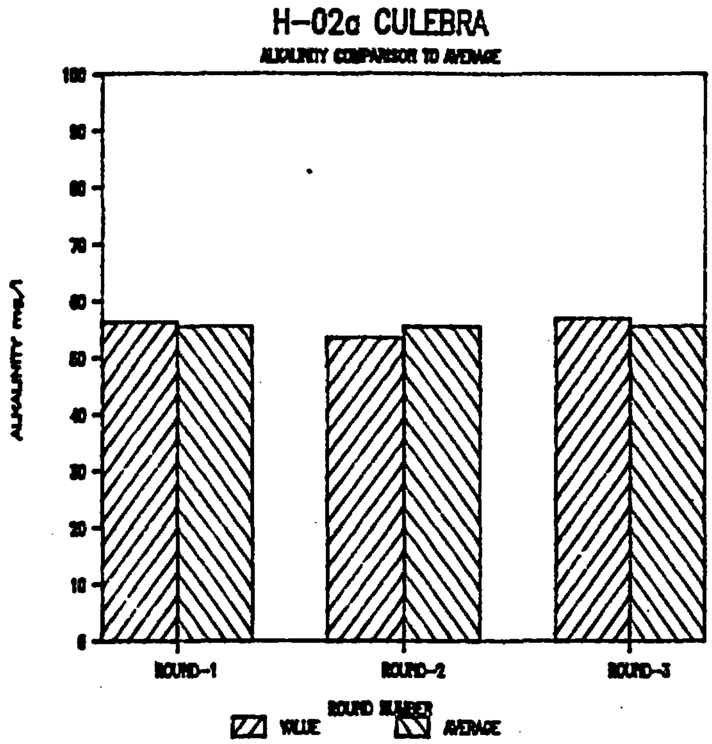
SODIUM
Deep Sample, 1989

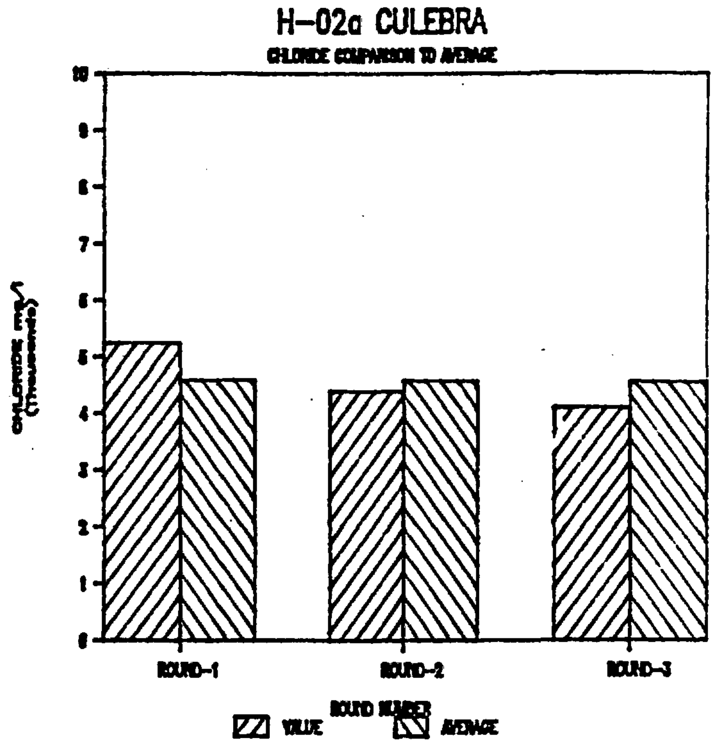


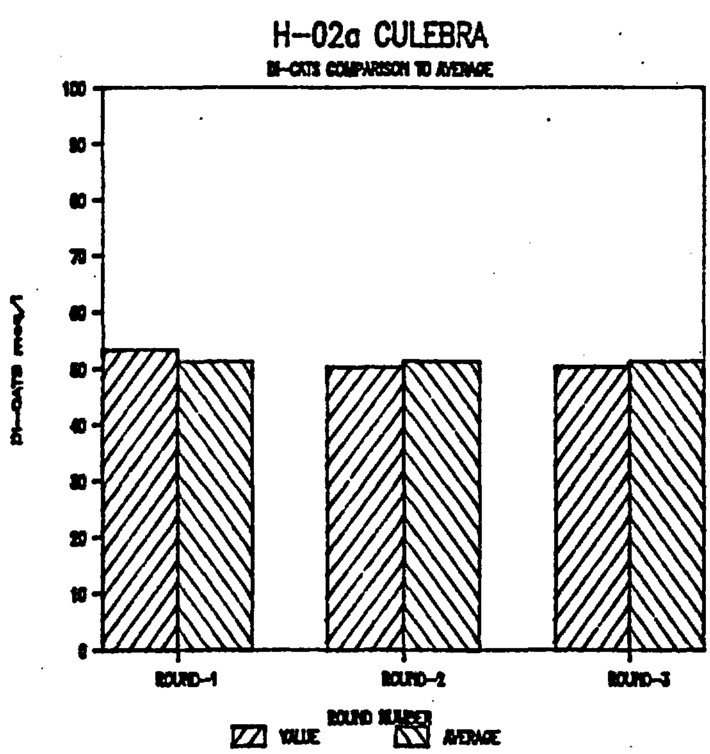
APPENDIX X
THE AVERAGE OF SELECTED LAST DAY SERIAL SAMPLING PARAMETERS
FOR CULEBRA WELLS SAMPLED IN 1989, WHICH WERE NOT SAMPLED FOR THE FIRST TIME

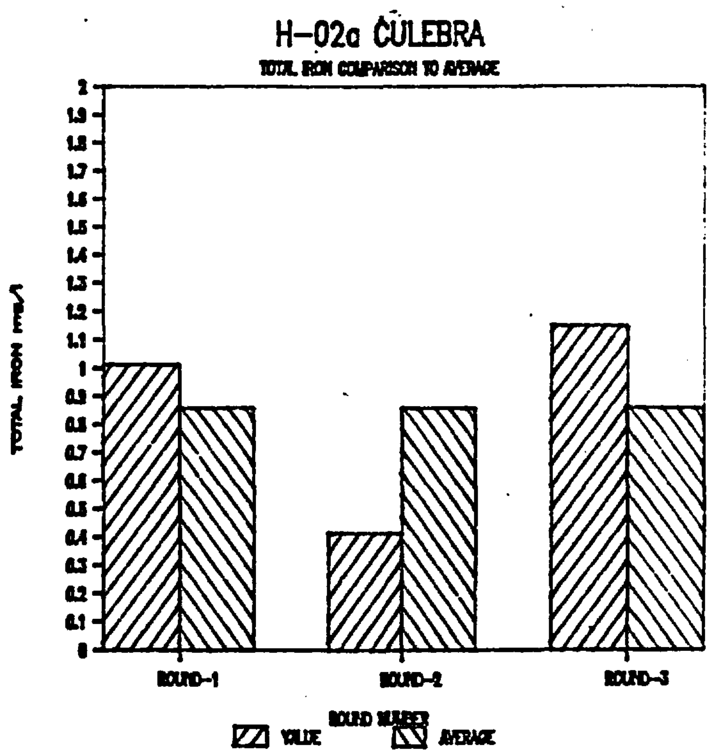
PARAMETER ROUND		CULEBRA WELLS									
		H-02a	H-03b3	H-04b	H-05b	H-06b	H-07b1	H-11b3	H-14	WIPP-19	WIPP-25
ALKALINITY	mg/l										
ROUND-1		56.3	51.6	70.0	48.9	94.1	121.0	53.4	40.3	84.0	126.5
ROUND-2		53.6	50.7	68.1	51.0	90.7	121.0	54.0	37.0	68.2	126.0
ROUND-3		56.9	51.0	69.1	47.6	94.0	123.0	55.1	38.1	60.9	124.7
ROUND-4			50.4	68.1	52.5	97.4	117.8	58.5		61.1	129.8
	X	55.58	50.93	68.83	50.00	94.04	120.70	55.25	38.47	68.55	126.75
	S	1.46	0.44	0.79	1.89	2.37	1.86	1.97	1.37	9.39	1.88
	CV	0.03	0.01	0.01	0.04	0.03	0.02	0.04	0.04	0.14	0.01
CHLORIDE	mg/l										
ROUND-1		5243	29330	7456	83400	32315	309	67922	8500	62000	6190
ROUND-2		4400	27361	7522	84900	32228	301	65886	8510	48800	6100
ROUND-3		4129	28000	7400	85600	32000	293	65000	8502	44200	6410
ROUND-4			27639	7403	84385	31615	290	63473		40440	6933
	X	4590.33	28082.50	7445.25	84571.25	32039.50	298.25	65570.25	8504.00	48860.00	6408.25
	S	474.28	755.04	49.60	802.02	270.74	7.40	1608.89	4.32	8143.64	323.27
	CV	0.10	0.03	0.01	0.01	0.01	0.02	0.02	0.00	0.17	0.05
DICATIONS	meq/l										
ROUND-1		53.4	167.8	71.4	256.0	190.7	46.4	187.6	126.0	286.0	81.5
ROUND-2		50.3	136.3	72.3	253.0	191.8	44.0	182.8	129.5	241.0	81.0
ROUND-3		50.4	137.0	70.0	259.0	191.0	40.4	185.0	132.9	208.0	82.7
ROUND-4			139.1	72.5	258.5	188.6	40.6	192.4		187.2	89.3
	X	51.35	147.03	71.22	256.00	191.17	43.60	185.13	129.47	245.00	81.73
	S	1.41	14.69	0.94	2.45	0.46	2.47	1.96	2.82	31.97	0.71
	CV	0.03	0.10	0.01	0.01	0.00	0.06	0.01	0.02	0.13	0.01
TOTAL IRON	mg/l										
ROUND-1		1.02	0.17	1.04	2.81	0.21	0.12	0.15	0.53	1.80	0.49
ROUND-2		0.42	0.23	1.22	4.01	0.10	0.08	0.30	0.16	1.31	0.41
ROUND-3		1.15	0.14	0.60	2.15	0.05	0.07	0.43	0.44	0.80	0.73
ROUND-4			0.15	0.48	3.06	0.44	0.14	0.46		1.71	0.72
	X	0.86	0.18	0.95	2.99	0.12	0.09	0.29	0.38	1.30	0.54
	S	0.32	0.04	0.26	0.77	0.07	0.02	0.11	0.16	0.41	0.14
	CV	0.37	0.21	0.27	0.26	0.56	0.24	0.39	0.42	0.31	0.25

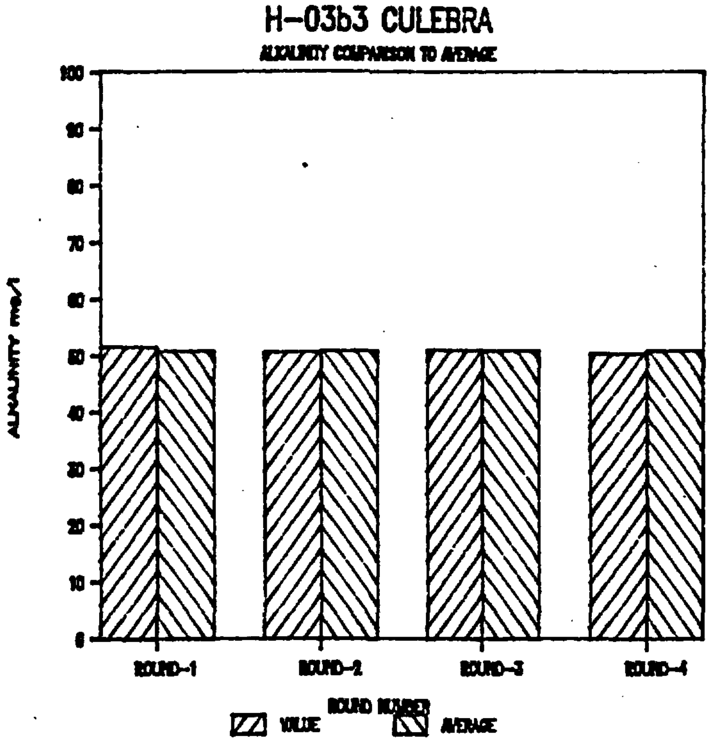
(X) AVERAGE (S) STANDARD DEVIATION (CV) COEFFICIENT OF VARIANCE

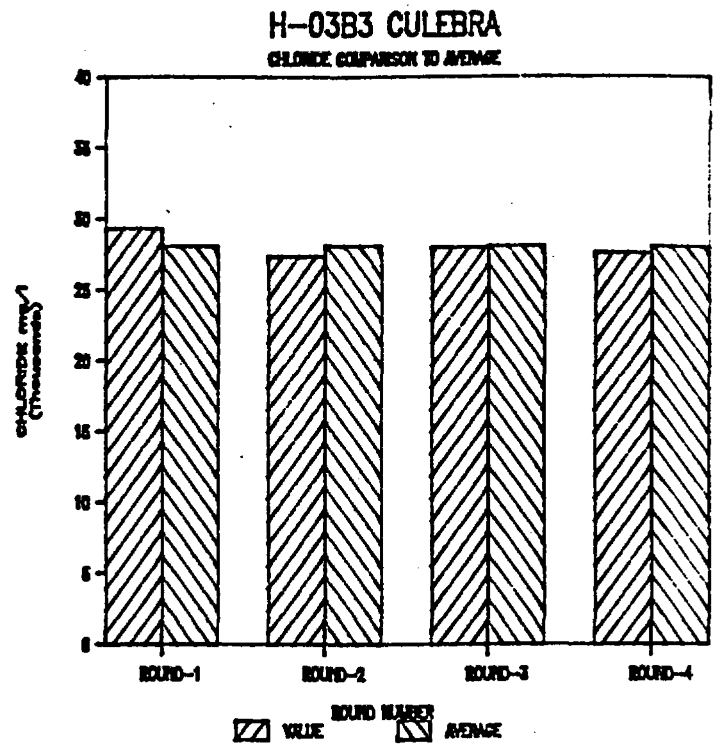

H-02a CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

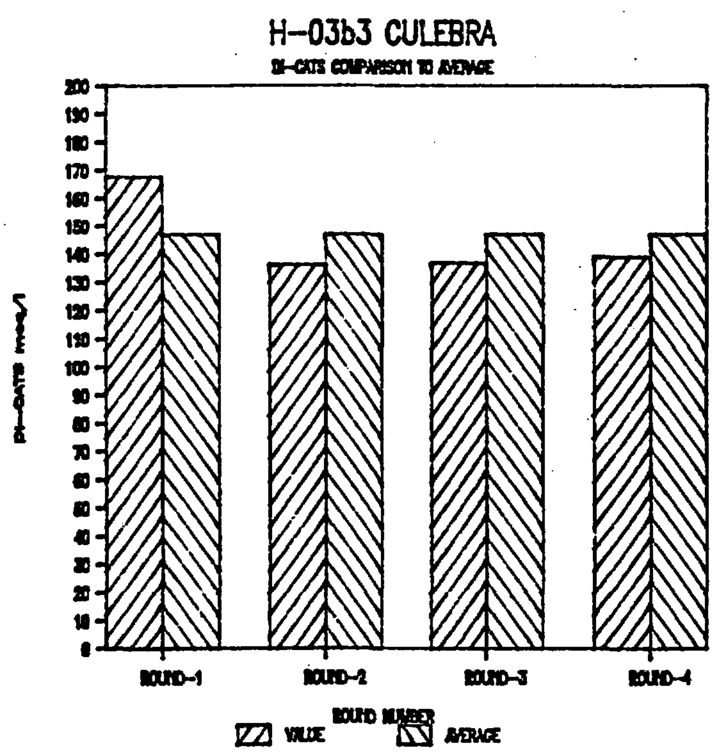

H-02a CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

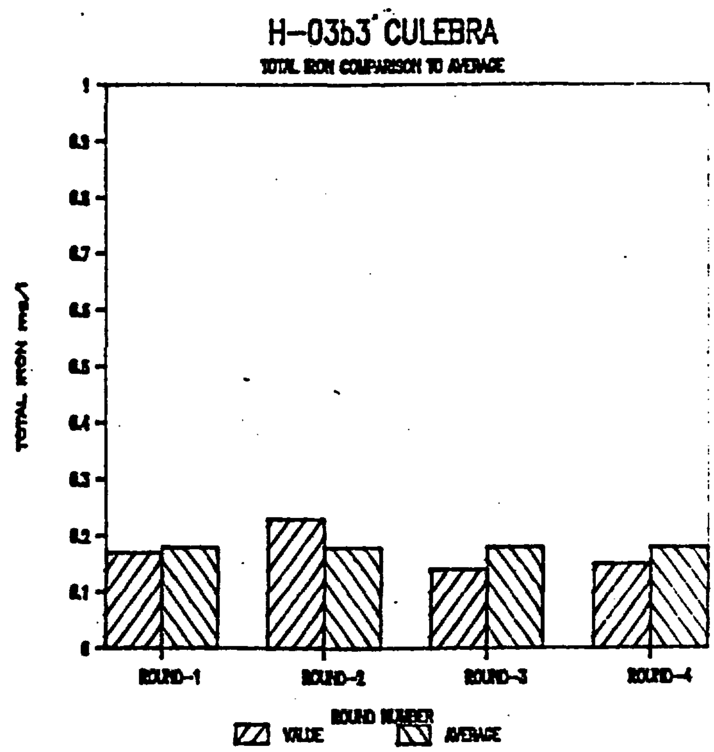

H-02a CULEBRA
BI-CATS COMPARISON TO AVERAGE
BI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

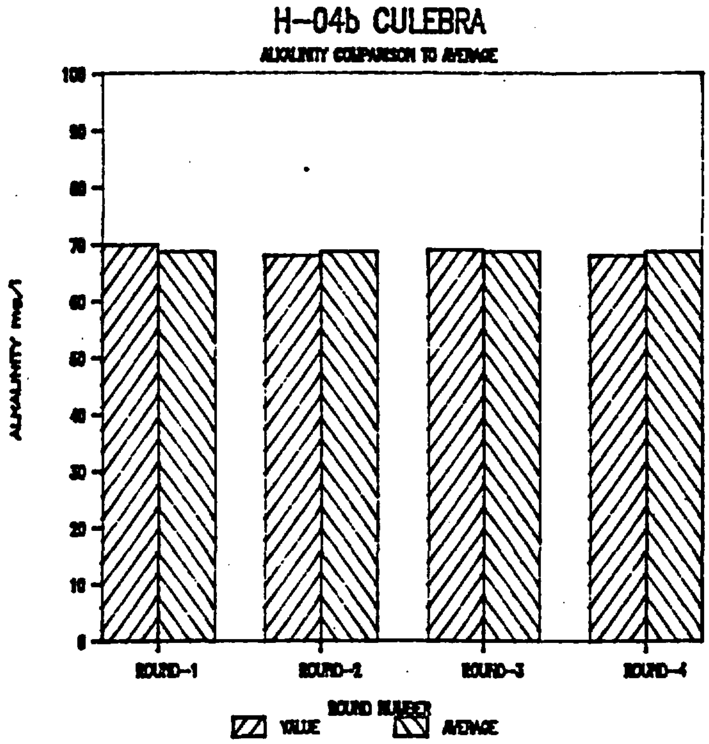

H-02a CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

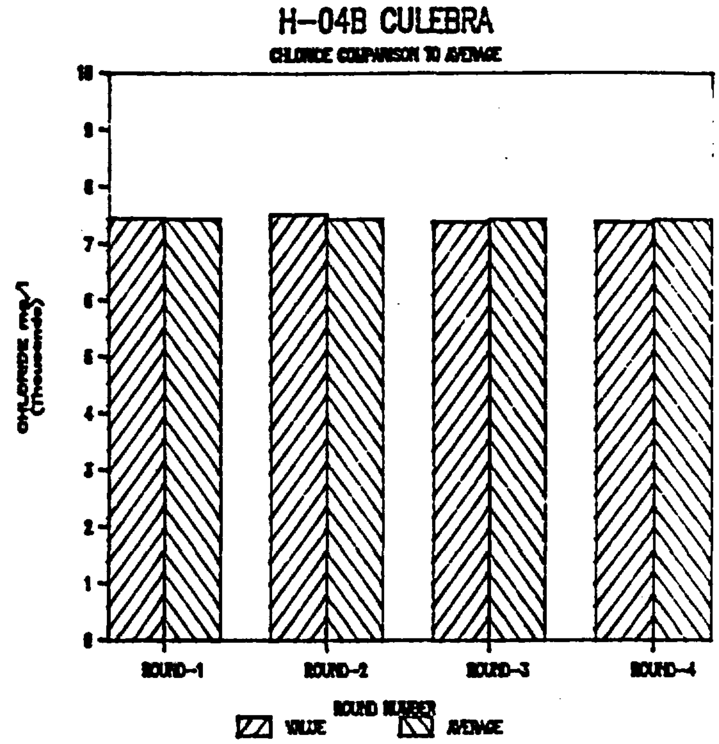

H-03b3 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

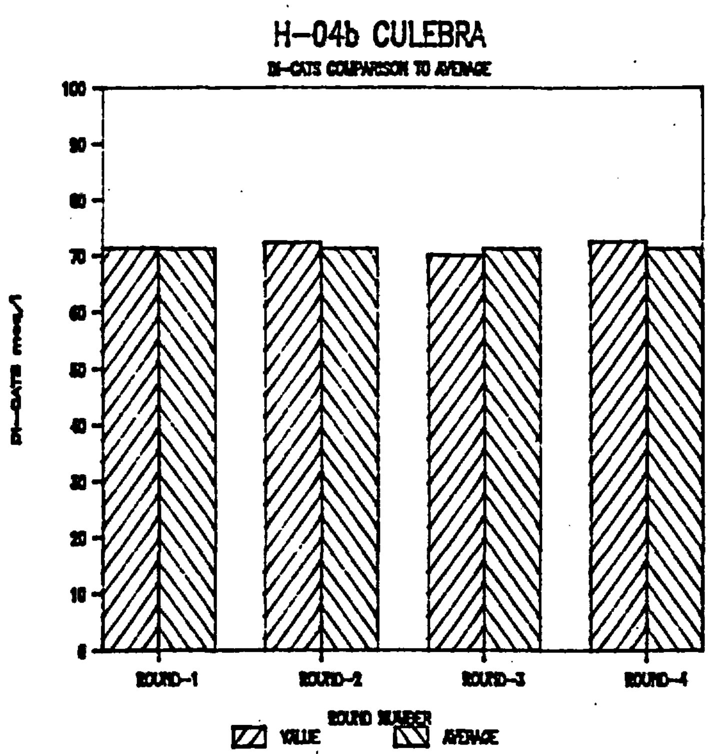

H-03B3 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

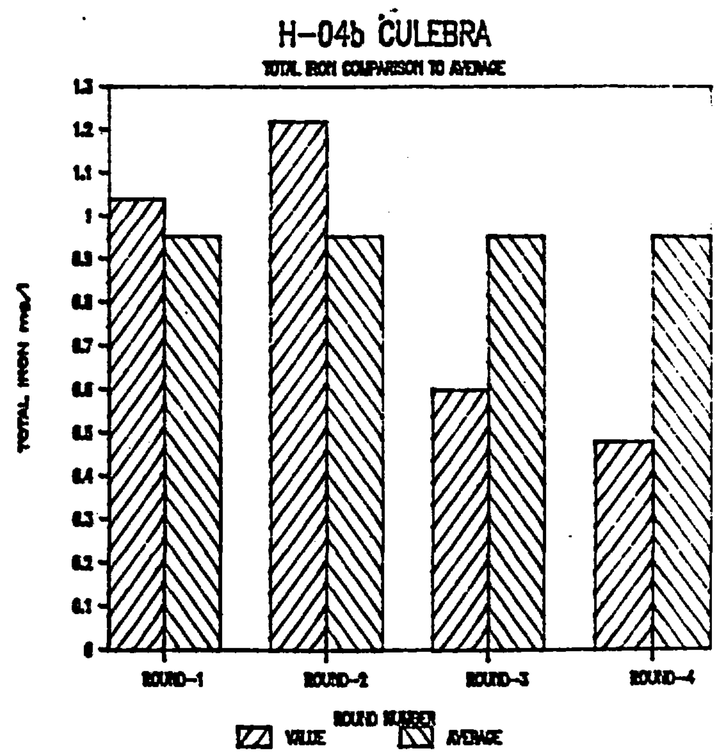

H-03b3 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS meq/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

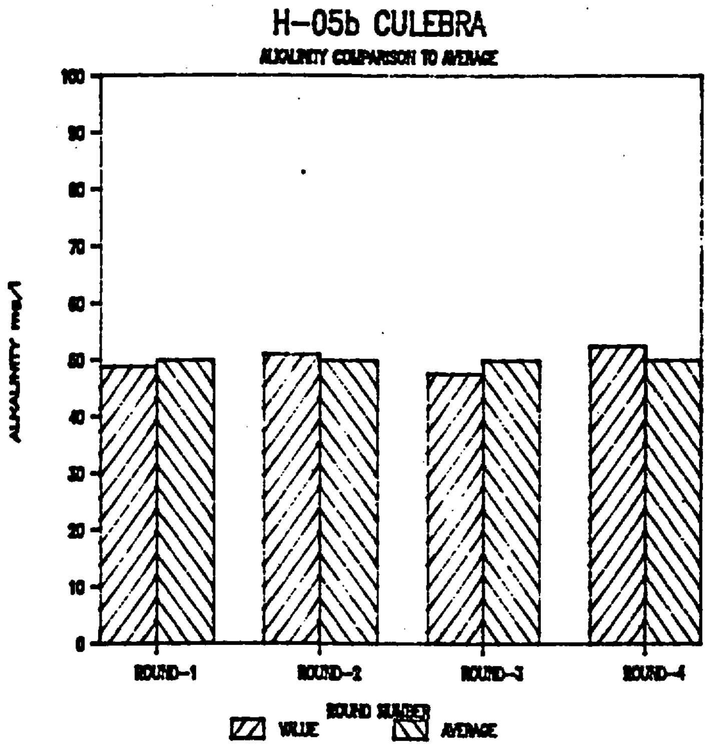

H-03b3 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

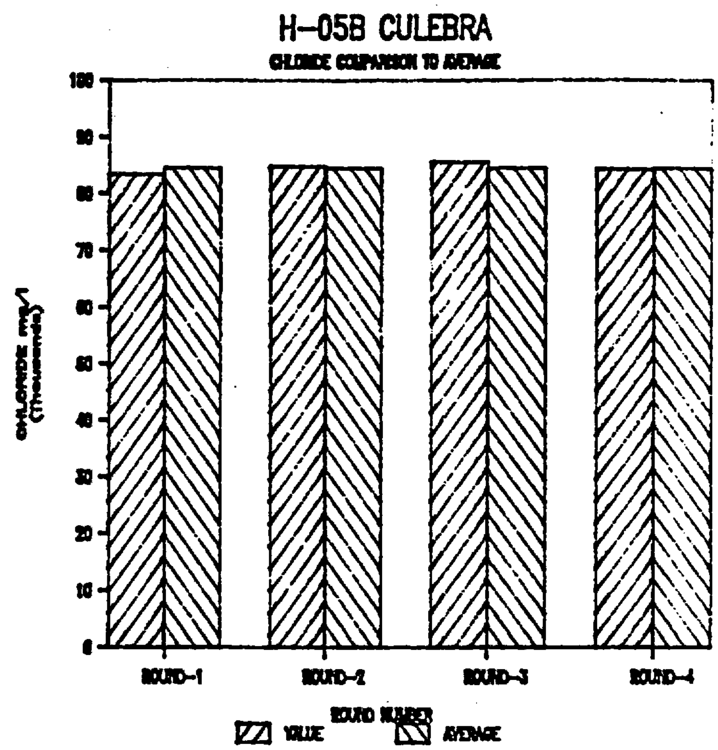

H-04b CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

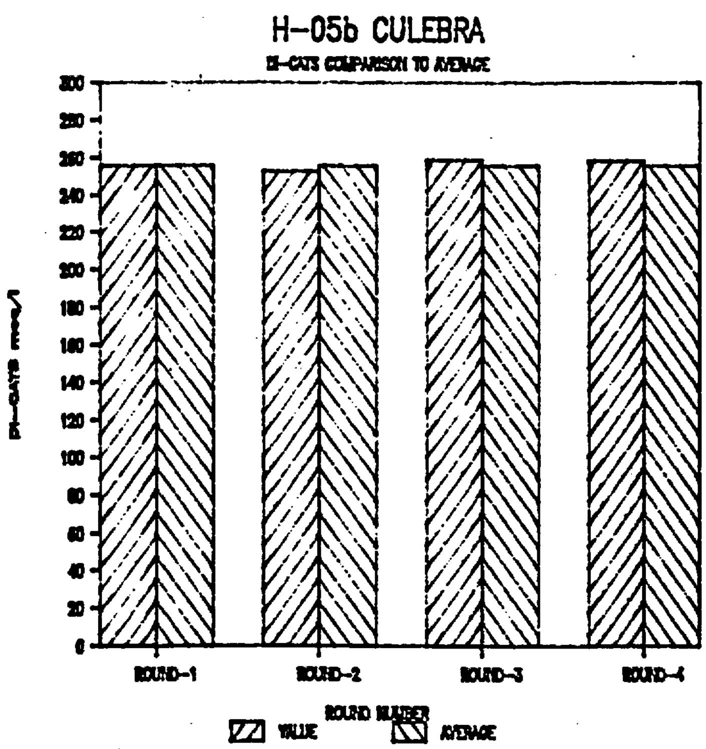

H-04B CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

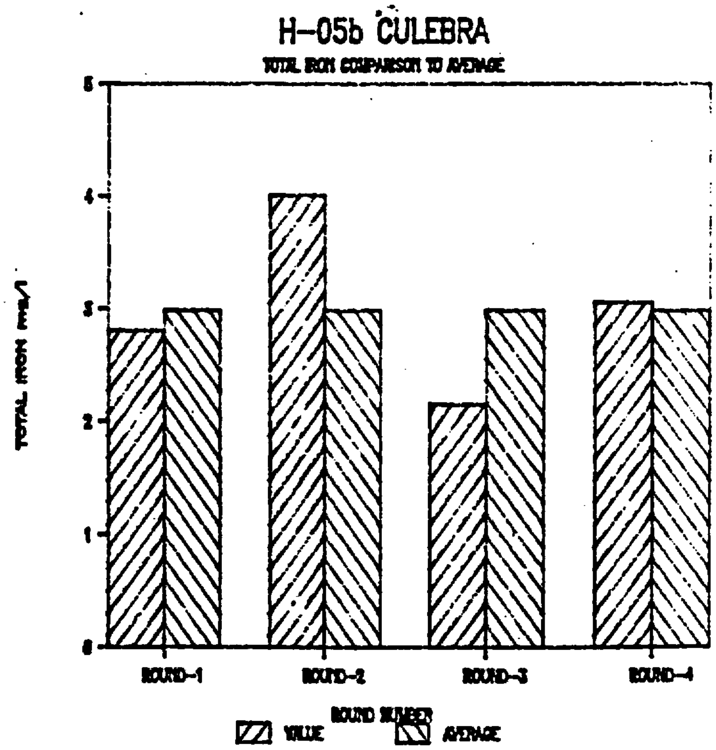

H-04b CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

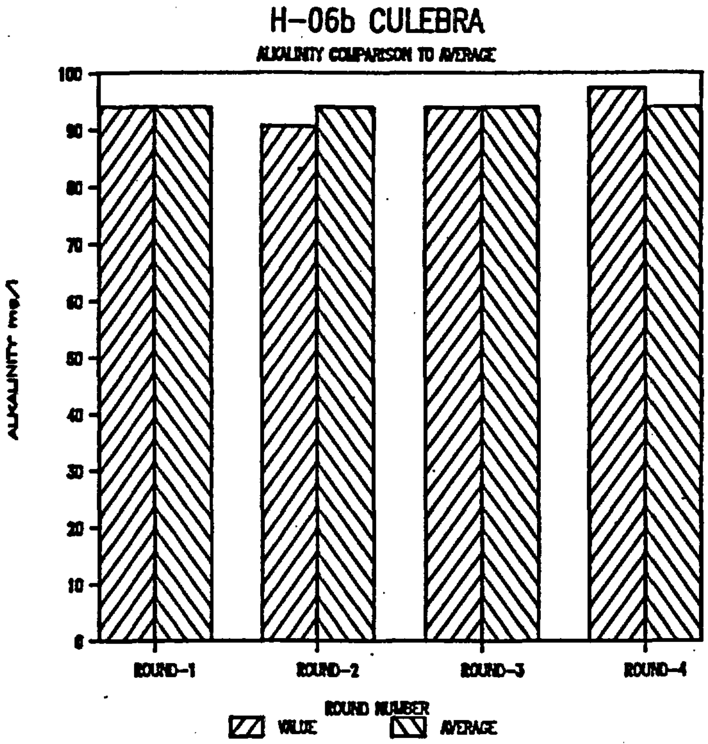

H-04b CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

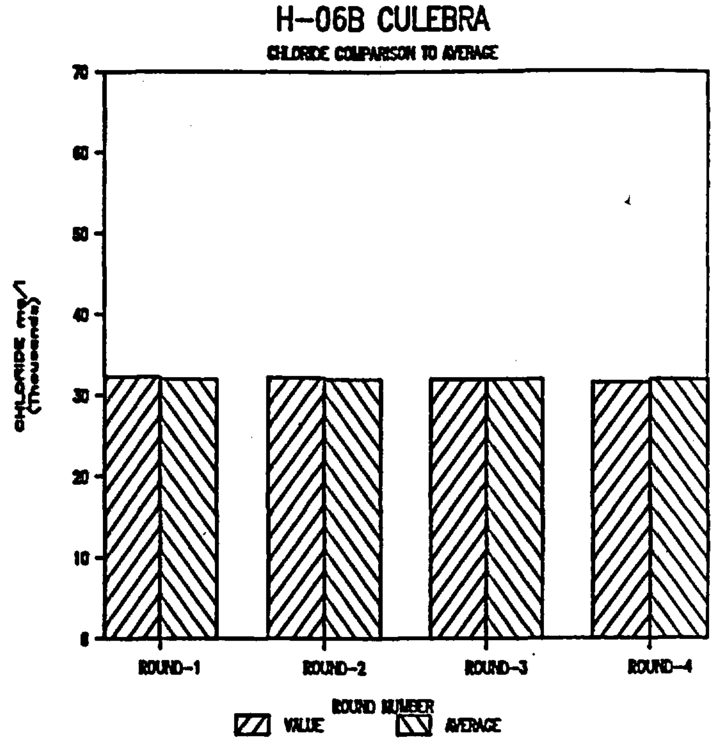

H-05b CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

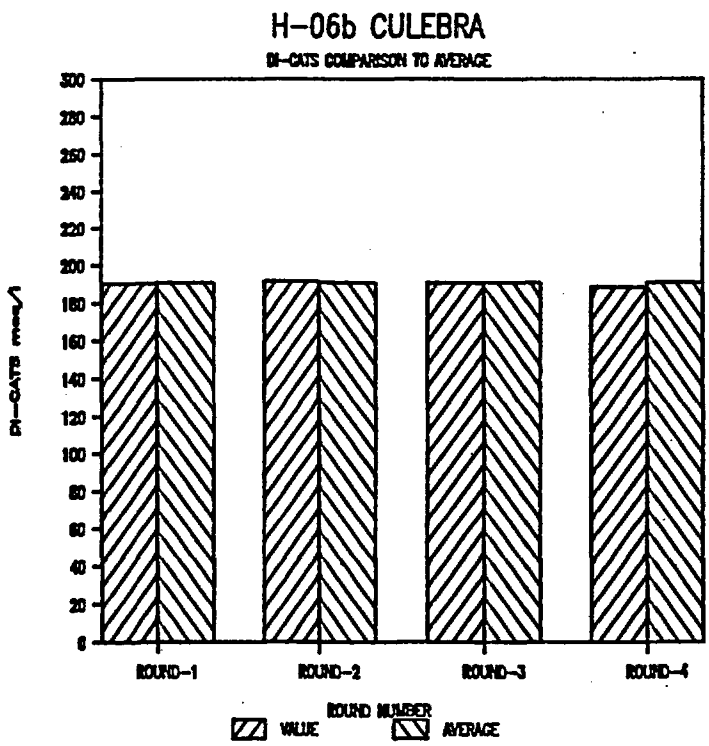

H-05B CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

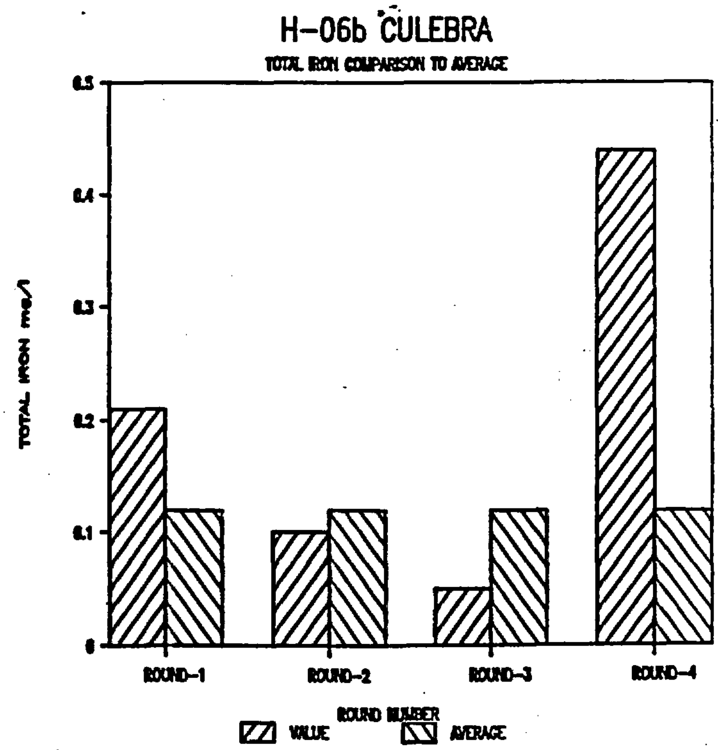

H-05b CULEBRA
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

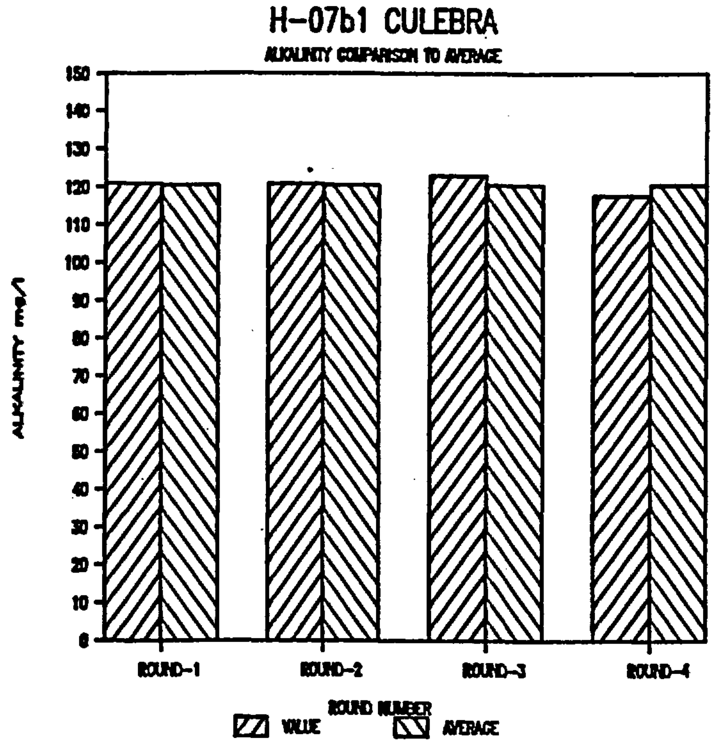

H-05b CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

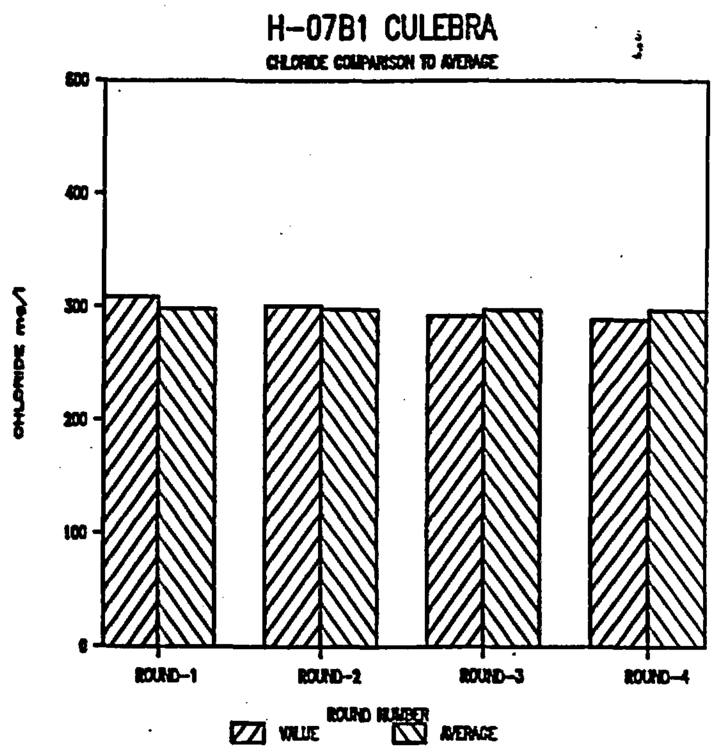

H-06b CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

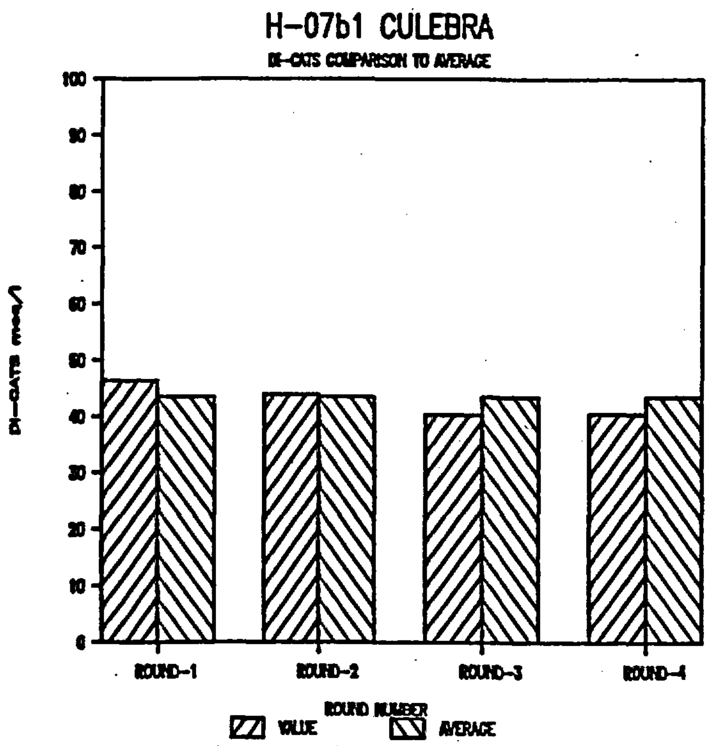

H-06B CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

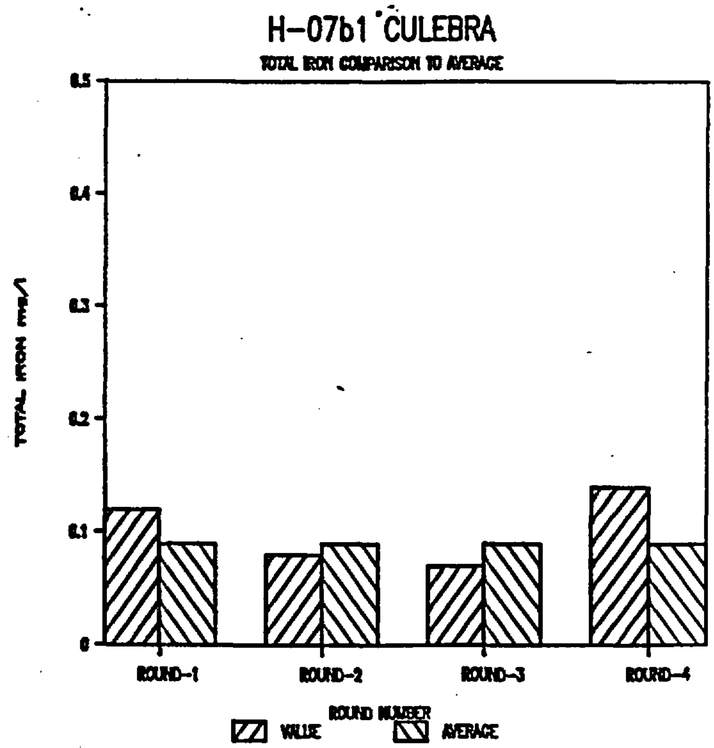

H-06b CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

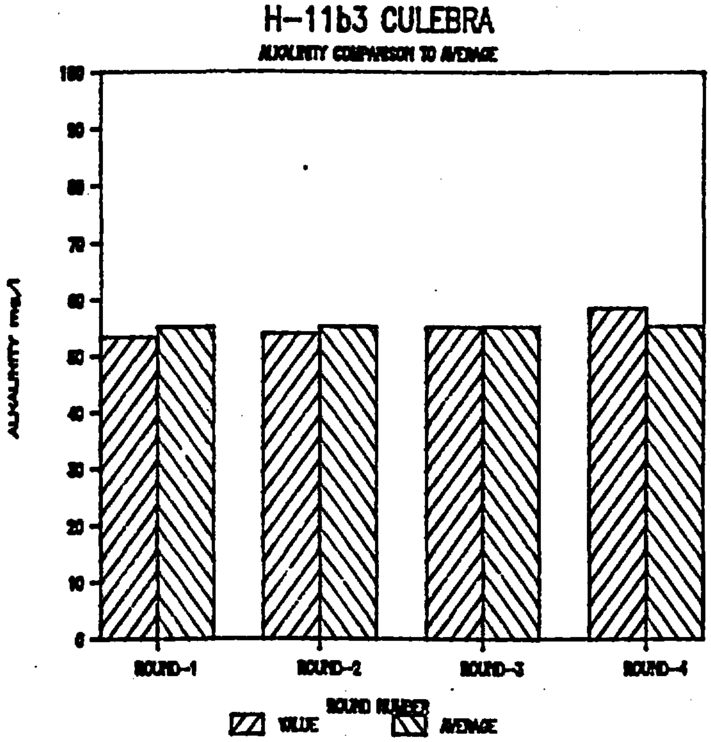

H-06b CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

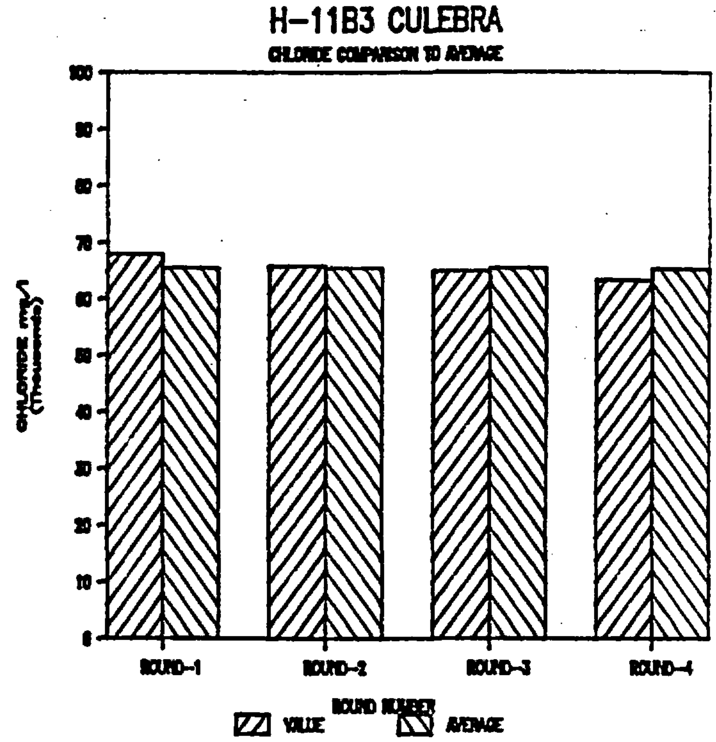

H-07b1 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

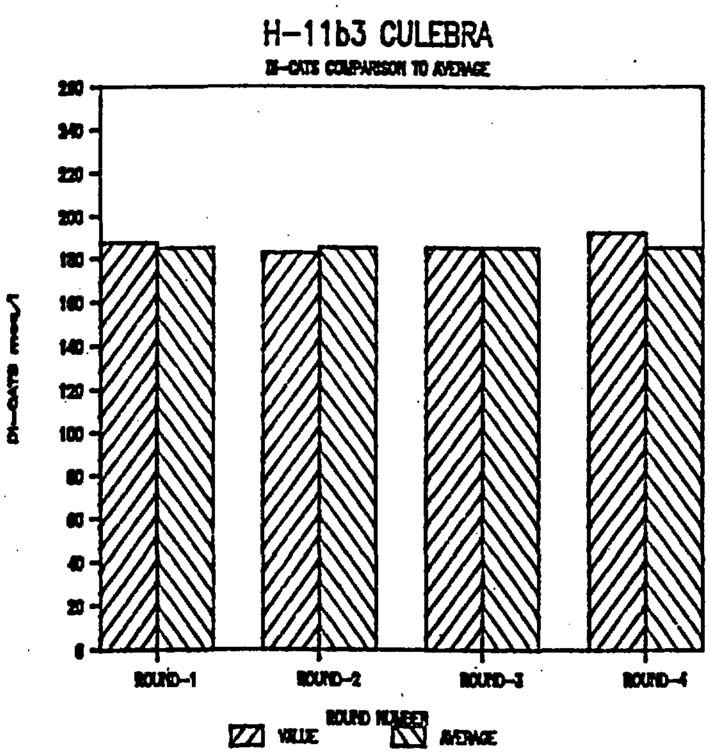

H-07B1 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

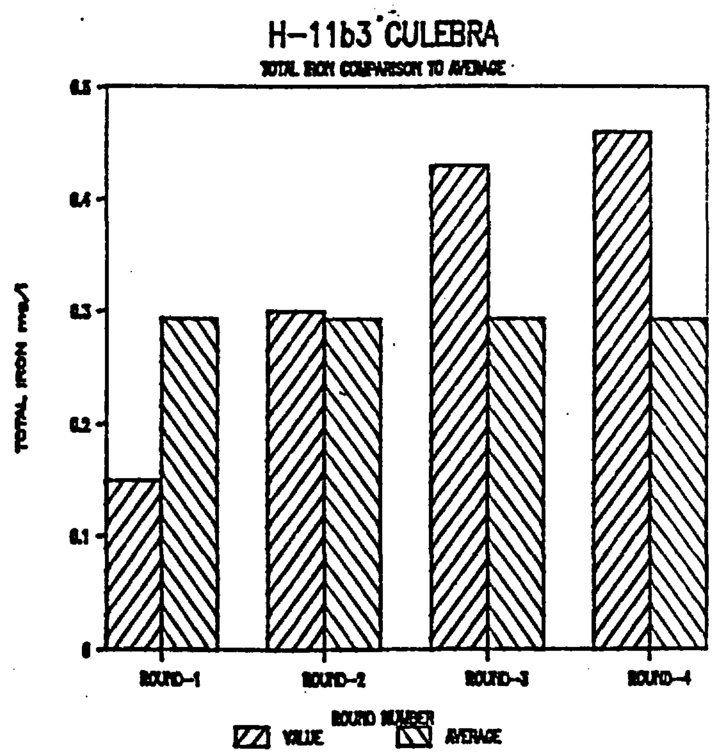

H-07b1 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

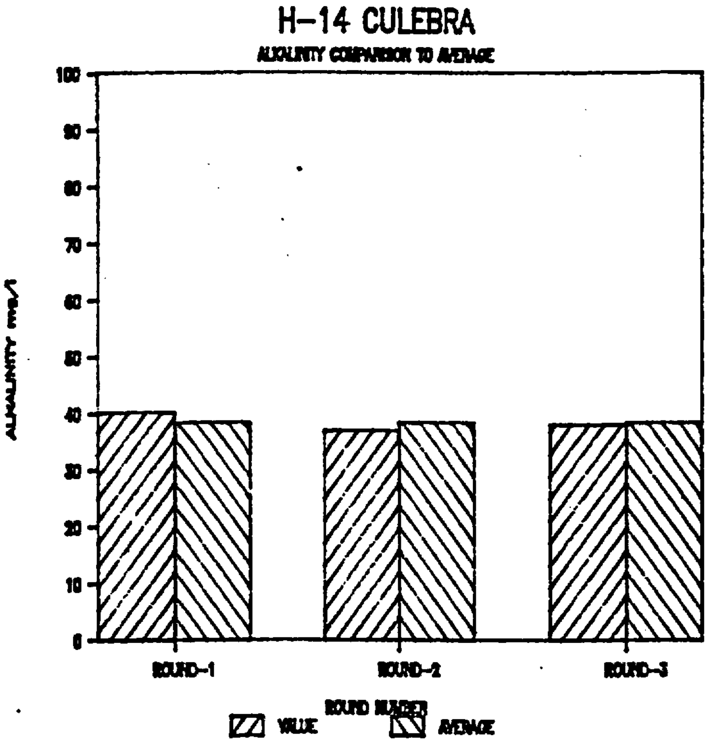

H-07b1 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

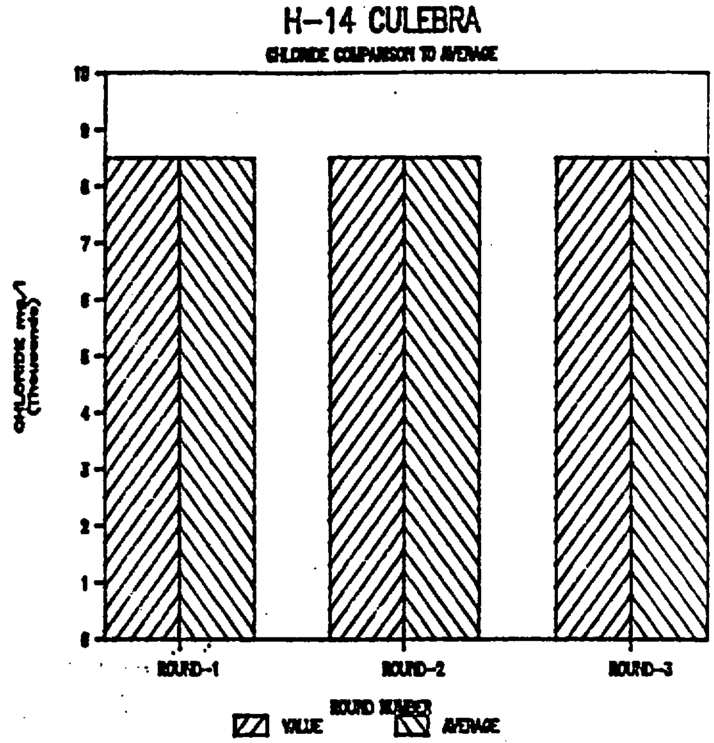

H-11b3 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

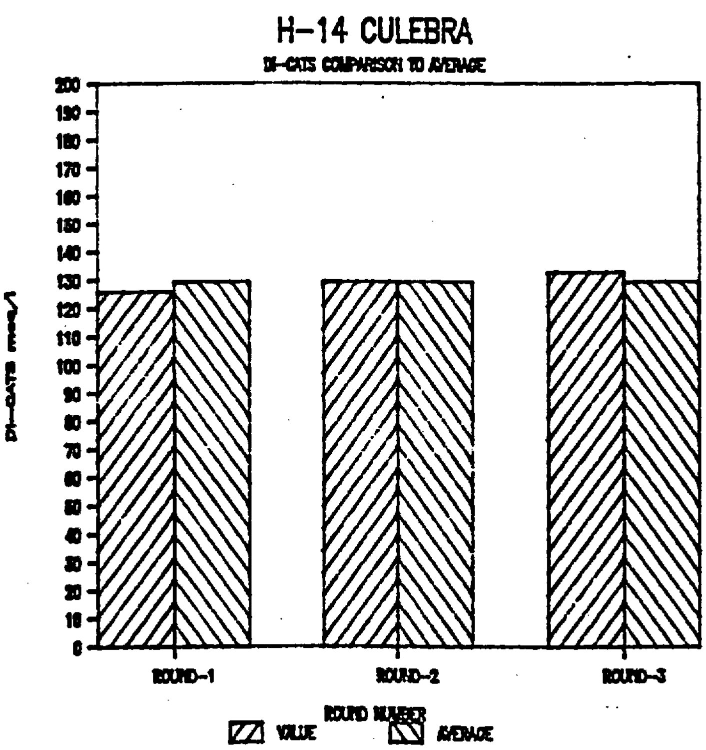

H-11B3 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

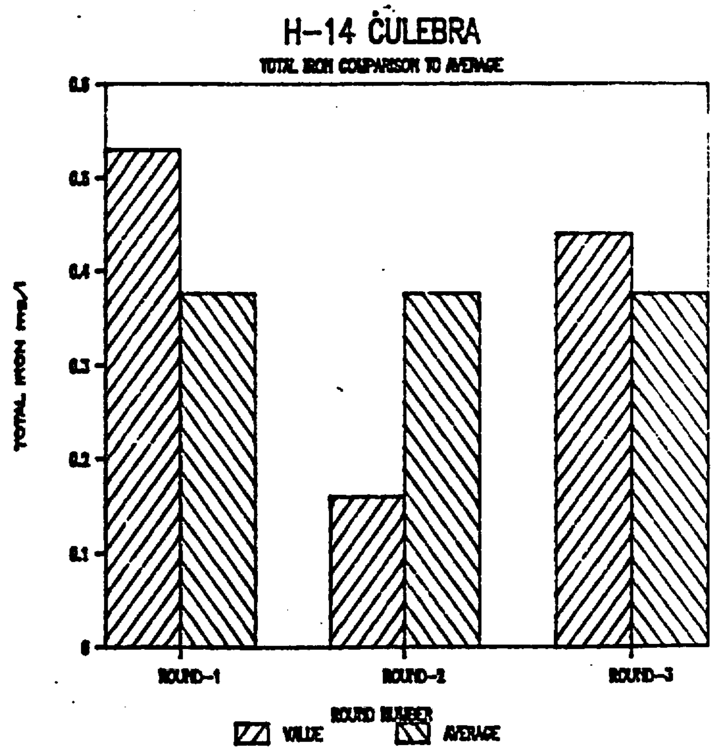

H-11b3 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

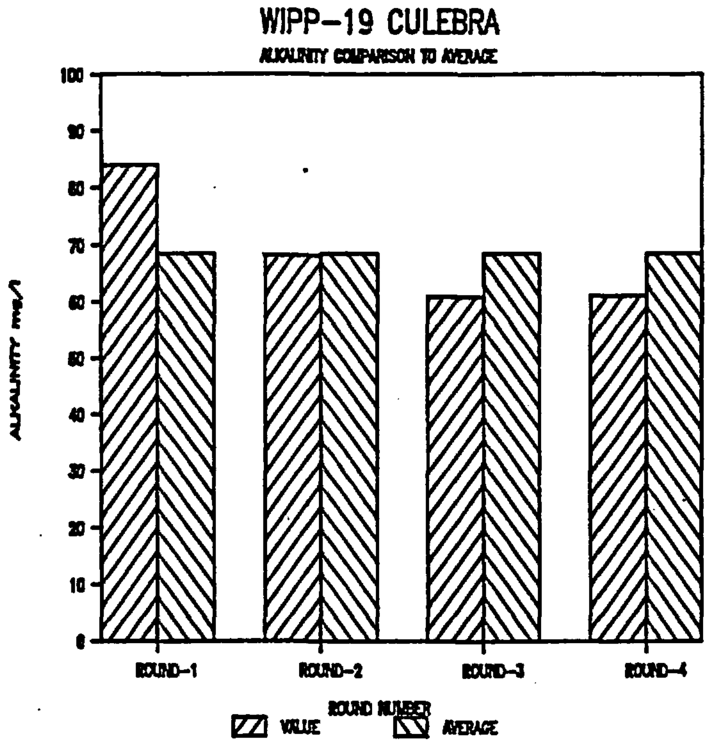

H-11b3 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

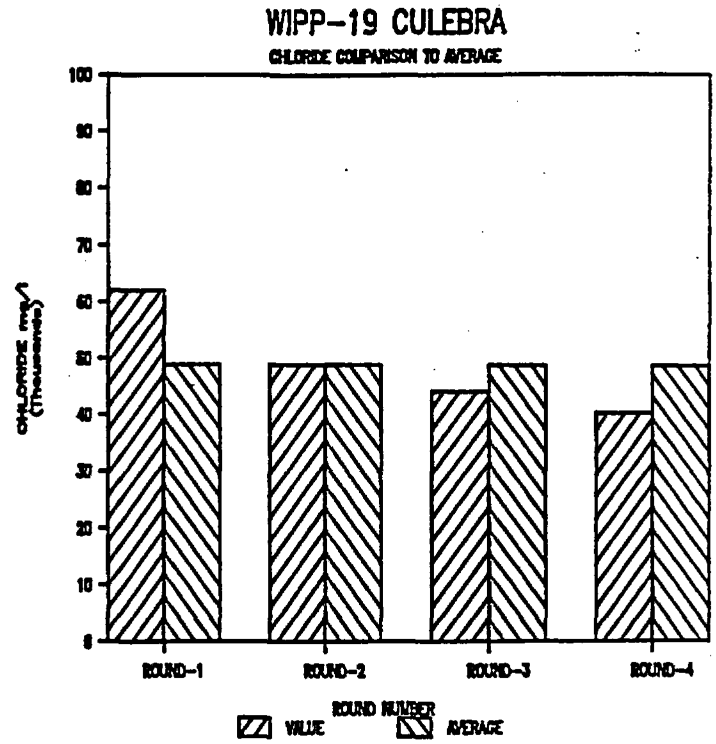

H-14 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
0
10
20
30
40
50
60
70
80
90
100
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

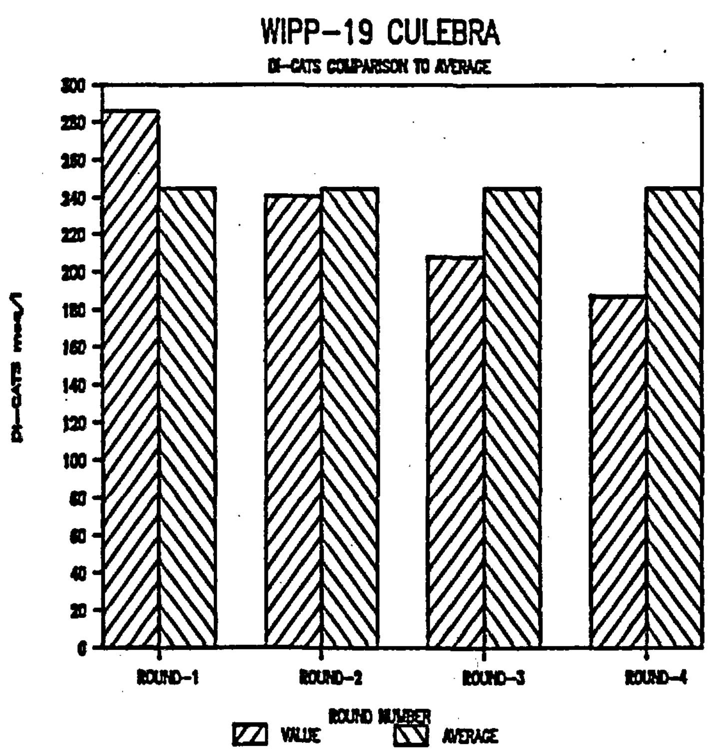

H-14 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
(Thousands)
0
1
2
3
4
5
6
7
8
9
10
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

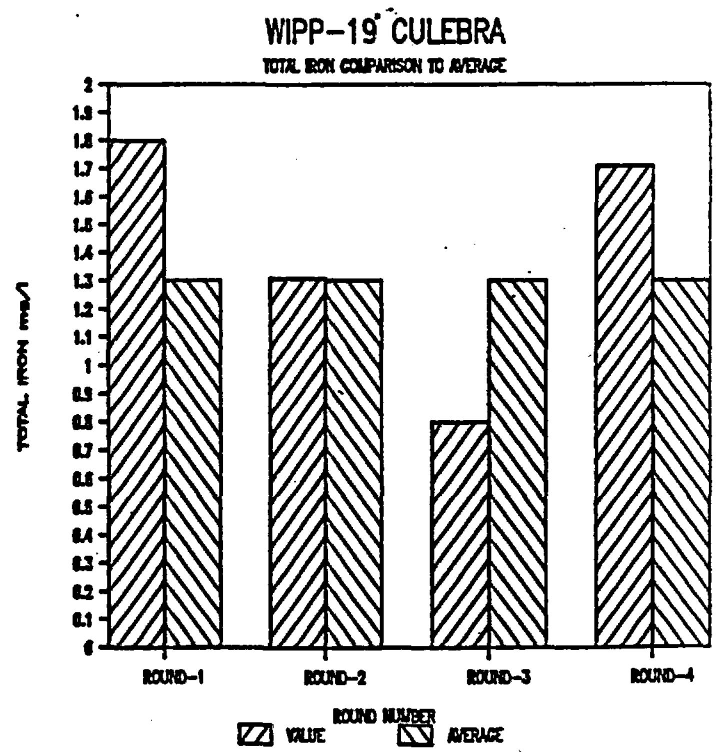

H-14 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

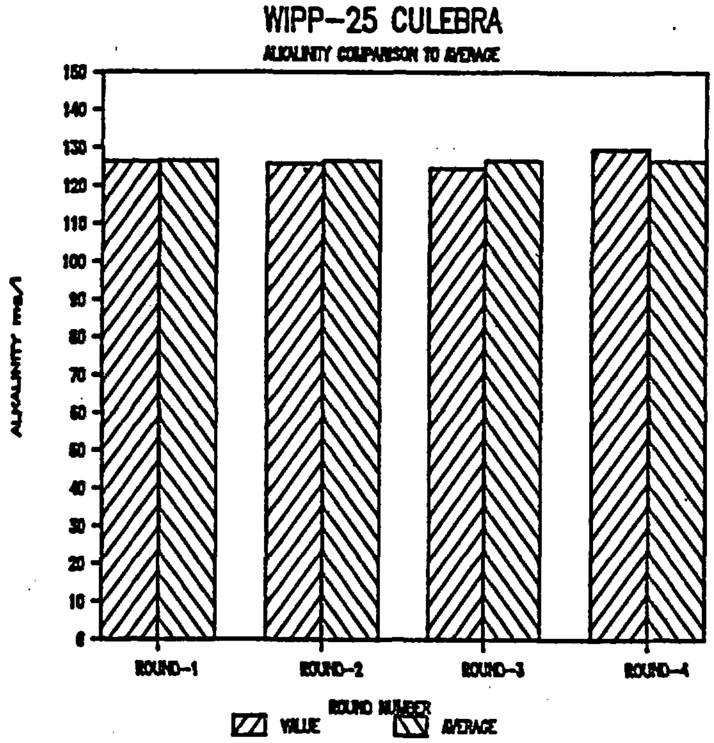

H-14 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
0
0.1
0.2
0.3
0.4
0.5
0.6
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

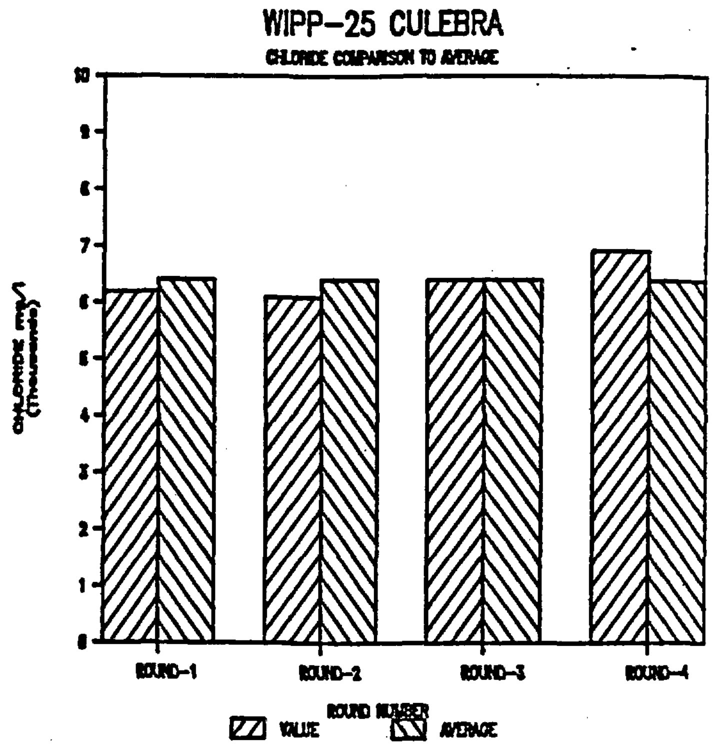

WIPP-19 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

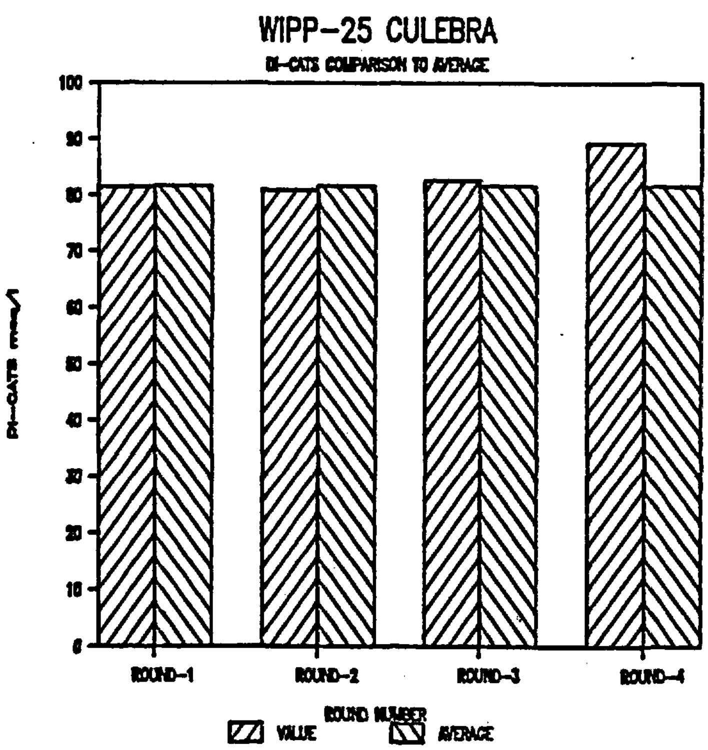

WIPP-19 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

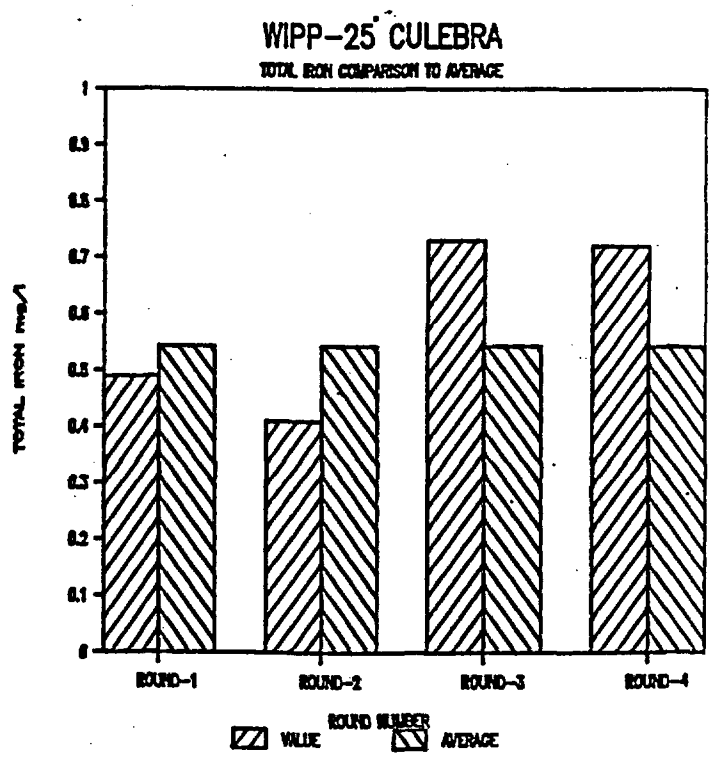

WIPP-19 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


WIPP-19 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


WIPP-25 CULEBRA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


WIPP-25 CULEBRA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
(Thousands)
0
1
2
3
4
5
6
7
8
9
10
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


WIPP-25 CULEBRA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
0
10
20
30
40
50
60
70
80
90
100
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

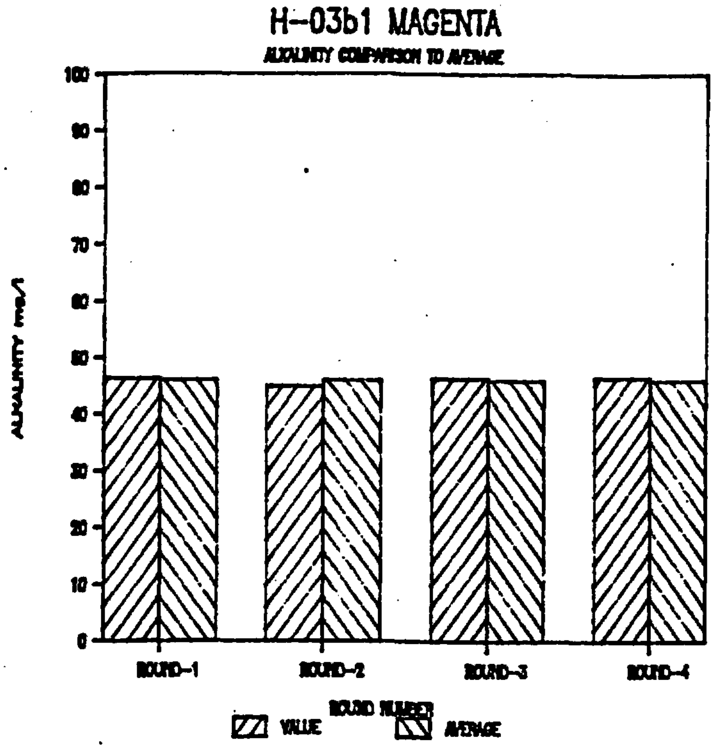

WIPP-25 CULEBRA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

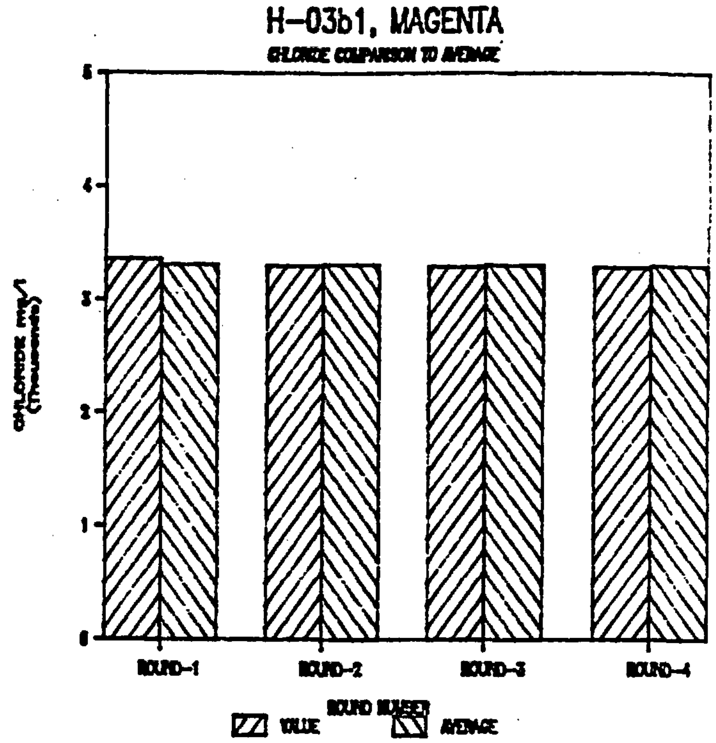
APPENDIX XI

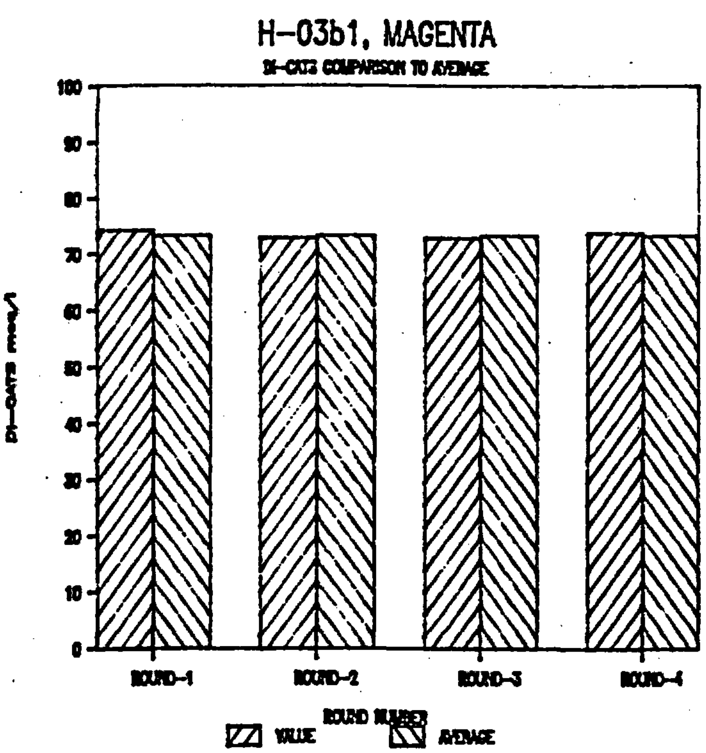
THE AVERAGE OF SELECTED LAST DAY SERIAL SAMPLING PARAMETERS
FOR MAGENTA AND DEWEY LAKE WELLS SAMPLED IN 1989
WHICH WERE NOT SAMPLED FOR THE FIRST TIME

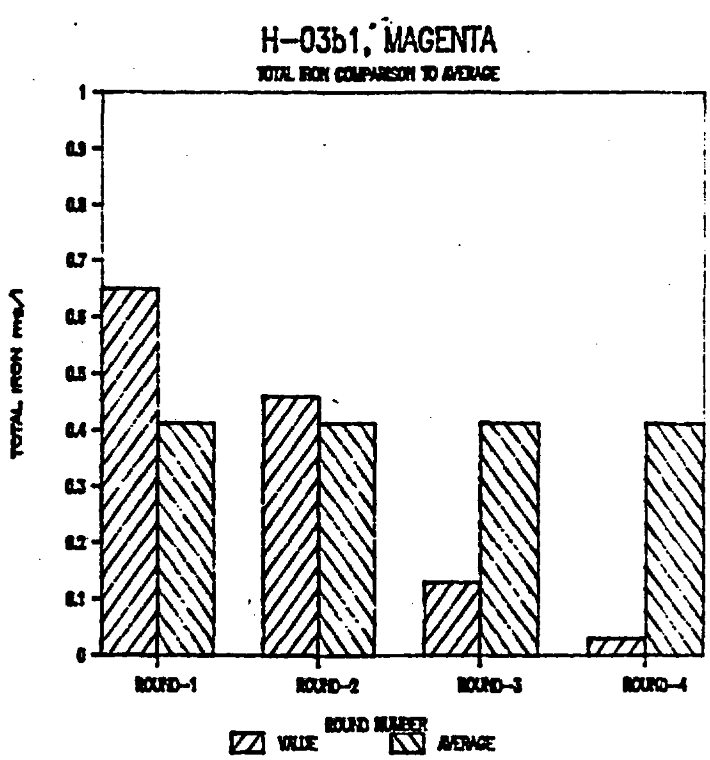
PARAMETER ROUND		MAGENTA WELLS H-03b1	MAGENTA WELLS H-04c	MAGENTA WELLS H-05c	MAGENTA WELLS H-06c	DEWEY LAKE WELLS RANCH WELL	DEWEY LAKE WELLS BARN WELL	DEWEY LAKE WELLS TWIN WELLS (PASTURE)
ALKALINITY	mg/l							
ROUND-1		46.4	76.5	57.3	50.5	217.3	276.0 *	224.7
ROUND-2		45.0	84.6	57.2	51.9	40.0 *	284.0 *	215.0 *
ROUND-3		46.4	82.1	57.5	52.4	249.0 *	283.4 *	221.0 *
ROUND-4		46.6	79.7	57.2	52.5	250.8 *		
	X	46.10	80.73	57.30	51.83	189.28	281.13	220.23
	S	0.64	2.99	0.12	0.80	87.21	3.64	4.00
	CV	0.01	0.04	0.00	0.02	0.46	0.01	0.02
CHLORIDE	mg/l							
ROUND-1		3363.0	8360.0	1050.0	418.0	396.5	51.5 *	44.1
ROUND-2		3302.0	8400.0	1040.0	420.0	470.0 *	43.0 *	400.0 *
ROUND-3		3300.0	8310.0	1030.0	408.0	453.0 *	46.8 *	38.5 *
ROUND-4		3299.0	8407.0	1023.0	404.0	328.0 *		
	X	3316.00	8369.25	1035.75	412.50	411.88	47.10	160.87
	S	27.16	38.62	10.21	6.69	55.55	3.48	169.11
	CV	0.01	0.00	0.01	0.02	0.13	0.07	1.05
DICATIONS	meq/l							
ROUND-1		74.3	69.2	41.9	41.1	37.8	6.4 *	5.9
ROUND-2		73.0	68.0	41.5	41.0	39.0 *	7.5 *	40.0 *
ROUND-3		73.0	68.5	42.1	41.3	39.0 *	6.5 *	4.1 *
ROUND-4		73.9	68.9	42.8	40.6	31.8 *		
	X	73.43	68.57	41.83	41.13	38.60	6.80	16.67
	S	0.61	0.49	0.25	0.12	0.57	0.50	16.52
	CV	0.01	0.01	0.01	0.00	0.01	0.07	0.99
TOTAL IRON	mg/l							
ROUND-1		0.65	1.85	2.26	0.38	NS	NS	NS
ROUND-2		0.46	0.22	0.29	0.19	NS	NS	NS
ROUND-3		0.13	0.18	0.69	0.34	NS	NS	NS
ROUND-4		0.03	0.20	0.21	0.31	NS	NS	NS
	X	0.41	0.75	1.08	0.30			
	S	0.21	0.78	0.85	0.08			
	CV	0.52	1.04	0.79	0.27			

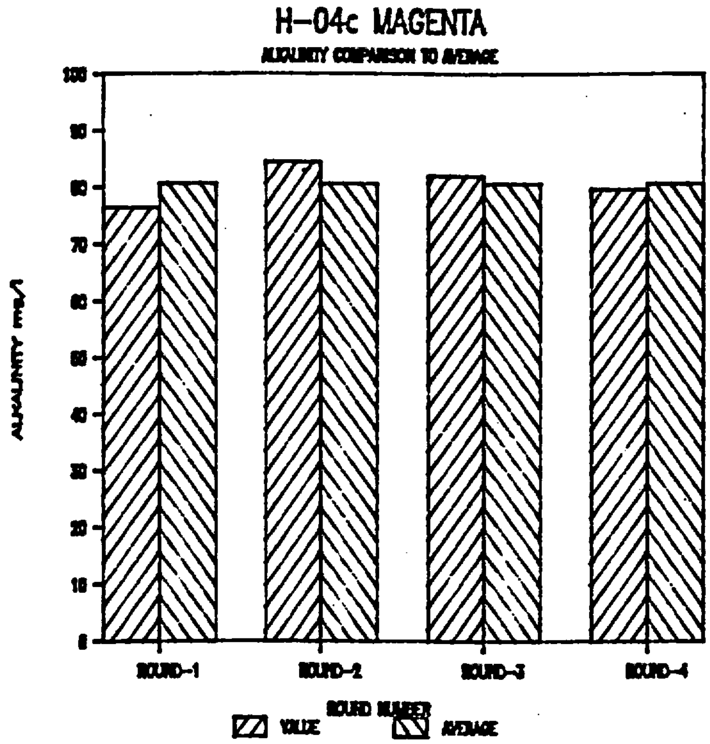
(X) AVERAGE (S) STANDARD DEVIATION (CV) COEFFICIENT OF VARIANCE (NS) NOT SAMPLED
(*) INDICATES THAT SAMPLE WAS A GRAB SAMPLE, NOT A SERIAL SAMPLE.

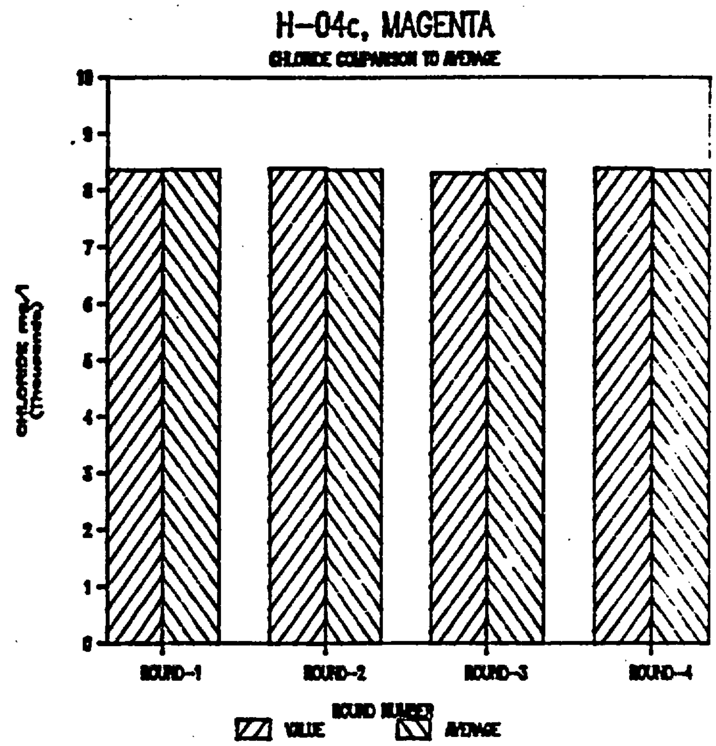

H-03b1 MAGENTA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

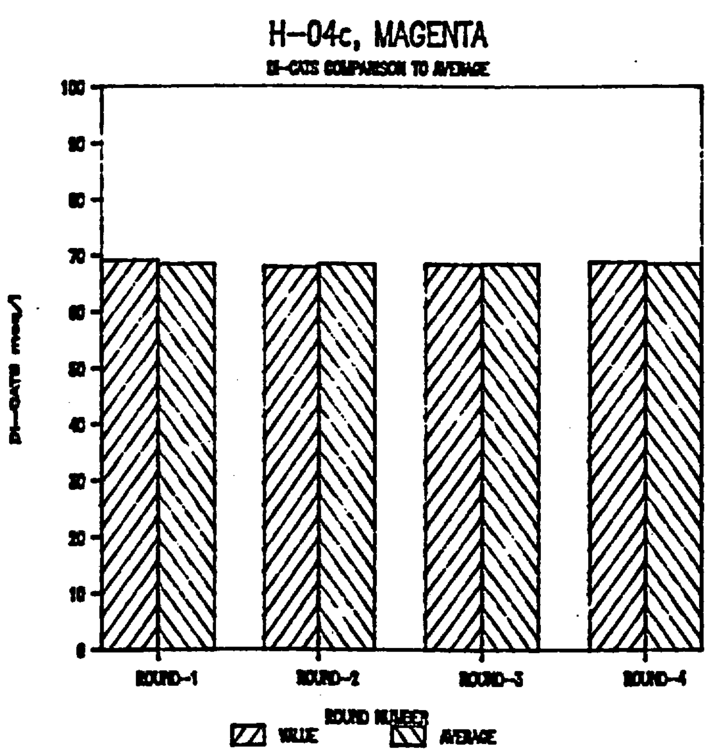

H-03b1, MAGENTA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

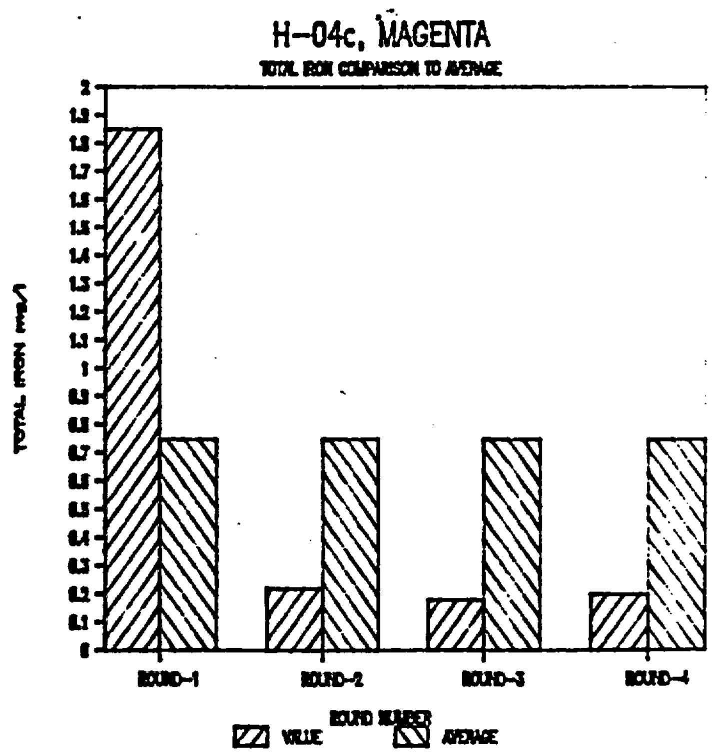

H-03b1, MAGENTA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

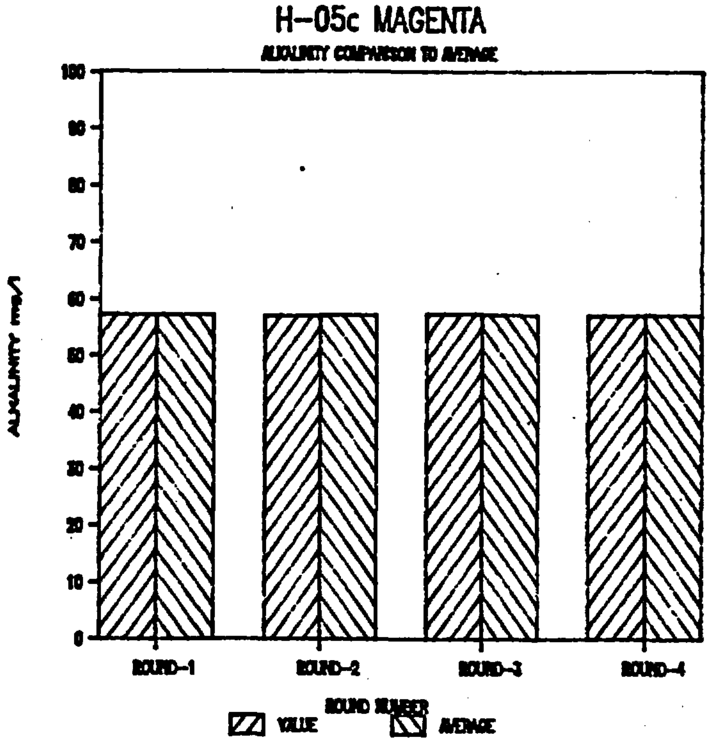

H-03b1, MAGENTA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

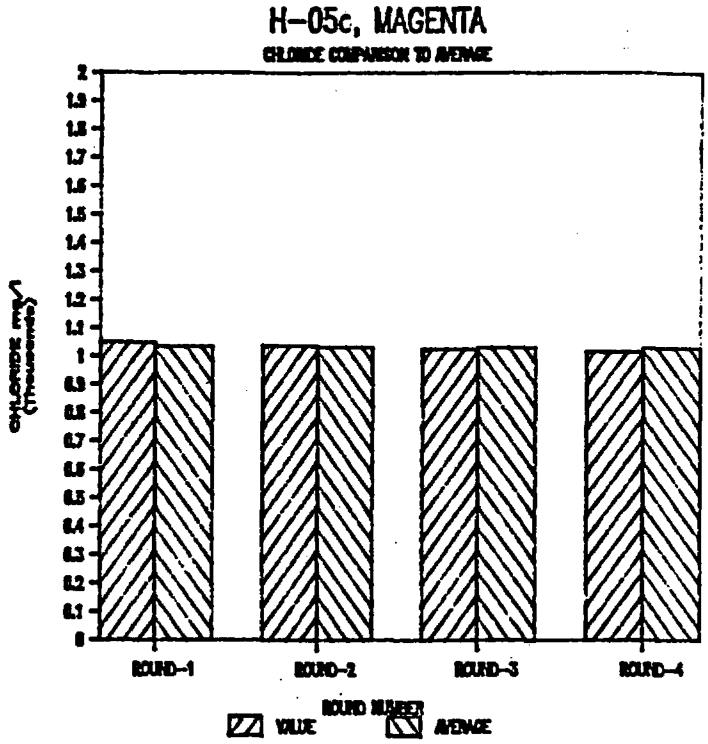

H-04c MAGENTA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
0
10
20
30
40
50
60
70
80
90
100
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

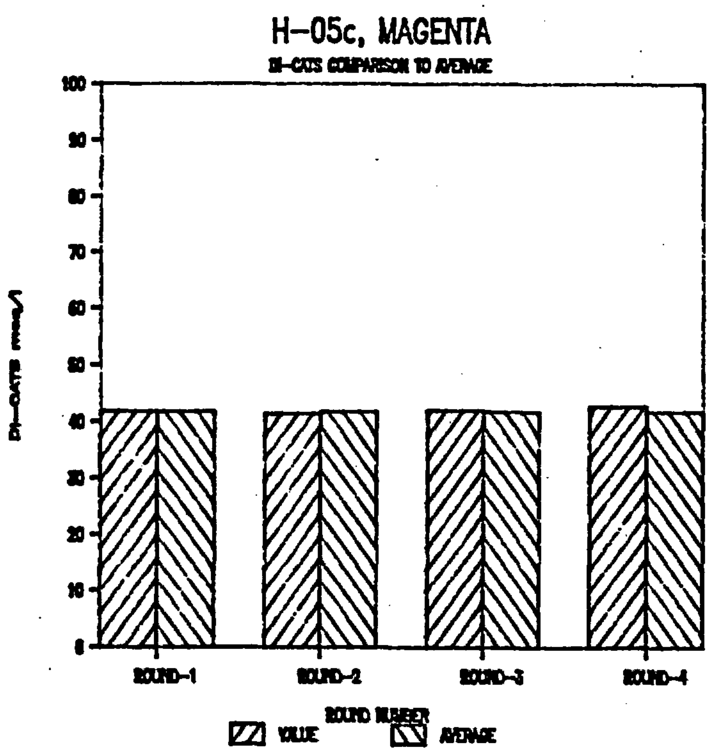

H-04c, MAGENTA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l (Thousands)
0
1
2
3
4
5
6
7
8
9
10
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

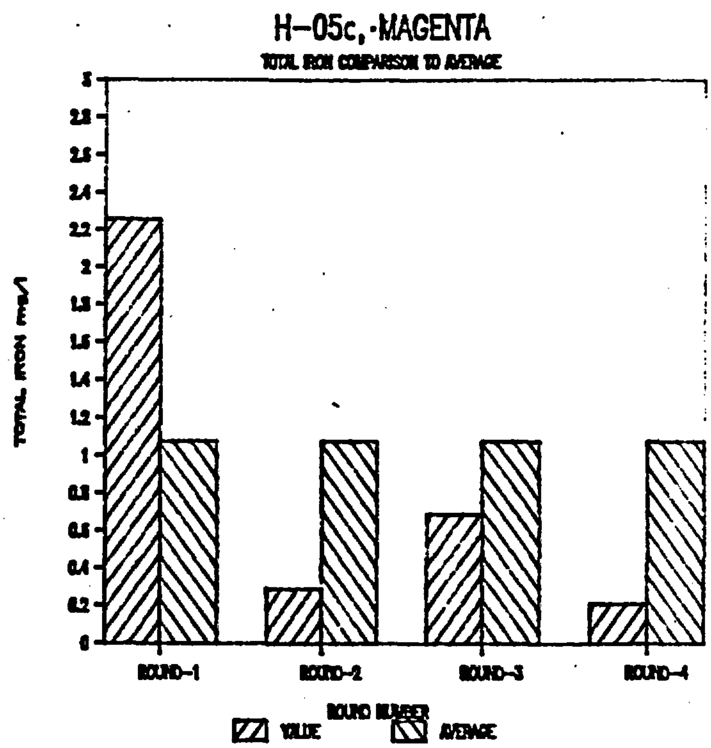

H-04c, MAGENTA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
0
10
20
30
40
50
60
70
80
90
100
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

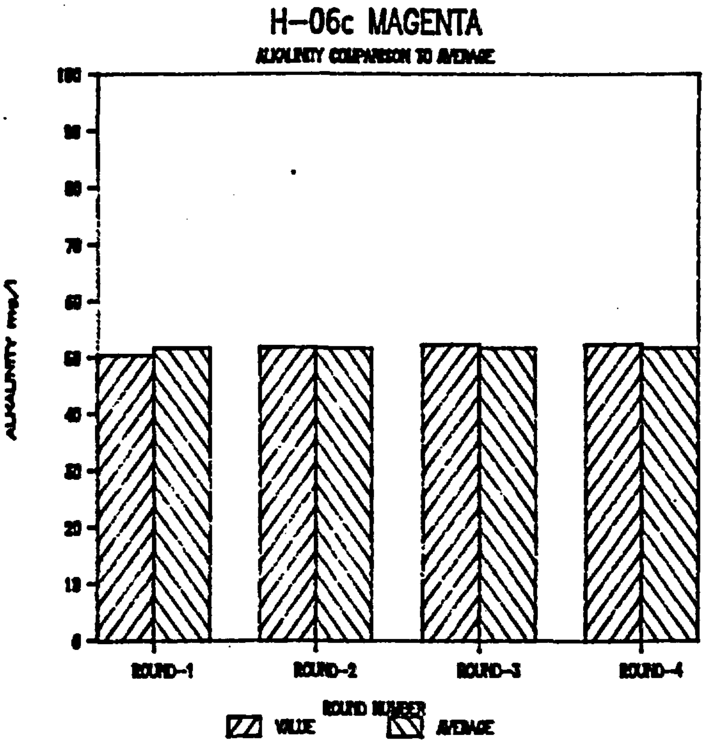

H-04c, MAGENTA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

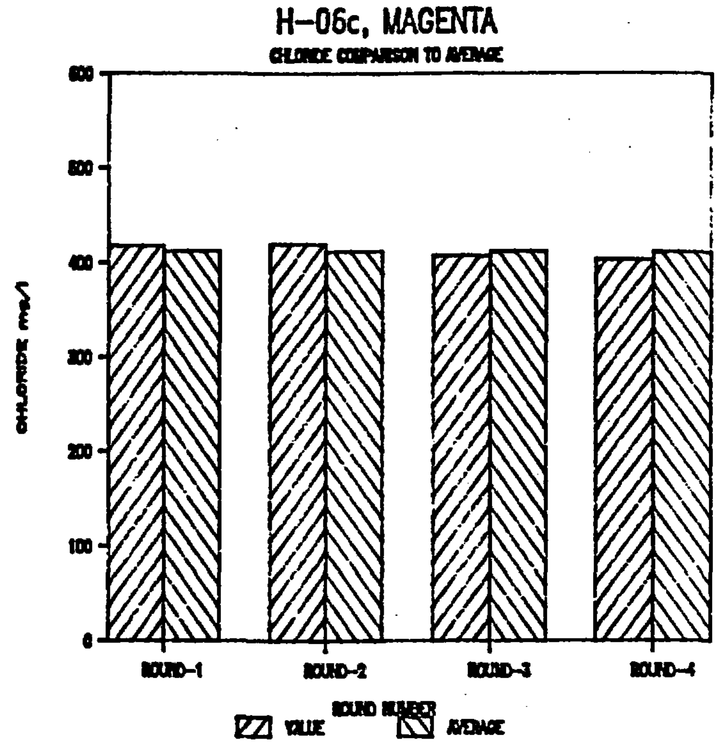

H-05c MAGENTA
ALKALINITY COMPARISON TO AVERAGE
ROUND-1
ROUND-2
ROUND-3
ROUND-4
VALUE
AVERAGE

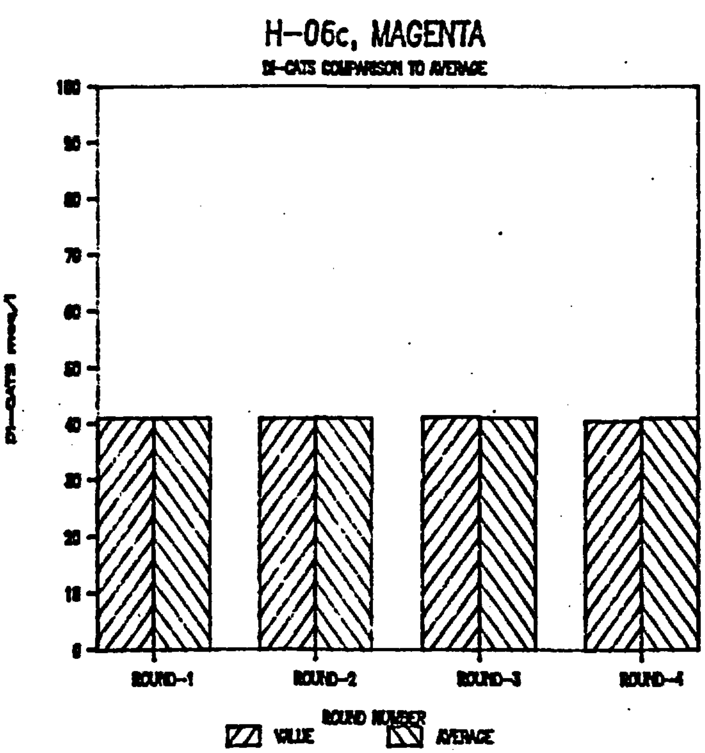

H-05c, MAGENTA
CHLORIDE COMPARISON TO AVERAGE
ROUND-1
ROUND-2
ROUND-3
ROUND-4
VALUE
AVERAGE

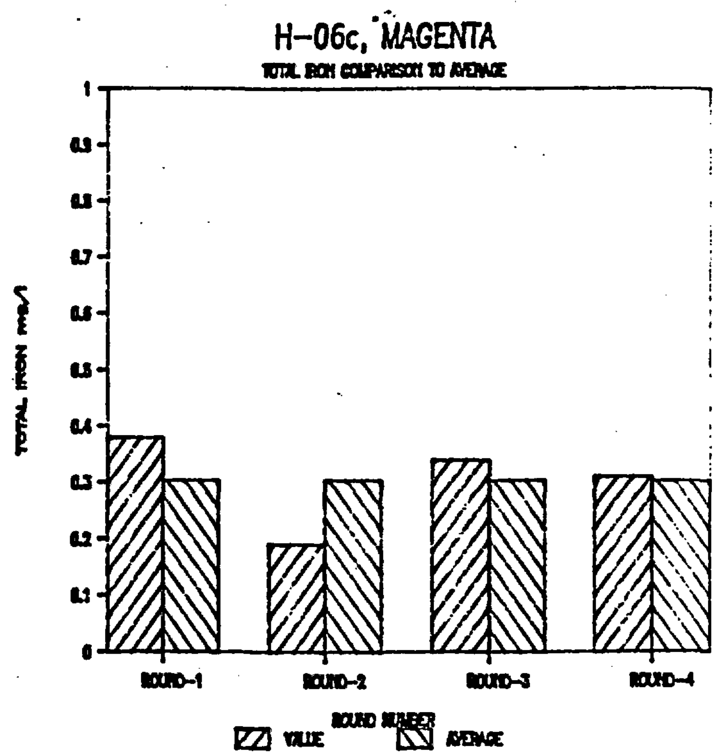

H-05c, MAGENTA
DI-CATS COMPARISON TO AVERAGE
ROUND-1
ROUND-2
ROUND-3
ROUND-4
VALUE
AVERAGE

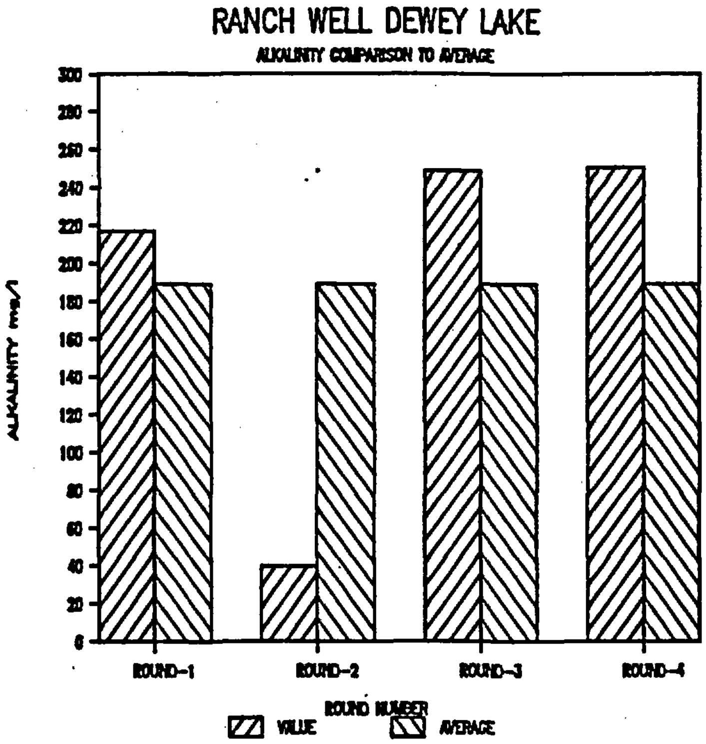

H-05c, MAGENTA
TOTAL IRON COMPARISON TO AVERAGE
ROUND-1
ROUND-2
ROUND-3
ROUND-4
VALUE
AVERAGE

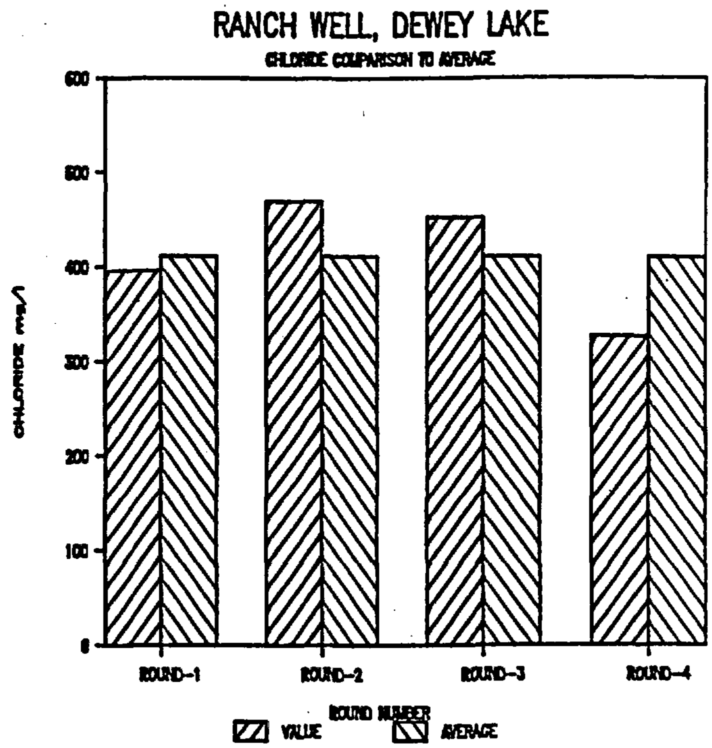

H-06c MAGENTA
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

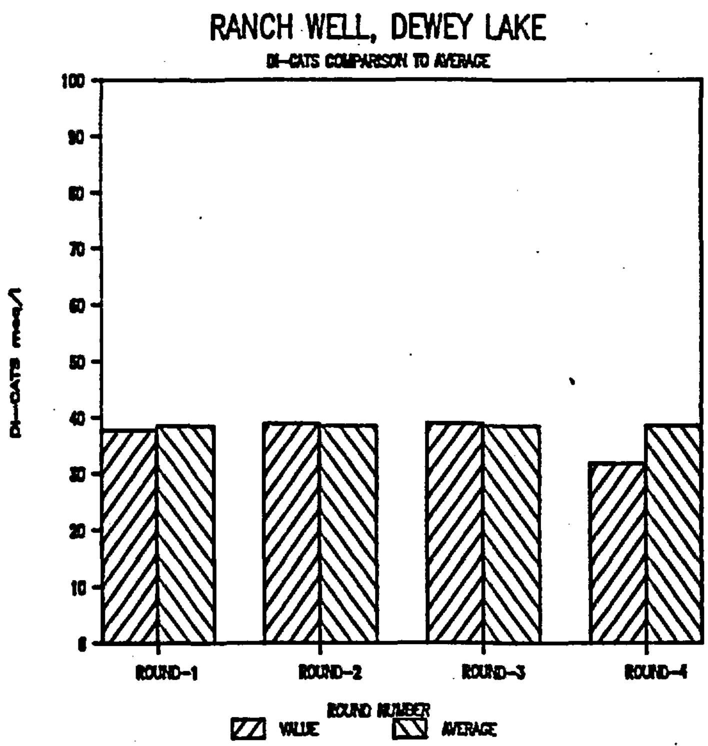

H-06c, MAGENTA
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

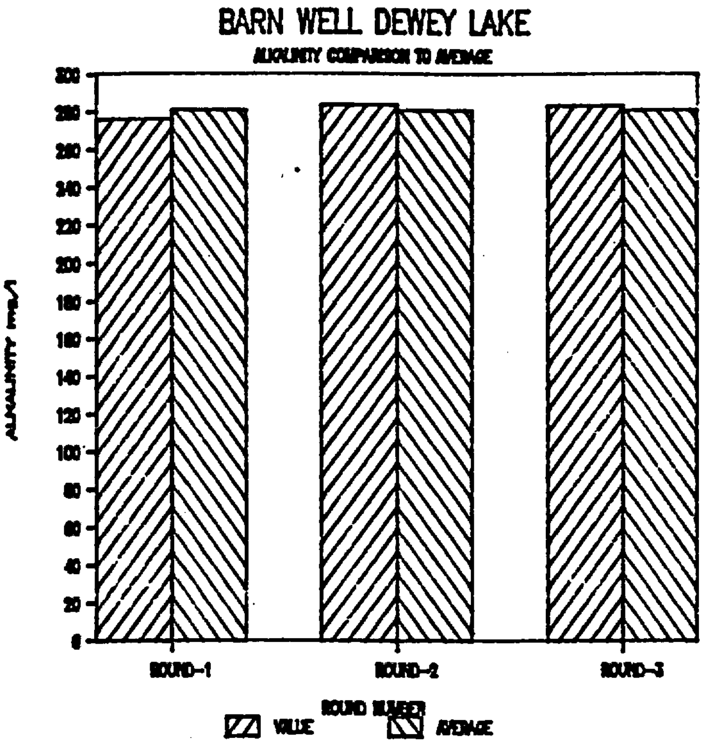

H-06c, MAGENTA
DI-CATS COMPARISON TO AVERAGE
DI-CATS mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

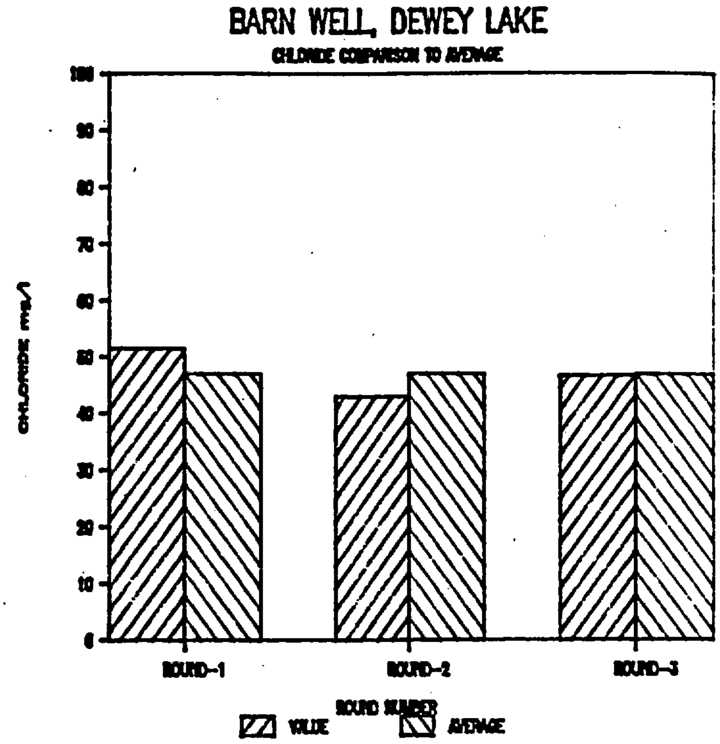

H-06c, MAGENTA
TOTAL IRON COMPARISON TO AVERAGE
TOTAL IRON mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

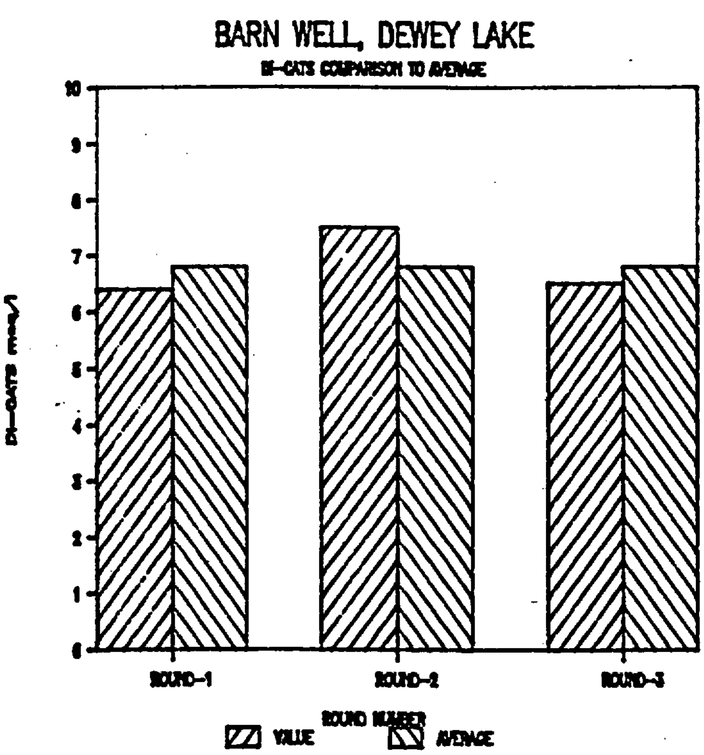

RANCH WELL DEWEY LAKE
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


RANCH WELL, DEWEY LAKE
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
600
500
400
300
200
100
0
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE


RANCH WELL, DEWEY LAKE
DI-CATS COMPARISON TO AVERAGE
DI-CATS meq/l
100
90
80
70
60
50
40
30
20
10
0
ROUND-1
ROUND-2
ROUND-3
ROUND-4
ROUND NUMBER
VALUE
AVERAGE

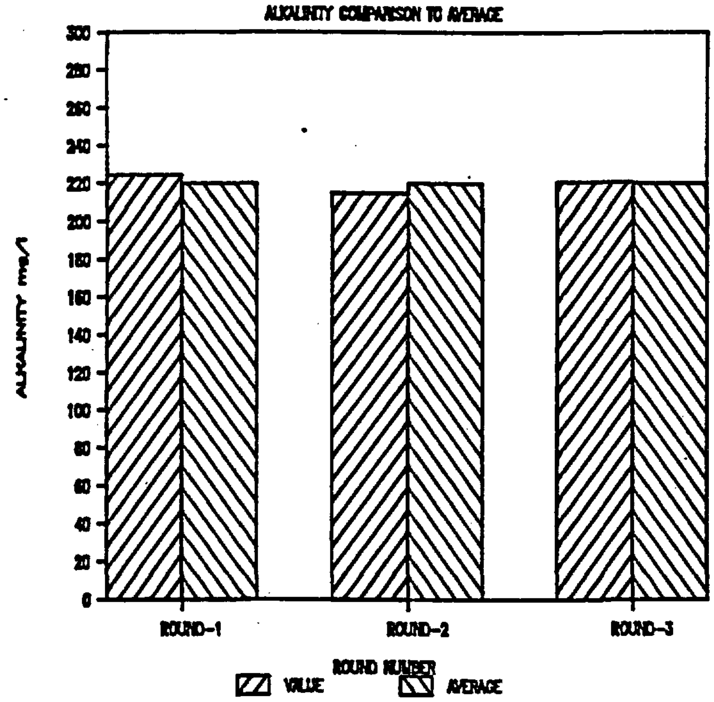

BARN WELL DEWEY LAKE
ALKALINITY COMPARISON TO AVERAGE
ALKALINITY mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE


BARN WELL, DEWEY LAKE
CHLORIDE COMPARISON TO AVERAGE
CHLORIDE mg/l
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE


BARN WELL, DEWEY LAKE
ROUND-1
ROUND-2
ROUND-3
ROUND NUMBER
VALUE
AVERAGE

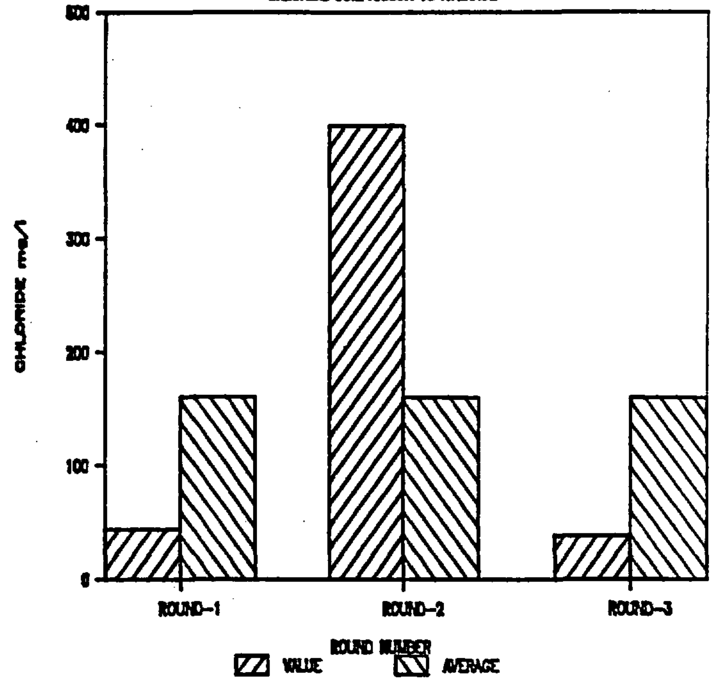
TWIN PASTURE WELL DEWEY LAKE

ALKALINITY COMPARISON TO AVERAGE



TWIN PASTURE WELL, DEWEY LAKE

CHLORIDE COMPARISON TO AVERAGE



TWIN WELL PASTURE, DEWEY LAKE

DI-CATS COMPARISON TO AVERAGE