Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

Fermilab 92/150
1104.100
UC-41

Site Environmental Report

For Calendar Year 1991

May 1, 1992

D. W. Grobe

Operated by Universities Research Association, Inc.
Under Contract with the United States Department of Energy,
Chicago Operations Office, Batavia Area Office

Fermi National Accelerator Laboratory
P. O. Box 500, Batavia, Illinois 60510

Fermilab 92/150
1104.100
UC-41

FERMILAB

SITE ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1991

by

D.W. Grobe, Editor

May 1, 1992

Contributors:

J. D. Cossairt,
R. Allen, V. R. Cupps, A. J. Elwyn, P. J. Hojsak,
K. Isakson, P. Kesich, E. Mieland, K. Moss, R. Walton

Operated by Universities Research Association, Inc.
Under Contract with the United States Department of Energy,
Chicago Operations Office, Batavia Area Office

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY FOR CY-1991 1

1.1 Compliance Summary 1
1.2 Environmental Program Information Summary 3
1.3 Environmental Radiological Surveillance Information 3

1.3.1 Radioactive Airborne Emissions 3
1.3.2 Penetrating Radiation 4
1.3.3 Radioactive Discharges to Surface Water 4
1.3.4 Monitoring for Radioactivity in Groundwater 5

1.4 Environmental Non-Radiological Surveillance Program Information 5

1.4.1 Airborne Emissions 5
1.4.2 Surface Waters 5
1.4.3 Groundwater 6

2.0 INTRODUCTION 6

2.1 Site Mission 6
2.2 Major Activities 6

2.2.1 Accelerator History 6
2.2.2 Current Operations 6

2.3 Operational Highlights 7
2.4 Site Description 7
2.5 Surface Characteristics of the Site 8

2.5.1 Industrial Water Ponding Systems 8

2.6 Sewage Treatment 9
2.7 Drinking Water Supplies 9
2.8 Subsurface Characteristics of the Site 9
2.9 Demography 10

3.0 COMPLIANCE SUMMARY 11

3.1 Current Issues and Actions 16
3.2 Environmental Permits 19

4.0 ENVIRONMENTAL PROGRAM INFORMATION 19

4.1 Environmental Program Description 19
4.2 Summary of Environmental Monitoring Performed in CY-1991 20
4.3 Description of Environmental Permits 21
4.4 Environmental Assessment for the Fermilab Main Injector 22
4.5 Prairie Reconstruction Activities 23
4.6 Summary of Prehistoric Archaeological Work at Fermilab 23
4.7 Environmental Survey Items 23
4.8 Pollution Prevention Awareness and Waste Minimization 25
4.9 ParkNet 26

4.10 Environmental Training....26
4.11 RCRA Facilities Investigation (RFI)....26

5.0 **Environmental Radiological Program Information**....27

5.1 Environmental Radiation Monitoring....27
5.2 Penetrating Radiation....27
5.3 Airborne Radioactivity....29
5.4 Monitoring Surface and Groundwater for Accelerator-Produced Radioactivity....30

5.4.1 Groundwater Radiological Surveillance....30
5.4.2 Groundwater Sampling for Radioactivity....31

5.4.2.1 Distribution Wells....32
5.4.2.2 Boring Holes....32

5.4.3 Surface Water Sampling for Radioactivity....32

5.4.3.1 Surface Water Sampling Plan....32
5.4.3.2 EIS/ODIS Reporting....32
5.4.3.3 Surface Water Surveillance for Radioactivity....33

5.5 Soil and Sediment Surveillance....34

5.5.1 Soil/Sediment Sampling....34
5.5.2 Soil Activation....34
5.5.3 Beryllium-7....35

5.6 Assessments of Potential Radiation Dose to the Public....35

5.6.1 Radon Assessment Conducted in CY-1989/1990....36

6.0 **ENVIRONMENTAL MONITORING FOR NONRADIOACTIVE POLLUTANTS**....37

6.1 Conventional Air Emissions....37

6.2.1 Chlorine....37
6.2.2 Bromine....37
6.2.3 Heavy Metals and Other Toxic Materials....38

6.3 Pesticides....38

6.3.1 Surface Waters....38
6.3.2 Annual and Perennial Weeds and Grasses....39
6.3.3 Insects....39
6.3.4 Miscellaneous Pest Control....40
6.3.5 Agricultural Pest Control Program....40

6.4 Polychlorinated Biphenyls....40
6.5 Chlorides....40
6.6 SARA Title III Chemical Inventory Findings....41
6.7 Environmental Occurences....41

7.0 QUALITY ASSURANCE IN CY-1991..42

7.1 Quality Assurance in Sampling Procedures..42
7.2 Quality Assurance in Analysis..43

7.2.1 Analytical Procedures at IT Corporation..43
7.2.2 Additional Quality Assurance Efforts..43

8.0 REFERENCES..44

9.0 ACKNOWLEDGMENTS..48

10.0 DISTRIBUTION LIST..49

APPENDIX A Tables..51

APPENDIX B Figures..77

APPENDIX C Acronyms..91

1.0 EXECUTIVE SUMMARY FOR CY-1991

This report summarizes the environmental status of Fermi National Accelerator Laboratory (Fermilab) for Calendar Year 1991 (CY-1991). It includes descriptions of the Fermilab site, mission, the status of compliance with applicable environmental regulations, planning and activities to accomplish compliance, and a comprehensive review of environmental surveillance, monitoring, and protection programs. Throughout its development, the Fermilab facility has exhibited a concern for protection of the environment. This has led to a philosophy of respecting environmental protection concerns at all stages of design and operation. The surveillance program monitors the Fermilab policy to protect the public, employees, and the environment from any adverse effects due to Lab activities and to minimize environmental impacts to the greatest degree practiceable.

1.1 Compliance Summary

Fermilab continues to strive for compliance with Department of Energy (DOE) orders and other Federal, State, and local environmental laws and regulations. These include, but are not limited to, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Clean Air Act (CAA), the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), the Toxic Substances Control Act (TSCA), and the National Environmental Policy Act (NEPA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), Executive Order 11988 "Flood Plain Management," and Executive Order 11990 "Protection of Wetlands." There were no abnormal occurrences which had an impact on the public, the environment, facility or its operation in CY-1991. The disposal of asbestos and airborne radionuclide and conventional air pollutant emissions from Fermilab facilities are regulated under the Clean Air Act (CAA) and amendments to that Act. Ventilation stacks for beam tunnel enclosures are subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for radionuclide release from DOE facilities found in 40 CFR 61, Subpart H. All potential radioactive air release points were evaluated and found to be in compliance with these regulations. Fermilab reported to the United States Environmental Protection Agency (USEPA) an individual offsite dose of 0.03 mrem in CY-1991 due to airborne emissions. This is 0.3% of the 10 mrem/year standard. The collective effective dose equivalent to offsite populations was estimated to be 0.21 person-rem (2.1 person-mSv). Asbestos encountered during renovation or demolition projects is removed in accordance with applicable NESHAP and Occupational Safety and Health Act (OSHA) regulations. Asbestos waste material is properly bagged and shipped offsite for disposal.

Fermilab has only minor sources of conventional air pollutants. All necessary permits have been obtained for those sources. All permitted sources met permit conditions in CY-1991. Annual air emission reports were filed with the Illinois Environmental Protection Agency (IEPA).

1991

The National Pollutant Discharge Elimination System (NPDES) was developed to achieve the goals of the Clean Water Act (CWA). The Illinois Environmental Protection Agency (IEPA) has been delegated the authority to implement the NPDES program. The discharge of process wastewaters to surface waters is prohibited at Fermilab. An application for a sitewide NPDES permit governing the on-going release of non-process, non-contact cooling water from acceleration operations was prepared for submission to the IEPA. The preparation of this application required the mapping of Fermilab's complex cooling pond system, water flow calculations, and the measurement of specified potential contaminants including thermal loading. The application was submitted in April 1992 and it is anticipated that a NPDES permit will soon be issued for outfalls to three onsite creeks.

A RCRA Part B permit was issued to Fermilab Hazardous Waste Storage Facility (HWSF) by IEPA in late October 1991. A RCRA Facilities Investigation (RFI) Workplan was prepared and submitted to the IEPA for 17 (consolidated to 15) identified Solid Waste Management Units (SWMUs).

Fermilab received IEPA closure approval following an investigation for potential groundwater contamination from a leaking underground storage tank at 30 Sauk. There are four remaining underground storage tanks onsite.

Compounds regulated by the Toxic Substances Control Act (TSCA) onsite are polychlorinated biphenyls (PCBs) and asbestos. At Fermilab, PCBs are contained in electrical capacitor and transformer oil, and in soil contaminated by leaks or spills of these oils. During CY-1991, all remaining high voltage PCB capacitors were removed and properly disposed offsite. Investigations continued to support the evaluation of twenty-four sites around the Main Ring Accelerator where transformer oil containing 2-5% PCBs was historically drained onto the ground during maintenance sampling. Decontamination was completed at the P-2 manhole and at the Booster Gallery West where spills had resulted in contamination. Cleanup of affected areas was conducted in compliance with applicable regulations contained in 40 CFR 761. A reduction of PCB concentration was accomplished in fifteen Main Ring transformers through a detoxification process.

Numerous National Environmental Policy Act (NEPA) project review documents, Environmental Evaluations (EEs), were prepared and submitted to DOE for review and approval in CY-1991. All were determined to be categorically excluded from further NEPA review. Work continued on the preparation of an Environmental Assessment (EA) for the Fermilab Main Injector project. A Finding of No Significant Impact (FONSI) was published in the Federal Register in April 1992.

Fermilab anticipates the arrival of the Tiger Team in May 1992. In preparation for the visit of this group who will appraise Fermilab's management of Environment Safety and Health (ES&H) programs, the Laboratory conducted an internal self assessment which resulted in 514 findings and 264 concerns. An Action Plan was developed and is being implemented to resolve the noted deficiencies.

1991

1.2 Environmental Program Information Summary

Monitoring and surveillance are critical elements of an effective environmental protection program. Fermilab has established and implemented comprehensive environmental monitoring and surveillance programs to ensure compliance with legal and regulatory requirements imposed by Federal, State, and local agencies and to provide for the measurement and interpretation of the impact of Fermilab operations on the public and the environment. The surveillance and monitoring activities are selected to be responsive to both routine and potential releases of penetrating radiation and liquid or airborne effluents. To evaluate the effects of Fermilab operations on the environment, samples of effluents and environmental media collected on the site and at the site boundary were analyzed and compared to applicable guidelines and standards. Surface water, air, groundwater, and soil/sediment were monitored for radionuclide concentrations. Surface waters were analyzed for potential chemical constituents. External penetrating radiation doses were measured, providing information for the estimation of potential radiation exposure to off-site populations. The results of the environmental surveillance program are interpreted and compared with environmental standards where applicable. The status of environmental protection activities and progress on environmental restoration and corrective action activities is discussed in this report.

1.3 Environmental Radiological Surveillance Information

1.3.1 Radioactive Airborne Emissions

As a result of accelerator operation, airborne radionuclides are released from the target stations in the experimental areas and at the Antiproton Source used to produce the antiprotons. There were no unplanned releases in CY-1991. This year's releases from monitored stacks was 95.3 Curies (3.52×10^{12} Bq), while unmonitored vent stack releases were calculated at approximately 11.8 Curies (4.4×10^{11} Bq), by scaling emission rates per delivered protons from monitored stacks. Table 7 summarizes radioactive airborne emissions for CY-1991. Airborne radionuclides such as ^{11}C, ^{13}N, ^{38}Cl, ^{39}Cl and ^{41}Ar have been identified in Fermilab beam tunnel vent stack emissions (Bu89). During CY-1991, a total of 107.1 Curies (3.96×10^{12} Bq) were released from vent stacks onsite, resulting in a maximum effective dose equivalent of 0.028 mrem (2.8×10^{-4} mSv) to a member of the public at the site boundary. This is comparable to the last four years and well below the standard of 10 mrem/yr (1×10^{-1} mSv/year). The collective effective dose equivalent for CY-1991 air emissions was estimated to be 0.21 person-rem (2.1 person-mSv). CAP88-PC was used to model the sources and to make dose assessments. The Radionuclide Air Emissions Monitoring Specific Quality Implementation Plan documents the program for radionuclide air emission monitoring (Cu92).

1.3.2 Penetrating Radiation

Other sources of ionizing radiation from accelerator operations are due to operation of the fixed target experimental areas. These operations produce ionizing radiation in the form of muons. The maximum effective dose equivalent due to penetrating radiation at the Fermilab site boundary in CY-1991 was determined to be 7.2 mrem (7.2×10^{-2} mSv) near the northeast corner of the site due to the operations of the MC beamline in the Meson Area. At the location of the nearest residence exposed to muons from this beamline, the maximum effective dose equivalent was 4.2 mrem (4.2×10^{-2} mSv). The MW beamline, also in the Meson Area, delivered 3.9 mrem (3.9×10^{-2} mSv) to a different location at the site boundary. This corresponded to 2.0 mrem (2.0×10^{-2} mSv) to the nearest residence. The NM beam in the Neutrino Area delivered 4.1 mrem (4.1×10^{-2} mSv) at the site boundary to another location also near the northeast corner of the site. The nearest residence exposed to the muons from the NM beam is quite near the site boundary. All other beamlines delivered less than 1 mrem (1×10^{-2} mSv) to various locations. (See Section 5.2 for more details.) The measurements which form the basis of this assessment of effective dose equivalent also include the use of detectors sensitive to neutrons. No neutron fields of environmental significance were identified during CY-1991 operations.

The maximum site boundary dose (fence line assuming 24 hr/day exposure) from the radioactive material stored at the Railhead (Figure 1) was 0.8 mrem (8.0×10^{-3} mSv) for CY-1991. The Railhead is closer to the site boundary than is the nearest house, making the actual maximum radiation exposure to an individual offsite much lower. The maximum individual potential radiation exposure due to radiation from the Railhead was 0.2 mrem (2×10^{-3} mSv) during CY-1991.

The total potential radiation exposure to the general offsite population from operations during CY-1991 was 7.61 person-rem (7.61×10^{-2} person-Sv). A summary can be found in Table 10. This is comparable to the estimate of 8.0 person-rem (8.0×10^{-2} person-Sv) for CY-1990 due to the continued operations of the accelerator in the fixed target mode and the resultant muon production. Since the exposure to the offsite population is only from penetrating radiation and short-lived airborne radionuclides, the 50 year dose commitment from operations in CY-1991 will be the same as the effective dose equivalent received in CY-1991 reported here.

1.3.3 Radioactive Discharges to Surface Water

The offsite release of tritium (^{3}H) in surface water totalled approximately 3646 mCi (1.4×10^{11} Bq), compared to 2024 mCi (7.5×10^{10} Bq) in CY-1990 (Co91). The increase was the result of more water from reportable discharges leaving the site during CY-1991. Water left the site via the Kress Creek spillway for 63% of the year in CY-1991 compared with 74% the year before. The primary source of tritium in water reaching Casey's Pond from drainage ditches in the Research Area was tritiated water discharging from an underdrain system beneath the Neutrino Target Service

Building, a target, and a beam dump system. The target was the primary target in the Neutrino Area at one time receiving most of the protons accelerated by Fermilab. After the CY-1982 operating period ended, the target was moved to a new location with a different underdrain system. Thus, the tritium released in CY-1991 from this area was essentially from operations before CY-1983. The release from the Neutrino Target Service Building, though reported, is probably an anomaly due to a malfunctioning sump pump.

A summary of offsite releases of radioactive effluents in CY-1991 is given in Table 1.

1.3.4 Monitoring for Radioactivity in Groundwater

Radioactivation of soil can occur in some areas in the vicinity of beam targets and dumps. Onsite wells are routinely sampled for the presence of radioactivity. There has been no measurable accelerator-produced radioactivity found in these wells. See Table 17 for analysis specifications. Monitoring wells installed to allow sampling of the vadose zone in localized areas of soil activation have yielded samples with low concentrations of tritium.

1.4 Environmental Non-Radiological Surveillance Program Information

1.4.1 Airborne Emissions

Operating permits have been obtained as required for all identified sources of airborne emissions. Operations are reviewed at least annually to ensure that permitted equipment continues to operate and to be maintained in accordance with permit conditions. Fermilab is not a large source of air pollutants. Air pollution permits at Fermilab contain conditions for open burning, restrictions on amounts of nitrogen oxides that can be emitted from boilers, and limits on total organic emissions from freon degreasers. There have been no known instances of non-compliance emissions.

1.4.2 Surface Waters

Fermilab does not currently have a NPDES permit to discharge process wastewater to surface waters and therefore it is prohibited. The Laboratory has prepared a permit application for transmittal to the IEPA that will cover on-going releases of comingled non-process, non-contact cooling water and stormwater runoff to surface waters. In the future, sampling requirements will be determined by the NPDES permit. Currently annual samples of surface water are taken from selected bodies of water onsite and analyzed for trace metals, various organics, and pH. These analysis parameters were selected to measure contaminants from possible yet improbable onsite sources. In CY1991 surface water monitoring for chemical contaminants was limited to Kress Creek and the Fox River Inlet to Kress Creek. Table 2 summarizes sampling results. The Kress Creek watershed collects storm water runoff from the experimental beamline areas. Only samples taken as water entered the site via Kress Creek and the Fox River intake exceeded general water quality standards. These samples showed iron concentrations in excess of the standard. The sample taken of Kress Creek at the point where it leaves the site showed a decrease in iron concentration.

1.4.3 Groundwater

Public drinking water systems supplied by three onsite wells were monitored for bacterial and chemical contaminants as required in the regulations and rules of the Illinois Department of Public Health (IDPH) and Illinois Environmental Protection Agency (IEPA). All results showed the drinking water supplies to be in compliance.

Water samples from wells used to monitor for chlorides and chromates in an old perforated pipe field yielded measurable levels of chromium, hexavalent chromium, and chloride. Concentrations were below the maximum concentration limits established for drinking water in the Safe Drinking Water Act (SDWA). Results are given in Table 21.

2.0 INTRODUCTION

2.1 Site Mission

Fermilab is a national laboratory managed by Universities Research Association, Inc. (URA) for the U.S. Department of Energy (DOE). The Lab's mission is to provide resources to conduct basic research in high-energy physics and related disciplines. The Fermilab facility consists of a series of proton accelerators which became operational in 1972, producing higher energy protons than any other accelerator in the world.

2.2 Major Activities

2.2.1 Accelerator History

From 1976 throught 1982 substantial improvements allowed the accelerator to gradually increase its routine operation from the original design energy of 200 GeV (billion electron volts) to 400 GeV. In 1982, the addition of superconducting magnets allowed the particle energy to be doubled once again to 800 GeV. Studies initially involved only fixed-target configurations but in 1987 collisions of 900 GeV protons and anti-protons became possible.

2.2.2 Current Operations

To carry out its mission, the Laboratory operates an 8 GeV anti-proton source that provides anti-protons for the colliding beam studies program as well as several internal fixed-target experiments. A 2 TeV center-of-mass proton-anti-proton collider and two general purpose collider detectors support the collider program. Fermilab's 800 GeV proton synchrotron and the unique array of high-energy secondary beams available are utilized for fixed-target experiments.

1991

When the proton beam is extracted for fixed target physics from the 1.2 mile (2 km) diameter main accelerator, the protons are delivered to three different experimental areas onsite: the Meson, Neutrino, and Proton Laboratories located in the Research Area (Figure 1). For colliding beam studies, antiprotons are produced by extracting 120 GeV protons from the ring of conventional magnets inside the main accelerator tunnel. These protons strike a fixed target at the Antiproton Area (Figure 2) and negatively charged antiprotons are collected. Radioactivity is produced as a result of interaction of the accelerated protons with matter. The accelerator operations produce some airborne radioactivity as well as some radiation which penetrates the shielding material. Also, some radioactivation occurs in the water used to cool beam components and in the soil around the accelerator tunnel and external beamlines. There are numerous other activities conducted at the Lab in support of accelerator operation and site maintenance. When not providing beam for high energy physics experiments, 66MeV protons from the linear accelerator (Linac) are frequently used to produce neutrons for cancer patient treatment at the Neutron Therapy Facility (NTF).

2.3 Operational Highlights

During CY-1991, operation of the high-energy accelerators at Fermilab consisted of a fixed target run using 800 GeV beams of protons and antiprotons. This period of operations began in January with a fixed target experiment in the Antiproton Area. In June, operations delivering 800 GeV protons to the Neutrino and Proton Areas were added. Meson experiments began in July. Operations continued with beam being delivered to these areas through January 13, 1992.

2.4 Site Description

Fermilab is located in Kane and DuPage Counties in the greater Chicago area (Figure 3) on a 10.6 square miles (27.5 square kilometers) tract of land in an area which is rapidly changing from farming to residential use. There are many municipalities in the vicinity, resulting in a distinct pattern of increasing population concentration eastward toward Chicago (Figure 4).

The land within the site boundary was primarily farmland before the State of Illinois acquired it for the DOE Fermilab site. Much of the land, approximately 1740.5 acres (7.0 km^2) in CY-1991, has remained in crop production, primarily corn (Figure 13). A total of 918 acres (3.7 km^2) has been planted in native prairie vegetation to date. The site also includes areas of upland forest, floodplain woods, oak savanna, prairie remnant, non-native grassland, old fields, pastureland, fence rows, and various types of wetlands. In addition to the research accelerators, man-made structures onsite include various administrative, research, storage, and other support facilities. The small village of Weston, population 380 at the time the land was acquired for Fermilab, was located on the eastern side of the property (Figure 1). The remaining housing complex, known as the Village, now provides residences for visiting scientists.

1991

2.5 Surface Characteristics of the Site

The two major environmental features near the Laboratory are the Fox River to the West, and the West Branch of the DuPage River which passes east of the site (Figure 3). The Fox River flowed south with an average of 7.3 $X10^8$ gallons (2.8 X 10^9 liters) per day as measured at Algonquin, IL in CY-1991. The West Branch of the DuPage River flowed south at an average rate as measured near Warrenville of 8.1 X 10^7 gallons (3.1 X 10^8 liters) per day for the same period (Figure 3). Kress Creek, which flows to the West Branch of the DuPage River, averaged 1.2 X 10^7 gallons/day (4.6 X 10^7 liters/day) at West Chicago. Average daily flow rates were obtained from the U.S. Department of the Interior, Water Resources Division (Du92). The rainfall in the vicinity of Fermilab, taken at O'Hare International Airport, during 1991 was 35.02 inches (88.9 cm) (NOAA 91). The land on the site is relatively flat as a result of past glacial action. The highest area, with an elevation of 800 ft (244m) above mean sea level (MSL) is near the western boundary. The lowest point, with an elevation of 715 ft (218 m) above MSL, is in the southeast. There are three watersheds that collect water onsite: Kress Creek (to the north), Indian Creek (in the southwest), and Ferry Creek (in the southeast). Kress and Ferry Creeks are tributary to the West Branch of the DuPage River, while Indian Creek flows to the Fox River.

2.5.1 Industrial Water Ponding Systems

There are several water systems used for cooling magnets and for fire protection: The Industrial Cooling Water (ICW) System consists of Casey's Pond (Figure 2) at the end of the Neutrino Beamline and underground mains to fire hydrants and sprinkler systems throughout the Central Laboratory Area and Experimental Areas. Casey's Pond is supplied by surface drainage and can be supplied by pumping from the Fox River. The pond holds 18,000,000 gallons (68,000,000 liters).

The Swan Lake/Booster Pond System (Figure 2) is used for cooling purposes at the Central Utility Building (CUB). Water is pumped from the Booster Pond into a ditch in which it runs by way of West Pond into Swan Lake. The water is then returned to the Booster Pond by a return ditch. Water is also pumped from Swan Lake to NS1 Service Building (near G9 in Figure 6) for cooling purposes, from which it returns by a surface ditch. This system can be supplied water from the ICW System and it overflows into Indian Creek (Figures 2 and 5).

The Main Ring Ponding System consists of a series of interconnecting canals completely encircling the interior of the Main Ring with a large reservoir pond (Figure 2). This water is used in heat exchangers at the service buildings for cooling the Main Ring magnets. The system is generally supplied by surface drainage, although make-up water can be pumped from Casey's Pond. The system overflows into Lake Law (Figures 2 and 5).

1991

2.6 Sewage Treatment

Until late 1986 the Village sewage was treated onsite in the Village Oxidation Pond. This required an NPDES permit. In December 1986, the Village was connected to the City of Warrenville Sewer/Naperville (Springbrook Treatment Plant) system. The Naperville plant is a modern sewage treatment system with ample capacity. The IEPA terminated the NPDES permit for the Village Oxidation Pond on May 12, 1987, at the Department of Energy's request. The Main Site sewer system serving the Wilson Hall area was connected to the City of Batavia system June 26, 1979.

2.7 Drinking Water Supplies

The primary drinking water supply at Fermilab is provided by a well that taps the shallow Silurian aquifer, pumping from depths of approximately 65 ft. (19.8 m) to 220 ft. (67.1 m) deep (Sa82). This well, W-1 in Figure 7 is located in the Central Laboratory Area. A second well, W-3 in Figure 7 pumps from the same aquifer and supplies water to the Main Site system when demand exceeds the capacity of well W-1. Since January 28, 1987, the Village drinking water has been supplied from Warrenville, the neighboring community to the east. Well W-5 in Figure 7, became operational in November 1988, supplying water to the Colliding Beams Experiment Facility at D0. Eight additional shallow water wells serve individual buildings at outlying facilities onsite. These are wells formerly associated with the farm sites that existed when the land was acquired for the Fermilab site.

The Main Site system is chlorinated at the Central Utility Building (CUB) when Well W-1 is providing water. The alternate supply source, Well W-3, has its own reservoir and chlorinator. Monthly samples are analyzed from both systems by the IEPA for total coliform per 100 ml. The system at D0 is also a chlorinated system but uses sodium hypochlorite rather than chlorine gas. The chlorine level in these chlorinated drinking water supplies is tested each workday. The average use from Well W-1 and Well W-3 combined was approximately 85,000 gallons/day during CY-1991. Zero violations occurred in CY-1991 for the D0 and Main Site drinking water supplies.

2.8 Subsurface Characteristics of the Site

A number of studies have documented the hydrogeologic regime in the vicinity of the Fermilab site (DOE88, Pf74, Sa82, Vi85, Vi88). The geology of the Fermilab area can generally be characterized as about 100 feet (30.5 m) of glacial till composed primarily of low permeability clay overlying Silurian dolomite bedrock (Sa82). The clay acts as an impedance to groundwater flow through the glacial till. There is, however, a general lack of detailed knowledge about the hydraulic properties and flow characteristics of the glacial deposits at any given location. This is due to the sporadic occurrence of occasional sand and gravel deposits typical of glacial sediments. These irregular sand and gravel lenses occur across the region (Ze62). A basal sand and gravel horizon has also been identified across the site. The glacial deposit regions are most likely recharged by ponds and wetlands.

Fractures in the upper 10 feet (3 m) of the Silurian dolomite formation, and the basal saturated sand and gravel region that lies immediately above it, produce sufficient water for private wells. This saturated zone is generally considered the uppermost aquifer in the region. Isolated perched groundwater zones may also exist throughout the site. The flow of the groundwater is toward the south/southeast with a possible groundwater divide at the southern portion of the site. Two groundwater extraction wells pump sufficient quantities of groundwater to produce zones of influence which create localized perturbations in the generalized groundwater flow direction. Figure 8 is a groundwater level contour map for this aquifer. Beneath the Silurian dolomite are older sedimentary formations, separated by a shale containing horizon, of the Cambrian and Ordovician periods consisting of dolomite and sandstone. Several studies, including those designed for siting the SSC, have explored these older bedrock units underlying the site. Specific formations of the bedrock units are also sufficiently permeable to be used as drinking water aquifers.

The majority of supplies used in community systems surrounding the Fermilab area are withdrawn from the sandstone aquifer in Cambrian/Ordovician formations at a depth of approximately 1200 feet (366 m). However, the shallow Silurian dolomite aquifer, the bedrock formation nearest the surface that contains significant volumes of groundwater, is also used heavily to supply water in the vicinity of Fermilab in DuPage, Cook and Will Counties. Heaviest withdrawals occur in DuPage County, where the estimated 1984 pumping rates (not including rural domestic and livestock wells) exceeded the withdrawal rate from the deeper Ordovician aquifer (Su59, Ze62, Cs62, Sa81, Ki85). Quarry operations and heavy pumping for general use due to population increases have partially dewatered large areas of the Silurian dolomite formation.

2.9 Demography

Fermi National Accelerator Laboratory is located in the densely populated Chicago area. There are about eight million people living within 50 mile (80 km) of the site. There are 483,325 people within 10 miles (16 km) of the center of the Main Ring Accelerator based on the 1990 census results. The detailed distribution of population as a function of distance and direction from Fermilab is given in Table 3 (Wi92). The population distribution close to Fermilab, according to the 1990 Census, is shown in Figures 3 and 4. The 1990 census results reveal that communities in the vicinity of Fermilab continued to experience significant population growth between 1980 and 1990. Adjacent to the Laboratory boundaries are the cities of Batavia, Warrenville, West Chicago, and Aurora.

3.0 COMPLIANCE SUMMARY

This summary addresses the status of compliance with applicable regulations at Fermi National Accelerator.

Clean Air Act - The major Federal law regulating the air emissions of the Department of Energy's (DOE's) processes and facilities is the Clean Air Act (CAA). Under the authority of the CAA the Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for concentrations of the criteria pollutants: sulfur dioxides, particulate matter, carbon monoxide, ozone, nitrogen oxides, and lead. The Clean Air Act Amendments of 1990 authorized the EPA to designate non-attainment areas for ozone, carbon monoxide, and particulate matter and to classify them according to severity. Classification triggers State control requirements to bring non-attainment area into attainment by specified dates. Fermilab is located in an area that is designated a "Severe-17" non-attainment area for ozone but that is in attainment for carbon monoxide and particulate matter. The National Emissions Standards for Hazardous Air Pollutants (NESHAPs) have also been established to control emissions of listed hazardous air pollutants (e.g., radionuclides, asbestos). Fermilab has obtained Illinois Environmental Protection Agency (IEPA) operating permits for both radiological and non-radiological emissions sources onsite. There are no major NESHAP release points at Fermilab that require monitoring under 40 CFR 61.93 (b) (4) (i), but ventilation stacks contributing the majority of the radionuclide air emissions are continuously monitored. Radionuclide emissions from other less significant unmonitored sources are estimated by scaling emissions according to the emission rates measured for the monitored sources per delivered proton. Minor release points subject to confirmatory measurements are associated with Tevatron fixed target mode operations which have been suspended until late CY-1994. Further evaluation will have to wait until the configuration of the fixed target experimental physics program is known. A quality assurance plan which meets the requirements of 40 CFR Part 61, Appendix B, Method 114 will be developed.

One new air pollution emission source was issued an operating permit this year by the Illinois Environmental Protection Agency (IEPA). This permit is for the operation of a vapor degreaser located in the Transfer Hall South. Open burn permits for firefighting instruction and for prairie/land management were renewed.

An application for a permit to construct a modified NESHAP source, the Fermilab Main Injector, was submitted in accordance with the provisions of 40 CFR Part 61. An IEPA permit to construct this new source of radionuclide emissions was granted in April 1991. Concurrently, an application for approval to construct this source was submitted to the United States Environmental Protection Agency (USEPA). The USEPA granted approval in May 1991. Because a continuous program of construction or development had not started by the expiration date of that permit, a modification to extend the expiration date was sought and approved in January 1992.

There were no known instances of noncompliance air emissions on or offsite in CY-1991.

1991

Clean Water Act - Under the authority of the Clean Water Act (CWA) the Environmental Protection Agency (EPA) has promulgated regulations for monitoring liquid effluent discharges to surface water bodies and to publicly-owned treatment systems. Under Section 402 of the Act, the National Pollutant Discharge Elimination System (NPDES) is established, whereby that agency issues permits to facilities that directly discharge pollutants to the waters of the United States. Facilities that discharge to a municipal or publicly-owned wastewater system do not have to obtain a NPDES permit but must ensure that industrial dischargers remove or treat all pollutants that could pass through the municipal system untreated or could adversely affect the performance of the municipal system. Fermilab does not currently have a NPDES permit. Industrial discharges are characterized and municipal approval for sewerage is sought prior to release. Fermilab operations result in a discharge of cooling, storm, and certain treated waters to the surface waters onsite. Prior to May 1, 1992 the Laboratory submitted a sitewide NPDES permit application to the EPA for a permit to discharge non-process, non-contact cooling waters to surface waters. Stormwater permit applications will be prepared for the Fermilab Main Injector construction project and for any other applicable activities.

An IEPA Section 401 Water Quality Certification and a Department of the Army Nationwide Permit were issued in CY-1991 for the proposed fill of 7.1 acres of wetlands in the construction of the Fermilab Main Injector (FMI). A one year extension to the Section 404, Nationwide Permit was granted.

The Accelerator Division initiated a survey of all point-of-generation wastewater discharges from industrial processes in their division in order to better characterize what is being sent to sanitary sewers. The resultant inventory is currently being evaluated.

A pretreatment permit application is being prepared for the Central Utility Building Regeneration Process and will soon be submitted to the IEPA. The acquisition of this permit, along with the many improvements made to the regeneration process over the last year, should make it possible to discharge this effluent to the sanitary sewer. This would allow the closure of the Class V injection well that currently receives the effluent.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/Superfund Amendments and Reauthorization Act of 1986 (SARA) - The CERCLA/SARA legislation establishes a program to identify sites where hazardous substances have been released into the environment and ensures the cleanup of these sites. The intent of CERCLA is to provide for response to and cleanup of environmental problems that are not adequately covered by the permit programs of other environmental laws including the CAA, CWA, SDWA, and RCRA. CERCLA site notification has been filed for two sites at the Laboratory: the Meson Hill where asbestos was deposited from 1970 to 1980 and the old Main Ring Perforated Pipe Field where chromate contamination associated with cooling tower "blowdown" containing zinc chromate was discharged from 1974 to 1976. A preliminary assessment report on the Main Ring Perforated Pipe Field was submitted to the United States Environmental Protection Agency (USEPA) in CY-1990. No response has been received to date.

Endangered Species Act and the Fish and Wildlife Coordination Act - In conjunction with the Fermilab Main Injector (FMI) Environmental Assessment, numerous field surveys have been conducted at the proposed project site. Findings indicate that there are no state or federally listed endangered or threatened species of plants, invertebrates, or vertebrates that would be affected by the proposed construction. In CY-1991, consultation included communication with the Illinois Department of Conservation (IDOC) and the United States Department of the Interior, Fish and Wildlife Services, concerning the potential impact of the FMI.

Executive Orders 11988, "Floodplain Management" and 11990, "Protection of Wetlands" - Planning for the proposed Fermilab Main Injector, located in a floodplain and wetlands, has addressed requirements in these orders. A public notice of "Floodplain and Wetland Involvement Notification for Proposed Construction of the Main Injector at Fermi National Accelerator Laboratory, Batavia, Illinois," was published in the Federal Register on June 11, 1991.

Pursuant to permit requirements, a Wetlands Mitigation Action Plan was prepared for the FMI project. This plan was approved by the United States Corp of Engineers.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - This act applies to storage and use of herbicides and pesticides at Fermilab. In CY-1991, pesticides/herbicides were handled in accordance with FIFRA.

The Migratory Bird Treaty Act - An ornithologist was employed to prepare recommendations and precautions for the protection of a great blue heron rookery that exists inside the proposed Fermilab Main Injector site. Although this area would not be directly disturbed by construction activities, these recommendations and precautions would ensure that the project would have no significant impact on the heron rookery or on other migratory birds. The recommendations and precautions were shared with the United States Fish and Wildlife Service and the Illinois Department of Conservation. A baseline noise study was undertaken in 1991 to aid in the evaluation of the potential noise impacts of the FMI construction on the heron rookery.

National Environmental Policy Act (NEPA) - NEPA requires that projects with potentially significant impacts to the environment be carefully reviewed and reported in documents such as Environmental Evaluations (EEs), Environmental Assessments (EAs), or Environmental Impact Statements (EISs). In February 1990, the Secretary of Energy issued SEN-15-90, which specified increased formality in reviewing all DOE actions under provisions of this law. Fermilab has responded to the procedures specified by this SEN by implementing a program of reviewing all of its activities at the purchase requisition level. Documentation of this program was included in the

1991

Fermilab Environment, Safety, and Health Manual in January 1991 and is currently under revision. During CY-1991, 24 requests for categorical exclusions were submitted to DOE. Of these, 22 were approved. The approval of two others is awaiting more information. An additional project was reviewed for NEPA compliance this year but DOE determined that it did not require a categorical exclusion. Six additional environmental evaluations initiated in CY-1991 are still underway. Included in the activities categorically excluded from further NEPA review in CY-1991 were ones for routine maintenance and ParkNet activities at Fermilab. An Environmental Assessment for the Fermilab Main Injector project is nearing approval.

National Historic Preservation Act (NHPA), Archaeological Resources Protection Act - Compliance with these Acts was accomplished through a program of reviewing all proposed land-disturbing projects to assess potential impacts on cultural resources and by continuing efforts to survey the entire site for cultural resources. Phase I prehistoric and historic archaeological surveillance has been completed for the entire Fermilab site. A programmatic agreement for an archaeological resources management plan at Fermilab has been approved by the Illinois State Historic Preservation Officer but has not been approved by the Advisory Council on Historic Preservation, pending the submission of additional information.

This year the Illinois Deputy State Historical Preservation Officer determined that pursuant to Section 106 of the NHPA, the FMI project would have no effect on historical properties listed on, or eligible for the National Register of Historic Places (NHRP).

Resource Conservation and Recovery Act of 1976 (RCRA) - RCRA establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste. A RCRA Part B operating permit for building WS-3 at the Hazardous Waste Storage Facility became effective on October 28, 1991. Buildings WS-1 and WS-2 continue to operate under RCRA interim status. A RCRA Facility Investigation (RFI) is required as a condition of the permit and is in progress. The Phase I Workplan for this investigation of 15 Solid Waste Management Units was prepared and submitted to the IEPA. A Partial Closure Plan for buildings WS-1 and WS-2 was prepared and submitted to the IEPA in November 1991. The plan was revised and resubmitted in March 1992, incorporating comments from the IEPA. RCRA closure is anticipated to begin in November 1992, due to loss of interim status for those two units.

On May 17, 1991, DOE issued a moratorium prohibiting the off-site shipment of RCRA-hazardous and TSCA-regulated waste originating in radiologically controlled areas to commercial facilities not licensed by the Nuclear Regulatory Commission or an Agreement State. To lift this moratorium, DOE requires that Fermilab prepare and obtain DOE approval of a Performance Objective developed following DOE guidance. Fermilab has submitted this Performance Objective and is awaiting a DOE response. The inability to ship hazardous waste, as mandated by this moratorium has placed Fermilab in noncompliance with the one year waste storage limitation included in the Hazardous and Solid Waste

Amendments to RCRA. On March 26, 1992 DOE/EM-30 agreed to allow a one-time shipment of non-compliant waste. Due to the uncertainty of when the moratorium will be lifted, an extensive modification to the RCRA Part B permit is planned. After closure of the two interim status buildings (WS-1 and WS-2) in November, this modification will be necessary to allow for greater than 90 day storage of hazardous waste, which is not addressed in the current Part B permit.

Following the removal in 11/89 of a leaking gasoline underground storage tank (LUST) at 30 Sauk, the IEPA requested that hydrogeological studies be completed at the site to determine the extent of subsurface contamination. Monitoring wells were installed and a thorough evaluation was submitted to the IEPA for review. Upon completing a review of the subsurface investigation, the IEPA concluded in June 1991 that no further remediation was necessary.

There are four remaining underground storage tanks onsite. The Laboratory continues to monitor the two underground storage tanks (USTs) at Site 38 for petroleum releases through monthly inventory control measures and annual tank tightness testing. Removal of the two other USTs at the CUB is planned. Meanwhile, nearly 8000 gallons of fuel oil were used to fire a permitted boiler at the CUB in preparation for the pending removal effort.

Safe Drinking Water Act - The Safe Drinking Water Act (SDWA) of 1974 was established to provide safe drinking water to the public. To comply with this Act, the EPA has established National Primary Drinking Water Regulations (NPDWR) applicable to public water supplies. These regulations set maximum contaminant levels (MCLs) on bacteriological, chemical, and physical contaminants that may have an adverse effect on consumer health if found in public water systems. Illinois has obtained primary responsibility for enforcement and administration of national SDWA regulations by adopting the NPDWRs through the Illinois Environmental Protection Act. Primary responsibility for the drinking water portions of the State Act has been delegated to the IEPA. In Illinois non-transient, non-community wells (NTNC) are regulated by the Illinois Department of Public Health (IDPH). The two NTNC supplies onsite are regulated by IDPH regulations. A satellite supply connected to the City of Warrenville public water supply is regulated by the IEPA. By Memorandum of Agreement between the IEPA and the IDPH, the IEPA has agreed to handle our two NTNC supplies as well as the satellite supply. The three distribution systems were sampled for bacteriological and chemical contaminants in CY-1991. All results were in compliance with regulatory limits.

An IEPA construction permit was obtained to connect a second domestic water supply line to the Village from the City of Warrenville community water supply system.

Another provision of the SDWA established programs to prevent contamination of underground sources of drinking water by underground injection of contaminated fluids. Fermilab continues to operate two Class V underground injection wells onsite: a septic field at D0 and a tile field inside the Main Ring for resin regeneration effluent containing water, salt, trace quantities of heavy metals (primarily copper), and radionuclides (principally Be-7). Effluents discharged to

1991

both injection wells have been characterized as non-hazardous using the Toxicity Characteristic Leaching Procedure (TCLP) analysis.

Toxic Substance Control Act (TSCA) - The application of TSCA requirements to Fermilab involves the regulation of PCBs and asbestos. During CY-1990 all remaining high voltage PCB capacitors were disposed of offsite. Also in CY-1990, in response to the 1987 DOE Survey finding indicating a possible noncompliance with 40 CFR 761, a thorough evaluation was undertaken at two of twenty-four sites around the Main Ring. At these sites, transformer oil containing 2-5% PCB's was historically drained onto the ground as part of a sampling procedure to verify dielectric properties. Results of CY-1990 assessments were presented to the USEPA along with a request for guidance in clean-up requirements. Based on the guidance received from the EPA, PCB sampling was completed at buildings B-3 and C-2 in CY-1991 and a preliminary risk assessment was prepared. A proposal for further action is still under preparation.

Progress was made on another Environmental Restoration and Waste Management Five-Year Plan project, the F-2 Manhole at the Captree was successfully decontaminated, closing this item.

A reduction of PCB concentration in Main Ring transformers has been accomplished by detoxification of fifteen transformers to reduce their PCB concentrations. Nine additional transformers were disposed of in compliance with applicable regulations. Currently there are eight PCB transformers still at Main Ring service buildings. There is a plan to replace these during the construction of the FMI.

In April 1991 a small leak (less than 4 ounces) was discovered from a transformer located at the Booster Gallery West. This transformer contains oil with 84 ppm PCBs. Clean-up of the affected area was done in accordance with 40 CFR 761.125.

3.1 Current Issues and Actions
A Summary for January 1 through April 1, 1992

Efforts to address environmental protection issues are continuing in CY-1992 including the following:

In response to a deficiency noted in a December 1988 IEPA engineering evaluation of the Village public water supply, a cross connection control program has been developed that will bring the Lab into compliance with Sections 607 and 653 of the Illinois Administrative Codes on public water supplies. This program has been sent to the IEPA for their review and has been incorporated as Fermilab policy in the Fermilab ES&H Manual.

1991

A "Fermilab Sampling Plan for Lead and Copper in Drinking Water" was prepared in response to an IEPA request for selection of sampling locations for our public water supplies. This plan was submitted to the IEPA in February 1992.

The IEPA has reviewed and accepted the Bacteriological Sampling Site Plan that Fermilab submitted in June 1990 for each of the three onsite public water supplies.

After preliminary consultation with the IEPA, the necessary information has been gathered to complete application forms for a NPDES permit for non-process, non-contact cooling water releases to surface water. The permit application was submitted prior to May 1, 1992.

Efforts to conduct a sitewide hydrogeological assessment have begun in conjunction with a study of groundwater activation in target areas.

Significant improvements to the CUB regeneration process have been made and an application for a pretreatment permit to allow discharge of this effluent to the City of Batavia sewer system is nearly ready for submission to the IEPA.

A Phase I RFI Workplan was submitted to the IEPA in February 1992 for Solid Waste Management Units (SWMUs) identified in a RCRA Facility Assessment. We are currently awaiting their approval to continue.

Past practices and spill incidents have resulted in some areas of localized contamination which are in various stages of characterization and cleanup. These areas are addressed in the Department of Energy's Five-Year Plan for Environmental Restoration and Waste Management and include small PCB spills at various transformer/capacitor installations, a mineral oil spill from a ruptured non-PCB transformer, and a drain tile field used for the disposal of cooling water in which chromates were used as a corrosion inhibitor. None of these areas pose any threat to the health and safety of the public or site workers. Evaluation of possible remediation of these and progress in other areas continues as part of the RFI Workplan and as part of other efforts.

Other sections of this report document continued environmental monitoring efforts and progress in the solution of the problems described above. Especially pertinent are efforts to address the recommendations of the DOE Environmental Survey which was conducted in September of 1987. Fifteen out of twenty of the recommendations of the Survey have now been acted upon and have been considered closed out by DOE-CH-ESHD. Two more recommendations are awaiting DOE-CH-ESHD closure. Efforts at addressing the remaining three are underway.

Also, this year Fermilab continued to implement strengthened procedures to comply with DOE NEPA procedures in its reviews of all projects.

Appraisals and Assessments - The IEPA conducted a RCRA Facility Assessment of Fermilab on February 27, 1991. One minor violation was found during the inspection. This violation was resolved at the time of the inspection.

DOE-CH-ESHD conducted an environmental protection appraisal of Fermilab from April 1-April 10, 1991. The areas of environmental protection appraised included the general administration of the program, and compliance with the regulatory requirements of NEPA,TSCA, RCRA, CERCLA, SARA, the CAA, the CWA, the SDWA, and DOE orders pertaining to handling of radioactive waste, radiation protection of the public, and the management of the environmental monitoring program. Deficiencies were found in the Lab's compliance with NEPA, TSCA, RCRA, the CAA, the SDWA, and the DOE orders pertaining to characterization of radioactive waste and radiation protection. Fifteen recommendations were made that addressed regulatory or DOE requirements and eighteen best management practice recommendations were made. There were two noteworthy practices identified. The appraisers concluded that the Fermilab environmental protection program should be accorded a rating of "good." These recommendations have been included in the action plan for the October 1991 DOE appraisal.

A USEPA Compliance Evaluation Inspection was conducted on April 4-5, 1991. The visit included evaluation for compliance with the following regulations: TSCA, FIFRA, UST regulations, CWA (NPDES), and review of the Fermilab Spill Prevention, Control, and Countermeasures Plan. No findings were issued. In January 1991, a letter was received from the USEPA stating that Fermilab's SPCC Plan conforms to 40 CFR 112.

From October 4-30 1991, DOE conducted a multi-discipline ES&H appraisal that assessed Fermilab's compliance with the regulatory requirements of TSCA, RCRA, CERCLA, the CAA, NEPA and with applicable environmental DOE orders. A total of 18 findings and 12 recommendations were made in RCRA, CERCLA, NEPA, CAA, and DOE Order 5400.5. Laboratory compliance in these areas received a rating of "good". An action plan has been developed to address these findings in a timely manner.

An Internal Assessment of Fermilab management of ES&H programs was conducted between July 25, 1990 and March 28, 1991 with a resultant 514 findings and 264 concerns. The Internal Assessment Group (IAG) Action Subcommittee reviewed the results of the IAG findings/concerns and coordinated the development of the Lab's plans to resolve these concerns/findings, preparing an Action Plan for all IAG report findings/concerns.

Also, an Environment Safety and Health Policy Advisory Committee (ESHPAC) was formed to develop and coordinate the implementation of an Action Plan for the Fermilab Internal Assessment (March 1991), to review current ES&H training procedures and to develop a plan for a laboratory-wide ES&H training program, to develop a Laboratory ongoing self-assessment plan, and to review the various Fermilab Safety manuals and current ES&H DOE Orders for compliance, developing Laboratory ES&H policy as needed. The area of environmental protection is being given special attention by a subcommittee of ESHPAC.

DOE-ER conducted an ES & H Management Appraisal on February 19-20, 1992. A final report has not been received.

An IEPA RCRA inspection was conducted on February 21, 1992. It included a review of waste manifests, annual reports, training records, the contingency plan, the closure plans, the Part B permit, and operating records. Four satellite waste accumulation areas and the Hazardous Waste Storage Facility were visited. No deficiencies were cited.

DOE Chicago Field Office began an ES&H Assessment of Fermilab in March 1992. This assessment continued in April 1992.

The DOE Tiger Team Assessment of Fermilab is scheduled for May 11, 1992 to June 8, 1992.

3.2 Environmental Permits

Fermilab now has 7 operating permits for air pollution emission sources, 2 air pollution permits for open burning, 2 permits to construct/operate public water supplies, and a RCRA Part B permit all issued by the IEPA. Other permits have been obtained in conjunction with construction of the Fermilab Main Injector. The air pollution permits cover radionuclide emissions associated with operation of the Tevatron, the operation of 8 boilers used for heating buildings, a vapor recovery system on gasoline dispensing tanks, 2 vapor degreasers, and a grit blaster. The open burn permits cover the conduct of prairie burning in connection with land management and the large-scale prairie reconstruction project, and the burning associated with firefighting training. Recent inspections by IEPA and the USEPA have identified no noncompliances with conditions of these permits.

4.0 ENVIRONMENTAL PROGRAM INFORMATION

4.1 Environmental Program Description

The National Environmental Policy Act of 1969, as amended, mandates the Federal Policy to restore and enhance the environment and to attain the widest range of beneficial use without degradation. Since its inception, Fermilab has endeavored to protect and enhance the environment. A number of programs and organizations exist at Fermilab to ensure compliance with applicable environmental statutes, regulations, and standards. Fermilab operations are monitored to evaluate their impact on the environment.

1991

The emphasis of the routine sitewide monitoring has been placed on potential environmental exposure pathways appropriate to high-energy physics laboratories. These pathways include external exposure and internal exposure. The external exposure potential is from direct penetrating and airborne radiation. The internal exposure pathway is from ^{3}H and ^{22}Na in potential drinking water. There is one unique characteristic at Fermilab which requires closer consideration. Large volumes of sand and gravel were used in two locations to assist in stopping high-energy protons and secondary particles. Protection for the groundwater beneath these two areas is afforded by water-impervious membranes and by underdrain systems that were designed to collect the water leaching through activated soil. Radiological monitoring of soil and water in this vicinity has been conducted to evaluate the potential for groundwater contamination. Monitoring results are also reported for nonradioactive pollutants.

4.2 Summary of Environmental Monitoring Performed in CY-1991

The Fermilab environmental and effluent radiological monitoring program follows the guidance given in the Department of Energy (DOE) 5400 series of Orders (DOE) and in the guidance Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE 91). This includes adherence to the standards given in other existing DOE orders. The Environmental Protection Group in the Environment, Safety, and Health Section is the Laboratory organization who is responsible for the routine environmental monitoring program at Fermilab.

Fermilab performed extensive environmental monitoring in CY-1991, to measure the three phases of accelerator-produced radiation: penetrating, airborne, and waterborne. During this year of operation the predominant source of penetrating radiation was due to muons from the experimental areas. Radioactive air emission sources were monitored for ^{11}C, ^{13}N, ^{38}Cl, ^{39}Cl, and ^{41}Ar as continuously operating stack monitors recorded the concentration released. Surface water and groundwater samples were analyzed to determine concentrations of tritium and other accelerator-produced radionuclides, ^{22}Na, ^{7}Be, ^{60}Co, ^{45}Ca, and ^{54}Mn. The fraction of the year the water left the site was determined by weekly inspections of the Kress Creek spillway. Additional monitoring for radionuclides in soil and sediment on the site was conducted to investigate other possible pathways to the offsite environment.

Data on radioactive effluents was reported to the Department of Energy via the Effluent and Onsite Discharge Information Systems (EIS/ODIS) operated for the Department of Energy by EG&G, Idaho.

Monitoring results during operations in CY-1991 indicated compliance with the applicable standards in every case. In particular, the highest site boundary penetrating radiation level was 7.2% of the 100 mrem (1m Sv) relevant standard in CY-1991. Airborne radionuclide concentrations and waterborne concentrations at the site boundary were so low as to be immeasureable. See Section 8.0 for applicable standards.

Monitoring for bacterial and chemical pollutants in onsite drinking water systems was accomplished in CY-1991. Public water supplies were sampled monthly for coliform in accordance with the sampling plan submitted to IEPA. Results were in compliance with SDWA standards for all the public water supplies.

4.3 Description of Environmental Permits

Table 4 lists Fermilab's environmental permits, including current issue and expiration dates.

Emco Wheaton coaxial vapor recovery systems have been installed on all gasoline dispensing equipment at Fermilab under a permit (I.D. No. 043807AAI, Application No. 86020057) issued by the Illinois Environmental Protection Agency (IEPA).

Fermilab has an IEPA permit (I.D. No. 043807AAI, Application No. 87110096) for three natural gas boilers at the Central Utility Building (Figure 2), two natural gas boilers at the Wide Band Lab in the Proton Area (Figure 2), and one propane gas boiler at Industrial Building #2 in the Industrial Area (Figure 1). A grit blast operation at Industrial Building #2 is also included on this permit.

Fermilab has a permit (I.D. No. 043807AAI, Application No. 89090071) for two natural gas fired hot water boilers, one at Lab A (Neutrino Area) and the other at the Meson Detector Building.

Fermilab has received a permit (I.D. No. 043807AAI, Application No. 88010042) for the operation of an open top vapor degreaser at Industrial Building #3 in the Industrial Area. Also a permit to construct and operate an open top vapor degreaser in the Transfer Hall South (I.D. No. 043807AAI, Application No. 91100025) was obtained in CY-1991.

The magnet debonding oven and its associated afterburner has an Illinois Environmental Protection Agency permit (I.D. No. 043807AAI, Application No. 79070012). This oven is a potential source of radionuclide emissions. This facility debonds failed magnets prior to repair by decomposing epoxy at a high temperature (800^{o}F). This oven did not operate in CY-1991.

Fermilab also has an IEPA permit (I.D. No. 043807AAIAAD, Application No. 89080089) for radionuclide emissions associated with accelerator operations and also for construction of the FMI (I.D. No. 043807AAI, Application No. 91030001).

Fermilab has an IEPA air pollution open burning permit (I.D. No. 089801/043807, Application No. B9110110) for prairie and land management. Burning occurred on a number of the prairie tracts. Open burning was conducted in such a manner as not to create a visibility hazard on roadways, railroad tracks, or airfields. Other standard conditions for open burning were also carried out. Because of the large size of the Laboratory property (6800 acres), the smoke from the fire caused no offsite problems.

Also, Fermilab has an IEPA permit (I.D. No. 043807, Application No. B9201038) to allow burning of one gallon of motor fuel per session of firefighting instruction.

Fermilab has obtained a permit under the Resource Conservation and Recovery Act (RCRA) (Part B Permit) to operate the onsite Hazardous Waste Storage Facility. Regulated chemical wastes are stored in this facility, as well as a limited quantity of radioactive mixed waste. Typical regulated chemical wastes are hazardous wastes, polychlorinated biphenyls (PCBs), and used oil. Radioactive mixed waste (RMW), ^{241}Am and lead debris from a fire in 1987, were shipped off-site for disposal in CY-1991. Only wastes generated by Fermilab are stored at the facility until proper off-site disposal can be arranged.

The Lab has a permit from the Illinois Department of Public Works (Permit No. 12170) that allows water to be taken from the Fox River for use onsite.

No permit was needed for the septic field installed near D0 (north of W-5 in Figure 7). It was classified as a Class 5W32 injection well in CY-1988. The CUB tile field (Figure 2) was also classified as a Class 5W20 injection well in the same year.

As mentioned elsewhere in this report, Fermilab has prepared an application for a a sitewide NPDES permit governing the release of storm, cooling, and non-process, nont-contact cooling water to surface waters.

4.4 Environmental Assessment for the Fermilab Main Injector

A major NEPA activity during CY-1991 was the preparation of a draft environmental assessment for the proposed Fermilab Main Injector (FMI). This project proposes to construct a 150 GeV synchrotron to replace the Main Ring. This accelerator would require a separate underground beam enclosure located in the southwest corner of the Fermilab site. A variety of studies of the affect of the construction of this accelerator on the environment were included in the Environmental Assessment (EA). Other activities related to the environmental protection aspects of this project which occurred during CY-1991 included the submission and approval of an application for a permit to construct a modified NESHAP source. The IEPA issued a Section 401 Water Quality Certification and the Department of the Army granted a Nationwide Permit for the proposed fill of wetlands in the FMI construction. The Illinois Department of Conservation (IDOC) and the United States Department of the Interior, Fish and Wildlife Services were consulted concerning the potential impact of the FMI. A public notice of floodplain/wetland involvement was published in the Federal Register. A wetlands Mitigation Action Plan was prepared and given U.S. Corp of Engineers approval. A

1991

baseline noise study was undertaken to aid in the evaluation of the potential noise impacts of construction on the heron rookery. After reviewing reports on archaeological sites in the vicinity of the FMI, the Illinois Deputy State Historical Preservation Officer made a determination that the project would have no effect on historic properties listed on or eligible for the National Register of Historic Places.

4.5 Prairie Reconstruction Activities

In the early 1970's Fermilab began a prairie reconstruction project on a 388 acre (1.57 square km) plot inside the Main Ring Accelerator. Beginning in 1984 additional plots outside the ring have been planted, resulting in a current total of approximately 918 acres (3.71 km^2) that have been planted in native grasses.

4.6 Summary of Prehistoric Archaeological Work at Fermilab

Phase I archaeological surveys of both prehistoric and historic cultural resources have now been completed for the entire site (Lu90). With the addition of the five sites identified in CY-1990, the total number of known prehistoric archaeological areas at Fermilab is now 32. The report on the historical survey is till in draft form.

4.7 Environmental Survey Items

The U.S. Department of Energy Environmental Survey for Fermi National Accelerator Laboratory was conducted from September 14 to September 25, 1987. The purpose of this effort was to identify, via baseline surveys, existing environmental problems and areas of environmental risk at Fermilab. This survey was part of a larger effort to rank the findings on a DOE-wide basis and to establish priorities for addressing the environmental problems found. The Survey team consisted of two members from the DOE Headquarters in Washington, D.C., and seven independent specialists with expertise in various environmental disciplines. Fermilab continues to submit to DOE a detailed status report called the Environmental Survey Action Plan. Major survey action items, along with routine waste handling operations, were incorporated in the DOE's Five-Year Plan for Environmental Restoration and Waste Management. The following summarizes significant action in response to this Survey. A number of the survey items have been incorporated as SWMUs in the Lab's RCRA RFI Workplan and will be further evaluated through that process.

The Survey team found that the missing mineral oil from the T82A transformer spill (Ba86) in 1985 could have potentially been as much as 6000 gallons (22,710 liters). During the Survey approximately 125 gallons (475 liters) were located in a vault under the Capacitor Tree near the Master Substation. This oil entered the vault by flowing down an open electrical cable duct on the transformer pad the night the spill occurred. Oil also collected in a sump in an underground enclosure about 25 ft. (7.5 m) east of the transformer pad. The sump collects water near the footings of the enclosure about 20 ft. (6 m) below the ground surface. In CY-1986 through 1988 about 115 gallons (436 liters) of oil

1911

was collected. Monitoring wells were used to study the risk of groundwater contamination from this source. During 1989, an assessment by an outside consultant was completed. It was concluded that this leak is an improbable source of groundwater contamination. (See Co90a for a more complete discussion.)

The Survey team suggested that discharges of chromates (Ba75a) from 1974 to 1976 to the old CUB perforated pipe field might be a source of soil and groundwater contamination. This old perforated pipe field is located very near another tile field currently used to the discharge effluent from a resin regeneration process at the Central Utilities Building. In 1988 five shallow (15 ft or 4.6 m) wells and two deeper (38 ft or 11.6 m) wells were drilled in the perforated pipe field to search for chromates. The soil samples were analyzed for chlorides and total chromium. Sodium chloride also discharged to the area was used as a tracer (Ba73). A distinct chloride plume was found showing migration along the top of the low permeability clay layer (Yorkville till) toward the southeast. The only soil sample indicating a chromium level above background was near the surface but that sample did not have measureable hexavalent chromium concentrations (detection limit of 10 mg/kg). One well was installed downstream of the chloride plume. Samples from that hole did not contain elevated chromium levels. It was concluded that there was no evidence for migration of chromates in advance of the chloride plume. The holes were cased so that water could continue to be monitored for chromates. Surface sampling was conducted during CY-1990 by an outside consultant. The EP toxicity test for chromium from a sample inside and immediately surrounding the perforated pipe resulted in leachate concentrations of less than 100 micrograms/liter. This is much less than the 5 milligrams/liter threshold for declaring this material to be hazardous waste, but it would still be considered regulated waste. In CY-1991 water samples from the monitoring wells continued to show concentrations far below the maximum given in the Safe Drinking Water Act (Table 21). The consultant's studies concluded that the perforated tile field posed no significant groundwater, soil, or sediment contamination. They concluded also that there was no evidence for migration of the chromates. A preliminary assessment documenting these conclusions was submitted to USEPA Region 5 on October 24, 1990. No reply has been received. Closure of the current tile field is anticipated once arrangements can be made to send the effluent to the City of Batavia sewage system.

The Survey team identified some PCB spills that had occurred during removal of the capacitors from the Capacitor Tree and from earlier leaks. Cleanup work was already in progress at the time of the Survey. The total amount of PCBs spilled at this site was estimated to be below the reportable quantity of 10 lbs (4.54 kg) (40CFRa). Three cleanup efforts were conducted in CY-1988. The sampling at the end of each cleanup indicated residuals above the cleanup criterion of 10 parts per million (ppm) PCBs. During 1989, a fourth cleanup was attempted. The metal surfaces of the Capacitor Tree have been successfully cleaned and a contaminated manhole cover was replaced. Sampling results indicated that TSCA cleanup requirements have been met everywhere except for some sludge in the bottom of one of the manholes. Cleanup efforts using the services of a subcontractor continued in CY-1991 with progress towards successfully meeting the TSCA cleanup requirements.

The Survey team also identified PCB spills at the 24 transformer locations around the Main Ring accelerator. These spill sites originated when small amounts of oil were drained on the ground in the course of testing fluid for its dielectric properties. An assessment of two such sites was performed to evaluate the spread of this contamination to determine the extent of a possible cleanup. The assessment determined that PCB concentrations in excess of 10 ppm were localized in the gravel hardstand that underlies the transformers. There was little or no evidence of PCBs penetrating the clay under the hardstand. The results of this assessment were reviewed in CY-1991 and presented to the USEPA along with a request for guidance in clean-up requirements. A preliminary risk assessment has been prepared and a proposal for further action is under preparation.

Soil radioactivation due to accelerator operations has occurred near the N01 and M01 target areas (Neutrino Area and Meson Area primary targets in Figure 9) and near the NW4 beam dump (Neutrino Area Encl. 100 Upstream Dump in Figure 9). Nine 45^{o} sampling holes were drilled beneath the target areas and beam dump in CY-1988 and CY-1989, sampling the soil for ^{3}H and ^{22}Na, searching for a high permeability sand and gravel layer which could shunt radioactivity laterally away from wells, and for sampling the deeper laying aquifer nearby. Monitoring wells for future shallow water sampling were also installed at these locations (Figure 10). This monitoring program was described more fully in previous Site Environmental Reports (Co90 and Co90a). The soil borings found no sand and gravel layer beneath the Neutrino Area primary target which would provide a mechanism to carry radionuclides away horizontally. There was evidence for sand and gravel at elevation 715 ft (218 m) near the M01 target and around 712 ft (217 m) near the NW4 beam dump and at other places onsite. It was concluded that there is no evidence for a continuous layer which could provide a pathway for the horizontal movement of water over large distances, nor for the downward migration of radionuclides that might pose a risk to groundwater.

4.8 Pollution Prevention Awareness and Waste Minimization

During CY-1991, the Fermilab Waste Minimization of Pollution Prevention Plan was completed and incorporated into the Fermilab Environment, Safety and Health Manual. This plan covers such topics as waste assessment techniques, training and awareness, reporting, and quality assurance. The goal of the program under this plan is to systematically eliminate or reduce the generation of waste from site operations to prevent or minimize the release of pollution in any environmental medium. Some of the waste minimization initiatives implemented already include: training of building managers in waste management; division/section review of purchase requisitions to identify potential environment, safety and health concerns; office paper recycling; recycling of some degreasing solvents in some operations; substitution of biodegradable, non-toxic degreasers for halogenated solvents in other operations. In an effort to minimize the generation of mixed waste, batteries, unnecessary equipment, and tools were moved from areas in beam tunnels where radioactivation is possible. Waste minimization certifications and waste reduction reports were included, as required, in the Annual Hazardous Waste Report submitted to the IEPA.

4.9 ParkNet

During CY-1991, one ParkNet project was cancelled, two projects were completed, four new projects were approved by the Environmental Advisory Committee (EAC) and initiated, and two new proposals have been submitted and are awaiting approval by the EAC (Table 5). These projects will add to the accumulation of baseline data on the site and address land management and specific ecological questions. A request for categorical exclusion of routine ParkNet activities was submitted to DOE and approved.

Planning continued for the N-3 Experimental area project, a twenty-year project to create a large series of replicated plots for the study of prairie and grassland ecosystem processes. ParkNet continued to work with the Fermilab Prairie Committee to determine the most appropriate managment of the reconstructed prairie areas. Fermilab completed production of "The Fragile Balance," a video about the DOE ParkNet program.

4.10 Environmental Training

Fermilab personnel involved in hazardous waste management operations receive training which is tailored to their particular needs. Hazardous Waste Storage Facility personnel are trained in accordance with the requirements identified in the Part B RCRA storage facility operating permit. Fermilab personnel expected to identify and respond to spills are trained annually in the contents of the SPCC Plan.

4.11 RCRA Facilities Investigation (RFI)

Fermilab was issued a RCRA Part B Permit for its Hazardous Waste Storage Facility (HWSF) by the Illiniois Environmental Protection Agency (IEPA) on October 28, 1991. This permit allows the HWSF to store certain specified hazardous wastes for greater than ninety (90) days. Prior to granting the Part B Permit, the IEPA performed a RCRA Facility Assessment (RFA) of Fermilab. During the RFA, the IEPA identified onsite solid waste management units (SWMUs) and has required that seventeen (later consolidated to fifteen) of these be addressed in an RFI to determine if any require corrective action to protect human health and the environment from the potential release of any of the hazardous constituents listed in Appendix H of 35 Illinois Administrative Code Part 721. PRC Environmental Management was selected through a competitive bidding process to initiate the RFI. RFI work began in November 1991 and an RFI Work Plan was submitted to the IEPA within the 120 days from permit issuance, as required. Once DOE and the IEPA approves the workplan, the SWMUs will be investigated to determine if corrective actions are required at any of the sites.

1991

5.0 ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

5.1 Environmental Radiation Monitoring

Three types of accelerator-produced radiation are monitored: penetrating radiation, airborne radioactivity, and waterborne radioactivity. These radiations usually have direct pathways to the offsite population. Other more indirect and improbable pathways, such as through the food chain, have received much less attention. The decision to monitor is based on the type of operation, the radionuclides released, the potential hazard and experience from previous monitoring results here and at other high-energy physics laboratories.

5.2 Penetrating Radiation

During CY-1991 the Tevatron was operated in the fixed target mode. The CY-1991 fixed target run of the Tevatron actually extended through the first few days of January 1992. Only approximately 5% of the fixed target operations during the run as measured by the integrated Tevatron beam intensity delivered to the experiment areas, occurred during the first few days of CY-1992. Further, fixed target operations are not scheduled for any portion of CY-1992. Hence the environmental dose equivalents due to these few days of operations (approximately 5% of the total delivered during the run) are included in the totals given for CY-1991. The significant sources of offsite radiation exposure due to penetrating radiation were muons from the experimental areas (Meson, Neutrino and Proton) and the gamma rays from the Railhead storage area.

A network of detectors was used to monitor penetrating radiation. Typically, there are approximately 100 detectors deployed around the site with the primary purpose of controlling onsite radiation. The majority of these detectors were connected to a data logger which automatically recorded the radiation levels for subsequent examination (Aw71). In CY-1991 three detectors logged information for possible use in environmental radiation monitoring. One was a large volume, 110 liter, ionization chamber (called a Hippo) used to detect gamma rays and charged particles at its location near the Boneyard at the Railhead (Figure 2). Another Hippo was located at Site 3 (Figure 2) near the site boundary. The last was a tissue-equivalent ion chamber located at 14 Shabbona in the Village (Figure 2). Approximately 70 environmental TLD's were exchanged and read each quarter, providing additional information on radiation levels sitewide and at the site boundary.

As described in more detail elsewhere (Co83, El88), the muon fields on and near the Fermilab site boundary are measured by use of scintillation counters mounted in a vehicle, the Mobile Environmental Measurements Laboratory (MERL). The raw data consists of measurements of the normalized muon fluence (muons/cm^2 per 10^{12} protons) obtained during scans transverse to the muon trajectories. The data is based on average counts (background-corrected) in each of two plastic scintillation paddles. The fluence is converted to effective dose equivalent delivered during the calendar year by multiplying this normalized fluence by the total number of protons delivered during the year and by using a

1991

fluence-to-dose conversion factor determined by G.R. Stevenson (St83). This factor has a value of 1 mrem/25000 muons/cm^2 (or 40 fSv-m^2). The only significant muon radiation fields produced by Fermilab operations occur to the northeast of the site. The peaks are located along extensions of the beamlines delivering protons to the fixed target beamlines (Figure 11) because the production of muons sufficiently energetic to penetrate shielding is restricted to forward angles with respect to proton beams incident on a target.

During the fixed target operations conducted in CY-1991, 6 beamlines produced muon fluences which were readily measured. Two of these beamlines (designated MW and MC) are in the Meson area while a third, called NM, is in the Neutrino area. These three beamlines were, by far, the most significant source of the muons. The MP beamline was reported as a source of muons in CY-1990 (Co91), but did not operate in CY-1991. In the Proton Area, the PW, PE, and PB beamlines produced muon radiation fields which were barely measurable near the site boundary. The configurations of all 6 of these beamlines are quite similar to the way they existed during the fixed target runs of 1987-1988 and 1990. In general, measurements of the muon radiation fields made during the CY-1991 fixed target run agree well with those observed in 1987-1988 and 1990. There were no locations beyond the site boundary where the muon radiation fields of adjacent beamlines overlap significantly. Table 6 gives the effective dose equivalent at the site boundary due to each proton beamline producing a measurable muon fluence during CY-1991. The muon fluences have been determined to obey an inverse-square law dependence upon the distance from the source of the muons (which is generally the production target that is struck by the accelerated proton beam). This observation is used to correct fluence measurements made on roads near the site boundary to values shown in Table 6 which are for the actual site boundary. A complete discussion is given by Cossairt and Elwyn (Co92).

The primary radioactive materials storage area onsite, the Boneyard, is also the primary source of offsite gamma radiation. Activated accelerator components and shielding, primarily iron and concrete, are stored in the Boneyard at the Railhead (Figure 1) for future disposal or for reuse following radioactive decay. As shown in Figure 2, the Boneyard lies close to the site boundary. In 1987 radioactive material was moved into a cave constructed at the southwest corner of the Boneyard. In addition, there was is area nearby designated for storage of equipment for future use. A large amount of this equipment contains low-level radioactivity due to beam-induced activation. The site boundary dose for CY-1991 was determined using thermoluminescent dosimeters (TLD's) and the large volume ion chamber (Hippo). Data obtained previously by using a hand-held NaI (Tl) scintillator established the rate of decrease with distance (Ba89). The radiation level at the nearest point to the site boundary was 0.8 mrem (0.8 X 10^{-2} mSv) for CY-1991. The maximum exposure to the individual living closest to that point on the site boundary would have been 0.2 mrem (2 X 10^{-3} mSv) for CY-1991, assuming 24 hour per day occupancy. Since the distance from the site boundary to the residence is 1500 ft (460 m), the dose to a member of the public from the Boneyard was lower than the site boundary (fence line) dose.

5.3 Airborne Radioactivity

Radioactivation of air in measurable concentrations occurs wherever the proton beam or the spray of secondary particles resulting from its interactions with matter passes through the air. The beamlines which deliver extracted protons from the Tevatron to the experimental areas (Meson, Neutrino, and Proton) and from the Main Ring to the Antiproton Source consist of evacuated beam pipes. In this way, unacceptable beam loss is prevented by minimizing the interactions of the protons with air. At the target stations, where these beams of protons produce low intensity secondary beams, there are areas where the protons must travel in air. A large flux of secondary particles which are not useful for experiments are also produced at target stations. These two circumstances explain why the radioactivation of the air is concentrated at the major target stations. Monitoring of airborne radioactivity is carried out locally for purposes of personnel exposure control. Under no circumstances is the offsite concentration of airborne radioactivity expected to approach the limits for uncontrolled areas. Figure 12 shows the location of principle points of radionuclide emission related to accelerator operations.

During the period from June 1991 to early January 1992 the Antiproton Source was in operation as part of the fixed target program (see Section 2.3 about "accounting" for operations in the first few days of CY-1992). In this mode 120 GeV protons were focused onto a target (Antiproton Source in Figure 12) to produce antiprotons. During CY-1991 the antiprotons were used in a physics experiment within the storage rings associated with the Antiproton Source. This target was a radioactive air emission source emitting radionuclides produced from the interaction of secondary particles with the air at this target. Because this target is heavily shielded and the air volume is small, there were also many thermal neutrons radioactivating the air. The result was the production of a mixture of primarily ^{11}C and ^{41}Ar with smaller amounts of ^{13}N, ^{38}Cl, and ^{39}Cl. The ^{41}Ar, half-life of 1.8 hours, is produced by neutron capture in ^{40}Ar. Air contains about 1% argon which is essentially ^{40}Ar. The interaction of high-energy secondary particles with nitrogen and oxygen in the air produces ^{11}C (20 minute half-life) and ^{13}N (10 minute half-life). The interaction of high energy neutrons with argon in the air is probably the source of ^{38}Cl (37 minute half-life) and ^{39}Cl (58 minute half-life) (Bu89).

Fixed target operations utilizing 800 GeV protons similarly produced airborne radionuclide emissions. The principle sources of these emissions were recorded by Geiger-Müller based stack monitors. The composition of the radionuclide emissions from these sources has been measured previously (Bu89) and is similar to those noted for the Antiproton Source. Stack monitor outputs were logged continuously to record these emissions. The Meson Target Station monitor actually records the emissions of 4 target stations located in the same building (the Meson Detector Building). Table 7 summarizes the airborne radioactivity released due to accelerator operations conducted during CY-1991. This table not only includes releases for monitored stacks, but also contains estimates for unmonitored stack emissions. As can be seen in Table 7, airborne emissions from target areas is by far the largest contributor to Fermilab releases of radioactivity.

The site boundary concentrations were calculated using the computer program CAP88-PC (a Gaussian plume diffusion model). Meteorological conditions for O'Hare Airport about 27 miles (43 km) away were used as input. The terrain between Fermilab and the airport is relatively flat and thus these meteorologic conditions are expected to be valid. The maximum effective dose equivalent due to radioactive air emissions to a member of the population residing offsite was determined to be 0.028 mrem (2.8×10^{-4} mSv). This value amounts to 0.28% of the 10 mrem/year (1×10^{-3} mSv/year) limit. This limit replaced the former 25 mrem/year limit because of the promulgation of the National Emission Standard for Hazardous Air Pollutants (NESHAP) for radionuclides on December 15, 1989 in 40 CFR 61, Subpart H. The reported effective dose equivalents due to the release of airborne radionuclides have been calculated for the site boundary assuming the nearest resident to be present at that location. This is appropriate given the relatively high population density along the eastern site boundary and the fact that, due to the prevailing westerly winds, the highest site boundary effective dose equivalent from this source also occurs at that location. Stack monitors use EPA-approved monitoring procedures even though strict conformance with the monitoring requirements specified in the regulations are required only for release points which have the potential of exceeding 1% of the standard (0.1 mrem/year).

The magnet debonding oven was not an emission source for airborne radioactive releases in CY-1991 because it was not in use.

5.4 Monitoring Surface and Groundwater for Accelerator-Produced Radioactivity

Fermilab water sampling locations for detection of accelerator-produced activity in surface and groundwater are shown in Figures 6, 7, and 10.

5.4.1 Groundwater Radiological Surveillance

Radioactivation of soil is possible near the primary beam targeting and beam dump areas. Older targeting stations and dumps were designed with "bathtubs" to contain radionuclides produced in these areas, preventing their migration to the aquifer. Later design strategies substituted massive concrete and steel shields within beam enclosures to minimize soil radioactivation and groundwater contamination. Water samples from 41 wells/monitoring holes are analyzed at least once and as often as four times per year. Sampling frequency is determined by a well's proximity to areas of soil activation. Many of the groundwater samples are taken from old out-of-service farm wells onsite. Additional wells and boring holes have been installed to provide better monitoring in areas of potential soil activation. Fermilab's groundwater protection strategies are documented in The Fermilab Groundwater Protection Management Plan (GPMP).

1991

Samples of water are taken routinely from wells and boring holes located on the FNAL site. These samples are analyzed for accelerator-produced radionuclides (^{3}H, ^{7}Be, ^{22}Na, ^{45}Ca, ^{54}Mn, ^{60}Co) at groundwater sensitivities (Table 17). Procedures are documented in the Environmental Protection Procedures Manual (EPPM). Sampling frequency is based on the following rationale:

1) Wells located the closest to areas of maximum soil activation (targets and dumps) and/or those in the direction the water is expected to flow in the aquifer are sampled quarterly (Wells 39A, 43, 45A, 49, 59, 78, 79, 80, 81, S-1059, S-1087).

2) The following wells located near the Main Ring or Fixed Target Beamlines are sampled semiannually (Wells W-1, W-3, W-4, W-5, 5, 17A, 20, 24B, 29, 55B, S-1088 and S-1089). These are sampled less frequently than those above because of reduced potential for radioactivation.

3) Wells located near the site boundary, backups to more frequently sampled wells, and drinking water supplies other than those already listed are sampled annually (Wells 7A, 12, 50, 52, 56, 58, 64, 68, 74, 75A, S-1058, S-1060, S-1061, S-1062, S-1063).

5.4.2 Groundwater Sampling for Radioactivity

Fermilab has been monitoring some parameters in onsite groundwater for many years. Current groundwater monitoring relies primarily on sitewide monitoring of old farm wells that have been maintained, including over 65 samples per year from 29 wells (Figure 7) which draw water from the dolomite aquifer. This program concentrates on analysis for accelerator-produced radiochemicals ^{45}Ca, ^{54}Mn, ^{22}Na, ^{60}Co, ^{3}H, and ^{7}Be. To date no measurable (Table 17) concentrations of these radionuclides have ever been detected in well samples. In all cases the lower limit of detection was at least an order of magnitude below the applicable Derived Concentration Guide (DCG's) for accelerator-produced isotopes as taken from the DOE Order 5400.5 and EPA Regulations set forth in 40 CFR 141. The DOE DCGs correspond to the delivery of a committed effective dose equivalent of 4 mrem per year (4×10^{-2} mSv per year) to a person drinking only from that source. Limited chemical analysis has also been conducted on samples from a number of onsite wells. Sampling water supply wells draws water from beneath much of the aerial extent of the site providing some information on the overall quality of groundwater that reaches this aquifer. It is recognized that this method will be able to measure only those contaminants that, after being subjected to dilution, reach the drinking water aquifer in detectable concentrations. This method would not, in a timely manner, detect potential contaminants migrating vertically through the glacial till that overlies the aquifer nor would it see those moving horizontally in sand lenses or in layers within the till. Groundwater monitoring for radiochemicals has been improved by adding vadose zone monitoring in the two areas where soil radioactivation could be a potential source for groundwater contamination.

1991

5.4.2.1 Distribution Wells

There are three wells onsite (W-1, W-3 and W-5) that supply water to two public drinking water systems. These were also sampled for accelerator-produced radionuclides and no radioactivity was detected.

5.4.2.2 Boring Holes

Boring/monitoring holes were installed earlier at target areas on the Meson and Neutrino fixed target beamlines. (See Section 5.5.2.)

5.4.3 Surface Water Sampling for Radioactivity

In early beam enclosures "bathtubs" were installed underneath primary beam target stations and dumps in an attempt to contain the radionuclides produced there to prevent their migration to the aquifer. Later beamline designs incorporated massive steel and concrete shields within beam enclosures, thus minimizing radioactivation of surrounding soil and eliminating the need for "bathtubs." Water collected by underdrains within the "bathtubs" is received in retention pits. Underdrains that collect water from outside "bathtubs" and from around footings of buildings and beam enclosures discharge to onsite surface waters via ditches. Radionuclide concentrations are monitored in selected sumps, ditches, and surface waters (Figure 6).

5.4.3.1 Surface Water Sampling Plan

To provide information to estimate annual onsite and offsite releases of radioactive effluents for EIS/ODIS reporting, samples of water are taken routinely from sumps, retention pits, and monitoring holes located within the accelerator ring and fixed target tunnel enclosures. An annual routine sampling plan is developed by the ES&H Section Environmental Protection Group in consultation with Accelerator Division and Research Division Radiation Safety Officers. Sample sites are selected by their proximity to target areas, closed loop (recirculating) cooling systems, and areas of soil radioactivation resulting from accelerator operations. Generally speaking, sumps closest to areas of maximum soil activation are sampled most frequently.

5.4.3.2 EIS/ODIS Reporting

Fermilab reports radioactive effluent releases (offsite) and discharges (onsite) to DOE in its Annual EIS/ODIS Report. The five sumps that were reported in CY-1990 as EIS-ODIS discharge points N01SP4, M01SP3, NW4SP1, NTSBSP1 and NTSBSP2 (G9, MF5, N2, G4, and G5 in Figure 6) and areas where there was potential for contamination were scheduled for more frequent sampling in CY-1991. A summary of sumps showing detectable (Table 17) tritium concentrations can be found in Table 8.

Three liquid discharge points and three liquid effluent releases were reported for CY-1991. The sumps reported as contributing to these discharge points were M01SP3, N01SP4, NW4SP1, and NTSBSP1. The reported discharge points were the ditches receiving the waters from these sumps and emptying into Kress Creek. The total offsite release to surface waters attributable to these sumps, though not measurable in surface water samples, is calculated based on average radionuclide concentrations found in sumps and estimated sump discharge volumes. In CY-1991 an estimated total of 3646 mCi (1.4 X 10^{11} Bq) of tritium was released offsite by these sumps. This is an increase over the 2024 mCi (7.5 X 10^{10}Bq) of tritium reported in CY-1990. An increased release was calculated even though there was an 11% decrease in water leaving the site. Increases in potential activity were contributed by N01SP4 (300 mCi or 1.1 X 10^{10} Bq) and especially NTSBSP1 (3200 mCi or 1.2 X 10^{11} Bq). Although the average tritium concentration for both sumps was relatively low, the hour meters showed copious quantities of water being pumped out by these sumps. There were problems with both sumps that resulted in an overestimate of the volume of water released. There were no one time releases of waters with concentrations greater than 1000 pCi/ml (37 Bq/ml) tritium in CY-1991. Another sump, PC4SP1 located in the Proton area warranted reporting in CY-1991. Tritium concentrations averaged 62 pCi/ml (2.3 Bq/ml) in samples taken from this sump. Total activity released from this sump was not included in the EIS/ODIS report submitted in April 1992 because information to estimate the volume released was not available. The EIS/ODIS CY-1991 will be amended to include PC4SP1 when the necessary information is available. See Table 25 for EIS/ODIS liquid release summary.

The following beamline tunnel ventilation stacks were reported as EIS/ODIS air effluents in CY-1991: the Neutrino Target Hall stack, the Meson M05 stack, the Neutrino NM-2 stack, the Proton PB-4 stack, and the Neutrino NW-8 stack. There were no radioactive air emissions from the Magnet Debonding Oven in CY-1991.

5.4.3.3 Surface Water Surveillance for Radioactivity

Although radionuclides associated with FNAL operations are routinely identified in sumps discharging into ditches onsite, concentrations are well below applicable standards and remain undetectable (Table 17) in all ditch, pond, creek, and lake sampling locations. Samples are taken annually from ditches, ponds, creeks, and lakes onsite (Figure 6) including locations where creeks enter and exit the site. Samples are analyzed for accelerator-produced radionuclides (^{3}H, ^{7}Be, ^{22}Na, ^{45}Ca, ^{54}Mn, and ^{60}Co). Sampling procedures are site-specific and are documented in the Environmental Protection Procedures Manual (EPPM).

Casey's Pond and the ditches that receive water from the experimental areas and drain to Casey's Pond, are sampled annually for accelerator-produced radionuclides. Kress Creek is sampled any week the water is observed leaving site via the Kress Creek spillway. Surface water from the experimental areas (Figure 5) left the site via Kress Creek for approximately 63% of the year in CY-1991, an 11% decrease over CY-1990.

5.5 Soil and Sediment Surveillance

Surface soil samples are collected at selected locations. The purpose of the annual soil sampling is to detect the possible build-up of contaminants from the deposition of airborne and waterborne radioactive effluents released from FNAL facilities.

5.5.1 Soil/Sediment Sampling

An assessment of contributions from operations is made by comparing results from samples collected near release points onsite with those collected from onsite background locations. In addition, results obtained from each location are compared to results obtained from the same location in previous years. In CY-1991 the radiochemical composition of soil/sediment was measured at 13 sample sites. At each ventilation stack location one composite sample of soil was taken. Sampling procedures are documented in the Environmental Protection Procedures Manual (EPPM). The CY-1991 soil/sediment sampling results are summarized in Table 9. The radionuclides ^{60}Co, ^{7}Be, ^{22}Na, ^{57}Co and ^{54}Mn are accelerator-produced and expected at these locations. The ^{3}H measured near soil near ventilation stacks is also accelerator-produced.

5.5.2 Soil Activation

Because the percolation rates for water in Fermilab soils are calculated to be very low, certainly less than 3 ft (1 m) per year (Il78), analyses of well waters do not provide the early warning desired for detection of accelerator-produced radioactivity in the groundwater. On the other hand, these low percolation rates also make the probable transit times of the radionuclides in the water to be long compared with their lifetimes. To provide more information, several years ago soil samples were taken from the vicinity of targets and other locations where proton interactions result in some radioactivation of the soil. Quantitative measurements were made only on those major long-lived radionuclides leachable from Fermilab soils, ^{3}H and ^{22}Na (Bo72). Historically, most of the soil activation occurred around the Neutrino Area primary target which was located in the Target Tube until 1982. Between 1982 and 1988 the primary target was relocated 300 ft south of the Target Tube. By the end of February 1988, the neutrino production program was completed. During CY-1988 and CY-1989, additional boring holes were installed in the vicinity of the Neutrino Area primary target to investigate possible downward migration of radioactivity leaching from activated soils (Figure 11). This work was discussed in detail in a previous Site Environmental Report (Co90a). Results obtained during CY-1991 found some samples from S-1059 with concentrations of tritium as high as 43 pCi/ml (1.6 Bq/ml), more than the 20 pCi/ml (.74 Bq/ml) standard for community drinking water supplies specified in 40 CFR 141 (Table 24).

5.5.3 Beryllium-7

Both ^3H (12.3 year half-life) and ^7Be (53.3 day half-life) are produced in the closed cooling water systems. The ^7Be is chemically active and is easily removed from the water by the resins used to maintain water purity. The tritium remains in the cooling water system. The resins are regenerated at the Central Utility Building (CUB). The effluent from these systems is sent to a settling tank for removal of suspended solids and most of the radioactivity before it is sent to a clay tile field (Class 5 underground injection well) inside the Main Ring (see Section 6.5 and Figure 2). There it percolates into the soil about 2 ft. (60 cm) below the surface. Trace amounts of accelerator-produced radionuclides were detected in the 1991 CUB Tile Field soil sample (see Table 9). Significant gains were made in CY-1991 in improving the CUB resin regeneration process and in cleaning up the effluent. It is hoped that this effluent will be able to be sent to the City of Batavia sewer system. A pretreatment permit application has been prepared.

5.6 Assessments of Potential Radiation Dose to the Public

The maximum dose equivalent rate at the site boundary in CY-1991 from Fermilab operations was 7.2 mrem (7.2×10^{-2} mSv), due to muons from the Meson Area (Section 5.2). The point where that exposure occurred is along the northeastern site boundary. This is approximately 2.4% of the average effective dose equivalent of 300 mrem (3 mSv) delivered to individuals through natural sources (NRC90). The effective dose equivalent at the site boundary due to the Boneyard was 0.8 mrem (8.0×10^{-3} mSv) during CY-1991 but decreased to only 0.2 mrem (2.0×10^{-3} mSv) at the nearest residence to the north of the site. The maximum effective dose equivalent at the site boundary due to airborne radioactivity was 0.028 mrem (2.8×10^{-4} mSv) to the east of the site. Thus the three principle sources of radiation exposure at the site boundary are located at different places so that no offsite resident is significantly exposed to more than one of them.

The radiation exposure to the general population from operation of Fermilab in CY-1991 was approximately 7.61 person-rem (7.6×10^{-2} person-Sv). This is summarized in Table 10. This exposure was from penetrating radiation and from airborne radionuclides. The population dose due to muons increased somewhat from the CY-1990 value despite the reduced site boundary peak dose equivalents chiefly because of the rapid population growth near the Fermilab site as recorded by the 1990 U.S. Census. This total is to be compared with a total of approximately 2.4×10^6 person-rem (2.4×10^4 person-Sv) to the population within 50 miles (80 km) from natural background radioactivity. Based on typical United States radiation exposures from diagnostic x-rays, nuclear medicine treatments, and other artificial sources an additional 5×10^5 person-rem (5×10^3 person-Sv) would be expected for the population within 80 km

(50 mile) of Fermilab in CY-1991 (NRC90). (NOTE: Increased natural background exposures taken from this ref. (NRC90) include the effects of improved understanding of the indoor radon problem.)

Some releases of radioactive water occurred from sumps collecting water from areas under tunnels where protons interacted. About 63% of this volume of water left the site while Casey's Pond was full (Figure 2). Casey's Pond is the reservoir receiving water from discharges in the three external areas to which protons are delivered. The mean concentration of tritium during the period of release was less than one percent of the Derived Concentration Guide for prolonged exposure to the general population. Drinking water in the area was taken from wells rather than from the creek receiving the discharge. Hence, the dose from the release was negligible. The component of the annual effective dose equivalent to members of the public due to airborne emissions is restricted to 10 mrem (1×10^{-1} mSv) by DOE 5400.5 and by 40 CFR 61, Subpart H. The applicable annual limit on effective dose equivalent for public drinking water standards is 4 mrem (4×10^{-2} mSv) according to DOE 5400.5 and 40 CFR 141.

5.6.1 Radon Assessment Conducted in CY-1989/1990

During late CY-1989 and early CY-1990, DOE contracted with UNC Geotech through its Grand Junction Projects Office to conduct an indoor radon study of its major facilities in response to Public Law 100-551, the Indoor Radon Abatement Act. This included the collection of air samples from various buildings using alpha-track screening measurements and also drinking water samples. Fermilab participated in this study and was allocated 137 air sampling detectors along with 3 water samples. The air samples were taken in virtually every laboratory building in November 1989 and removed and submitted for reading in February 1990. Beam enclosures were excluded because the operations of the fixed target program would have caused prompt radiation fields sufficient to render the radon measurements invalid. (The beam enclosures are unoccupied during such operations.) The relevant concentration in air for comparison is the USEPA's residential standard of 4 pCi/liter (.15 Bq/L). The following distribution of the results was obtained:

<1 pCi/liter	107 detectors
1-2 pCi/liter	22 detectors
2-4 pCi/liter	7 detectors
>4 pCi/liter	1 detector.

The single reading in excess of the 4 pCi/liter (.15 Bq/liter) standard was a value of 6.9 pCi/liter (.25 Bq/liter) found in the basement of a house used by Security personnel in the Emergency Services Department. In response to this survey, a sub-slab suction system was installed to reduce the radon concentration. Measurements subsequent to this modification recorded a concentration of 1.4 pCi/liter (.05 Bq/liter).

Water samples were taken for three wells used for general drinking water supplies onsite, Wells W-1, W-3, and W-5. The radon concentrations for these wells were found to be 300 (11), 120 (4.4), and 100 (3.7) pCi/liter (Bq/liter), respectively. These values are typical of those found at many DOE facilities. This study is documented in a written report (DOE90b).

6.0 ENVIRONMENTAL MONITORING FOR NONRADIOACTIVE POLLUTANTS

6.1 Conventional Air Emissions

Monitoring of conventional emissions is conducted in accordance with the requirements of applicable Federal, State, and local regulations authorized by the Clean Air Act (42 U.S.C. 7401, et. seq.), Section 118. Operating permits have been obtained from the Illinois Environmental Protection Agency (IEPA), Division of Air Pollution Control, for all applicable Fermilab sources of airborne emissions (Table 11). Permitted equipment operates as described in the application on file with the IEPA. Operations are, at a minimum, reviewed annually. One review takes place at the time of submission of the annual Air Emission Reports as required by IEPA (Ill. Adm. Code 201.302). Equipment owners/operators are required to ensure that the permitted equipment continues to operate and be maintained in accordance with permit conditions. Operations are also reviewed when applying for renewal of an existing operating permit. The annual emissions reports that are submitted to IEPA indicate whether maximum emissions have increased, remained the same, or decreased as compared to operating parameters in the application on file with that agency.

6.2.1 Chlorine

In addition to the routine chlorination of the Main Site water system and the swimming pool, a chlorination system for the Swan Lake cooling pond system has proved successful in controlling biological fouling of heat exchanger surfaces. Chlorine is added to the cooling water for a period of 30 minutes four times a day at a rate which results in a chlorine concentration of 0.5 ppm as the cooling water leaves the equipment. Only one piece of equipment within the plant is chlorinated at a time. Consequently the concentration of chlorine entering the Swan Lake system is significantly reduced from 0.5 ppm. Three thousand pounds (3000 lbs or 1361 kg) of chlorine were used in CY-1991.

6.2.2 Bromine

Bromine was used for the first time in 1987 for water treatment at Fermilab. Water pumped from Casey's Pond was treated with a 1-Bromo-3-chloro-5,5-dimethyl hydantoin chemical in a pellet form. This chemical, Nalco 85WT-037/7343, is supplied by Nalco Chemical Company, One Nalco Center, Naperville, Illinois 60566. The bromamines formed when the chemical reacts with agricultural based amines are more effective biocides than chloramines. This treatment discourages biological fouling of the ICW distribution system and equipment utilizing the ICW for cooling. A comprehensive monitoring program to minimize the amount of chemical required has been initiated. The total available halogen is adjusted to be 0.2 mg/liter or less in the water as it leaves the heat exchangers. This product is only used during summer months, May through October. It is fed for two hours per day, with a maximum of four days per week. The total amount of Nalco 85WT-037 used in CY-1991 was only 300 lbs (136 kg).

6.2.3 Heavy Metals and Other Toxic Materials

The chlorinated Swan Lake cooling pond water was passed through the cooling system and a biodispersant, Nalco 7349, was added which lifted deposits from the metal surfaces so they could be oxidized by the chlorine, thus assisting in limiting biological fouling. It was applied at a rate of 8 ml/min for 60 minutes per day with a 20 mg/liter residual. Nalco 7349 is a polyglycol manufactured by Nalco Chemical Company. Another Nalco product, Nalco 1332, was applied at a rate of 9-21 ml/minute with a peak residual of 1-2 ppm. Nalco 1332 is an organophosphorus compound which prevents scale formation. It does not have the toxic properties of organic phosphorus esters found in some restricted-use pesticides (Wo81). In CY-1991, a total of 2300 gallons (8706 liters) of Nalco 1332 and 48 gallons (182 liters) of Nalco 7349 was used. Another Nalco product, Nalco 71-D AntiFoam, was used intermittently to reduce foam in the CUB cooling water sump. Three gallons (11 liters) were used in CY-1991.

Although it was necessary to chemically treat some waters to control the growth of algae and weeds during CY-1991, efforts were made to keep these treatments as low as possible in order to protect wildlife and fish. Copper was applied to Fermilab surface water for algae control. It was applied as a copper-ethanolamine complex which prevents the copper from precipitating out with carbonates and bicarbonates in the water. See Section 6.3.1 for further discussion. Algicide applications to surface waters in CY-1991 are listed in Table 12.

6.3 Pesticides

Pesticides were used on-site during CY-1991 by licensed Fermilab personnel and outside contractors as part of Fermilab's pest control program. All pesticides were EPA registered and applied according to the manufacturer's instructions and Federal, State, and local laws. Licensed Fermilab personnel applied pesticides onsite for control of aquatic algae, annual and perennial weeds and grasses, and insects.

6.3.1 Surface Waters

The following pesticides were applied to control and maintain water quality onsite by inhibiting the growth of algae and cattails. Applications of aquatic algicide were made to no more than half of a body of water at one time. This was done to avoid stressing fish populations due to oxygen depletion in the water from decaying algae.

1991

Cutrine Plus EPA #8959-10AA - A total of 777.4 liters (205.4 gal) of Cutrine Plus, containing 9% of the active ingredient Copper, was applied to 16 acres of water in CY-1991. The copper was contained in a mix of copper-ethanolamine complexes. The ethanolamines prevent the precipitation of copper with carbonates and bicarbonates in water, eliminating the problem of toxic accumulations of copper in the sediments that can occur with non-chelated copper compounds like copper sulfate. See Table 22 and accompanying illustration for monitoring results.

6.3.2 Annual and Perennial Weeds and Grasses

A total of 20 gallons (75.7 liters) of Roundup (EPA #524-308-AA - Isopropylamine Salt of N-(phosphonomethyl) Glyphosate, 41.0%) was applied in CY-1991. A total of 19.5 gallons (73.8 liters) of Surflan (EPA #1471-113 - Oryzalin (3,5-dinitro-N^4, N^4-dipropylsulfanilamide), 40.4%) was also used. These pesticides were applied as a mix around the bases of trees, sign posts, foundations, LP gas tanks, electrical transformers, air conditioners, hardstands, and fire hydrants in the following areas of landscape maintenance: Fermilab Village and Sauk Circle, East Gate Area, Batavia Road, D Road, Pine Street, Wilson Hall, CDF, Industrial Areas, D0 Assembly Building, CHL, Bison pasture fences and corrals, Master Substation, Lab G, and Sites 29 and 52. Equal amounts of each pesticide 1.5 oz. (44 ml) were mixed in a tank and applied at a rate of one tank per 1000 ft^2 (92.9 m^2).

The Roundup was applied separately (24 oz. (0.71 liters)) to the edge of the Reflecting Ponds, along Swenson Farm Road, and the Main Ring north section and south edge as a 5% mix with water.

The pesticide 2,4-D-Amine (EPA #1386-43-534 - Dimethylamine salt of 2,4-Dichlorophenoxyacetic acid, 47.2%) was applied once to 80 acres of the Bison pasture. It was applied at a rate of 2 quarts per acre. The total amount applied was 40 gallons (151.4 liters).

6.3.3 Insects

The pesticide Cythion ULV (EPA #241-208AA - Malathion [S-(1,2-Dicarbethoxyethyl)-0,0-dimethyl--dithio phosphate), 91.0%) was applied at Fermilab during CY-1991 for the purpose of mosquito control. Fourteen sitewide applications occurred. Applicators avoided lakes, streams and ponds. It was applied as an ultra low volume fog at a rate of 2 ounces (59 ml) per minute at a vehicle speed of 10 mph. The total amount applied was 70 gallons (265.0 liters).

The pesticide Orthene 75S (EPA #239-2418-AA - Acephate (O, S-Dimethyl acetylphosphoramidothioate), 75%) was applied to fruit and flowering trees at Sites 29, 38, 50, 52 and 58, in the Village, at CHL and in the Industrial Area for control of tent caterpillars. It was applied at a rate of 0.3 pounds per 100 gallons of water. The total amount applied was 1 lb (0.45 kg).

The pesticide Dursban 4E (EPA #464-524 - Chlorpyrifos (0, 0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate) 44.4%) was applied to Scotch and Austrian Pines in the following areas: South Eola Road, Batavia Road, Site 29 and 55, Wilson Road, North Eola Road, and the Fire Department. It was used to control the effects of the Pine Sawyer Beetle and the Zimmerman Pine Moth. It was applied at a rate of 1 quart per 100 gallons of water. The total amount applied was 4.5 gallons (17.0 liters).

6.3.4 Miscellaneous Pest Control

A licensed contract exterminator was retained during CY-1991 for miscellaneous pest control in kitchens, laboratories, and living areas throughout the site (Table 13).

6.3.5 Agricultural Pest Control Program

During CY-1991 Fermilab leased 1740.5 acres (7.0 km^2) of land to farmers for agricultural production (Figure 13). The leasees hired subcontractors to perform their pesticide applications. The pesticides applied are listed in Table 14.

6.4 Polychlorinated Biphenyls

An inventory of onsite polychlorinated biphenyls (PCBs) is maintained. PCB inspections are performed and records are maintained as required by TSCA (40CFR761.180).

6.5 Chlorides

The potential environmental impact of release of chlorides from the resin regeneration process into the CUB clay tile field (Figure 2) has been evaluated. The regeneration process uses sodium hydroxide and hydrochloric acid, yielding sodium chloride (salt) and water. Assuming the salt released in one year (before CY-1986) all ends up in the nearest drinking water well (W-1 in Figure 7) and is diluted in the water normally pumped from the well for one year, the concentration would be less than 25% of the applicable limit of 250 mg/liter. Thus, the environmental impact should be minimal. Disposal of large volumes of salt in the CUB Tile Field was halted in CY-1986.

6.6 SARA Title III Chemical Inventory Findings

Fermilab conducted a sitewide chemical inventory in accordance with the reporting requirements for CY-1991 for SARA Title III. Additional information on quantities and onsite locations was also collected to facilitate reporting for:

Section 304:	Emergency Notification;
Section 311-312:	Community Right to Know Requirements; and
Section 313:	Toxic Chemical Release Reporting.

Reporting has been completed under Section 311-312 for hazardous chemicals used in quantities greater than or equal to 10,000 lbs (4536 kg) for extremely hazardous substances in quantities greater than or equal to 500 lbs (227 kg) or the threshold planning quantities, whichever was lower. The majority of these chemicals are used in the Central Utility Building, Sites 38, 43, 65, the transformers for the Main Ring and utilities, Meson, Neutron, and Proton areas. Lists of other chemicals for which we have received MSDS's are available to local emergency planning committees and the State Emergency Response Commission. These lists are updated monthly. An inventory of all hazardous chemicals, regardless of quantity, has been completed. This information is available to the local Fire Department, and includes the location and quantities of all flammable, corrosive, toxic, and reactive chemicals. This information is used primarily to protect emergency response personnel in case of a fire or other emergency onsite. A list of the large quantity chemicals used at Fermilab during CY-1991 can be found in Table 15.

6.7 Environmental Occurrences

In February 1991, 85 gallons of pseudocumene (1,2,4 trimethylbenzene) were spilled at the Tagged Photon Lab. Thirty gallons were pumped into drums. Fifty-five gallons went into a ditch. The spill will be reported in the SARA Release Report for CY-1991.

Five environmental occurrences were reported in CY-1991 in accordance with DOE Order 5000.3A. None were determined to have a significant impact on health, safety, or the environment.

In April 1991 a transformer oil leak was detected at the Booster Gallery West. The leak consisted of visible droplets and a noticeable stain on the concrete, measuring 33 X 24" in its maximum dimension. The PCB concentration in the transformer oil is 84 ppm. The transformer was repaired and cleanup in accordance with 40 CFR 761.125 began immediately. Cleanup consisted of removing the stain with absorbent pads and hexane and removing some soil. Following cleanup activities, wipe and soil samples were analyzed to confirm that the cleanup had been carried out to acceptable levels. The excavated area was backfilled with clean soil. The total volume of oil lost was estimated at no more than 4 ounces.

In May 1991, a vendor left the Fermilab site after picking up hazardous waste, recyclable solvent waste, without a signed uniform hazardous waste manifest. This was a violation of RCRA, Department of Transportation (DOT), and Fermilab shipping requirements. The driver returned one hour later to obtain the required generator's signature. A letter was sent to the vendor to document this violation.

In June 1991, a diesel fuel leak from a leasee's farm tractor was discovered at Site 3. The estimated loss was 27 gallons and a visible stain measured approximately 10 X 12 X 1 feet. A second visible stain measuring 3 X 3 X 1/2 feet was also present. The leak was stopped immediately and 28 drums of contaminated soil were collected.

In August 1991, 4 quarts of motor oil leaked from the oil pan of a vehicle involved in an accident in a drainage ditch along C-road west. The oil spill was contained in the ditch. The oil was absorbed with booms.

In September 1991, a transformer outside the G-2 Service Building failed, causing a rupture of the oil reservoir at a primary feedthrough, and resulting in a fire in the transformer switchgear. Firefighters were able to contain the spilled oil to the concrete pad. The remaining oil was drained from the transformer into drums.

7.0 QUALITY ASSURANCE IN CY-1991

Routine environmental water samples collected by the Environment, Safety and Health Section's Environmental Protection (EP) Group were analyzed for radiochemicals by TMA/Eberline. Other samples were counted at the Fermilab Activation Analysis Laboratory (AAL).

In CY-1991 Fermilab contracted with Industrial and Environment Analysis, Inc. (IEA) to provide general chemical analysis on samples that were not radioactive. Samples containing radioactivity were sent to Controls for Environmental Pollution, Inc. (CEP) for chemical analysis.

7.1 Quality Assurance in Sampling Procedures

The EP Group of the ES&H Section has developed an Environmental Protection Group Procedures Manual (EPPM) that documents all routine monitoring and surveillance procedures. Specific procedures have been developed in accordance with established standards, practices, and protocols. Samples at all locations are collected using documented procedures. These procedures ensure that samples are representative of the media from which they are collected and will yield reliable and consistent results.

Most chemical analysis samples taken by other groups at the Lab are of liquid process streams. Grab samples are usually taken directly or with a disposable glass coliwasa. Surface soil samples are taken with contaminant-inert scoops.

7.2 Quality Assurance in Analysis

Samples are analyzed using standard analytical procedures. Data quality is verified by a continuing program of analytical laboratory quality control, participation in interlaboratory cross-checks, and replicate sampling and analysis. When applicable to analysis requested, analytical labs must be certified. Several inspection visits were made to IEA (Illinois) in order to approve their procedures. CEP (New Mexico) was evaluated based on written procedures and telephone conversations. Ongoing precision and accuracy is monitored by analysis of the following with each batch of samples: laboratory standards, duplicate determinations, matrix spikes and matrix spike duplicates. This data is used to calculate recovery and relative standard deviation. The quality of the data is then evaluated and compared to regulatory limits to determine acceptability. A range of radiochemical spikes are used to test the vendor's ability to achieve the required sensitivity for each parameter and reliability in detecting accelerator-produced radionuclides at or below the concentration guide standards (Table 17). Fermilab's Activation Analysis Laboratory (AAL), formerly called the Nuclear Counting Lab (NCL), and the primary vendor contracted for radioanalysis, TMA/Eberline both participated in DOE's EML quality assurance program. Both chemical analysis labs, IEA and CEP, participated in the USEPA's quality assurance program for analysis of water supplies (WS) and water pollutants (WP) and have obtained state certification. The WS/WP Round Robin data generated by these labs was reviewed and deemed acceptable by Fermilab staff.

Fermilab and TMA results in the DOE Environmental Measurements Laboratory (EML) quality assurance program (Sa91, Sa92) are found in Tables 18, 19, and 20. The results of both TMA/Eberline and the AAL in Fermilab's radiochemical spike quality assurance program can be found in Table 16. The range of radiochemical spikes were prepared to test the ability to achieve the required sensitivity (Table 17) for each parameter and the reliability in detecting accelerator-produced radionuclides at or below the concentration guide standards (Table 17).

7.2.1 Analytical Procedures at IT Corporation

Analysis specifications are summarized in Table 17.

7.2.2 Additional Quality Assurance Efforts

The Environment, Safety and Health Section reviews all analytical data for samples analyzed under its contracts with CEP and IEA. The results are reviewed relative to the accompanying QA/QC results and compared with regulatory

1991

limits for acceptability. These reviews include inspection of chain-of-custodies, sample stewardship, sampling handling and transport, and sampling protocols.

8.0 REFERENCES

The appropriate Radiation Protection Standard for penetrating radiation applied to individuals in uncontrolled areas was taken from the DOE Order 5400.5 (DOE 90a). The annual dose limit for whole body exposure is 100 mrem (1 mSv) including all exposure modes.

The Concentration Guides used in the analyses of the surface water samples (Table 17) for radioactivity were taken from DOE Order 5400.5 (DOE90a) and Derived Concentration Guides (DCGs); Concentrations of Radionuclides in Water and Air that could be Continuously Consumed or Inhaled, Respectively, and Not Exceed an Effective Dose Equivalent of 100 mrem/year (1 mSv/year). These Derived Concentration Guides are based on guidance given in International Commission on Radiological Protection (ICRP) Publications 23, 26, and 30, Pergamon Press, New York. The source for EPA guidance on radon exposure is document EPA-OPA-86-004, issued in August 1986. The recommended residential limit is 4 pCi/liter (11 Bq/liter).

In analysis of groundwater samples for all radionuclides other than tritium, 4% of the Derived Concentration Guide values specified in DOE Order 5400.5 (DOE90a) were used as concentration guides. These correspond to 4 mrem/year (4×10^{-2} mSv/year) to a full-time consumer of such water to be consistent with the USEPA's limit specified in 40 CFR 141 pertaining to community drinking water systems. For tritium, however, 40 CFR 141 specifically states a limit of 2×10^{-5} µCi/ml (compared with 8×10^{-5} µCi/ml obtained as 4% of the DOE 5400.5 DCG). The smaller value as specified by USEPA is used as the concentration guide for that radionuclide. The specified sensitivity and precision of the analyses are sensitive at 10% or less of these concentration guides.

The Air and Water Pollution Standards for nonradioactive pollutants were taken from the State of Illinois Pollution Control Board Rules and Regulations (Il90a and Il90b). The water's onsite were considered to be in the "general use" category. The value used for total hexavalent chromium general water quality standard was 0.05 mg/liter. The maximum contaminant level for chloride in water for general use is 500 mg/liter and the level of total dissolved solids is 1000 mg/liter. In public drinking water the standards for chloride and total dissolved solids are 250 mg/liter and 500 mg/liter, respectively (Ilb). The Air Quality Standards limit the release for oxides of nitrogen to 136 g (0.3 lbs) per 252 million calories (per million Btu's) of actual heat input in any one hour. Release of sulfur dioxide shall not exceed 2000 ppm (Il75).

1991

The appropriate regulations for PCBs and hazardous wastes are found in the U.S. Code of Federal Regulations 40 CFR 761 and 40 CFR 260-265, respectively.

40CFR141 National Primary Drinking Water Regulations

40CFR143 National Secondary Drinking Water Regulations

40CRFa U.S. Code of Federal Regulations 40 CFR 302, Table 302.4

40CFRc U.S. Code of Federal Regulations 40 CFR 260-265.

Aw71 Awschalom, M., et al. "Radiation Monitoring at NAL: Instruments and Systems," International Conference on Protection Against Accelerator and Space Radiation, CERN Report 71-16, p. 1035, Geneva, Switzerland, July 1971.

Ba73 Baker, S. I. National Accelerator Laboratory Environmental Monitoring Report for Calendar Year 1972, March 1973.

Ba75a Baker, S. I. National Accelerator Laboratory Environmental Monitoring Report for Calendar Year 1974, April 1975.

Ba75b Baker, S. I. "Soil Activation Measurements at Fermilab," Third ERDA Environmental Protection Conference, Chicago, September 23-26, 1975, ERDA-92, pp. 329-347.

Ba82 Baker, S. I. Fermi National Accelerator Laboratory Environmental Monitoring Report for Calendar Year 1981, Fermilab Report 82/22, May 1982.

Ba85 Baker, S.I. Fermi National Accelerator Laboratory Environmental Monitoring Report for Calendar Year 1984, Fermilab Report 85/32, May 1985.

Ba86 Baker, S. I. Fermi National Accelerator Laboratory Environmental Monitoring Report for Calendar Year 1985, Fermilab Report 86/37, May 1986.

Ba89 Baker, S. I. Fermi National Accelerator Laboratory Site Environmental Report for Calendar Year 1988, Fermilab Report 89/63, May 1989.

Bi91 Bird, M. C. and R. Lurie, "Report of the 1990 Field School Investigations at Fermi National Accelerator Laboratory: Antiproton Collider Hall 204 and Pine Street Prairie Restoration Area," Cultural Resource Management Report, 92, February 21, 1991.

Bo72 Borak, T. B., et al. Health Physics 23, 679 (1972).

Bu89 Butala, S. W., S. I. Baker, and P. W. Yurista. Health Physics 57, 909 (1989).

Co90 Cossairt, J. D., and D. W. Grobe. "Summary of Subsurface Exploration Near the Neutrino and Meson Target Areas," E.P. Note #2, March, 1990.

Co90a Cossairt, J.D. Fermi National Accelerator Laboratory Site Environmental Report for Calendar Year 1989, Fermilab Report 90/51, May 1990.

Co91 Cossairt, J.D., Fermi National Accelerator Laboratory Site Environmental Report for Calendar Year 1990, Fermilab Report 90/57, May 1991

1991

Co92 Cossairt, J.D. and Elwyn, A. J. "Calculation of Dose Equivalents Due to Offsite Muons for Calendar Year 1991," E.P. Note #6, April 1992

Cs62 Csallany and Walton. Yields of Deep Sandstone Wells in Northern Illinois, Illinois State Water Survey Report of Investigation 43.

Cu92 Radionuclide Air Emissions/ES&H Section, Specific Quality Implementation Plan, May 1992.

DOE88 U.S. Department of Energy, Final Environmental Impact Statement on the Superconducting Super Collider, Volume I, Chapter 4, 1988.

DOE90a Radiation Protection of the Public and the Environment, DOE Order 5400.5, U.S. Department of Energy, Washington, D.C., June 5, 1990 (latest version).

DOE90b "Results of the Department of Energy Indoor Radon Study," DOE/ID/12584-75 prepared by UNC Geotech, August 1990.

DOE90c "Occurrence Reporting and Processing of Operations Information," U.S. Department of Energy, Washington, D.C., May 30, 1990.

DOE90d General Environmental Protection Program, DOE Order 5400.1, U.S. Department of Energy, Washington, D.C., June 29, 1990

DOE91 Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance, DOE/EH-0173T, January 1991.

Du92 Duncker, J. United States Department of the Interior, Geological Survey, 102 East Main St., Urbana, Illinois 61801, January 1992.

Ea70 Early, A. M. 1970. NAL 1970 Archaeological Survey: The Prehistoric Occupations of the National Accelerator Laboratory Site.

Ea71 Early, A. M. 1971. 1971 Salvage Excavations National Acceleratory Laboratory.

Ei91 Eichleay Engineers, Inc., "Soil Characterization Sampling in an Excavated Soil Pile Near the West Meson Detector Building, Fermi National Accelerator Laboratory, Batavia, Illinois," February 4, 1991.

El88 Elwyn, A.J., J.D. Cossairt, and W.S. Freeman, "The Monitoring of Accelerator-Produced Muons at Fermilab," Fermilab-CONF 001107, Proceedings of the 22nd Midyear Topical Meeting of the Health Physics Society, San Antonio, Texas, December 4-8, 1988.

EMP Environmental Monitoring Plan, Fermilab, October 1991.

EPPM Environmental Protection Procedures Manual, Fermilab, October 1991.

GPMP Groundwater Protection Management Plan, Fermilab, October 1991

Ha88 J. Harvey, IT Corporation, private communication, 1988.

Il78 Measurements and Calculations by R. Schicht and A. Wehrmann, Illinois State Water Survey, private communication, 1978.

Il90a Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution Control Board, August 1990.

Il90b Illinois Rules and Regulations, Title 35: Environmenal Protection, Subtitle B: Air Pollution, Chapter I: Pollution Control Board, September 1990.

1991

Ilb	Illinois Revised Statutes Part VIII Public Drinking Water, IEPA Supplement No. 1 304D, Table 2.

Ki85	Kirk, J.R., et al. Water Withdrawals in Illinois, 1984, Illinois State Water Survey Circular 163.

La71	Landon, R. A., and J. P. Kempton. Stratigraphy of the Glacial Deposits at the National Accelerator Laboratory Site, Batavia, Illinois, Circular 354, Illinois State Geological Survey, Champaign, Illinois, 1971.

Lu90	Lurie, R. Report on the Wooded Areas Survey, Gazebo Site 1990 Testing, Collector Interviews, and Review of Prehistoric Site Status and Location at Fermi National Accelerator Laboratory, Batavia, Illinois. Cultural Resource Management Report, 56, January 28, 1990.

Mo79	Moore, R. E., et al. "AIRDOSE-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides," Oak Ridge National Laboratory Report ORNL-5532, June 1979.

Mo86	Moore, R. E., et al. "CAAC, Code System for Implementation of Atmospheric Dispersion Assessment Required by the Clean Air Act," Oak Ridge National Laboratory Report CCC-476, December 1986.

NOAA91	Local Climatological Data Monthly Summaries, January - December 1991, National Oceanic and Atmospheric Administration, National Weather Service Office, 10600 West Higgins Rd., Chicago, IL.

NRC90	National Research Council: Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR Report National Academy Press, 1990.

Pf74	Pfingsten, C.W., et al. Ground Water Flow Study, National Accelerator Laboratory, near Batavia, Illinois, Soil testing Services, Inc., Northbrook, Illinois, 1974.

Sa81	Sasman, R.T., et al. Verification of the Potential Yield and Chemical Quality of the Shallow Dolomite Aquifer in DuPage County, Illinois, Illinois State Water Survey, Circular 149, 1981.

Sa82	Sasman, R. T., et al. Water Level Trends, Pumpage, and Chemical Quality in the Cambrian-Ordovician Aquifer in Illinois 1971-1980, Illinois State Water Survey, Champaign, Illinois (1982).

Sa91	Sanderson, C. G. and S. C. Scarpitta, Semiannual Report of the Department of Energy, Operational Safety, Health, and Environment Division - Quality Assurance Program, U.S. DOE Environmental Measurements Laboratory Reports EML-539, July 1, 1991.

Sa92	Sanderson, C. G. and S. C. Scarpitta, Semiannual Report of the Department of Energy, Deputy Assistant Secretary for Environment, Quality Assessment Program, U.S. DOE Environmental Measurements Laboratory Report EML-543, January 2, 1992.

St83	Stevenson, G.R., "Dose and Dose Equivalent from Muons," CERN Report TISI-RP1099, European Organization for Nuclear Research, CERN, Geneva, Switzerland, 1983.

Su59	Suter, M., et al. Preliminary Report on Groundwater Resources of the Chicago Region, Illinois, Illinois State Water Survey and Geological Survey Cooperative Groundwater Report 1, 1959.

Vi 85	Visocky, A.P., et al. Geology, Hydrology and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois, Illinois State Water Survey, Illinois State Geological Survey, U.S. Geological Survey Cooperative Groundwater Report 10, Champaign, Illinois, 1985.

Vi88	Visocky, A.P., et al. Groundwater Investigations for Siting the Superconducting Super Collider in Northeastern Illinois. ISWS/CIR-170/88, Illinois State Water Survey, Champaign, Illinois, 1988.

1991

Wi92 Wilson, D. Martin Marietta Energy Systems, Inc., Geographic Data Systems Computing and Telecommunications, Post Office Box 2008, Oak Ridge, Tennessee 27831, February 1992.

Wo81 Wolf, C. H. Nalco Chemical Company, private communication, 1981.

Ze62 Zeizel, A.J., et al. Groundwater Resources of DuPage County, Illinois, Illinois State Water Survey and Geological Survey, Cooperative Groundwater Report 2, 1962.

9.0 ACKNOWLEDGMENTS

Thanks to Eric Mieland who collected most of the environmental monitoring data. A special thanks to Paul Kesich for his major contribution in compiling the environmental monitoring data. Also thanks to Monica Sachse for her patience and hard work in typing this year's report. Contributing authors are listed on the cover page. The figures containing photos were recently updated versions of those in the Fermi National Accelerator Laboratory Graphic Overview System compiled for the Department of Energy by H. Berry, Z. Burson, and others in the EG&G Energy Measurement Group, P.O. Box 1912, Las Vegas, Nevada 89101.

1591

10.0 DISTRIBUTION LIST

No. of Copies	Recipient
32	U.S. Department of Energy
	Chicago Operations Office (10)
	Office of Environmental Compliance (5) (EH-22)
	Office of Environmental Audit (2) (EH-24)
	Office of NEPA Project Assistance (2) (EH-25)
	J. Farley (ER-65)
	A. E. Mravca (12)
4	Illinois U.S. Congressional Delegation
10	Chicago Area Press
72	Fermi National Accelerator Laboratory

J. Peoples, Director
K. Stanfield, Deputy Director
B. Chrisman, Associate Director
D. Theriot, Associate Director
R. Rubinstein, Assistant Director
R. Allen
C. Anderson
B. Arnold
J. Appel
R. Auskalnis
D. Austin
J. Barry
S. Benesch
M. Blotch
D. Bogert
D. Bowron
S. Butala
H. Casebolt
S. Collins
D. Cossairt
V. Cupps
R. Dorner
G. Dugan
A. Elwyn
D. Finley
J. Finks, Jr.
W. Fowler
W. Freeman
P. Garbincius
M. Gerardi
K. Graden
D. Grobe
R. Hall
R. Hanft
M. Harrison
P. Hojsak
S. Holmes
K. Isakson
H. Jostlein
P. Kesich
B. Kobiella
J. Kofron
S. Krstulovich
F. Krueger
V. Kuchler
B. Lach
A. Leveling
R. Lewis
J. MacNerland
E. Major
F. Markley
C. Marofske
R. Mau
E. Mieland
T. Miller
G. Mitchell
J. Moecher
K. Moss
T. Nash
W. Nestander
B. Nicholson
T. Pawlak
R. Rebstock
T. J. Sarlina
R. Stefanski
D. Thurston
C. Turner
L. Vonasch
K. Vaziri
R. Walton
S. Wilson
T. Yamanouchi
C. Zonick

1991

2 Argonne National Laboratory
C. L. Cheever, N. Golchert

1 Battelle Columbus Laboratory
G. Kirsch

1 Battelle, Pacific Northwest Laboratories
R. Jaquish

3 Brookhaven National Laboratory
R. Miltenberger, J. Naidu, R. Casey

1 CEBAF
G. Stapleton

1 EG&G Energy Measurements Group, Las Vegas, H. Berry

3 Illinois Environmental Protection Agency
R. Carlson, T. Denning, M. Swartz

1 Illinois Historic Preservation Agency
W. G. Farrar

2 Illinois State Geological Survey
D. Gross, J. Kempton

1 Illinois State Natural History Survey
W. Brigham

1 Illinois State Water Survey
K. Benson

1 Lawrence Livermore National Lab
R. Thomas

1 Los Alamos National Laboratory
J. Miller

2 Oak Ridge National Laboratory
R. Durfee, P. Rohwer

1 Princeton Plasma Physics Laboratory
J. Stencel

1 Stanford Linear Accelerator Center
G. Warren

2 SSC Laboratory
S. Baker, L. Coulson

6 U.S. Environmental Protection Agency
V. Adamkus, W. Gunter (2), L. Johnson, T. McLaughlin, N. Philippi

1 U.S. Geological Survey
J. Duncker

TABLES

Table 1 Summary of Radioactivity Released to the Offsite Environment in CY-1991 52

Table 2 Chemical Analysis of Kress Creek CY1991 53

Table 3 Incremental Population Data in Vinicity of Fermilab, 1990................54

Table 4 List of Fermilab Environmental Permits................55

Table 5 ParkNet Projects 56

Table 6 Maximum Effective Dose Equivalent at Site Bondary Due to Muons in CY-1991............57

Table 7 Airborne Radioactivity Released Due to Accelerator Operations During CY-1991 58

Table 8 Tritium Detected in Sump Water Samples................59

Table 9 CY-1991 Soil/Sediment Results 60

Table 10 Summary of Collective Effective Dose Equivalent for CY-1991 Within a 50 mile (80 km) Radius of Fermilab 61

Table 11 Fermilab IEPA Air Pollution Permit Conditions................62

Table 12 Pesticide Applications to Surface Waters at FNAL in CY-1991................63

Table 13 Pesticides Applied by Licensed Contractor of CY-1991................64

Table 14 Pesticides Applied to Leased Farm Tracts CY-1991................65

Table 15 Large Quantity Chemical Materials in the SARA Title III Inventory for CY-1991...........66

Table 16 Fermilab QA Program Results for TMA/Eberline and Fermilab AAL................67

Table 17 Specifications for the Analyses of Accelerator-Produced Radionuclides in Water..............68

Table 18 EML Quality Assurance Program Results for Fermilab AAL (Sa91, Sa92) 69

Table 19 EML Quality Assurance Program Results for TMA/Eberline (Sa91) 70

Table 20 EML Quality Assurance Program Results for TMA/Eberline (Sa92) 71

Table 21 CY-1991 CUB Tile Field Monitoring Results 72

Table 22 1991 Swan Lake Total Copper Concentrations................73

Table 23 1991 Pesticide Application Summary for Leased Farm Tracts at FNAL 74

Table 24 1991 Boring Hole Results................75

Table 25 EIS/ODIS Activity Summary Report for Liquid Releases................76

Table 1

Summary of Radioactivity Released to the Offsite Environment in CY-1991

Release Point	Pathway	Radionuclide	Half-Life	Release in (Ci)	Release in (Bq)
Beam Tunnel Ventilation Stacks					
AP0	Air	^{13}N	9.97 minutes	7.0	2.6×10^{11}
		^{11}C	20.38 minutes	21.0	7.8×10^{11}
		^{41}Ar**	1.83 hours	22.0	8.1×10^{11}
		^{15}O	2.04 minutes	0	0
M05	Air	^{13}N	9.97 minutes	3.5	1.3×10^{11}
		^{11}C	20.38 minutes	12.0	4.4×10^{11}
		^{41}Ar**	1.83 hours	0	0
		^{15}O	2.04 minutes	0.5	1.9×10^{10}
NM-2	Air	^{13}N	9.97 minutes	1.1	4.1×10^{10}
		^{11}C	20.38 minutes	2.1	7.8×10^{10}
		^{41}Ar	1.83 hours	0	0
		^{15}O	2.04 minutes	0.1	3.7×10^{9}
PB-4	Air	^{13}N	9.97 minutes	3.0	1.1×10^{11}
		^{11}C	20.38 minutes	8.9	3.3×10^{11}
		^{41}Ar**	1.83 hours	9.4	3.5×10^{11}
		^{15}O	2.04 minutes	0	0
NW-8	Air	^{13}N	9.97 minutes	0.5	1.85×10^{10}
		^{11}C	20.38 minutes	1.4	5.2×10^{10}
		^{41}Ar**	1.83 hours	2.8	1.0×10^{11}
		^{15}O	2.04 minutes	0	0
Unmonitored	Air	^{13}N	9.97 minutes	1.2	4.4×10^{10}
		^{11}C	20.38 minutes	3.5	1.3×10^{11}
		^{41}Ar**	1.83 hours	7.1	2.6×10^{11}
		^{15}O	2.04 minutes	0	0
Debonding Oven	Air	^{3}H	12.3 years	0*	0*
Kress Creek Spillway	Water	^{3}H	12.3 years	3.646	1.4×10^{11}

* Not operated in CY1991

** ^{38}Cl and ^{39}Cl are modelled as ^{41}Ar

1991

Table 2

Chemical Analysis of Kress Creek
CY1991
(Results are in mg/liter)

PARAMETER	General Use Standards*	Kress Creek Onsite 6/91	Kress Creek Off-site 6/91	Fox River Inlet 6/91
Oil-grease	**	382	331	485
Cyanide	0.022	.015	.006	<.005
Al	–	1.600	1.420	.599
Cd	0.03***(a)	<.005	<.005	<.005
Cr (total)	4.0***(b)	<.01	<.01	<.01
Cu	0.045***(c)	<.025	<.025	<.025
Fe	1.0	2.280	.75	1.03
Pb	0.1	<.05	<.04	<.05
Mn	1.0	.0721	.0658	.106
Ni	1.0	<.04	<.04	<.04
Zn	1.0	<.015	<.015	<.015
PCB's	—	U	U	U
pH	6.5 - 9.0	7	7	NA

* From State of Illinois Rules and Regulations Title 35, Subtitle C, Chapter I, Part 302, Subpart B, as amended through July 9, 1990. Concentrations are the acute standard for these parameters. These concentrations shall not be exceeded at any time except where mixing is allowed.

** Section 302.203 Offensive Conditions
Waters of the State shall be free from ...visible oil...of other than natural origin.

*** The following formula, based on the Hardness of the surface water, was used to calculate the acute standard concentration of these parameters:

$\exp[A + B\ln(H)]$
H = Hardness (270 mg/L)

(a) A = -2.918
B = 1.128
Standard concentration is not to exceed 0.05 mg/L

(b) A = 3.688
B = 0.8190

(c) A = -1.464
B = 1.273

NA = Not Available
U = Undetected
< 0.0005 mg/L for Aroclor 1016,1221,1232,1242, and 1248.
< 0.001 mg/L for Aroclor 1254 and 1260.

Table 3

Incremental Population Data in Vinicity of Fermilab, 1990

Latitude = 41°, 50 minutes, 0 seconds
Longtitude = 88°, 15 minutes, 0 seconds

Distance, Kilometers	0-16	16-32	32-48	48-64	64-80	80-97	97-113	113-128
Distance, Miles	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
N	2089	87415	91726	82233	47449	40045	32429	196267
NNE	21917	166874	160005	150130	154133	101765	130460	93160
NE	43752	113168	357243	107609	0	0	0	0
ENE	62241	196032	827290	524318	0	0	0	0
E	41712	186062	976520	695707	0	0	16428	47516
ESE	45485	141995	328815	579674	337302	191967	88206	20935
SE	59613	67595	105945	134451	42548	29546	13853	11368
SSE	15573	28592	114436	6165	22319	61408	9818	10126
S	12189	10150	21310	19396	7762	8550	2962	11951
SSW	60844	10074	2760	15139	6636	23354	16186	8112
SW	42105	10932	9544	4875	28479	31635	11556	8311
WSW	11461	5342	7864	4890	10477	6100	11706	9996
W	5551	3190	3133	3802	14119	7683	26524	38543
WNW	14870	5171	51081	4389	20166	33921	11767	36862
NW	19352	9424	8276	4943	74962	160650	72098	25555
NNW	24571	34138	15233	28241	14856	32552	23120	53682
Total	**483325**	**1076154**	**3081181**	**2365962**	**781208**	**729176**	**467113**	**572384**
Cummulative Total	483325	1559479	4640660	7006622	7787830	8517006	8984119	9556503

1991

Table 4

List of Fermilab Environmental Permits

Issuing Agency Type, and No.	Description	Current Issue Date	Expiration Date
IEPA-air Appl.#86020057	Gasoline dispensing tanks	10/19/90	10/16/95
IEPA-air Appl.#87110096	5 gas-fired hot water boilers 1 propane-fired boiler 1 grit blaster	1/15/88	11/24/92
IEPA-air Appl.#89090071	2 gas-fired hot water boilers (Lab A & Meson Detector Building)	11/28/89	11/20/94
IEPA-air Appl.#88010042	Open Top Vapor degreaser (IB-3)	4/14/88	3/31/93
IEPA-air Appl.#79070012	Magnet debonding oven with Afterburner	11/2/89	3/5/94
IEPA-air Appl.#89080089	Radionuclide emissions from TeV operations	10/30/89	8/28/94
IEPA-open burn Appl.#B9110110	Prairie/Land ecological management	10/29/91	10/24/92
IEPA-open burn Appl.#B9201038	Fire Fighting Instruction	1/30/92	4/17/93
RCRA IEPA I.D.890105010 USEPA.IL6890030046	Hazardous Waste Storage Facility	10/28/91	10/28/01
IL Dept of Public Works Permit No. 12170	Water intake from Fox River	1/7/69	12/31/09
Warrenville Water Supply II Permit #0099		2/1/91	till revoked
IEPA - Air Appl. #91030001, ID#043807AAI	Fermilab Main Injector Construction Permit for Radionuclide Emissions	1/21/92	4/1/93 If construction has not commenced
IEPA - Air Appl #91100025, ID#043807AAI	Open Top Vapor Degreaser-Transfer Hall S. (Construction & Operating)	10/17/91 (Operating)	10/09/96

1991

Table 5

ParkNet Projects

Investigator(s)	Institution	Project Description	Status
Anderson, R	Illinois State University	Ordination of existing data	Cancelled
Bowles, M. & Flankne, R.	Morton Arborteum	Distribution of *Quercus bicolor*	Awaiting Proposal
Hennen, M.	Chicago Academy of Science	Bluebird Population study	Initiated
Jastrow, J.	Argonne National Laboratory	N-3 Experimental Area Project*	Initiated
Jewell, M.	Miami University	Prairie Small Mammal Study	Initiated
Kaiser, J.	University of Tennessee	Endophytic Fungi In Grasses To Decrease Intrusions By Mammals In Waste Areas	Proposed
McArdle, E.	Northeastern Illinois University	Advanced Field Ecology Class Use of Grasses	Completed**
Weis, A.	University of California, Irvine	*Eurosta* Galls On *Solidago*	Completed
Whelan, C.	Morton Arboretum	Effect Of Smoke On Seed Germination	Initiated

*Proposed and initiated by the Fermilab ParkNet program.
**Intiated and completed in 1991.

1991

Table 6

Maximum Effective Dose Equivalent at Site Boundary Due to Muons in CY-1991

Beamline	Maximum Effective Dose Equivalent Offsite (mrem)	(mSv)
MW*	3.9	0.039
MC*	7.2	0.072
NM	4.1	0.041
PW	0.009	9×10^{-5}
PE	0.24	2.4×10^{-3}
PB	0.51	5.1×10^{-3}

*For these beamlines, the distances from the site boundary to the nearest residence are rather large. The maximum effective dose equivalents at the nearest residences for these beamlines were 2.0 mrem (0.02 mSv) for MW, and 4.2 mrem (0.042 mSv) for MC.

Table 7

Airborne Radioactivity Released Due to Accelerator Operations During CY-1991

Stack Monitor	Activity Released (Curies)	(Becquerel X 10^{11})
Antiproton Source	50.0	18.6
Meson Target Stations	16.0	5.81
NM Target Station	3.3	7.88
PB Target Station	21.3	1.70
NW8 Target Station	4.7	1.22
Unmonitored Stacks	11.8	4.37
Total	**107.1**	**39.6**

Table 8

Tritium Detected in Sump Water Samples [Concentration (C) in Ci/ml (Bq/ml)]

Collection Point	Number of Samples	C Max*	C Min**	C Mean***	Percentage of Concentration Guide (%)****
AP0	2	2.64×10^{-11} (9.7×10^{-1})	4.87×10^{-12} (1.8×10^{-1})	1.56×10^{-11} (5.8×10^{-1})	7.8×10^{-1}
g1	2	4.00×10^{-12} (1.48×10^{-1})	4.5×10^{-13} (1.67×10^{-2})	2.23×10^{-12} (8.25×10^{-2})	1.12×10^{-1}
M01SP2	3	3.55×10^{-12} (1.3×10^{-1})	1.64×10^{-12} (6.0×10^{-2})	2.54×10^{-12} (9.0×10^{-2})	1.3×10^{-1}
M01SP3	3	3.91×10^{-11} (1.45)	1.27×10^{-11} (4.7×10^{-1})	2.65×10^{-11} (9.8×10^{-1})	1.33
N01SP3	2	6.98×10^{-12} (2.6×10^{-1})	2.43×10^{-12} (9.0×10^{-2})	4.71×10^{-12} (1.7×10^{-1})	2.4×10^{-1}
N01SP4	5	1.22×10^{-10} (4.52)	1.09×10^{-11} (4.2×10^{-1})	7.11×10^{-11} (2.63)	3.56
NM1SP	5	1.96×10^{-11} (7.3×10^{-1})	1.34×10^{-12} (5.0×10^{-2})	8.55×10^{-12} (3.2×10^{-1})	4.3×10^{-1}
NM3	1	5.75×10^{-12} (2.13×10^{-1})	5.75×10^{-12} (2.13×10^{-1})	5.75×10^{-12} (2.13×10^{-1})	2.88×10^{-1}
NTSBSP1	2	8.98×10^{-11} (3.32)	5.03×10^{-11} (1.86)	7.01×10^{-11} (2.59)	3.50
NTSBSP2	3	3.18×10^{-12} (1.2×10^{-1})	7.60×10^{-13} (3.0×10^{-2})	1.59×10^{-12} (6.0×10^{-2})	8.0×10^{-2}
NW4SP1	4	9.73×10^{-11} (3.60)	3.48×10^{-11} (1.29)	6.50×10^{-11} (2.41)	3.25
PC4SP2	2	8.83×10^{-11} (3.27)	3.22×10^{-11} (1.19)	6.02×10^{-11} (2.23)	3.01
PW6SP2	2	3.90×10^{-12} (1.33×10^{-1})	2.44×10^{-12} (9.03×10^{-2})	3.17×10^{-12} (1.17×10^{-1})	1.59×10^{-1}
PW6SP3	1	3.44×10^{-12} (1.27×10^{-1})	3.44×10^{-12} (1.27×10^{-1})	3.44×10^{-12} (1.27×10^{-1})	1.72×10^{-1}

* The highest concentration detected in a sample from that location.
** The lowest concentration detected in a sample from that location.
*** The average concentration for samples taken from that location.
**** Concentration Guide for Tritium is 2.0 x 10-9 Ci/ml (74 Bq/ml). Percentage is calculated from the mean concentration.

Table 9

CY-1991 Soil/Sediment Results

LOCATION		Be-7	Na-22	Mn-54	Co-57	Co-60	Zn-65	Cs-137	H-3*	CY-1990 H-3*
Indian Creek	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
Kress Creek on	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
Kress Creek off	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
Ferry Creek	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
AP0 STACK	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	<2.0 E-6 <7.4 E-2	NA
N01 STACK	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	4.9 +/- 0.52 E-6 1.8 +/- 0.19 E-1	1.6 +/- 0.26 E-7 5.8 +/- 1.0 E-1
N01 SPUR STACK	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	2.4 +/- 0.45 E-6 8.9 +/- 1.7 E-2	7.3 +/- 2.3 E-6 2.7 +/- 0.9 E-1
M01 STACK	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	<2.0 E-6 <7.4 E-2	<3.1 E-6 <0.1
N01SP4 SUMP	µCi/g Bq/g	ND	3.4 +/- 0.9 E-7 1.3 +/- 0.3 E-2	ND	ND	ND	ND	ND	NA	NA
NW4SP1 SUMP	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
M01SP3 SUMP	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA
CUB TILE FIELD	µCi/g Bq/g	5.4 +/- 1.15 E-6 2.0 +/- 0.4 E-1	ND	2.8 +/- 0.8 E-7 1.0 +/- 0.2 E-2	2.0 +/- 0.5 E-7 7.4 +/- 1.9 E-3	1.1 +/- 0.2 E-6 4.1 +/- 0.5 E-2	ND	ND	NA	NA
SITE 12	µCi/g Bq/g	ND	ND	ND	ND	ND	ND	ND	NA	NA

All analysis was performed at the Fermilab Activation Analysis Laboratory.
* Tritium values are reported as µCi/ml and Bq/ml of soil moisture.
NA - Not Available.
ND - Not Detected.

1991

Table 10

Summary of Collective Effective Dose Equivalent for CY-1991
Within a 50 mile (80 km) Radius of Fermilab

Source	Collective Effective Dose Equivalent person-rem	person-Sv
Penetrating radiation from muons	6.20	6.20×10^{-2}
Penetrating radiation from the Boneyard (gamma rays)	1.20	1.20×10^{-2}
Airborne radioactivity from the target stations	0.21	2.1×10^{-3}*
Total	**7.61**	$\mathbf{7.61 \times 10^{-2}}$

*Population dose from airborne radioactivity was calculated using CAP88-PC.

1991

Table 11

Fermilab IEPA Air Pollution Permit Conditions

Application No.	Description	Special Conditions
B9201038	Open burning for firefighting instruction/ research	
B9110110	Open burning for prairie/land management	
86020057	Gasoline dispensing tanks	WBL boilers restricted to <1.2 tons/yr nitrogen oxides
87110096	5 gas-fired hot water boilers; 1 propane-fired boiler; 1 grit blaster	WBL boilers restricted to <1.2 tons/yr nitrogen oxides
89090071	2 gas-fired hot water boilers (Lab A & Meson Detector Bldg)	Lab A <0.12 lb/hr nitrogen oxides Lab A <0.45 tons/yr nitrogen oxides Meson Det. Bldg. <0.26 lb/hr nitrogen oxides Meson Det. Bldg. <0.98 tons/yr nitrogen oxides
91100025	Open top vapor degreaser (Transfer Hall South)	Nominal organics emission rates must be 0.1 lb/hr and <0.44 tons/yr. Maintain records of solvent purchase and use to calculate actual VOC emissions
88010042	Open top vapor degreaser (IB3)	<1 ton/yr organic emissions
79070012	Magnet debonding oven with afterburner (IB2)	25 mrem/yr whole body* 75 mrem/yr critical organ to any member
91030001	Fermilab Main Injector construction permit for radionuclide emissions	Radionuclide emissions shall not exceed those that would cause an annual effective dose equivalent of 10 mrem/yr to any member of the public
89080089	Radionuclide emissions TeV operations	25 mrem/yr whole body* 75 mrem/yr critical organ to any member

*Conditions superseded by more stringent provisions of 10 CFR 61, Subpart H.

Table 12

Pesticide Applications to Surface Waters at FNAL in CY-1991

Cutrine Plus Treatment Area	Acres	# of Applications	Total Applied (liters)
Booster Pond	1.6	10	114
Center Reflecting Pond	1.3	3	15
East Reflecting Pond	1.5	3	20
Booster Feed Ditch CP-3	1.0	2	4
Swan Lake	7.8	10	564
Swan Lake Ditch	1.5	2	15
West Pond	1.3	3	45

1991

Table 13

Pesticides Applied by Licensed Contractor in CY-1991

Pesticide	EPA Reg No.	Active Ingredient
AC Formula	56-56	Chlorophacinone 0.005%
Contrac Pellets	12455-36	Bromodiolone 0.005%
Talon-G Pellets	10182-38&40	Brodifacoum 0.005%
Weather-Blok	10182-48	Brodifacoum 0.005%
Baygon 2% Bait	3125-121	Propoxur 2.0%
Maxforce Bait	1730-67	Hydramethylnon 1.65%
Combat Bait	1730-68	Hydramethylnon 0.9%
Pro Roach Kill	45385-20203	Boric Acid 99.0%
Ficam D	45639-3	Bendiocarb 1.0%
Ficam W	45639-1	Bendiocarb 0.5 & 0.25%
Demon WP	10182-71	Cypermethrin .2 & .1%
Tempo 20 WP	3125-380	Cyfluthrin 0.1 & 0.05%
Empire 20	464-629	Chlorpyrifos 0.4 & 0.2%
Dursban LO	464-571	Chlorpyrifos 0.5 & 0.25%
Gencor 9%	2724-351-50809	Hydroprene 0.07%
PT230 Tri-Die	499-223-AA	Pyrethrins Silica Gel 0.3%
PT240 Permadust	499-220-AA	Boric Acid 20.0%
PT250 Baygon	499-157-ZA	Propoxur 1.0%
PT270 Dursban	499-147	Chlorpyrifos 0.5%
PT280 Orthene	499-230	Acephate 1.0%
PT265A Knoxout	499-228	Diazinon 1.0%
PT515 Waspfreeze	499-240	Phenothrin 0.25%
PT565 Plus	499-285	Pyrethrins D-Trans Allenthrin 0.25%
ZP Tracking Powder	12455-16AA	Zinc Phosphide 10.0%
Rozol Tracking Powder	7173-172	Chlorophacinone 0.2%

1991

Table 14

Pesticides Applied to Leased Farm Tracts CY-1991

Pesticide	EPA Reg No.	Active Ingredient
Aatrex 4L	100-479	Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) 42.2%
Aatrex 9-0	100-585	Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) 85.5%
Accent	352-534	Nicosulfuron 3-pyridimecarboxamide,2[[4,6-dimethoxypyrimidin2-yl))amino-carbonyl] aminosulfony]-N,N-dimethyl 75%
Banvel	55947-1	Dimethylamin salt of dicamba (3,6-dichloro-o-anisic acid) 48.2%
Basagran	7969-45	Sodium salt of bentazon (3-(1 methylethyl)-1H-2,1,3-benzothiadiazin-4 (3H-one 2,2 dioxide) 42%
Buctril	264-437	Octanoic acid ester of bromoxynil (3,5-dibromo-4-hydroxybenzonitrile) 33.4%
Counter 15G	241-238	Terbufos [s{[(1,1-dimethylethyl) thio] methyl} 0,0-diethyl phosphorodithioate] 15.0%
Crop Oil		Light petroleum oil and emulsifier (Petroleum Hydrocarbon 83.0%)
Lasso	524-314-AA	Alachlor [2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide] 45.1%
Lorsban 15G	464-523	0,0-diethyl 0-(3,5,6-trichloro-2-pyridinyl) phosphorothioate, (chlorpyrifos) 15%
Marksman	55947-39	Potassium salt of dicamba (3,6-dichloro-o-anisic acid) 13.4% Atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) 22.2%
Pursuit	241-310	Imazethapyr [Ammonium Salt of (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]] 21%
Treflan	62719-116	Alpha, alpha, alpha-Trifluoro-2,6-dinitro-N-N-dipropyl-p toluidine 41.6% Monochlorotoluene 58.4%

199

Table 15

LARGE QUANTITY CHEMICAL MATERIALS IN THE SARA TITLE III INVENTORY FOR CY-1991

Material Category	Amount (lbs)	Amount (kg)
Heat Transfer/Antifreeze Liquids	85,116	38,608
Ethylene glycol		
Flammable Gases		
Ethane	15,791	7,163
Argon/Ethane (50/50)	17,261	7,830
Propane	33,512	15,201
Oxidizers		
Oxygen Gas (Compressed)	132,782	60,230
Compressed Gas		
Argon/CO_2	87,934	39,887
Nitrogen	58,162	26,382
Argon	75,457	34,227
Liquified Gases		
Argon	307,811	139,622
Nitrogen	962,137	436,422
Solvent		
Freon 113 (1,1,2-Trichloro-1,2,2-trichfluoroethane)	37,950	17,214
Corrosives		
Hydrochloric Acid	38,115	17,289
Sodium Hydroxide	53,200	24,131
Toxics (extremely hazardous)		
Chlorine	8,550	3,878
Polychlorinated Biphenyls	~15,000	6,804
Scintillation Fluid (contains 1,2,4-Trimethyl Benzene)	32,400	16,003
Asbestos	504,000	228,613

Table 16

Fermilab QA Program Results for TMA/Eberline and Fermilab AAL

Sample Number	Radionuclide	Prepared Conc. (pCi/ml)	TMA Conc. (pCi/ml)	AAL Conc. (pCi/ml)	Ratio of Prepared to TMA	Ratio of Prepared to AAL
9101	H-3	136.58	123	142.5	0.90	1.04
	Na-22	7.33	6	7.61	0.82	1.04
	Mn-54	4.29	4.1	4.61	0.96	1.07
	Co-60	9.84	9	10.9	0.91	1.11
9102	H-3	136.58	123.04	142.1	0.90	1.04
	Na-22	7.33	6.8	7.49	0.93	1.02
	Mn-54	4.29	4.3	4.3	1.00	1.00
	Co-60	9.84	10	10.2	1.02	1.04
9103	H-3	6.76	7.17	7.01	1.06	1.04
	Na-22	0.7	0.616	0.8	0.88	1.14
	Mn-54	0.19	0.171	0.24	0.90	1.26
	Co-60	0.04	0.034	ND	0.85	-
9113	H-3	6.76	6.93	7.18	1.03	1.06
	Na-22	0.7	0.608	0.75	0.87	1.07
	Mn-54	0.19	0.139	0.21	0.73	1.11
	Co-60	0.04	0.034	ND	0.85	-
9104	H-3	10.68	10.86	11.1	1.02	1.04
	Na-22	1.05	0.97	0.86	0.92	0.82
9114	H-3	10.68	10.32	9.9	0.97	0.93
	Na-22	1.05	0.87	0.9	0.83	0.86
9105	H-3	106.82	106.67	99.5	1.00	0.93
9115	H-3	106.82	105.69	101.7	0.99	0.95
9106	H-3	4.01	3.72	4.6	0.93	1.15
	Na-22	0.39	0.325	0.5	0.83	1.28
	Mn-54	0.15	0.157	ND	1.05	-
	Co-60	0.04	0.056	ND	1.40	-
9116	H-3	4.01	4.33	4.8	1.08	1.20
	Na-22	0.39	0.266	0.34	0.68	0.87
	Mn-54	0.15	0.15	0.42	1.00	2.80
	Co-60	0.04	ND	ND	-	-
9107	H-3	53.41	54.3	55.1	1.02	1.03
9117	H-3	53.41	56.99	53.1	1.07	0.99
9108	H-3	2.62	2.5	2.5	0.95	0.95
9118	H-3	2.62	2.82	2.3	1.08	0.88
9109	H-3	157.49	157.3	151.4	1.00	0.96
9119	H-3	157.49	158.2	148.9	1.00	0.95
9110	H-3	5.25	5.84	5.4	1.11	1.03
9120	H-3	5.25	5.72	5.7	1.09	1.09
9111	H-3	52.5	51.8	52.9	0.99	1.01
9121	H-3	52.5	52.5	51.3	1.00	0.98

Table 17

Specifications for the Analyses of Accelerator-Produced Radionuclides in Water

Radionuclide	Half-Life	CONCENTRATION GUIDE FOR POPULATION (pCi/ml)		SPECIFIED SENSITIVITY AND PRECISION* (pCi/ml)	
		Surface Water	Groundwater	Surface Water	Groundwater
^{3}H	12.3 years	2000	20***	3.0	1.0
^{7}Be	53.3 days	1000	40	0.5	0.5
^{22}Na	2.6 years	10	0.40	0.3	0.22
^{45}Ca	165 days	50	2	0.3	0.02
^{54}Mn	312 days	50	2	0.1	0.07
^{60}Co	5.27 years	5	0.2	0.1	0.02

* The precision and sensitivity are stated for the 95% confidence level (approximately two standard deviations). The precision required is the value specified or ±10 percent, whichever is the lesser precision. The sensitivity is taken to be the minimum concentration which can be detected within the 68 percent confidence level.

** Taken from DOE Order 5400.5 (6/5/90)

*** Taken from EPA Drinking Water Regulations 40 CFR 141

Table 18

EML Quality Assurance Program Results for Fermilab Activation Analysis Lab (Sa91,Sa92)

Sample Date	Sample Type	Isotype	Ser	Reported Value	Reported % Error	EML Value	Rp/EML	Ratio +/-	Units
03/91	Air	^{7}Be	1	0.557E+02	8	0.530E+02	1.09	0.10	Bq/Filter
"	"	^{7}Be	2	0.602E+02	11	0.530E+02	1.14	0.14	"
"	"	^{54}Mn	1	0.480E+01	11	0.480E+01	1.00	0.12	"
"	"	^{54}Mn	1	0.511E+01	11	0.480E+01	1.06	0.13	"
"	"	^{57}Co	1	0.564E+01	9	0.582E+01	0.97	0.10	"
"	"	^{57}Co	2	0.614E+01	8	0.582E+01	1.05	0.10	"
"	"	^{60}Co	1	0.530E+01	16	0.514E+01	1.03	0.18	"
"	"	^{60}Co	2	0.518E+01	7	0.514E+01	1.01	0.09	"
"	"	^{137}Cs	1	0.500E+01	10	0.453E+01	1.10	0.12	"
"	"	^{137}Cs	2	0.510E+01	10	0.453E+01	1.13	0.13	"
"	"	^{144}Ce	1	0.535E+02	8	0.522E+02	1.02	0.10	"
"	"	^{144}Ce	2	0.567E+02	8	0.522E+02	1.09	0.10	"
"	Soil	^{40}K	1	0.391E+03	10	0.374E+03	1.05	0.12	Bq/kg
"	"	^{137}Cs	1	0.152E+03	9	0.150E+03	1.01	0.11	"
"	"	^{241}Am	1	0.230E+01	65	0.176E+01	1.31	0.86	"
"	Veg.	^{40}K	1	0.118E+04	10	0.115E+04	1.03	0.11	"
"	"	^{137}Cs	1	0.719E+02	10	0.676E+02	1.06	0.13	"
"	"	^{241}Am	1	0.340E+01	55	0.829E+00	4.10	2.29	"
"	Water	^{3}H	1	0.362E+03	16	0.361E+03	1.00	0.16	Bq/liter
"	"	^{54}Mn	1	0.242E+03	9	0.213E+03	1.14	0.13	"
"	"	^{57}Co	1	0.242E+03	7	0.230E+03	1.05	0.09	"
"	"	^{60}Co	1	0.215E+03	6	0.201E+03	1.07	0.09	"
"	"	^{137}Cs	1	0.191E+03	9	0.169E+03	1.13	0.12	"
"	"	^{144}Ce	1	0.463E+02	11	0.351E+02	1.32	0.16	"
09/91	Air	^{7}Be	1	0.515E+02	10	0.538E+02	0.96	0.11	Bq/Filter
"	"	^{7}Be	2	0.505E+02	11	0.538E+02	0.94	0.11	"
"	"	^{54}Mn	1	0.236E+02	8	0.243E+02	0.97	0.09	"
"	"	^{54}Mn	2	0.229E+02	8	0.243E+02	0.94	0.09	"
"	"	^{57}Co	1	0.171E+02	8	0.166E+02	1.03	0.09	"
"	"	^{57}Co	2	0.168E+02	8	0.166E+02	1.01	0.09	"
"	"	^{60}Co	1	0.214E+02	6	0.230E+02	0.93	0.07	"
"	"	^{60}Co	2	0.219E+02	5	0.230E+02	0.95	0.07	"
"	"	^{95}Zr	1	0.214E+02	6	0.229E+02	0.93	0.07	"
"	"	^{95}Zr	2	0.214E+02	2	0.229E+02	0.93	0.05	"
"	"	^{137}Cs	1	0.274E+02	8	0.280E+02	0.98	0.09	"
"	"	^{137}Cs	2	0.269E+02	8	0.280E+02	0.96	0.09	"
"	"	^{144}Ce	1	0.511E+02	8	0.508E+02	1.01	0.09	"
"	"	^{144}Ce	2	0.495E+02	8	0.508E+02	0.97	0.09	"
"	Soil	^{40}K	1	0.455E+03	10	0.430E+03	1.06	0.11	Bq/kg
"	"	^{137}Cs	1	0.358E+03	10	0.312E+03	1.15	0.13	"
"	"	^{238}U	1	0.751E+02	19	0.289E+03	2.60	0.52	"
"	Veg.	^{40}K	1	0.993E+03	10	0.992E+03	1.00	0.10	"
"	"	^{137}Cs	1	0.256E+02	10	0.271E+02	0.94	0.10	"
"	Water	^{54}Mn	1	0.109E+03	10	0.103E+03	1.06	0.11	Bq/liter
"	"	^{57}Co	1	0.182E+03	7	0.166E+03	1.10	0.09	"
"	"	^{60}Co	1	0.326E+03	7	0.291E+03	1.12	0.09	"
"	"	^{137}Cs	1	0.513E+02	10	0.460E+02	1.12	0.12	"
"	"	^{144}Ce	1	0.252E+03	10	0.226E+03	1.12	0.12	"

Table 19

EML Quality Assurance Program Results for TMA/Eberline (Sa91)

Sample Date	Sample Type	Isotype	Ser	Reported Value	Reported % Error	EML Value	Ratio Rp/EML	+/-	Units
03/91	Air	^{7}Be	1	0.631E+02	2	0.530E+02	1.19	0.04	Bq/Filter
"	"	^{54}Mn	1	0.590E+01	3	0.480E+01	1.23	0.05	"
"	"	^{57}Co	1	0.705E+01	1	0.582E+01	1.21	0.05	"
"	"	^{60}Co	1	0.551E+01	3	0.514E+01	1.07	0.06	"
"	"	^{90}Sr	1	0.914E+01	29	0.789E+01	1.16	0.37	"
"	"	^{137}Cs	1	0.583E+01	3	0.453E+01	1.29	0.06	"
"	"	^{144}Ce	1	0.673E+02	1	0.522E+02	1.29	0.05	"
"	"	^{239}Pu	1	0.146E+00	11	0.154E+00	0.95	0.22	"
"	"	^{241}Am	1	0.940E- 01	10	0.101E+00	0.93	0.14	"
"	"	^{234}U	1	0.514E- 01	19	0.350E- 01	1.48	0.34	"
"	"	^{238}U	1	0.444E- 01	20	0.350E- 01	1.27	0.32	"
"	"	^{238}U	2	0.444E- 01	20	0.350E- 01	1.27	0.32	"
"	Soil	^{40}K	1	0.348E+03	12	0.374E+03	0.93	0.12	Bq/kg
		^{90}Sr	1	0.144E+02	9	0.920E+01	1.57	0.25	"
"	"	^{137}Cs	1	0.154E+03	2	0.150E+03	1.03	0.04	"
"	"	^{238}Pu	1	0.108E+02	17	0.115E+02	0.94	0.17	"
"	"	^{239}Pu	1	0.327E+01	24	0.340E+01	0.96	0.24	"
"	"	^{241}Am	1	0.148E+01	25	0.176E+01	0.84	0.23	"
"	"	^{234}U	1	0.267E+02	10	0.294E+02	0.91	0.10	"
"	"	^{238}U	1	0.230E+02	10	0.300E+02	0.77	0.11	"
"	Veg.	^{40}K	1	0.492E+03	9	0.115E+04	0.43	0.04	"
"	"	^{90}Sr	1	0.151E+03	5	0.186E+03	0.81	0.11	"
"	"	^{137}Cs	1	0.744E+02	7	0.676E+02	1.10	0.11	"
"	"	^{238}Pu	1	0.359E+01	10	0.406E+01	0.88	0.12	"
"	"	^{238}Pu	2	0.350E+01	11	0.406E+01	0.86	0.12	"
"	"	^{239}Pu	1	0.962E+00	11	0.140E+01	0.69	0.11	"
"	"	^{241}Am	1	0.608E+00	18	0.829E+00	0.73	0.13	"
"	Water	^{3}H	1	0.321E+03	5	0.361E+03	0.89	0.06	Bq/liter
"	"	^{54}Mn	1	0.194E+03	1	0.213E+03	0.91	0.05	"
"	"	^{57}Co	1	0.187E+03	0	0.230E+03	0.81	0.04	"
"	"	^{60}Co	1	0.178E+03	1	0.201E+03	0.89	0.05	"
"	"	^{90}Sr	1	0.853E+01	4	0.863E+01	0.99	0.07	"
"	"	^{137}Cs	1	0.150E+03	1	0.169E+03	0.89	0.04	"
"	"	^{144}Ce	1	0.333E+02	6	0.351E+02	0.95	0.08	"
"	"	^{239}Pu	1	0.665E+00	12	0.773E+00	0.86	0.13	"
"	"	^{241}Am	1	0.123E+01	10	0.119E+01	1.03	0.14	"
"	"	^{234}U	1	0.236E+00	19	0.219E+00	1.08	0.22	"
"	"	^{238}U	1	0.275E+00	18	0.219E+00	1.26	0.24	"

1991

Table 20

EML Quality Assurance Program Results for TMA/Eberline (Sa92)

Sample Date	Sample Type	Isotype	Ser	Reported Value	% Error	EML Value	Rp/EML	Ratio +/-	Units
09/91	Air	^{7}Be	1	0.747E+02	6	0.538E+02	1.39	0.12	Bq/Filter
"	"	^{54}Mn	1	0.271E+02	2	0.243E+02	1.12	0.05	"
"	"	^{57}Co	1	0.200E+02	1	0.166E+02	1.20	0.05	"
"	"	^{60}Co	1	0.236E+02	2	0.230E+02	1.03	0.05	"
"	"	^{90}Sr	1	0.773E+00	7	0.663E+00	1.17	0.15	"
"	"	^{137}Cs	1	0.316E+02	1	0.280E+02	1.13	0.06	"
"	"	^{144}Ce	1	0.545E+02	2	0.508E+02	1.07	0.05	"
"	"	^{239}Pu	1	0.704E- 01	18	0.840E- 01	0.84	0.15	"
"	"	^{241}Am	1	0.858E- 01	23	0.104E+00	0.82	0.21	"
"	"	^{234}U	1	0.518E- 01	20	0.395E- 01	1.31	0.29	"
"	"	^{238}U	1	0.585E- 01	18	0.388E- 01	1.51	0.30	"
"	Soil	^{40}K	1	0.301E+03	17	0.430E+03	0.70	0.12	Bq/kg
"	"	^{137}Cs	1	0.240E+03	2	0.312E+03	0.77	0.05	"
"	"	^{239}Pu	1	0.825E+01	17	0.735E+01	1.12	0.22	"
"	"	^{241}Am	1	0.131E+01	45	0.158E+01	0.83	0.37	"
"	"	^{234}U	1	0.253E+02	13	0.289E+02	0.88	0.12	"
"	"	^{238}U	1	0.261E+02	13	0.289E+02	0.90	0.12	"
"	Veg.	^{40}K	1	0.819E+03	19	0.992E+03	0.83	0.16	"
"	"	^{90}Sr	1	0.308E+03	9	0.439E+03	0.70	0.08	"
"	"	^{137}Cs	1	0.117E+02	83	0.271E+02	0.43	0.36	"
"	"	^{239}Pu	1	0.352E+00	21	0.365E+00	0.96	0.23	"
"	"	^{241}Am	1	0.222E+00	16	0.266E+00	0.83	0.23	"
"	Water	^{3}H	1	0.166E+02	59	0.100E+03	0.17	0.10	Bq/liter
"	"	^{54}Mn	1	0.912E+02	2	0.103E+03	0.89	0.04	"
"	"	^{57}Co	1	0.154E+03	0	0.166E+03	0.93	0.04	"
"	"	^{60}Co	1	0.261E+03	1	0.291E+03	0.90	0.04	"
"	"	^{90}Sr	1	0.840E+01	8	0.101E+02	0.83	0.09	"
"	"	^{137}Cs	1	0.428E+02	4	0.460E+02	0.93	0.06	"
"	"	^{144}Ce	1	0.201E+03	2	0.226E+03	0.89	0.04	"
"	"	^{239}Pu	1	0.519E+00	15	0.510E+00	1.02	0.17	"
"	"	^{241}Am	1	0.620E+00	17	0.570E+00	1.09	0.22	"
"	"	^{234}U	1	0.426E+00	16	0.462E+00	0.92	0.16	"
"	"	^{238}U	1	0.485E+00	15	0.478E+00	1.01	0.16	"

1991

Table 21

CY-1991 CUB Tile Field Monitoring Results
(post-purge)

Location	Parameter	Results
MWS1	Cr	<0.002 mg/l
	hex Cr	<0.01 mg/l
	Cl	580 mg/l
MWS2	Cr	0.0035 mg/l
	hex Cr	<0.01 mg/l
	Cl	1210 mg/l
MWS3	Cr	0.0028 mg/l
	hex Cr	<0.01 mg/l
	Cl	810 mg/l
MWS4	Cr	0.0032 mg/l
	hex Cr	<0.01 mg/l
	Cl	70 mg/l
MWS5	Cr	<0.002 mg/l
	hex Cr	<0.01 mg/l
	Cl	3.1 mg/l
MWD1	Cr	0.0057 mg/l
	hex Cr	0.017 mg/l
	(duplicate)	0.023 mg/l
	Cl	140 mg/l
	(duplicate)	140 mg/l
MWD2	Cr	0.0374 mg/l
	hex Cr	<0.01 mg/l
	Cl	6.3 mg/l
Field Blank	Cr	0.0021 mg/l
	hex Cr	<0.01 mg/l
	Cl	<1.0 mg/l

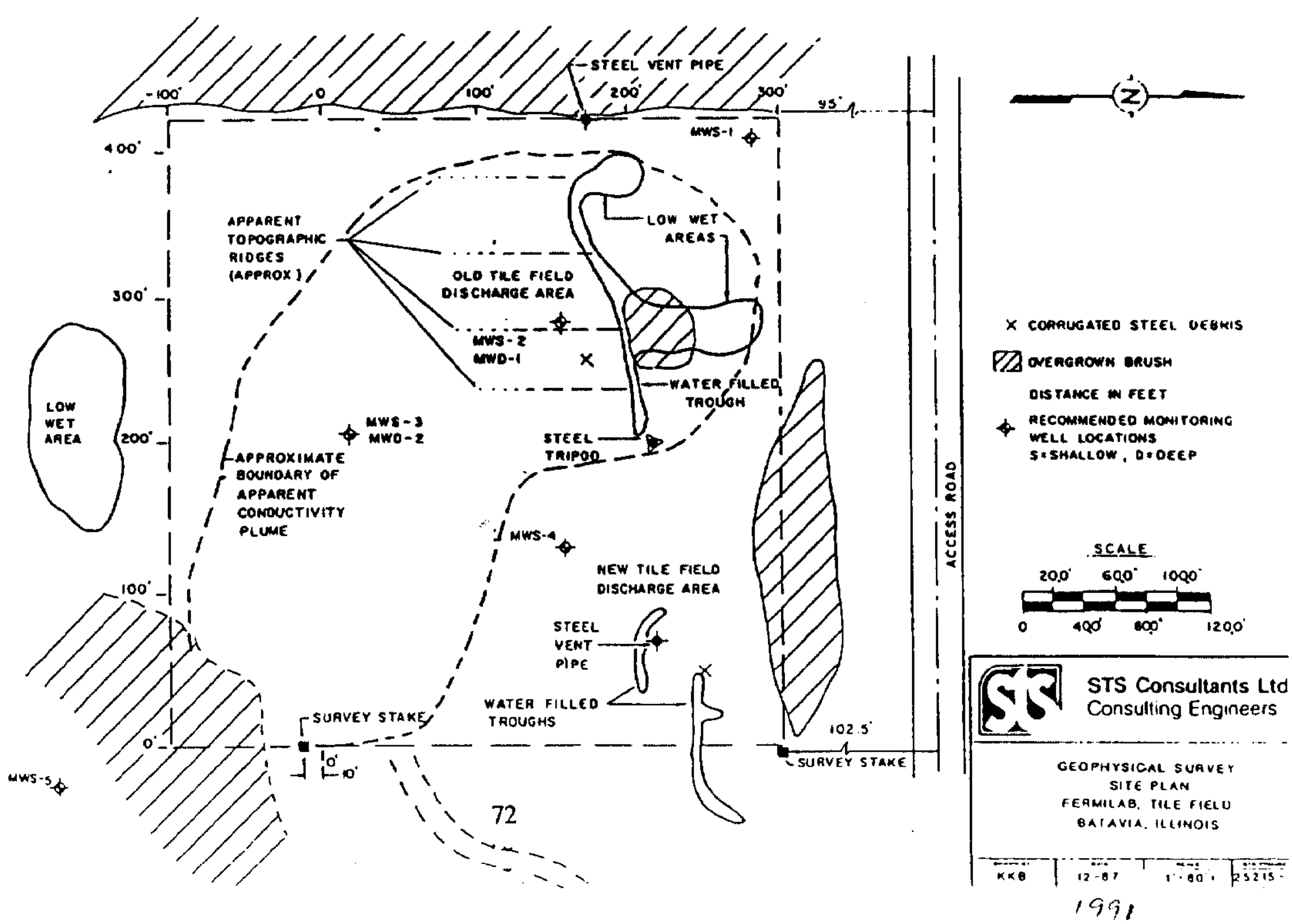
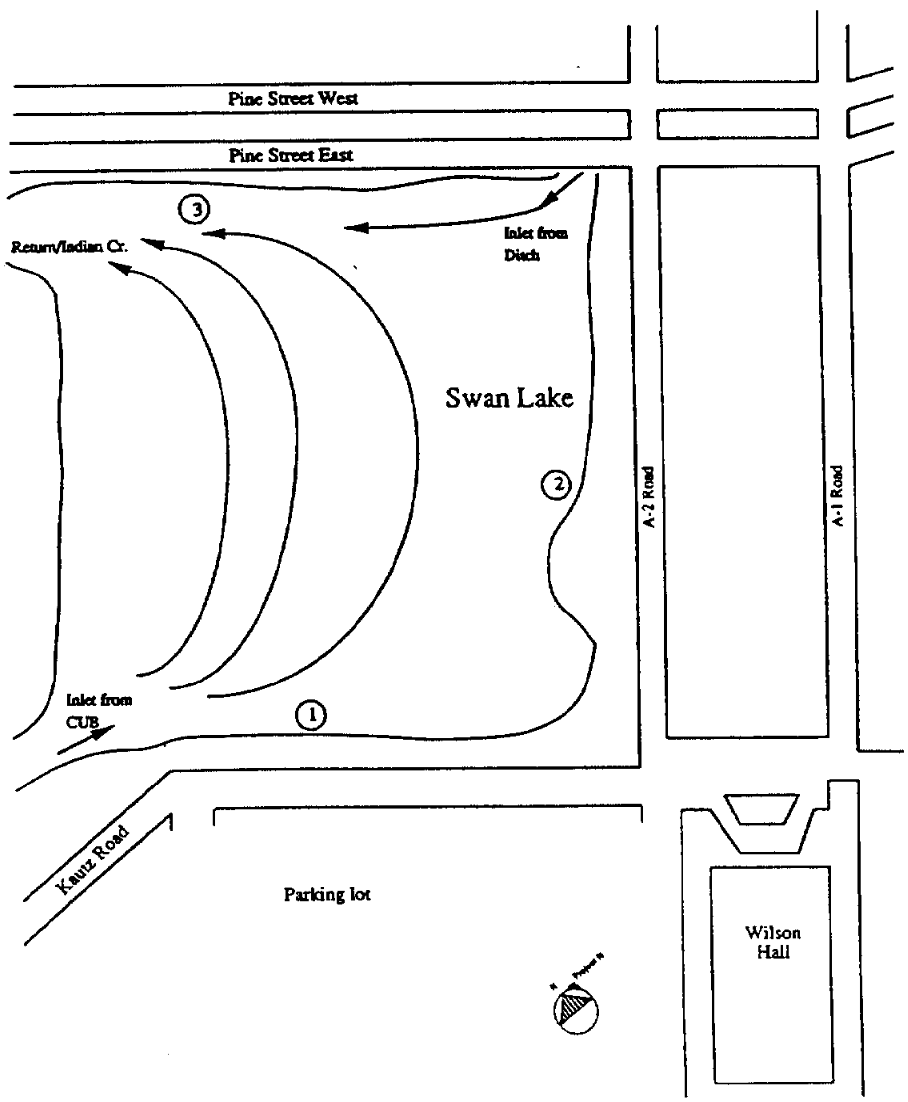


Table 22

1991 Swan Lake Total Copper Concentrations

Appl. Date	Analysis Date	(Mg/liter) Site 1	Site 2	Site 3
4/22	4/26	0.1	0.05	0.1
	4/30	0.0	0.0	0.2
	5/13	0.6	0.35	0.49
	5/15	0.0	0.0	0.05
	5/16	0.0	0.0	0.0
5/17	5/17	0.01	0.05	4.4
	5/20	0.0	0.0	0.0
	5/29	0.0	0.0	0.05
6/18	6/18	11.2	11.2	0.17
6/19	6/19	0.05	0.1	12.0
	6/20	0.0	0.05	0.19
	6/24	0.0	0.0	0.0
8/15	8/16	0.0	0.35	2.58
8/15	8/19	0.1	0.0	0.0



1991

Table 23

1991 PESTICIDE APPLICATION SUMMARY FOR LEASED FARM TRACTS AT FERMI NATIONAL ACCELERATOR LABORATORY

Pesticide Units	App. Rate (per acre)	B-1 Tract 100.7	C Tract 305.7	C-2 Tract 34.2	C-3 Tract 66.5	C-4 Tract 135.1	C-5 Tract 28.2	C-6 Tract 11.9	CA-1A Tract 86.8	CA-1B Tract 82.1	D-2 Tract 69.6	D-6 Tract 56.0	N-1 Tract 168.0	N-2 Tract 151.8	N-3 Tract 289
Counter 15G (kg) (lb)	3.9 8.7												655.2 1461.6		
Crop Oil (l) (gal)	0.95 0.25												159.6 42.0		
Aatrex 9-0 (kg) (lb)	0.6 1.3												100.8 218.4		
Lasso MT (l) (gal)	1.9 2.58* 0.5 .68*	191.3 50.4	580.8 152.9	65.0 171.0	126.4 33.3	256.7 67.6	54.7 14.1	22.6 6.0	164.9 43.4	156.0 41.1	132.2 34.8	106.4 28.0	319.2 84.0	392.0* 103.2*	746.0* 197.0*
Banvel (l) (gal)	0.5 0.13												84.0 21.8		
Marksman (l) (gal)	1.4 0.38												235.2 63.8		
Buctril (l) (gal)	0.5 0.13												159.6 21.8		
Treflan (l) (gal)	.95 .25													144.2 37.8	274.6 72.3
Pursuit (kg) (lb)	0.1 0.25													10.0 25.0	3.0 7.5
Artazine 4L (kg) (lb)	1.1 2.0													154.0 280.0	317.9 578.0
Counter (kg) (lb)	3.6 8.0													108.0 240.0	1040.4 2312.0
Lorsban (kg) (lb)	1.1 4.1* 2 9*	412.9 906.3	1253.4 2751.3	140.2 307.8	272.7 598.5	553.9 1215.9	115.6 253.8	48.8 107.1		336.6 738.9	285.4 626.4	229.6 504.0			
Accent (l) (gal)	.03 .01		3.0 1.0	1.0 0.3											
Basgran (l) (gal)	0.47 0.13								40.8 11.3						

1991

Table 24

1991 Boring Hole Results

BORING HOLE	SAMPLE DATE	PURGE	H-3				Na-22			
			pCi/ml		Bq/ml		pCi/ml		Bq/ml	
			Result	Error	Result	Error	Result	Error	Result	Error
S-1059	18-Apr	Pre	3.74E+01	9.40E-01	1.38E+00	3.48E-02	0.00E+00	1.20E-02	0.00E+00	4.44E-04
	26-Apr	Post	3.35E+01	8.70E-01	1.24E+00	3.22E-02	0.00E+00	1.60E-02	0.00E+00	5.92E-04
	14-Jun	Pre	4.00E+01	1.10E+00	1.48E+00	4.07E-02	0.00E+00	2.40E-02	0.00E+00	8.88E-04
	19-Jun	Post	4.30E+01	1.10E+00	1.59E+00	4.07E-02	0.00E+00	2.80E-02	0.00E+00	1.04E-03
	6-Aug	Pre	3.45E+01	9.90E-01	1.28E+00	3.66E-02	0.00E+00	2.60E-02	0.00E+00	9.62E-04
	13-Aug	Post	2.97E+01	9.20E-01	1.10E+00	3.40E-02	0.00E+00	1.70E-02	0.00E+00	6.29E-04
	15-Oct	Pre	3.31E+01	9.70E-01	1.22E+00	3.59E-02	0.00E+00	3.30E-02	0.00E+00	1.22E-03
	21-Oct	Post	2.69E+01	8.80E-01	9.96E-01	3.26E-02	0.00E+00	2.70E-02	0.00E+00	9.99E-04
S-1062	18-Apr	Pre	3.80E-01	1.90E-01	1.41E-02	7.03E-03	0.00E+00	1.50E-02	0.00E+00	5.55E-04
	26-Apr	Post	0.00E+00	3.00E-01	0.00E+00	1.11E-02	0.00E+00	1.90E-02	0.00E+00	7.03E-04
S-1087	17-Apr	Pre	0.00E+00	2.00E-01	0.00E+00	7.40E-03	0.00E+00	1.40E-02	0.00E+00	5.18E-04
	26-Apr	Post	0.00E+00	3.00E-01	0.00E+00	1.11E-02	0.00E+00	1.60E-02	0.00E+00	5.92E-04
	14-Jun	Pre	4.30E-01	2.50E-01	1.59E-02	9.25E-03	0.00E+00	2.20E-02	0.00E+00	8.14E-04
	19-Jun	Post	4.60E-01	2.60E-01	1.70E-02	9.62E-03	0.00E+00	2.40E-02	0.00E+00	8.88E-04
	6-Aug	Pre	0.00E+00	4.00E-01	0.00E+00	1.48E-02	0.00E+00	2.20E-02	0.00E+00	8.14E-04
	13-Aug	Post	5.70E-01	2.60E-01	2.11E-02	9.62E-03	0.00E+00	2.00E-02	0.00E+00	7.40E-04
	15-Oct	Pre	1.11E+00	2.90E-01	4.11E-02	1.07E-02	0.00E+00	2.90E-02	0.00E+00	1.07E-03
	21-Oct	Post	4.40E-01	2.60E-01	1.63E-02	9.62E-03	0.00E+00	2.50E-02	0.00E+00	9.25E-04
S-1088	17-Apr	Pre	5.79E+00	4.00E-01	2.14E-01	1.48E-02	0.00E+00	1.90E-02	0.00E+00	7.03E-04
	26-Apr	Post	4.90E+00	3.60E-01	1.81E-01	1.33E-02	1.30E-02	1.20E-02	4.81E-04	4.44E-04
	6-Aug	Pre	3.66E+00	3.90E-01	1.35E-01	1.44E-02	0.00E+00	3.10E-02	0.00E+00	1.15E-03
	13-Aug	Post	3.27E+00	3.80E-01	1.21E-01	1.41E-02	0.00E+00	1.80E-02	0.00E+00	6.66E-04
S-1089	18-Apr	Pre	5.52E+00	3.80E-01	2.04E-01	1.41E-02	0.00E+00	1.40E-02	0.00E+00	5.18E-04
	26-Apr	Post	5.02E+00	3.70E-01	1.86E-01	1.37E-02	0.00E+00	1.40E-02	0.00E+00	5.18E-04
	6-Aug	Pre	5.03E+00	4.40E-01	1.86E-01	1.63E-02	0.00E+00	2.50E-02	0.00E+00	9.25E-04
	13-Aug	Post	4.26E+00	4.10E-01	1.58E-01	1.52E-02	0.00E+00	2.70E-02	0.00E+00	9.99E-04

1991

Table 25

EIS/ODIS ACTIVITY SUMMARY REPORT FOR LIQUID RELEASES

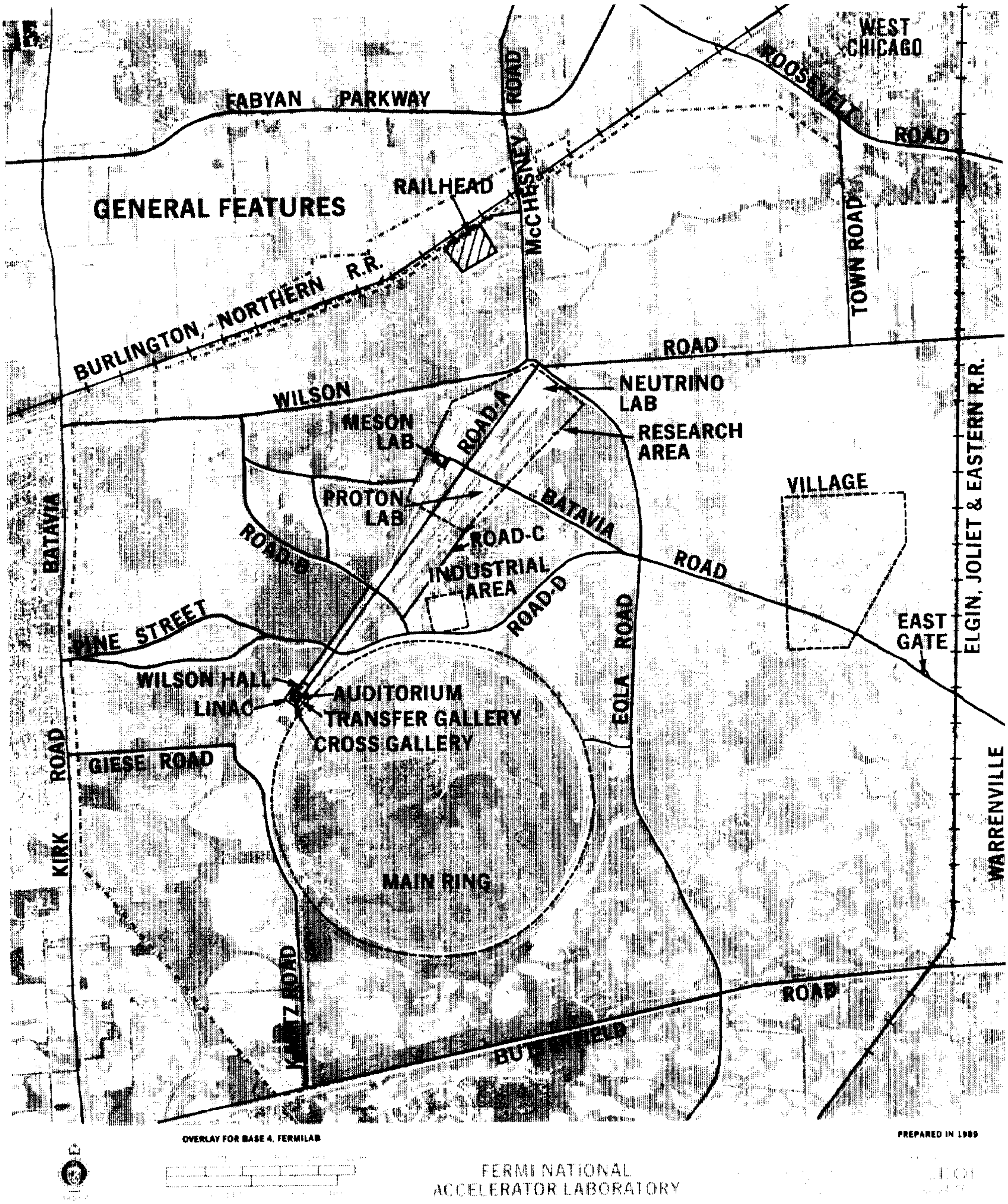
(mCi of H-3)

		CY 91	CY 90	CY 89	CY 88	CY 87
M01SP3	DISCHARGE	79	46	28	109	103
	EFFLUENT	59	37	17	56	40
N01SP4	DISCHARGE	447	245	273	372	639
	EFFLUENT	300	174	194	180	52
NW4SP1	DISCHARGE	134	1650	612	190	143
	EFFLUENT	87	1370	432	96	72
NTSBSP1	DISCHARGE	3,600	375	0.5	4	–
	EFFLUENT	3,200	260	<0.1	2	–

FIGURES

FIGURE 1	General Features	78
FIGURE 2	Fermilab Site	79
FIGURE 3	Location of Fermilab and Population Concentrations Within 5 miles (8 km) CY-1990	80
FIGURE 4	Location of Fermilab and Population Distribution Concentrations Within 50 miles (80 km) - CY-1990	81
FIGURE 5	Site Water Flow Map	82
FIGURE 6	Surface Water Sample Locations	83
FIGURE 7	Well Sample Locations	84
FIGURE 8	Shallow Dolomite Aquifer	85
FIGURE 9	Special Radiation Sites	86
FIGURE 10	Monitoring Well and Boring Location Diagram	87
FIGURE 11	Penetration Radiation (Muon) Directions	88
FIGURE 12	Map of the Fermilab Site Showing Existing Facilities Including Locations of Existing Sources of Radionuclide Emissions	89
FIGURE 13	Leased Farm Tracts CY-1991 Fermi National Accelerator Laboratory	90

Figure 1



GENERAL FEATURES
FABYAN PARKWAY
WEST CHICAGO
ROOSEVELT ROAD
RAILHEAD
McCHESNEY ROAD
TOWN ROAD
BURLINGTON, NORTHERN R.R.
WILSON ROAD
NEUTRINO LAB
RESEARCH AREA
MESON LAB
ROAD-A
PROTON LAB
BATAVIA ROAD
VILLAGE
ROAD-C
INDUSTRIAL AREA
ROAD-B
ROAD-D
EOLA ROAD
PINE STREET
EAST GATE
ELGIN, JOLIET & EASTERN R.R.
BATAVIA
KIRK ROAD
WILSON HALL
AUDITORIUM
LINAC
TRANSFER GALLERY
CROSS GALLERY
GIESE ROAD
WARRENVILLE
MAIN RING
ROAD
OVERLAY FOR BASE 4, FERMILAB
PREPARED IN 1989
FERMI NATIONAL
ACCELERATOR LABORATORY

Figure 2

Figure 2 - Fermilab Site

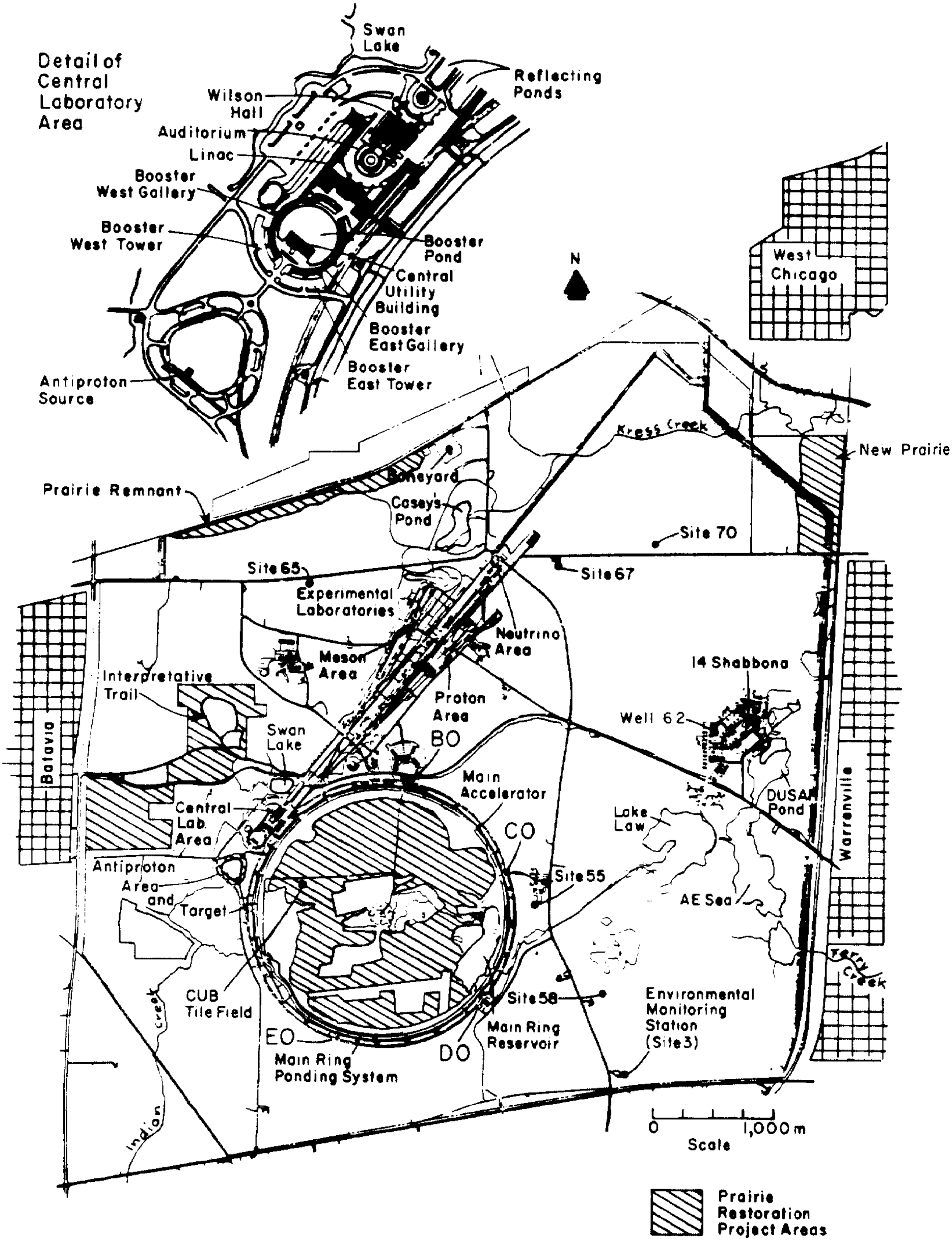


Figure 3

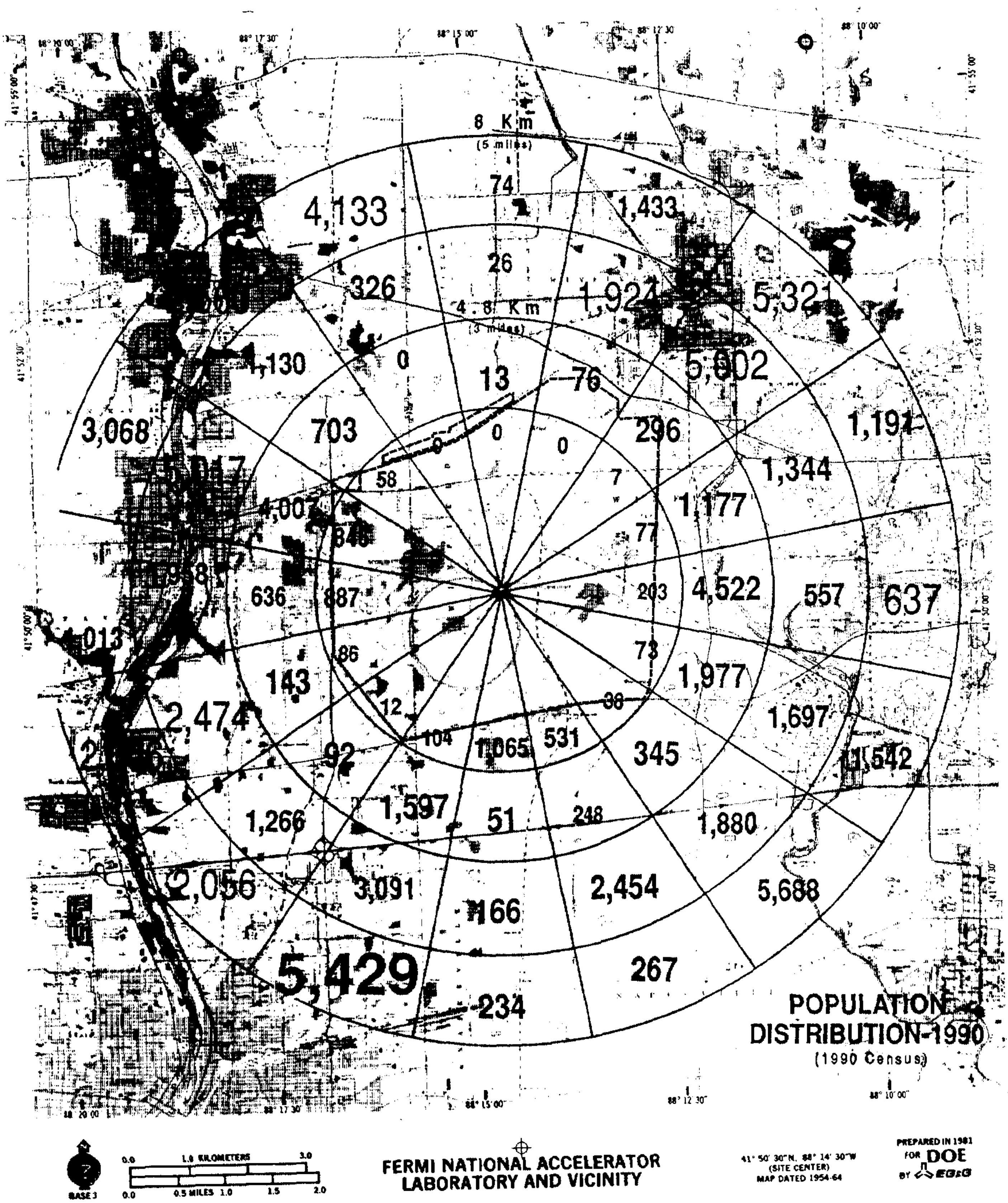

8 Km
(5 miles)
4.8 Km
(3 miles)
4,133
74
1,433
26
326
1,924
5,321
1,130
0
13
76
5,802
3,068
703
0
0
296
1,191
58
7
1,344
4,007
1,177
77
636
887
203
4,522
557
637
86
73
143
1,977
12
38
2,474
1,697
104
1,065
531
345
11,542
92
1,266
1,597
51
248
1,880
2,056
3,091
166
2,454
5,688
5,429
267
234
POPULATION
DISTRIBUTION-1990
(1990 Census)
88° 15' 00"
88° 12' 30"
88° 10' 00"
88° 17' 30"
41° 55' 00"
41° 52' 30"
41° 50' 00"
41° 47' 30"
BASE 3
1.0 KILOMETERS
0.5 MILES 1.0 1.5 2.0
FERMI NATIONAL ACCELERATOR
LABORATORY AND VICINITY
41° 50' 30"N, 88° 14' 30"W
(SITE CENTER)
MAP DATED 1954-64
PREPARED IN 1981
FOR DOE
BY EG&G

Figure 4

Population Distribution
(In Thousands)

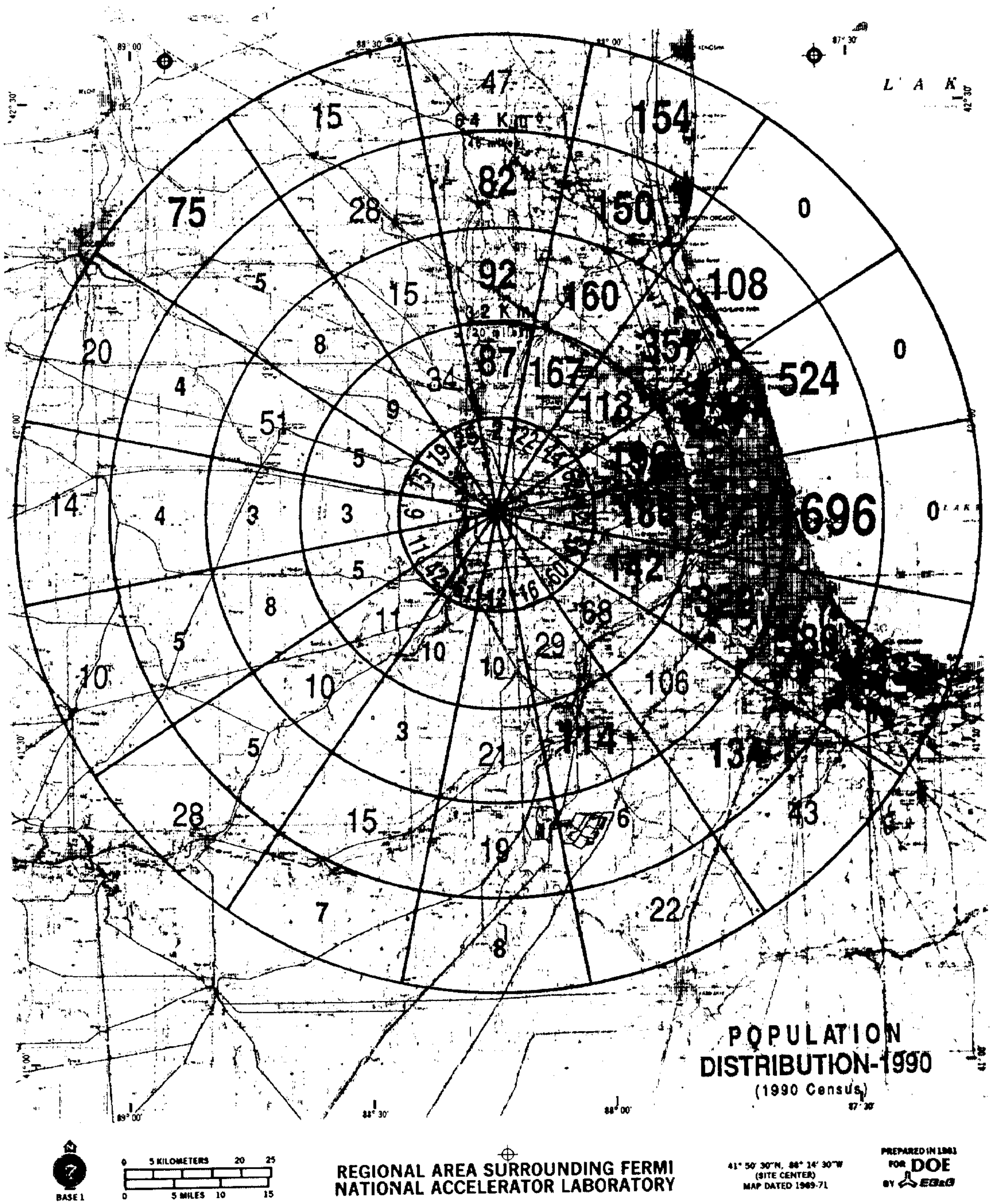


Figure 5

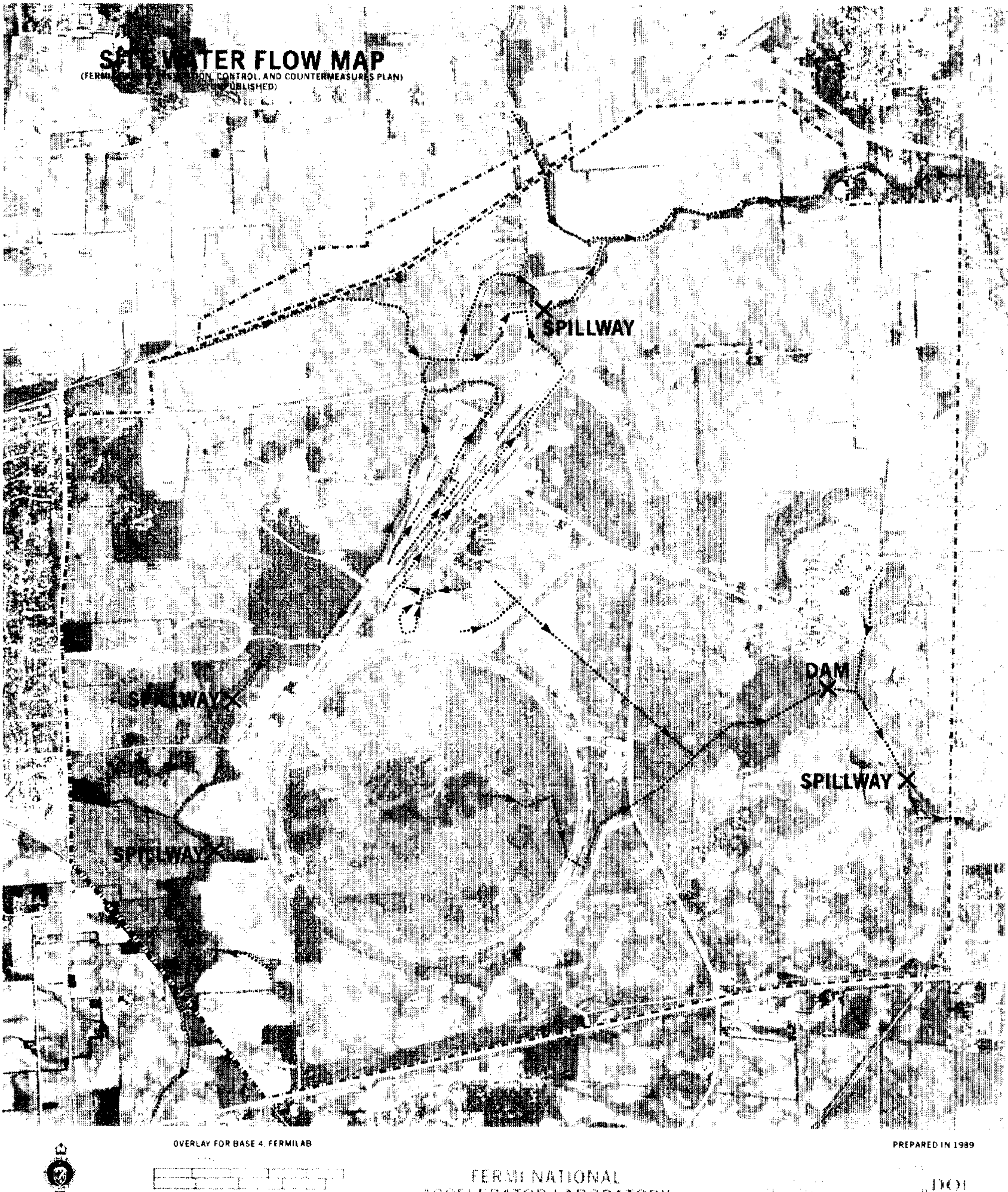
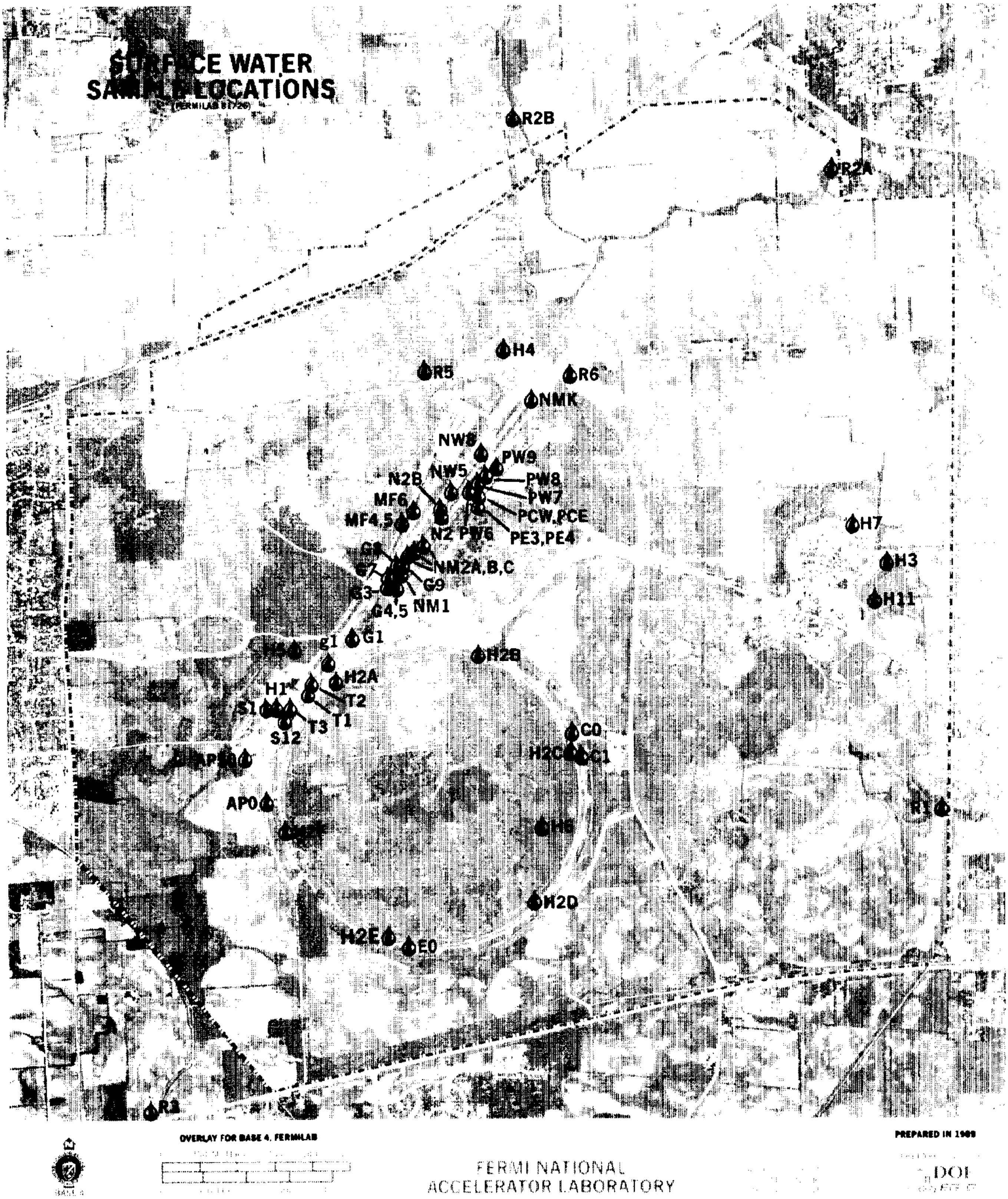

ER FLOW MAP
CONTROL, AND COUNTERMEASURES PLAN)
UBLISHED)
SPILLWAY
SPILLWAY
SPILLWAY
DAM
SPILLWAY
OVERLAY FOR BASE 4. FERMILAB
PREPARED IN 1989
FERMI NATIONAL
ACCELERATOR LABORATORY
DOE

Figure 6



R2B
R2A
H4
R5
R6
NMK
PW9
N2B
NW5
PW8
PW7
MF6
PCW,PCE
MF4,5
N2
PW6
PE3,PE4
H7
H3
NM2A,B,C
G9
H11
NM1
G4,5
G1
g1
H2B
H2A
H1
T2
T1
T3
S12
C0
H2C
C1
AP0
R1
H2D
H2E
E0
OVERLAY FOR BASE 4, FERMILAB
FERMI NATIONAL
ACCELERATOR LABORATORY
DOE

Figure 7

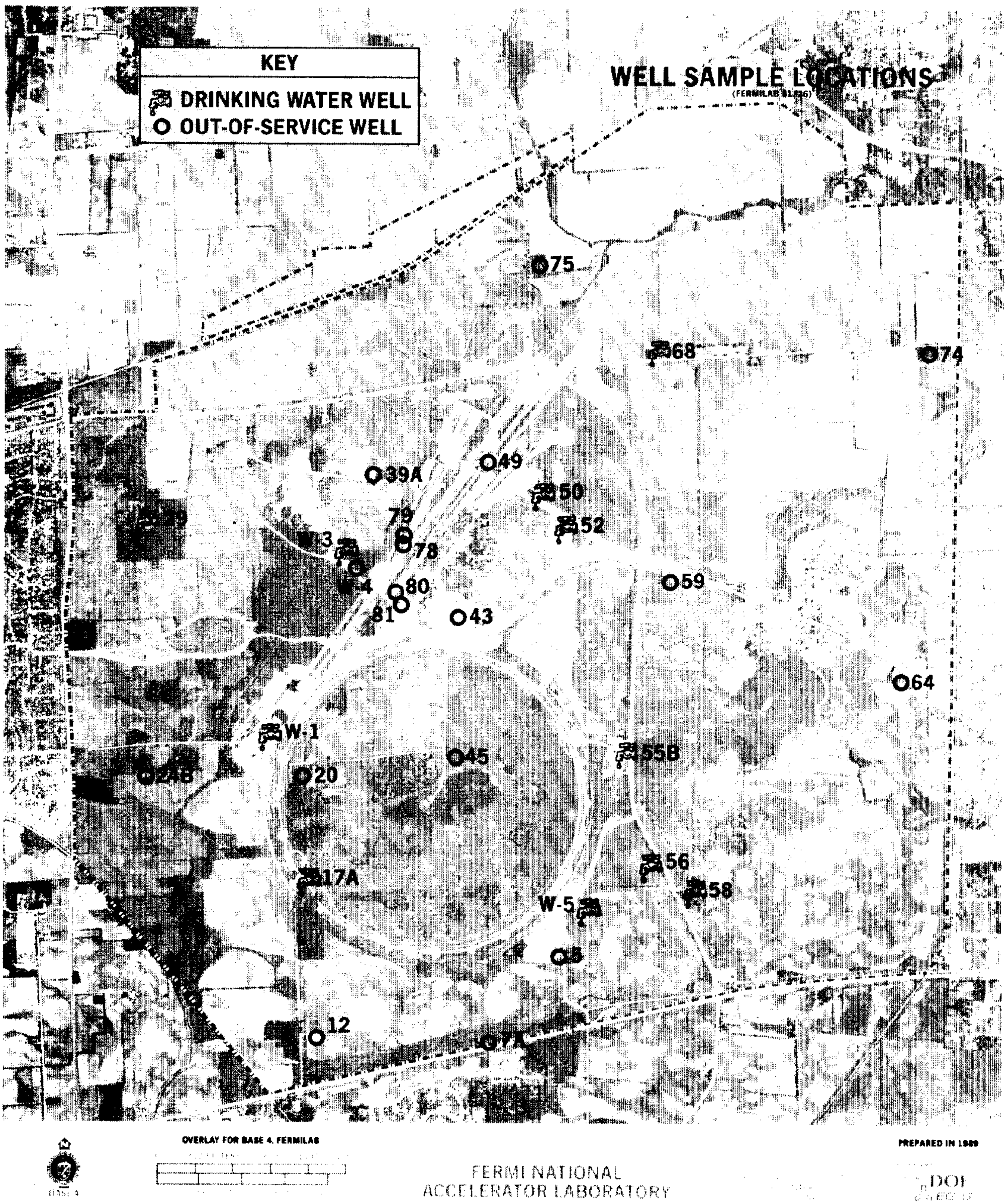
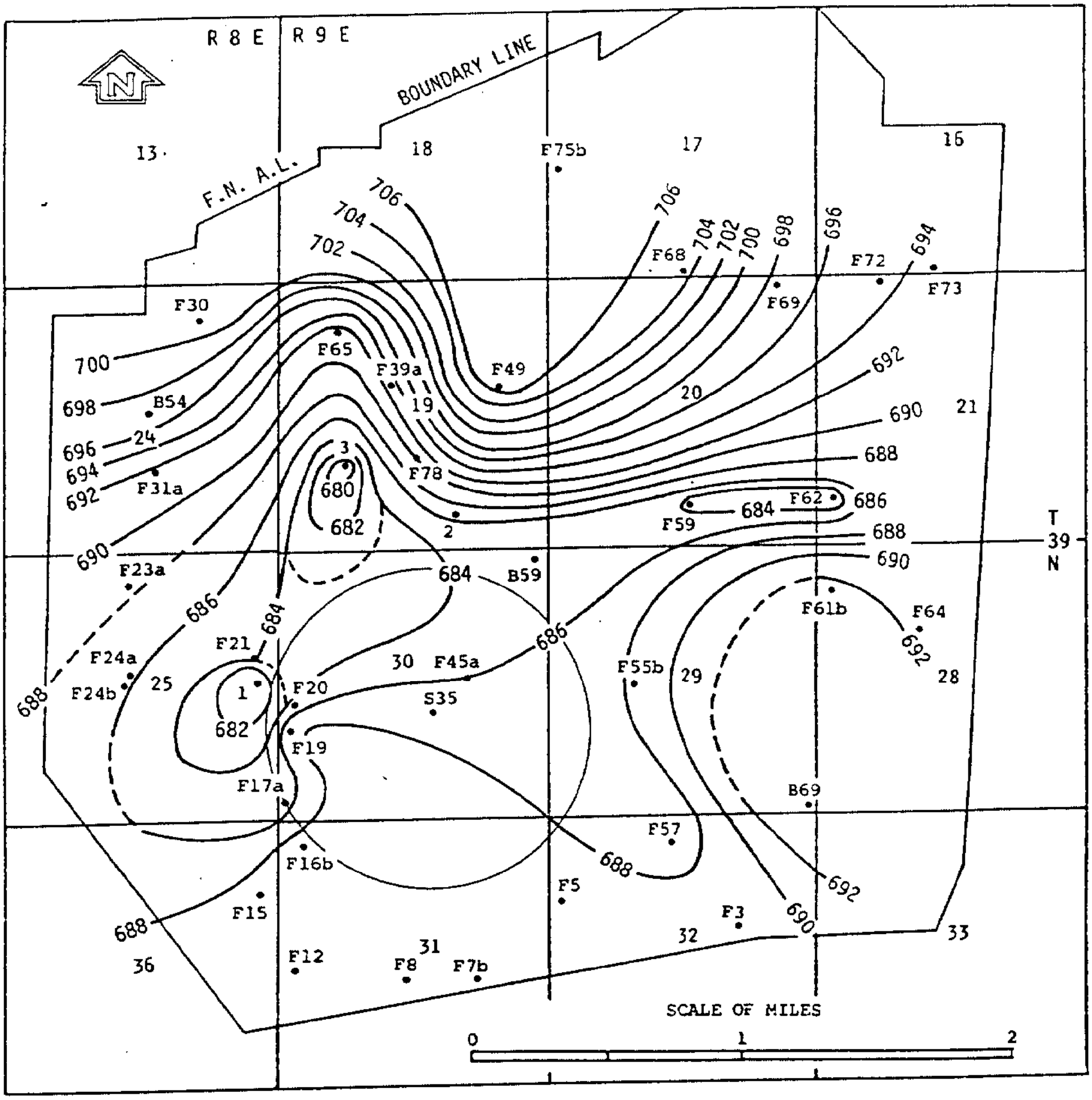

KEY
DRINKING WATER WELL
OUT-OF-SERVICE WELL
WELL SAMPLE LOCATIONS
75
68
74
49
39A
50
52
79
78
W-3
W-4
80
81
43
59
64
W-1
45
55B
20
17A
56
58
W-5
12
OVERLAY FOR BASE 4, FERMILAB
PREPARED IN 1989
FERMI NATIONAL
ACCELERATOR LABORATORY
DOE

Figure 8

FERMI NATIONAL ACCELERATOR LABORATORY

DuPage & Kane Counties, Illinois



SHALLOW DOLOMITE AQUIFER

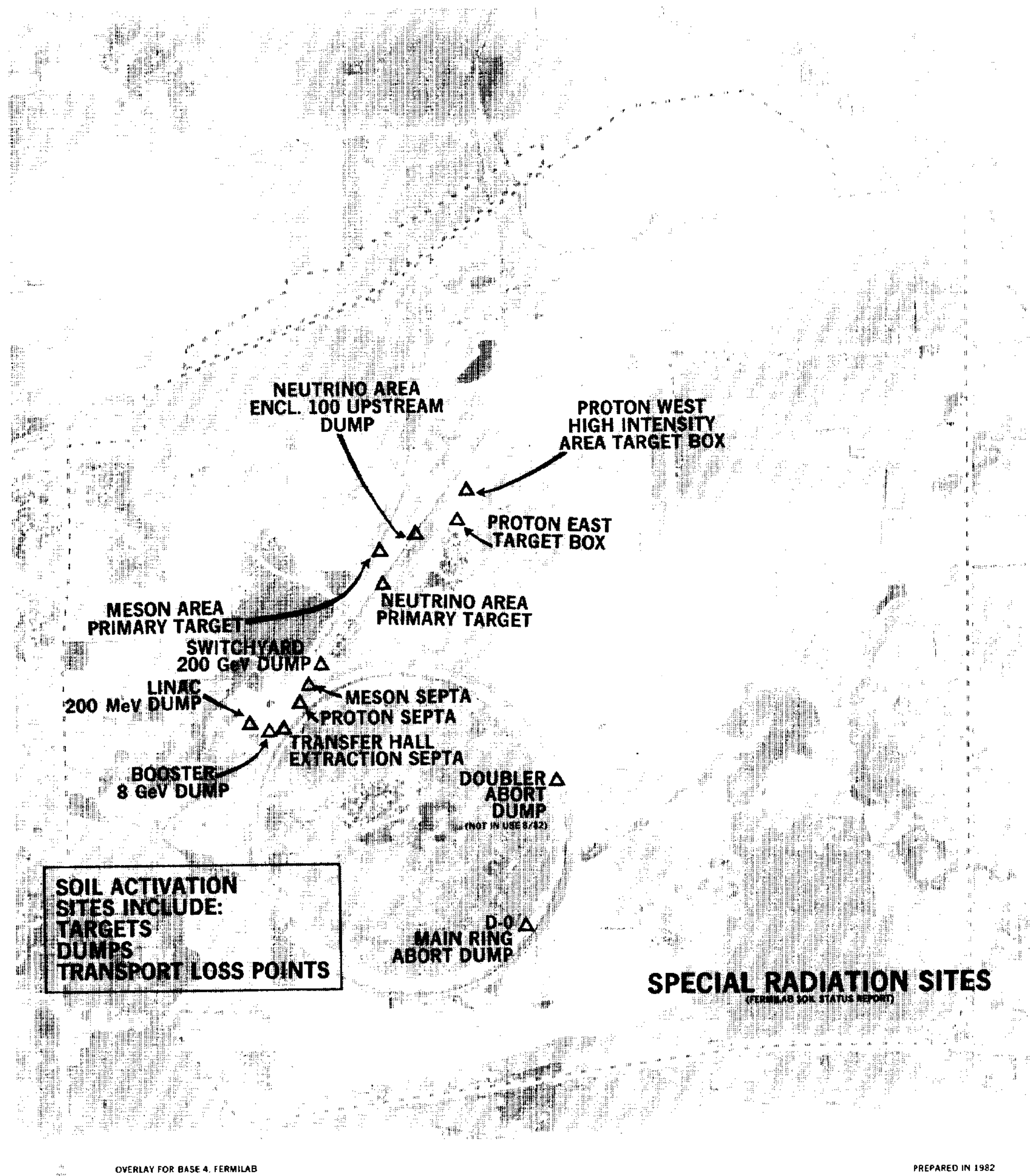
PIEZOMETRIC SURFACE

Elevations in feet above mean sea level

Illinois State Water Survey
June 1978

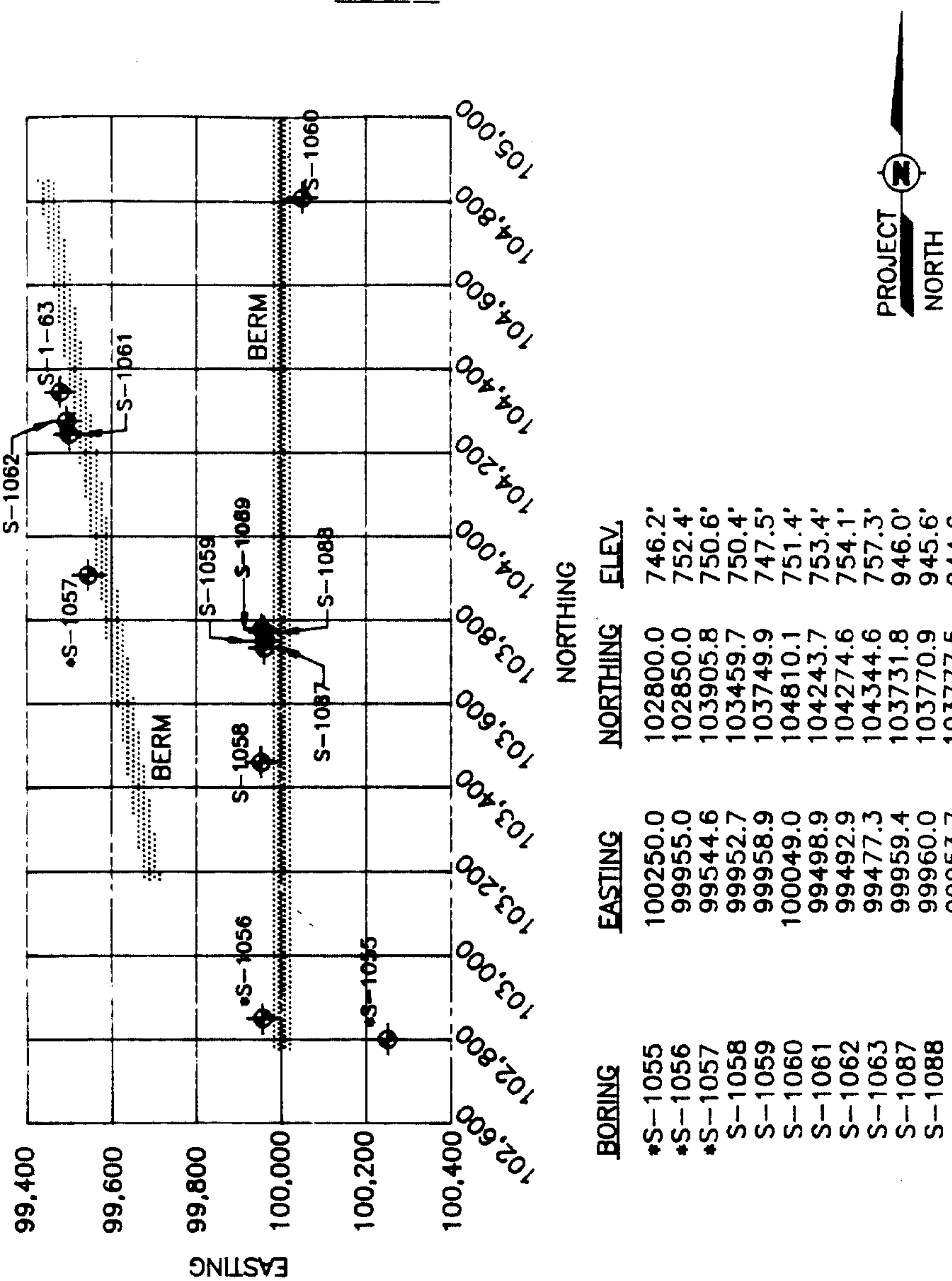
1991

Figure 9



FERMI NATIONAL
ACCELERATOR LABORATORY

Figure 10



BORING	EASTING	NORTHING	ELEV.
*S-1055	100250.0	102800.0	746.2'
*S-1056	99955.0	102850.0	752.4'
*S-1057	99544.6	103905.8	750.6'
S-1058	99952.7	103459.7	750.4'
S-1059	99958.9	103749.9	747.5'
S-1060	100049.0	104810.1	751.4'
S-1061	99498.9	104243.7	753.4'
S-1062	99492.9	104274.6	754.1'
S-1063	99477.3	104344.6	757.3'
S-1087	99959.4	103731.8	946.0'
S-1088	99960.0	103770.9	945.6'
S-1089	99953.7	103777.5	944.6

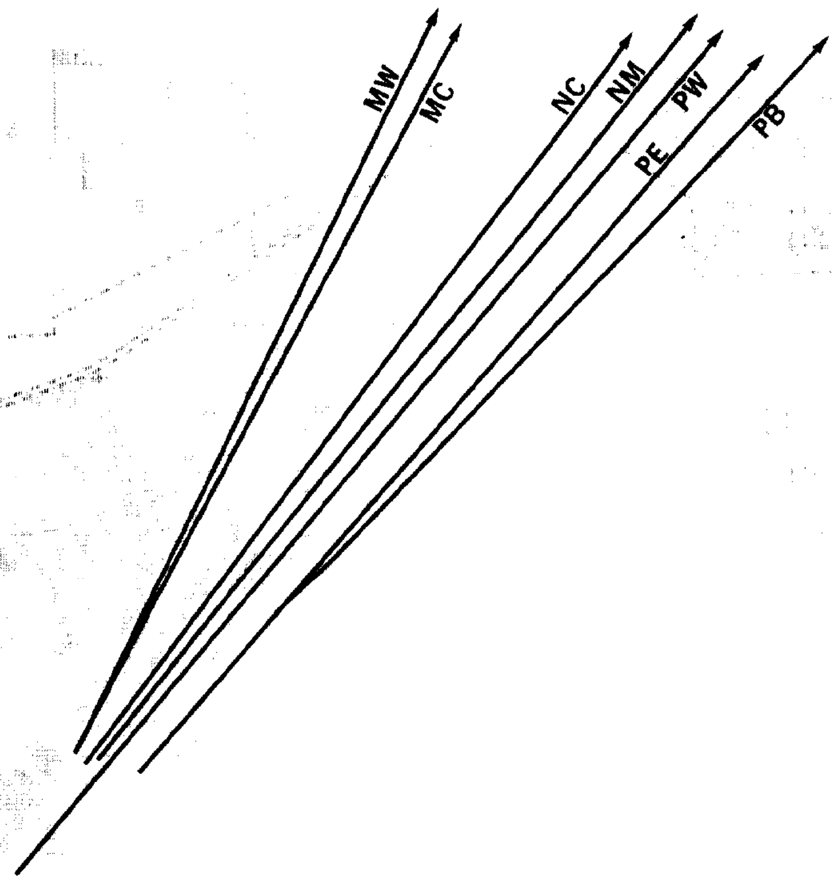
* = BEDROCK WELL

STS Consultants Ltd.
Consulting Engineers

BORING LOCATION DIAGRAM
ANGLE HOLES AT NEUTRINO TARGET AREA
FERMI NATIONAL ACCELERATOR LABORATORY
BATAVIA , ILLINOIS

DRAWN BY	GRS	10-89
CHECKED BY	DLG	10-89
APPROVED BY		
SCALE 1" =400'	FIGURE NO. 1	
STS DRAWING NO. 25635-XH		

Figure 11



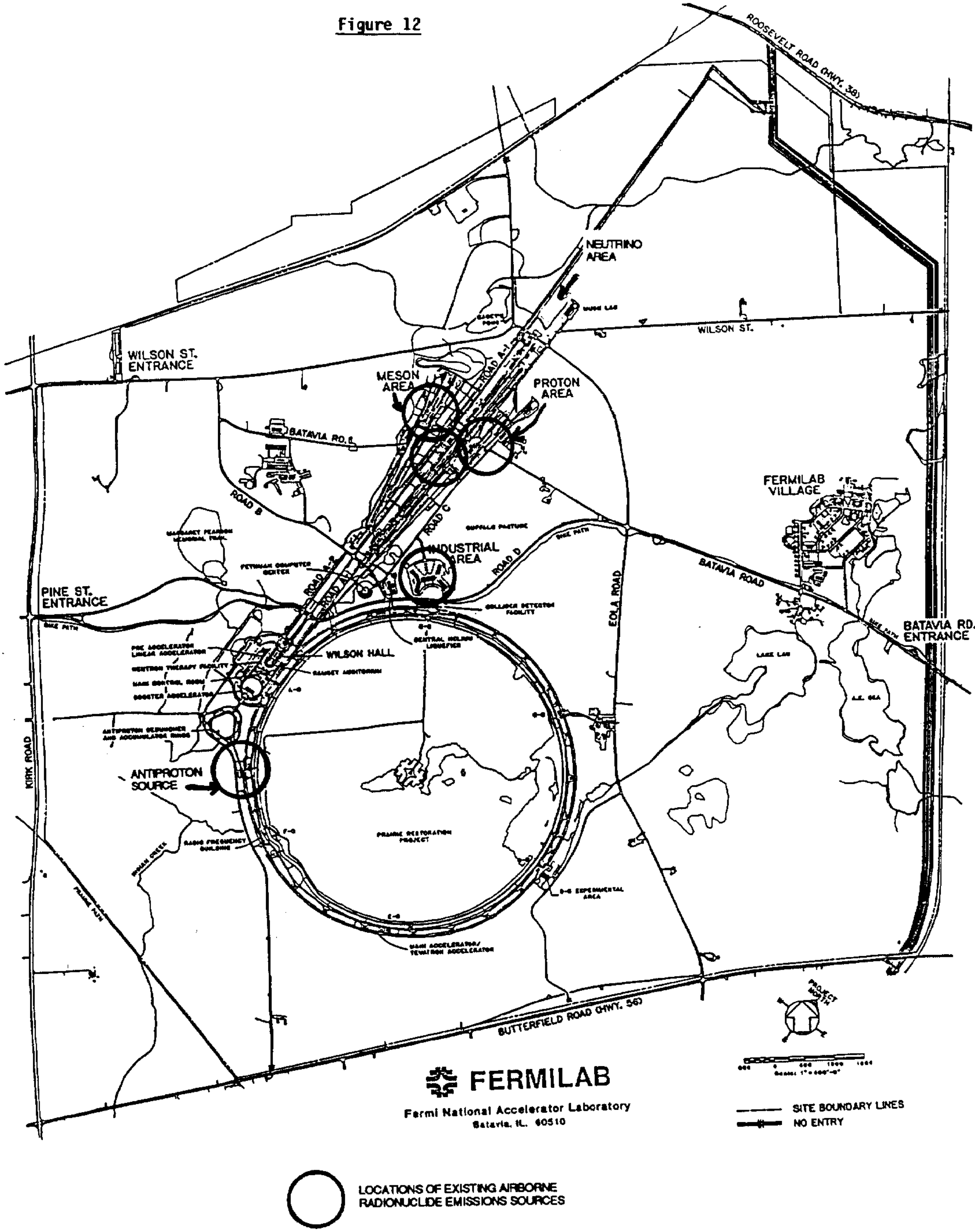
PENETRATING RADIATION (MUON) DIRECTIONS

(FERMILAB REPORT TM-1518 1988)

OVERLAY FOR BASE 4. FERMILAB

PREPARED IN 1989

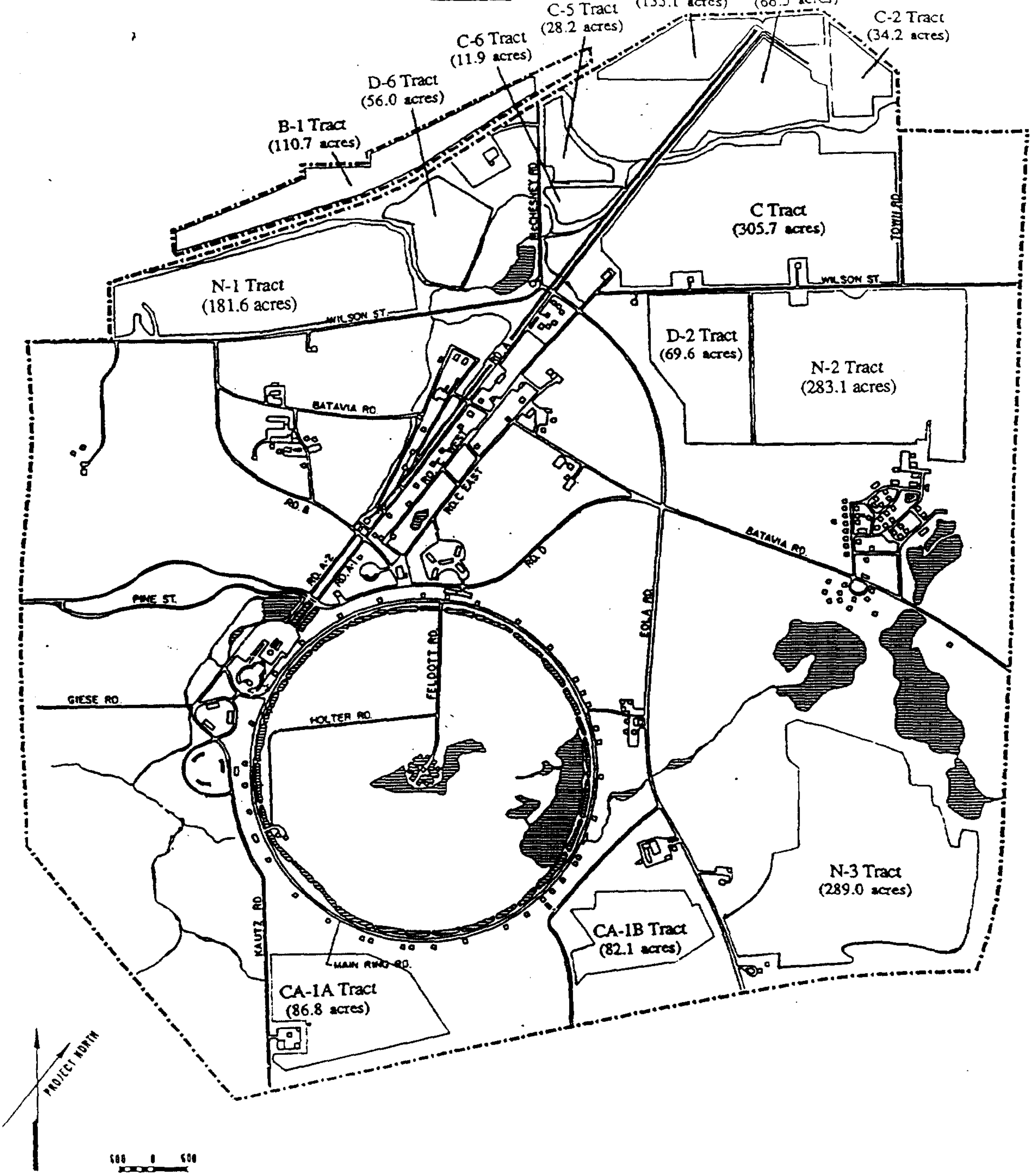
Figure 12



Map of the Fermilab site show existing facilities including locations of existing sources of radionuclide emissions.

1991

Figure 13



Leased Farm Tracts CY 1991
Fermi National Accelerator Laboratory

ACRONYMS

AAL	Activation Analysis Laboratory (Fermilab)
ALARA	As Low As Reasonably Achievable
ASTM	American Society for Testing and Materials
BAT	Best Available Technology
BETX	Benzene, Ethylbenzene, Toluene, and Xylene
BOD	Biological Oxygen Demand
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CUB	Central Utilities Building
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guides
DOE	U.S. Department of Energy
EA	Environmental Assessment
EE	Environmental Evaluation
EIS/ODIS	Effluent Information System/Offsite Discharge Information System
EML	Environmental Measurements Laboratory
EPPM	Environmental Protection Procedures Manual
ESA	Endangered Species Act
ES&H	Environment, Safety and Health
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FWS	Fish and Wildlife Service
HSWA	Hazardous and Solid Waste Amendments
HWSF	Hazardous Waste Storage Facility
IAC	Illinois Administrative Code
ICRP	International Commission on Radiation Protection
ICW	Industrial Cooling Water
IEPA	Illinois Environmental Protection Agency
NCRP	National Commission of Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyls
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facilities Assessment
RFI	RCRA Facilities Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SPCC	Spill Prevention Control and Countermeasures
SWMU	Solid Waste Management Unit
TLD	Thermoluminescent Dosimeter
TSCA	Toxic Substances Control Act
UIC	Underground Injection Control Well
UST	Underground Storage Tank
VOC	Volatile Organic Compounds