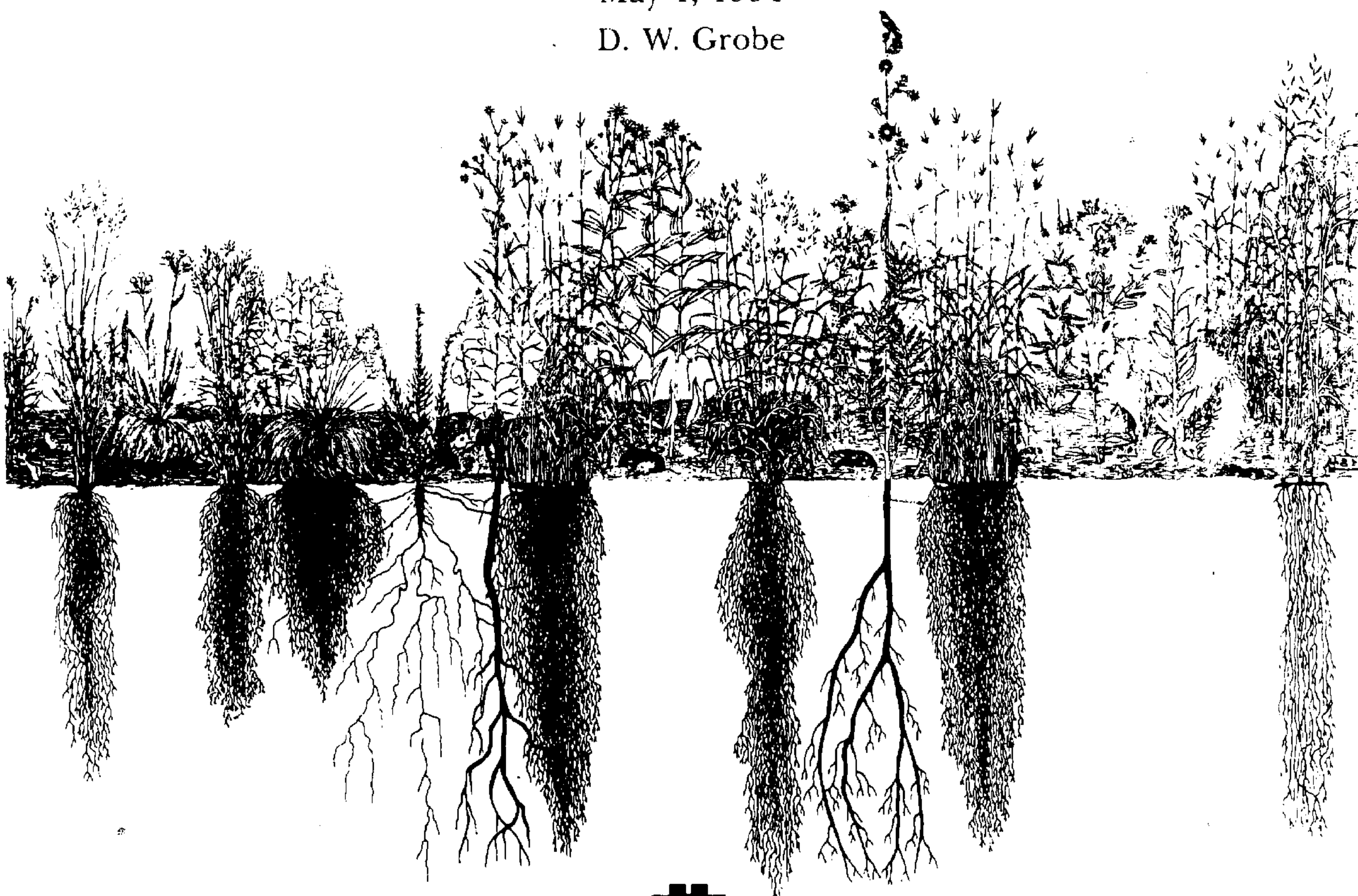
Site Environmental Report

For Calendar Year 1993

May 1, 1994

D. W. Grobe



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

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

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FERMILAB

SITE ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1993

by

D. W. Grobe, Editor

May 1, 1994

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1.0 EXECUTIVE SUMMARY FOR CY-1993

This report summarizes the environmental status of Fermi National Accelerator Laboratory (Fermilab) for Calendar Year 1993 (CY-1993). It includes descriptions of the Fermilab site, its 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), 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, the facility or its operation in CY-1993. Details of Fermilab's compliance status can be found in the Compliance Summary, Section 3.0 of this report.

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 also analyzed for potential chemical constituents. External penetrating radiation and airborne emissions were estimated, providing information for the potential radiation doses to off-site populations. The results of the environmental

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surveillance program are interpreted and compared with environmental standards where applicable. The status of environmental protection activities and the progress on environmental restoration and corrective action activities are discussed in this report.

1.3 Environmental Radiological Surveillance Information

The total potential radiation dose equivalent to the general offsite population from operations during CY-1993 was 1.46 x 10^{-2} person-rem (1.46 x 10^{-4}person-Sv). A summary can be found in Table 1. This is comparable to the estimate of 2.27 x 10^{-2} person-rem (2.27 x 10^{-4} person-Sv) for CY-1992 due to the continued operations of the accelerator in the Collider mode and the resultant decrease in muon production. Refinements in confirmatory measurements also substantially reduced the estimated total dose due to Fermilab operations (see Section 1.3.1 for further discussion). Because the dose to the offsite population is comprised only of penetrating radiation and short-lived airborne radionuclides, the 50 year dose commitment from operations in CY-1993 will be the same as the effective dose equivalent received in CY-1993 reported here. Table 2 provides a summary of radioactivity released to the offsite environment in CY-1993.

1.3.1 Radioactive Airborne Emissions Summary

Airborne radionuclide emissions from Fermilab facilities are regulated by the Clean Air Act (CAA) and are subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. As a result of accelerator operations, airborne radionuclides are released from target stations in the experimental areas and in the Antiproton Source to the atmosphere. During Calendar Year 1993 only the Antiproton Source received beam. Since there were no unplanned emissions, the Antiproton Source was the sole emissions source in CY-1993. See Table 9.

In response to recommendations by the Tiger Team, members of the Fermilab Radiation Physics Staff Group initiated a program in CY-1992 to study the emissions from the Antiproton Stack. First it was learned that approximately 30% of the air being exhausted from the AP0 vault, where the Antiproton source is located, was exiting through the AP0 service building and Target Hall, and hence was not monitored. The remaining 70% was being exhausted from the AP0 stack as modeled in past reports.

Past studies of emissions from the AP0 stack had determined the radionuclide composition by fitting a multiple exponential function to the experimentally determined decay curve of a volume of stack gas confined to a lead pig. The lead pig negated the concomitant use of gamma ray spectroscopy in the experimental measurements. No method was used to evaluate how well the fitted function emulated the experimental measurements. The study program initiated in CY-1992 employed concomitant gamma ray spectroscopy and used a χ^2 minimization to constrain the fitting function to the experimental data. The stack gas was taken from the stack in an approximately 20 ft. run of copper tubing whereas it was taken from a 40 ft. run of plastic (Tygon) tubing in previous studies. Flow rates in all studies were between 4 and 6 lpm.

The net result of these new studies is that we now believe Fermilab has seriously overestimated its airborne radionuclide emissions in past reports. Monitored releases for CY-1993 from the AP0 Stack were measured as 11.00 Ci (4.07 x 10^{11} Bq). Airborne radionuclides ^{11}C(58.7%), ^{13}N(37.6%), ^{38}Cl(1.0%), ^{39}Cl(1.1%), ^{41}Ar(1.5%), and ^{82}Br(<0.1%) were identified in the emissions from the AP0 Stack. Due to its extremely low concentrations, the ^{82}Br was difficult to observe, and was seen only on an activated charcoal filter placed in the sampling line. Unmonitored releases from the AP0 target hall and service building were estimated at 10.77 Ci (3.99 x 10^{11} Bq) by scaling emission rates per delivered proton from the AP0 Stack. Since these releases occurred approximately 20 minutes upstream of the AP0 stack, the relative % composition of each of the airborne radionuclides changed to ^{11}C(42.4%), ^{13}N(55.9%), ^{38}Cl(0.5%), ^{39}Cl(0.5%), ^{41}Ar(0.6%), and ^{82}Br(<0.05%).

Our present Illinois Environmental Protection Agency (IEPA) NESHAP (National Emission Standard for Hazardous Air Pollutants) air pollution permit application states that our releases will average 100 Ci/year (3.70 x 10^{12} Bq) with a maximum of 900 Ci/year (3.33 x 10^{13} Bq). Modeling our releases with the computer code CAP88-PC, version 1.0, yielded a maximum site boundary dose equivalent to a member of the public of 0.00648 mrem (6.48 x 10^{-5} mSv) in Calendar Year 1993. This is well below the Environmental Protection Agency (EPA) standard of 10 mrem/year (1 x 10^{-1} mSv/year). The threshold for requiring EPA-approved continuous monitoring is set at 0.1 mrem/year. The collective dose equivalent to the public due to air emissions in CY-1993 was calculated to be 1.46 x 10^{-2} person-rem (1.46 x 10^{-4} person-Sv).

1.3.2 Penetrating Radiation Summary

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 fixed target areas did not operate in CY-1993. The collider running mode was operative this year. During the collider run, the only potential muon source is the C0 Abort. However, muons due to Tevatron aborts at C0 are attenuated and therefore the potential dose from this source was inconsequential. A record of protons aborted at C0 was used to estimate the effective dose equivalent at the site boundary at 2.90 x 10^{-4} mrem (2.90 x 10^{-6} mSv) for CY-1993. No neutron fields of environmental significance were identified during CY-1993 operations.

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The maximum site boundary dose (fence line assuming 24 hr/day exposure) from the radioactive material stored at the Railhead (Figure 1) was 0.72 mrem (7.2×10^{-3} mSv) for CY-1993. The Railhead is closer to the site boundary than is the nearest house, making the actual maximum radiation dose to an individual offsite slightly lower. The maximum individual potential radiation dose due to radiation from the Railhead was 0.15 mrem (1.5×10^{-3} mSv) during CY-1993.

1.3.3 Summary of Radioactive Discharges to Surface Water

The offsite release of tritium (^3H) in surface water totaled approximately 578 mCi (2.14×10^{10} Bq), compared to 203 mCi (7.5×10^9 Bq) in CY-1992 (Gr93). The increase was the result of more water from reportable discharges leaving the site during CY-1993. Water left the site via the Kress Creek spillway for 57.5% of the year in CY-1993 as compared with 35% the year before. The primary source of tritium in water reaching Casey's Pond from drainage ditches in the Research Area continues to be tritiated water discharged from an underdrain system beneath the Neutrino Target Service Building, a target, and a beam dump system. At one time the target was the primary target in the Neutrino Area, 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-1993 from this area was essentially from operations before CY-1983.

1.4 Environmental Non-Radiological Surveillance Program Information

1.4.1 Airborne Emissions

Conventional air pollutant emission from Fermilab facilities are regulated under the Clean Air Act (CAA) and its amendments. 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. Some emissions testing was conducted at the Magnet Debonding Oven in conjunction with its refurbishment. There were no known instances of non-compliance emissions in CY-1993. Tables 3 and 4 summarize permits held by Fermilab.

1.4.2 Surface Waters

Fermilab does not have a NPDES (National Pollution Discharge Elimination System) permit to discharge process wastewater to surface waters and therefore it is prohibited. The Laboratory has

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submitted permit applications to the Illinois Environmental Protection Agency (IEPA) that will cover on-going releases of comingled non-process, non-contact cooling water and stormwater runoff to surface waters. In conjunction with the NPDES application, surface waters have been sampled for various chemical constituents. Annual samples of surface water are also taken from selected bodies of water onsite and analyzed for trace metals, and selected organics. Analysis parameters were selected based on contaminants from possible, yet improbable onsite sources. In CY-1993 surface water monitoring for chemical contaminants was limited to Kress Creek and the Fox River Inlet to Kress Creek. Table 5 summarizes sampling results. The Kress Creek watershed collects stormwater runoff from the experimental beamline areas. Samples taken as water entered the site via Kress Creek intake exceeded general water quality standards. These samples showed iron concentrations in excess of the standard. The sample taken from Kress Creek at the point where it leaves the site also exceeded general water quality standards for iron, showing a slightly increased iron concentration as compared to the water entering the site.

1.4.3 Groundwater

Water samples from wells used to monitor for chlorides and chromates in an old perforated pipe field yielded measurable levels of total chromium, lead, chloride, and tritium in CY-1993. Chloride concentrations exceeded Illinois Ground Water Quality Standards (I191) for Class II groundwater. Results are summarized in Table 6. While it is believed that it is improbable that these contaminant levels pose a health risk, monitoring continues. The nearby Class V injection well which receives chloride-laden waste from the Central Utility Building (CUB) regeneration process is the source of the chloride. Chloride releases will soon terminate with the rerouting of the regeneration effluent to the City of Batavia sewer system.

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 through 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 antiprotons became possible. Such colliding beam collisions are now an important part of the research program at Fermilab.

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-antiproton 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. 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. 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).

During CY-1993, operation of the high-energy accelerators at Fermilab consisted of a Collider run using 800 GeV beams of protons and antiprotons. This period of operations which began in April 1992, continued with beam being delivered to these areas through May 1993. After a five month shutdown, the Collider resumed operation in November 1993 and ran through the end of CY-1993.

2.3 Site Description

Fermilab is located in Kane and DuPage Counties in the greater Chicago area. It covers 10.6 square miles (27.5 square kilometers) 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.

The land within the Fermilab boundaries was primarily farmland when the State of Illinois acquired it for the Department of Energy (DOE). Much of the land, approximately 1680.8 acres (6.8 km^2) in CY-1993, has remained in crop production, primarily corn (Figure 6). 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.

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 973 acres (3.94 km^2) of native grasses.

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 thirty-two. The report on the historical survey has been accepted by Fermilab.

2.4 Surface Characteristics of the Site

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. The Fox River flowed south with an average of 1.51 x 10^9 gallons (5.27 x 10^9 liters) per day as measured at Algonquin, IL in CY-1993. The West Branch of the DuPage River flowed south at an average rate as measured near Warrenville of 1.14 x 10^8 gallons (4.31 x 10^8 liters) per day for the same period. Kress Creek, which flows to the West Branch of the DuPage River, averaged 1.77 x 10^7 gallons (6.69 x 10^7 liters) per day at West Chicago. Average daily flow rates were obtained from the U.S. Department of the Interior, Water Resources Division (Du94). The rainfall in the vicinity of Fermilab, taken at O'Hare International Airport, during 1993 was 44.9 inches (114 cm) (NOAA 93). 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.

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2.4.1 Industrial Cooling 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 approximately 50,000,000 gallons (1.89 x 10^8 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 then flows to the Booster Pond through a return ditch. Water is also pumped from Swan Lake to NS1 Service Building 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 (Figure 2).

The Main Ring Ponding System consists of a series of interconnecting canals completely encircling the interior of the Main Ring and including 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 (Figure 2).

2.5 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 on June 26, 1979.

In September 1993 Fermilab received an IEPA permit to construct and/or operate water pollution control facilities at the CUB in conjunction with the pretreatment of demineralizer regenerant waste prior to its discharge to the City of Batavia sewer system. Releases from this process to Batavia did not occur in CY-1993.

2.6 Drinking Water Supplies

The primary drinking water supply at Fermilab is provided by a well that taps the shallow Silurian aquifer, with a pump placed at 220 ft. (67.1 m) depth (Sa82). This well, W-1 in Figure 3, is located in the Central Laboratory Area. A second well, W-3 in Figure 3, 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 3, became operational in November 1988, supplying water to the Colliding Beams Experiment Facility at D0. Seven 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. The system at D0 is also a chlorinated system but uses sodium hypochlorite rather than chlorine gas. The chlorine level in these drinking water supplies is tested each workday. The average daily use from Well W-1 and Well W-3 combined was approximately 57,720 gallons during CY-1993. Well W-5 supplied an average of 1200 gallons/day to D0, while an average of 22,975 gallons was purchased daily from Warrenville for the Fermilab Village.

2.7 Subsurface Characteristics of the Site

A number of studies have documented the subsurface characteristics in the vicinity of the Fermilab site (DOE88, Pf74, Sa82, Vi85, Vi88). The upper geology of the site is characterized by 60 to 100 feet (18.2 - 30.5 m) of glacial till overlying bedrock of Silurian dolomite (Sa82). Beneath this upper bedrock are older sedimentary formations of Cambrian and Ordovician dolomite and sandstone. The lower bedrock units are effectively confined from the upper bedrock by the Maquoketa shale group.

The till unit is composed primarily of low permeability clays interspersed with areas of higher permeability sand and gravel. The clays act as an impedance to ground water flow through the till, but the sporadic occurrence of the higher permeability regions and the existence of extensive, undocumented drain tile lines from past agricultural use make localized predictions of ground water flow difficult. The water table fluctuates seasonally between 5 and 15 feet (1.5 - 4.6 m) below the ground surface. The fractured upper 10 feet (3 m) of the Silurian dolomite formation and the basal sand and gravel horizon that lies immediately above it yield sufficient quantities of water for private production wells.

The direction of natural ground water flow beneath Fermilab is generally toward the south/southeast. Flow is heavily influenced, however, by ground water extraction wells used to supply drinking water to the

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majority of the site. Figure 4 is a piezometric contour map for this aquifer. Well 62, which prior to 1987 supplied drinking water to the Village, was properly abandoned in CY-1993. Well W-3 is maintained for backup supply to W-1, which is now the primary water supply and influence on the piezometric contour. Well W-5, in the southeast corner of the Main Ring, supplies water to the D0 Experimental Hall. Its influence on the piezometric contour has not yet been mapped. The Village area in the east part of the site is supplied by groundwater from the City of Warrenville distribution system. The majority of ground water supplies used in community systems surrounding the Fermilab site are withdrawn from the sandstone aquifer in the Cambrian/Ordovician formations at depths of approximately 1200 feet (366 m). Recent conversion to the use of surface water supplies drawn from Lake Michigan by communities east of Fermilab is reducing the demand on both the shallow and deep formations. The shallow Silurian dolomite aquifer is used heavily to supply water to private wells in the area. In the past heaviest withdrawals have occurred in DuPage County, east of Fermilab, where the estimated 1984 pumping rates (not including rural domestic and livestock wells) exceeded the withdrawal rate from the deeper Ordovician aquifer (Ki85). Quarry operations and heavy pumping for general use have partially dewatered large areas of the Silurian dolomite formation.

In CY-1992, an ad hoc committee was formed to study the potential migration of radionuclides in groundwater at Fermilab. To aid them in their investigation they hired a consultant to evaluate geologic, hydrologic, and geochemical conditions using existing site data and to evaluate the migration of groundwater activated by accelerator operations. The consultant's study involved the application of analytical transport models to five existing and two proposed accelerator loss points which are potential soil activation areas. The final report from the consultant was delivered in August 1993 (Wo93). The ad hoc committee summarized the consultant's results and their own study in two technical memorandum (Ma93 and We93). The results of the ad hoc committee work were submitted to the Environment, Safety, and Health Section (ES & H Section) for their review in late CY-1993. Following review of the documents, the ES&H Section plans to make a recommendation to the Fermilab Director as to how the study results should be utilized.

2.8 Demography

Fermi National Accelerator Laboratory is located in the densely populated Chicago area. There are about eight million people living within 50 miles (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 7 (Wi92). 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 (population 17,076), Warrenville (population 11,333), West Chicago (population 14,796), and Aurora (population 99,581).

3.0 COMPLIANCE SUMMARY

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

Clean Air Act (CAA) - 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). Fermilab has eleven air pollution permits covering eight non-radiological and three radiological emission sources onsite. Table 3 summarizes Fermilab air pollution permits. Four existing air pollution permits were renewed during Calendar Year 1993 (CY-1993) or early CY-1994. One new air pollution permit was received for a new fuel dispensing facility for which construction has not yet begun. The 1992 Annual Air Emission Report for Fermilab was submitted to the Illinois Environmental Protection Agency (IEPA) in September 1993. The 1993 Annual Air Report was submitted to the IEPA in April 1994 (Table 25). There were no known instances of noncompliant air emissions on or offsite in CY-1993.

National Ambient Air Quality Standards (NAAQS) - Under the authority of the CAA and its amendments, 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.

Clean Air Act Amendments of 1990 (CAAA) - 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 areas into attainment by specified dates. Fermilab is located in an area that has been designated a "Severe-17" non-attainment area for ozone. An Employee Commuting Options Team has been appointed and has begun to develop recommendations for a program that will assist Fermilab in complying with the State of Illinois Employee Commute Options Act (1993), Illinois' implementation of the employee trip reduction requirements of Section 182 of the Federal Clean Air Act.

National Emissions Standards for Hazardous Air Pollutants (NESHAPs) - The National Emissions Standards for Hazardous Air Pollutants have 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 the construction and operation of onsite radiological emission sources. There are no major NESHAP release points at Fermilab that require continuous monitoring under 40 CFR 61.93 (b). Beam tunnel ventilation stacks are minor sources of radionuclide emissions and are therefore subject to periodic confirmatory monitoring requirements. In CY-1993, the only radionuclide air emissions at Fermilab were those related to the operation of the Collider and its antiproton source. The releases from the Anti-Proton stack were continuously monitored. A program of confirmatory measurements is planned for the next fixed

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target mode run in FY-1996, when other minor sources will be identified. The Quality Assurance Program in Fermilab Environment Safety and Health (ES&H) Specific Quality Implementation Plan (SQIP) EP.2 now meets the requirements of Appendix B (Method 114) of 40 CFR 61. Radiological air emissions are reported annually to the United States Environmental Protection Agency (USEPA) and to the Department of Energy (DOE). Fermilab's CY-1993 Radionuclide Air Emissions Annual Report was submitted to DOE in April 1994. Radioactive air emissions are summarized in Tables 2 and 9.

NESHAP Asbestos Removal Program - While the NESHAP standard does not set a numerical threshold for asbestos fiber emissions, it requires those conducting asbestos-related activities, such as demolition and renovation, to follow approved procedures, and to adopt specific work practices to prevent release of asbestos to the air. A team of Fermilab employees is trained in the proper methods of asbestos removal. Asbestos is properly removed and disposed of during maintenance and renovation of equipment and buildings.

Clean Water Act - Under the authority of the Clean Water Act (CWA), the United States Environmental Protection Agency (USEPA) 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 facilities that directly discharge pollutants to the waters of the United States must obtain a permit to do so. The USEPA has delegated the authority to implement this program to the Illinois Environmental Protection Agency (IEPA). Fermilab operations result in a discharge of cooling, storm, and certain treated waters to the surface waters onsite. Accordingly, Fermilab submitted a preliminary application to the IEPA for a NPDES permit to discharge non-process, non-contact, cooling water on April 21, 1992. The application was supplemented in July 1993 with information on stormwater discharges from identified solid waste management unit (SWMU) sites being investigated under the Resource Conservation and Recovery Act Facility Investigation (RFI). In May 1994 Fermilab received a draft NPDES permit for the discharge of cooling water (NPDES permit No. IL0026123).

In October 1992, Illinois published a General NPDES Permit for discharge of stormwater associated with construction activities. The Laboratory notified the IEPA of its intention to be covered under this general permit as of October 1, 1992, and as required, a Stormwater Pollution Prevention Plan was developed for the Fermi Main Injector (FMI) project, a construction activity involving disturbance of more than five acres. The plan has been periodically updated to reflect the various phases of construction. Pursuant to permit requirements, a Wetland Mitigation Action Plan was prepared for the FMI project and approved by the United States Corps of Engineers. Approximately 10.3 acres of new wetlands have been constructed to replace the wetlands that will be lost in the FMI construction.

A pretreatment permit was issued by the IEPA in September 1993 allowing the release of a treated effluent from the Central Utility Building regeneration process to the City of Batavia sanitary sewer system. The acquisition of this permit, along with the many improvements made to the regeneration process, will soon make it possible to discharge

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this effluent to the sanitary sewer, allowing the closure of the Class V underground injection well that currently receives the effluent.

A water pollution control permit was sought and received in early 1994 for the construction of an additional recirculation cooling pond that will discharge to Kress Creek.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/Superfund Amendments and Reauthorization Act (SARA) -- Title I - The CERCLA legislation establishes a program to identify sites where hazardous substances have been released into the environment and to ensure 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.

Several years ago CERCLA site notification was 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 (PA) report on the Main Ring Perforated Pipe Field was submitted to the USEPA in CY-1990 and resulted in a determination that no further action was required. Further investigation of both of these sites has been included in the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Phase I Work Plan, prepared as a condition of obtaining our Part B permit. More information about the RFI is included in the RCRA discussion.

A Preliminary Assessment (PA) for the Main Ring Service Building PCB Contamination was submitted to the United States Environmental Protection Agency (USEPA) in November 1993. More information can be found in the Toxic Substances Control Act (TSCA) section.

In April 1993 the USEPA issued a unilateral administrative order to Universities Research Association, Inc. (URA)/Fermilab requiring participation in a CERCLA removal action at Elgin Salvage and Supply, Inc., located in Elgin, Illinois. Fermilab had transported some polyvinyl chloride (PVC) coated wire and lead metal to the site for recycling several years ago and therefore URA is named as one of five potentially responsible parties (PRPs) in the removal action. The PRPs hired a consultant to prepare a preliminary site investigation report which was submitted and accepted by the USEPA. A second consultant has prepared and submitted a Removal Plan to the USEPA. After receiving USEPA comments revisions were made and the plan was resubmitted in March 1994. The current schedule calls for the work to begin in the summer of 1994 and to continue for nearly six months.

Endangered Species Act and the Fish and Wildlife Coordination Act - The Endangered Species Act of 1973, as amended, provides for the designation and protection of wildlife, fish, and plants in danger of becoming extinct. The act also conserves the ecosystems on which such species depend. In conjunction with the Fermilab Main

Injector (FMI) Environmental Assessment, numerous field surveys were conducted at the proposed project site. Findings indicated that there were no state or federally listed endangered or threatened species that would be affected by construction or operation of the FMI. No compliance issues were identified in CY-1993 at Fermilab.

Executive Order 11988, "Floodplain Management" - This order was established to avoid long- and short-term impacts associated with the occupancy and modification of floodplains. Planning for the Fermilab Main Injector, located in a floodplain, addressed the requirements of Executive Order 11988. 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. Approximately 40.9 acre-feet of floodwater storage volume has been provided to compensate for the floodplain areas to be disturbed in future FMI construction activities. Evaluation of the impact of Fermilab activities on floodplains is ensured through the NEPA process.

Executive Order 11990, "Protection of Wetlands" - Executive Order 11990 was established to ensure that adverse impacts to wetlands are avoided when possible and responsibly mitigated when construction activities involve the destruction of wetlands. Evaluation of Fermilab activities in wetlands is ensured through the NEPA review process.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - This act applies to storage and use of herbicide and pesticides at Fermilab. It restricts the application of pesticides through a certification program. Fermilab controls pesticide use onsite and requires that certified applicators oversee the application of these substances. In CY-1993, the use of pesticides/herbicides at Fermilab was 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 existed inside the Fermilab Main Injector site. Although this area will not be directly disturbed by construction activities, these recommendations and precautions ensure that the project will have no significant impact on the heron rookery or on other migratory birds. The herons did not return to the rookery at the FMI site in CY-1993.

National Environmental Policy Act (NEPA) - This act requires the evaluation of proposed federal activities for their potential environmental impacts and the examination of alternatives to those actions. These evaluations are reported to DOE 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 NEPA. A Final Rule and Notice for "NEPA; Implementing Procedures and Guidelines Revocation" was published in April 1992 (57 FR 15122). Fermilab has responded to the procedures specified by DOE by implementing a program of reviewing all of its activities for NEPA compliance. In CY-1993, 24 requests for Categorical Exclusions (CXs) were submitted to DOE. Of these, all were

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approved in CY-1993 or in early CY-1994. The Environmental Assessment (EA) prepared for the KTeV Experimental Program Construction and Operation resulted in a Finding of No Significant Impact (FONSI). Approval to proceed with an EA for the new low-level radioactive waste handling building was received in February 1993.

National Historic Preservation Act (NHPA), Archaeological Resources Protection Act - Compliance with these Acts was accomplished through the NEPA review process which included an evaluation of all proposed land-disturbing projects in CY-1993 to assess any potential impacts on cultural resources. No new compliance issues were identified in CY-1993.

Resource Conservation and Recovery Act of 1976 (RCRA) - This act provides for the safe treatment and disposal of hazardous waste and regulated hazardous waste management practices for generators, transporters, and owners and operators of treatment, storage, and disposal facilities. Generators of hazardous waste, such as Fermilab, must follow very specific requirements for handling these wastes.

RCRA required that owners and operators of interim status hazardous-waste management facilities obtain operating permits for many waste management activities or officially initiate closure for the units by November 8, 1992. Fermilab received a RCRA Part B operating permit for building WS-3 at the Fermilab Hazardous Waste Storage Facility (HWSF) on October 28, 1991. Fermilab submitted a revised closure plan for the Site 55 Hazardous Waste Storage buildings WS-1 and WS-2 in March 1992. Subsequent IEPA comments resulted in modifications to the closure plan. The revised closure plan was resubmitted and received final approval in February 1993. Closure activities were conducted in April, with the Closure Sampling and Documentation Report being submitted to the IEPA in July 1993. Final closure approval was received from the IEPA in January 1994.

As a condition of the RCRA Part B permit, a RCRA Facility Investigation (RFI) is required. The purpose of the RFI is to investigate whether hazardous constituents have been released to the environment from the fourteen identified Solid Waste Management Units (SWMUs) located onsite. A Phase I Workplan for this investigation was prepared and submitted to the IEPA in February 1992. Subsequent IEPA comments resulted in modification to the workplan. The IEPA approved the revised RFI Phase I Workplan in November 1993. RFI sampling activities began in late November 1993 and continue in early CY-1994. The IEPA was notified of four newly identified SWMUs in accordance with regulations, bringing the total number of SWMUs to be investigated to nineteen.

In May 1991, DOE issued a moratorium prohibiting the offsite shipment of RCRA-hazardous and TSCA-regulated waste originating in radioactive material management areas (RMMAs) to commercial facilities not licensed by the Nuclear Regulatory Commission or an Agreement State. To lift this moratorium, DOE required that Fermilab prepare and obtain DOE approval of release criteria developed following DOE Performance Objective guidance. Fermilab submitted this documentation and received DOE/EM comments in March 1993. DOE/EM-30 continued, on a case-by-case basis, to allow the Lab to remain in compliance with hazardous waste regulations by allowing exceptions and approving several small quantity RMMA offsite shipments during CY-1993. The moratorium was lifted in October 1993 when Fermilab's procedures were approved.

There are two remaining underground storage tanks onsite. The Laboratory continues to monitor two underground storage tanks (USTs) at Site 38 for petroleum releases through monthly inventory control measures and annual tank tightness testing. The removal of two other USTs at the Central Utility Building (CUB) was accomplished in CY-1993. The CUB USTs were out of compliance with 40 CFR 280.70 and 280.71 standards because they had been out of service since April 1991 and had not yet been properly abandoned or removed. Soil contamination was observed during the excavation. Cleanup of accessible contaminated soil was accomplished. A closure report is currently being prepared. The report will request IEPA concurrence with site-specific cleanup objectives for this site.

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). Fermilab provides drinking water to its employees through three public water supplies, two NTNC supplies and a satellite supply connected to the City of Warrenville public water supply.

An IEPA Engineering Evaluation was performed for the Village, D0, and Main Site public water supplies on May 20, 1992. The engineer found the D0 and Village water supplies to be "in general compliance with regulatory requirements." We did not receive the report on the Main Site evaluation until May 1993. While deficiencies were cited in the inspection report, none constituted issues of compliance. A schedule for addressing the deficiencies is being written.

Fermilab public water supplies were sampled for bacteriological and chemical contaminants in CY-1993. Lead and copper sample site plans were submitted to the IEPA in February 1992 and then resubmitted in a new format as requested by the IEPA in February 1993. The plans were accepted by the IEPA in March 1993. The initial round of lead/copper (Pb/Cu) samples were collected for all three water supplies in CY-1993. Two of those supplies, D0 and the Main Site, exceeded the copper/lead Action Levels at more than ten percent of the sample sites. Two sets of Water Quality Parameters (WQPs) were collected for these supplies, as well as source water samples to be analyzed for copper and lead. Public education began in October 1993 with the distribution of brochures to all users of these Fermilab public water supplies and the display of posters, as required, in common areas of each of the buildings served by the supplies. An Optimal Corrosion Control Treatment (OCCT) recommendation to IEPA will be prepared for these water supplies.

Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA) or SARA TITLE III - This act was designed to address concerns about the effect of chemical releases on communities. These regulations require us to provide the EPA and state officials with an annual accounting of hazardous chemicals and extremely hazardous chemicals used or stored in quantities greater than a given threshold. Annual reports are submitted to the EPA as required. The CY-1993 inventory was submitted to state and local emergency services and disaster agencies in early CY-1994.

Toxic Substance Control Act (TSCA)-The application of TSCA requirements to Fermilab involves the regulation of polychlorinated biphenyls (PCBs) and asbestos. At twenty-four sites around the Main Ring, transformer oil containing 2-5% PCBs was drained onto the ground as part of past sampling procedures to verify that dielectric properties had not deteriorated. A characterization study was conducted at two of the buildings in FY 1989-1991. Because these were "historical spills" that occurred prior to the effective date of USEPA's PCB spill cleanup policy, criteria for cleanup will be established at the discretion of EPA Region V, in accordance with 40 CFR 761.120(a)(1) and CERCLA. With Region V's agreement, a consultant was hired in FY-1991 to conduct a risk assessment to assist EPA in determining criteria for cleanup as well as an appropriate schedule. The consultant's report indicated that there is very little risk to the public from the contamination in its current configuration, since it is contained in relatively small volumes, does not appear to be migrating, and is located in areas for which public access is restricted. In February 1993, the consultant's risk assessment report was transmitted to EPA for review and comment. Fermilab proposed to decontaminate the service building transformer sites at a rate of about two buildings per year, which can probably be accomplished within expected budget limitations and without interfering with accelerator operations. The EPA approved the report and Fermilab's proposal for cleanup in May 1993. A Preliminary Assessment (PA) for the Main Ring Service Building PCB Contamination was submitted to the USEPA in November 1993. Decontamination of two service building transformer sites (B3 and C2) was accomplished in CY-1993.

Fermilab's program to phase out PCBs in the Main Ring transformers and to eliminate them as potential PCB spill sources by retrofilling and/or chemical detoxification continues. The formal reclassification of 28 transformers as non-PCB and 1 as PCB-contaminated has received EPA approval. There are currently 7 PCB transformers and 1 PCB-contaminated transformer in the Main Ring. Reclassification of the 1 PCB-contaminated transformer in the Main Ring is pending EPA approval.

During the Tiger Team Assessment in May 1992, it was discovered that Fermilab was in noncompliance with TSCA due to the storage of PCB waste (three fifty-five gallon drums of PCB-contaminated solid debris) for greater than one year from the date that it was removed from service. The allowable storage time had been exceeded by nineteen days. The material was shipped for disposal in June 1992. Upon receipt of the waste, the disposal facility filed a One Year Exception Report notifying the USEPA. Fermilab received a Notice of Non-compliance (NON) from the USEPA in September 1993. No further action was required by the NON.

3.1 Appraisals and Assessments

The Tiger Team Assessment Report identified a total of 193 findings and concerns. Two of these were classified as Category II findings by the Safety and Health Team and these were addressed immediately. The remainder were addressed by 246 tasks in a comprehensive Corrective Action Plan (CAP). DOE approved the CAP in CY-1993 and 63 of the tasks have been completed. As stated in the Fermilab Corrective Action Plan dated September 1993 (FCAP93), all findings are scheduled for completion by the end of 1997.

An IEPA RCRA inspection was conducted on January 14, 1993. 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.

The USEPA conducted a TSCA/FIFRA inspection on September 12 and 13, 1993. No violations were observed during the inspection.

From April 26th through May 7th 1993, DOE/CH conducted a multi-disciplinary appraisal of Fermilab which resulted in thirteen "findings" and nine "recommendations." There were three quality assurance findings, five environmental protection findings, four industrial safety and fire protection findings, and one hazardous materials packaging and transportation finding. Nine findings and five recommendations have been closed.

3.2 Environmental Permits

Fermilab now has 9 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. The air pollution permits cover radionuclide emissions associated with the operation of the Tevatron, the construction of the FMI, and the operation of the magnet debonding oven; the operation of 8 boilers used for heating buildings; vapor recovery systems on fuel dispensing tanks; and the use of 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.

A NPDES permit application was submitted to the IEPA in 1992 to cover the discharge of non-process, non-contact cooling water to surface waters but permit issuance is still pending. Other permits have been obtained in conjunction with the construction of the Fermilab Main Injector including a general NPDES permit for stormwater releases related to construction activities. The planned development of an additional recirculation pond required the acquisition of a water pollution control permit. A pretreatment permit was obtained for the release of treated effluent from the CUB regeneration process to the City of Batavia sewerage system.

A permit to remove the CUB USTs was received from the Office of the State Fire Marshall.

Recent inspections by IEPA and the USEPA have identified no noncompliances with conditions of any of these permits. Permits are summarized in Tables 3 and 4.

4.0 GENERAL 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.

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 or 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-1993

Fermilab has a comprehensive sitewide monitoring plan that assesses the effect of past, current, and future Fermilab activities by measuring and monitoring effluents from Fermilab operations and by surveillance through measuring, monitoring and calculating the effects of those operations on the environment and public health. Monitoring is conducted to verify compliance with applicable Federal, State, and local effluent regulations and DOE Orders; to determine compliance with commitments made in Environmental Assessments, and other official documents; to identify potential environmental problems and to evaluate the need for remedial actions or mitigative measures. Determination of sampling frequency and type is based upon specific facility needs. Sampling is conducted in a manner that adequately characterizes effluent streams. Standard collection and analysis methods are used where applicable and are documented in the Environmental Protection Procedures Manual (EPPM). The Fermilab environmental and effluent radiological monitoring program attempts to follow the guidance given in the Department of Energy (DOE) 5400 series of Orders (DOE 90d) 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-1993, to measure three phases of accelerator-produced radiation: penetrating, airborne, and waterborne. During this year of operation the predominant source of offsite penetrating radiation was due to the storage of radioactive materials at the Railhead. Radioactive air emission sources were monitored for ^{11}C, ^{13}N, ^{38}Cl, ^{39}Cl, ^{41}Ar, and ^{82}Br as continuously operating stack monitors recorded the concentration released. Surface water and groundwater samples were analyzed to determine concentrations of tritium (^{3}H) 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-1993 indicated compliance with the applicable standards in every case. In particular, the highest site boundary penetrating radiation level was much less than 1% of the 100 mrem (1m Sv) relevant standard in CY-1993. Airborne radionuclide concentrations at the site boundary were so low as to be immeasurable. Low levels of tritium were detected (<1.0 pCi/ml) in two of three creeks leaving the site. See Section 8.0 for applicable standards.

Monitoring for bacterial and chemical pollutants in onsite drinking water systems was accomplished in CY-1993. Public water supplies were sampled monthly for coliform in accordance with the sampling plan submitted to IEPA.

Samples from three surface water outfalls were analyzed for a number of parameters in conjunction with the NPDES application. At IEPA's request, in April 1993 stormwater runoff samples were taken at specified SWMUs and at the RCRA Part B permitted facility.

Analysis of water from wells installed to monitor the Central Utilities Building (CUB) Tile Field showed both radiochemical and chemical constituents.

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4.3 Description of Environmental Permits

A list of Fermilab's environmental permits, including current issue and expiration dates can be found in Table 3.

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). A permit (I.D. No. 04387AAI, Application No. 94020002) to construct/operate a new gasoline and diesel dispensing facility with Stage I and Stage II vapor recover systems was received in early CY-1994.

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). The propane boiler was replaced with an electrically powered system in CY-1993. A grit blast operation at Industrial Building #2 is also included on this permit. This permit was renewed September 9, 1992.

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 renewed 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. The Lab has a permit to construct and operate an open top vapor degreaser in the Transfer Hall South (I.D. No. 043807AAI, Application No. 91100025).

A permit was renewed for the magnet debonding oven and its associated afterburner (I.D. No. 043807AAI, Application No. 79070012). This oven is a potential source of very low level radionuclide emissions. This facility debonds failed magnets and other devices prior to repair by decomposing epoxy at a high temperature (800^{o}F). This oven did not operate in CY-1993, except for emissions testing.

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 obtained an IEPA air pollution open burning permit (I.D. No. 043807, Application No. B9307046) for prairie and land management. Burning occurred on a number of the prairie tracts. Open burning

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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 held an IEPA permit (I.D. No. 043807, Application No. B9212022) to allow burning of one gallon of motor fuel per session of firefighting instruction.

Fermilab has obtained a permit (IEPA 0890105010; USEPA IL6890030046) 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. Wastes generated by Fermilab are stored at the facility until proper off-site disposal can be arranged.

In 1991 a permit was received from the IEPA to construct a second water supply line from Warrenville to the Fermilab Village (ID# 0099).

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.

In 1988, a construction/operating permit was obtained for the public water supply at D0.

No permit was needed for the septic field installed near D0 (north of W-5 in Figure 3). 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. A permit was received (1993-EE-3841) to pretreat demineralizer regeneration waste at the CUB prior to release to the City of Batavia sewers.

Fermilab submitted an application to the IEPA in CY-1992 for a sitewide NPDES permit governing the release of storm, and non-process, non-contact cooling water to surface waters. A Notice of Intent to be covered under the State's General Permit for the Discharge of Stormwater Associated with Construction Activity was filed prior to the October 1, 1992 deadline.

A water pollution control permit (#1994-EB-467) to construct an additional recirculation pond for cooling water on site was obtained in CY-1993.

Permit #2-022134 was obtained from the Office of the State Fire Marshall for the removal of two leaking underground storage tanks (LUSTS) at the CUB.

4.4 Fermilab Main Injector Project

The groundbreaking ceremony for the Fermilab Main Injector (FMI) project was held on March 22, 1993. Based on the Environmental Assessment (EA), DOE determined that the construction and operation of the FMI did not constitute a major Federal action significantly affecting the quality of the human environment and issued a Finding of No Significant Impact (FONSI) on July 6, 1992, with the wetland mitigation commencing soon thereafter. The FMI project is being constructed in accordance with a Mitigative Action Plan (MAP) approved by the COE.

In CY-1993 the FMI project did not create any negative environmental consequences not already anticipated in the EA and the FONSI. In September 1993, a field reconnaissance of the FMI wetland mitigation site showed the wetland to be in excellent shape. Performance standards for the first year were exceeded. A five year monitoring program, as required by the COE, is being implemented. The FMI is scheduled for completion in 1997.

4.5 Pollution Prevention Awareness and Waste Minimization

In Illinois, pollution prevention has been encouraged through passage of the Toxic Pollution Prevention Act (TPPA) in 1989, the Solid Waste Management Act, and most recently with the Illinois Pollution Prevention Act of 1992. The Waste Minimization Subcommittee was formed in 1992 at Fermilab to discuss, review, suggest, and implement waste minimization ideas. Equipment to recover Freon from air conditioners, chillers and refrigerators has been purchased and personnel have been trained in its use. Products containing Freon 113 were removed from the stockroom. Purchase orders for chemicals are being reviewed in an effort to encourage accountability for hazardous chemicals used on site. Freon 113 is being replaced with water/surfactant systems, dichlorofluoroethane, or a mixture of hydrocarbons and denatured alcohol where feasible. In conjunction with EPA's 33/50 Program, toxic air pollutant chemicals (e.g. methyl chloroform) are being replaced with less hazardous chemicals (Micro cleaner and water). Unneeded chemicals are being surplused to encourage use. Divisions and Section began process waste assessments in CY-1993.

Waste minimization certifications and waste reduction reports were included, as required by RCRA, in the annual Hazardous Waste Report submitted to the IEPA.

4.6 National Environmental Research Park (NERP)

During CY-1993, no National Environmental Research Park projects were completed at Fermilab. Three new projects were approved by the Environmental Advisory Committee (RS028 - RS030), and seven projects continued (Table 8). These projects will add to the accumulation of baseline data on the site and address land management and specific ecological questions.

Planting of prairie species was accomplished in the N-3 Experimental area project, a twenty-year project (RS016) to create a large series of replicated plots for the study of prairie and grassland ecosystem processes. A comprehensive survey of plant community characteristics, especially within the prairie restoration project, was continued for the second field season, resulting in two complete years of data.

4.7 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. Eighty Fermilab employees were trained in waste minimization and pollution prevention as part of waste management training in CY-1993. Fermilab personnel expected to identify and respond to spills are trained in the contents of the Spill Prevention Control and Countermeasures (SPCC) Plan.

4.8 RCRA Facilities Investigation (RFI)

Fermilab was issued a RCRA Part B Permit for its Hazardous Waste Storage Facility (HWSF) by the Illinois 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 Phase I Plan was submitted to the IEPA in February 1992. Subsequent IEPA comments have resulted in a revised workplan which was approved in November 1993.

Soil sampling occurred at the SWMU sites in November and December 1993. A total of thrity-nine soil samples and forty-seven quality assurance samples were collected. Six piezometers were installed around the Meson Landfill. Preparation of the Phase I report began in early 1994. An RFI Quarterly Report was transmitted to the IEPA for the fourth quarter of CY-1993 in January 1994. The IEPA was notified of four newly identified SWMUs in accordance with regulations. The total number of SWMUs is now nineteen.

4.9 Deer Studies

The Lab is currently in the second year of a five year deer study to investigate the impact of deer on forest and prairie plant communities. The study involves direct observation of deer and plants onsite (Nu93).

5.0 ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

Three types of accelerator-produced radiation are monitored: penetrating radiation, airborne radioactivity, and waterborne radioactivity. These radiations could 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.

5.1 Penetrating Radiation

A network of detectors is used to monitor penetrating radiation. Typically, there are approximately 100 detectors deployed around the site with the primary purpose of monitoring onsite radiation. The majority of these detectors are connected to a data logger which automatically records the radiation levels for subsequent examination (Aw71). In CY-1993, 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 TLDs were exchanged and read each quarter, providing additional information on radiation levels sitewide and at the site boundaries.

During CY-1992, the Tevatron was operated in the Collider mode. The CY-1992 Collider run of the Tevatron actually extended through the first few days of April 1993. The Collider running mode resumed in November 1993 and was operative for the remainder CY-1993. Because above ground muon fields during Collider operations are minimal, the primary contribution to offsite radiation exposure in CY-1993 was from gamma rays emitted from radioactive material stored at the Railhead. 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 is an area nearby designated for storage of equipment for future use. A large amount of this equipment contains low-level, beam-induced radioactivity. The site boundary dose for CY-1993 was determined using measurements made with thermoluminescent dosimeters (TLDs) and the large volume ion chamber

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(Hippo) at the Railhead. Previously obtained measurements made with a hand-held NaI (Tl) scintillator were used to establish the rate of decrease with distance (Cu89) in order to extrapolate a site boundary dose. The dose equivalent at the nearest point on the site boundary was estimated to be 0.72 mrem (7.2 X 10^{-3} mSv) for CY-1993. The maximum dose to the individual living closest to that point on the site boundary would have been 0.15 mrem (1.5 X 10^{-3} mSv) for CY-1993, 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.

The muon fields on and near the Fermilab site boundary are measured using scintillation counters mounted in a vehicle, the Mobile Environmental Radiation Laboratory (E188a, E188b). The raw data consists of measurements of the normalized muon fluence (muons/cm^2 per 10^{12} protons) obtained during scans conducted 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 per calendar year by multiplying this normalized fluence by the total number of protons delivered during the year and using a 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).

During the CY-1993 Collider run, the only potential source of muons was the C0 Abort. The effective dose equivalent at the site boundary due to this source was estimated to be 2.90 x 10^{-4} mrem (2.90 X 10^{-6} mSv) by using a record of protons aborted to calculate a potential dose based upon fluence measurements conducted previously.

5.2 Monitoring Airborne Radioactivity

Wherever the proton beam and secondary particles produced by the interaction of the beam with matter pass through the air, radioactivation of air occurs in measurable concentrations. The beam is generally delivered to the targeting areas via 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 and secondary particles must travel through air. This is why the radioactivation of the air is concentrated at the major target stations. Figure 5 shows the location of principle points of radionuclide airborne emissions related to accelerator operations.

During CY-1993, protons were focused onto a target (Antiproton Source in Figure 5) to produce antiprotons. This target was the only radioactive air emission source. Because this target is heavily shielded and the air volume is small, there were also many thermal neutrons that contributed to the radioactivation of the air. The result was the production of a mixture of primarily ^{11}C and ^{13}N with smaller amounts of ^{38}Cl, ^{39}Cl, ^{41}Ar, and ^{82}Br. The interaction of high-energy secondary particles with nitrogen and oxygen in the air produces the ^{11}C (20 minute half-life) and the ^{13}N (10 minute half-life). The ^{41}Ar, half-life of 1.8 hours, is produced by

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neutron capture in ^{40}Ar. Air contains about 1% argon which is essentially ^{40}Ar. 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) New studies conducted in CY-1992 indicate that Fermilab had previously overestimated its airborne radionuclide emissions due to errors in assumptions about radionuclide composition and in the calibration factor used to convert count-rate to released activity from the stack (Va93). Emissions from the AP0 stack were recorded by a stack monitor equipped with a Geiger-Müeller tube. The stack monitor output was logged continuously to record emissions. Table 9 summarizes the airborne radioactivity released due to accelerator operations conducted during CY-1993. This table not only includes releases for monitored stacks, but also contains estimates for unmonitored fugitive releases of airborne radioactivity from the AP0 Target Hall and Service Building.

As can be seen in Table 2, airborne emissions are by far the largest contributor to Fermilab releases of radioactivity. Even so, dose equivalents to offsite populations are well below EPA standards. Site boundary airborne radionuclide concentrations for CY-1993 were calculated using the computer program CAP88-PC, a Gaussian plume diffusion model. Meteorological input is received from the nearest National Oceanic and Atmospheric Administration (NOAA) monitoring station at O'Hare Airport, approximately 27 miles (43 km) away. The maximum effective dose equivalent to a member of the population residing offsite due to CY-1993 Fermilab radioactive air emissions was determined to be 0.00648 mrem (6.48 X 10^{-5} mSv). This value amounts to 0.065% of the 10 mrem/year (1 X 10^{-1} mSv/year) limit. With the promulgation of the National Emission Standard for Hazardous Air Pollutants (NESHAP) for radionuclides on December 15, 1989 in 40 CFR 61, Subpart H, this limit replaced the former 25 mrem/year limit. 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 conservative given the relatively low population density at this location 800 meters to the south southwest of AP0. 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 collective dose equivalent to the public from CY-1993 airborne radionuclide emissions was calculated to be 1.46 x 10^{-2} person-rem (1.46 x 10^{-4} person-Sv).

The magnet debonding oven was not in use in CY-1993 except for emissions testing.

5.3 Groundwater Radiological Surveillance

Radioactivation of soil is possible near the primary beam targeting and beam dump areas. Older targeting stations and dumps have "bathtubs" designed to contain radionuclides produced in these areas and thus prevent their migration to the aquifer. Later design strategies substituted massive concrete and steel shields within beam enclosures to minimize soil radioactivation and groundwater contamination. Many of the

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groundwater samples are taken from old out-of-service farm wells onsite. Sampling of 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 is only able to measure 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. A Fermilab committee, with the assistance of a qualified hydrogeolgic consultant recommended a new method for modelling radionuclide migration in groundwater. Further discussion can be found in Section 2.7 of this report. Groundwater monitoring for radiochemicals has been improved by adding shallow groundwater monitoring in the two areas where soil radioactivation could be a potential source for groundwater contamination (Table 23). Fermilab's groundwater protection strategies are documented in the Fermilab Groundwater Protection Management Plan (GPMP).

A site survey to document and classify the current monitoring well network locations was completed in CY-1993. An updated inventory was then submitted to the State and County Health Departments. Field and documentation investigations of old boring holes onsite continued. One old boring hole and several wells were properly abandoned during CY-1993.

Water samples from approximately 40 onsite wells/monitoring holes are analyzed at least once and as often as four times per year with sampling frequency determined by a well's proximity to areas of soil activation. These samples are analyzed for accelerator-produced radionuclides (^{3}H, ^{7}Be, ^{22}Na, ^{45}Ca, ^{54}Mn, ^{60}Co) at groundwater sensitivities (Table 10). 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, S-1059).

2) The following wells located near the Main Ring or Fixed Target Beamlines are sampled semiannually (Wells W-1, W-3, W-5, 5, 17A, 20, 24B, 29, 55B, S-1062, S-1087, S-1088, 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, 52, 56, 58, 64, 68, 74, 75A, W-4).

To date, no measurable (Table 10) concentrations of these radionuclides have ever been confirmed in groundwater samples. In all cases, the lower limit of detection has been at least an order of magnitude below the applicable Derived Concentration Guide (DCGs) 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 X 10^{-2} mSv per year) to a person drinking only from that source.

5.4 Monitoring Surface Water for Radioactivity

Water collected by underdrains within the beamline"bathtubs" is received in retention pits. Other underdrains collect water from outside "bathtubs" and from around footings of buildings and beam enclosures, discharging it to onsite surface waters via ditches. Radionuclide concentrations are monitored in selected sumps, ditches, and surface waters. 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 for 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. Although radionuclides associated with Fermilab operations are routinely identified in sumps discharging into ditches onsite, concentrations are well below applicable standards and remain barely detectable (Table 10) in ditch, pond, creek, and lake sampling locations. Samples are taken annually from waterways onsite including locations where creeks enter and exit the site. These 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 are sampled annually for accelerator-produced radionuclides. Kress Creek is sampled every week that the water is observed leaving site via the Kress Creek spillway. Surface water from the experimental areas left the site via Kress Creek for approximately 57.5% of the year in CY-1993.

5.5 EIS/ODIS Reporting

Annual estimates of onsite and offsite releases of radioactive effluents are reported to the DOE through the Effluent Information System/ Onsite Discharge Information System (EIS/ODIS). Three liquid discharge points and three liquid effluent releases were reported for CY-1993. The sumps/retention pit reported as contributing to these discharge points were M01SP3, N01SP4, NW4SP1, and N01SP1. The reported discharge points were the ditches receiving the waters from these sumps and emptying into Kress Creek. A summary of sumps showing detectable (Table 10) tritium concentrations can be found in Tables 11 and 12.

The total offsite release to surface waters attributable to these sumps, though barely measurable in surface water samples, is calculated based on average radionuclide concentrations found in sumps and estimated sump discharge volumes. In CY-1993 these sumps released an estimated total of 578 mCi (2.14×10^{10} Bq) of tritium offsite. This is an increase over the 203 mCi (7.5×10^{9} Bq) of tritium reported in CY-1992. The increased release can be somewhat attributed to a 23% increase in water leaving the site in CY-1993 as compared to the previous year. There were no one time releases of waters with concentrations greater than 1000 pCi/ml (37 Bq/ml) of tritium in CY-1993. The mean concentration of tritium during the period of release was significantly less than the Derived Concentration Guide for prolonged exposure to the general population. Drinking water in the surrounding communities is taken from wells rather than from the creeks receiving the discharge. Hence, the dose from these releases is negligible.

The AP0 beamline tunnel ventilation stack and unmonitored releases from the AP0 Target Hall and Service Building were reported as EIS/ODIS air effluents in CY-1993.

5.6 Soil/Sediment Sampling

Surface soil samples are collected annually 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 Fermilab. 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-1993 the radiochemical composition of soil/sediment was measured at 14 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-1993 soil/sediment sampling results are summarized in Table 13. The radionuclides ^{60}Co, ^{7}Be, ^{22}Na, ^{57}Co and ^{54}Mn are accelerator-produced and would be expected to be present at these locations. The ^{3}H measured in soil near the ventilation stacks is also accelerator-produced. The CY-1993 results showed no unexpected depositions.

5.7 Monitoring Radioactivity in the Central Utilities Building (CUB) Tile Field

Both ^{3}H (12.3 year half-life) and ^{7}Be (53.3 day half-life) are found in the closed-loop cooling water systems. The ^{7}Be 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 this regeneration system 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 6.4 and Figure 2). Here the discharge percolates into the soil about 2 ft.

(60 cm) below the surface. Trace amounts of accelerator-produced radionuclides were detected in the 1993 CUB Tile Field soil samples (Table 13). Significant gains were made over the past several years in improving the CUB resin regeneration process and in cleaning up the effluent. It is hoped that this effluent can soon be sent to the City of Batavia sewer system. A pretreatment permit has been received from the IEPA. Release to Batavia is pending the finalization of monitoring and reporting procedures.

5.8 A Summary of Assessments of Potential Radiation Dose to the Public

The effective dose equivalent at the site boundary due to the Boneyard was 0.72 mrem (0.72×10^{-3} mSv) during CY-1993 but decreased to only 0.15 mrem (1.5×10^{-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 0.00648 mrem (6.48×10^{-5} mSv) to the southwest of the site. Thus the two principle sources of radiation exposure at the site boundary are located at different places, neither resulting in significant exposure to offsite residents.

The potential radiation dose to the general population from operation of Fermilab in CY-1993 was approximately 1.46×10^{-2} person-rem (1.46×10^{-4} person-Sv). This is summarized in Table 1. This dose was primarily from airborne radionuclides, with a small contribution from penetrating radiation from the Railhead. 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-1993 (NRC90). (NOTE: Natural background doses taken from this reference (NRC90) include the effects of improved understanding of the indoor radon problem.)

6.0 ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

6.1 Criteria Air Pollutant Emissions

Monitoring of criteria air pollutant 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 3). 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 the Annual Air Emission Report is submitted as required by IEPA (Ill. Adm. Code 201.302). Equipment owners/operators are required to ensure that the permitted equipment

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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 Report that is submitted to IEPA is prepared using best available knowledge and in accordance with IEPA guidance. Carbon monoxide, nitrogen oxide, and volatile organic material (VOM) emissions from permitted Fermilab sources were reported in September 1993 for CY-1992. Table 25 gives these reported emissions.

6.2 Cooling Water System Treatment

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 less than 0.5 ppm. One thousand six hundred and fifty pounds (948 kg) of chlorine were used in CY-1993.

As the chlorinated Swan Lake cooling pond water is passed through the cooling system, Nalco product 1332, is applied at an average rate of 21.2 ml/minute with a peak residual of 1 to 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-1993, a total of 2200 gallons (8328 liters) of Nalco 1332 were used.

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. The bromamines formed when the chemical reacts with agricultural-based amines are more effective biocides than chloramines. This treatment discourages biological fouling of the industrial cooling water (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 in the water is adjusted to be 0.2 mg/liter or less as it leaves the heat exchangers. This product was used year-round in CY-1993. The total amount of Nalco 85WT-037 used in CY-1993 was 900 lbs (408 kg).

Although it was also necessary to chemically treat some waters to control the growth of algae and weeds during CY-1993, 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-1993 are listed in Table 14.

6.3 Pesticides

Pesticides were used on-site during CY-1993 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, Federal, State, and local guidelines. Licensed Fermilab personnel applied pesticides onsite for control of aquatic algae, annual and perennial weeds and grasses, stumps of trees, brush, and insects. Tables 14, 15, 16 and 17 summarize pesticide use in CY-1993.

6.3.1 Aquatic Pesticide Applications

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.

Cutrine Plus (EPA #8959-10AA) Cutrine Plus, containing 9% of the active ingredient copper, was applied to 40.7 acres of water to control algae in CY-1993. 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. A total of 48.2 gallons (185.5 liters) was applied in CY-1993. See Table 14.

Aquazine (EPA #100-650) Aquazine, containing 80% of the active ingredient Simazine [2-chloro-4,6-bis(ethylamino)-s-triazine], was used to control weeds in ditches and waterways. It was applied to 5.8 acres of water. A total of 26.5 lbs (12.0 kg) of Aquazine was applied in CY-1993. See Table 14 for application information.

6.3.2 Pesticides Applied to Annual and Perennial Weeds, Grasses, Trees and Stumps

The pesticides Roundup (EPA #524-308-AA) Isopropylamine Salt of N-(phosphonomethyl) Glyphosate, 41.0% and Surflan AS (EPA #1471-113) Oryzalin (3,5-dinitro-N^4, N^4-dipropyl-sulfanilamide), 40.4% 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 for

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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, propane tanks sitewide, RF Building, Feynman Computer Center, Reflecting Pond edges, Giese Road Substation, Tag Photon Lab (TPL), Railhead, A-0 and Sites 29, 38, 52 and 55. Equal amounts of each pesticide (1.5 oz.) were mixed in a tank and applied at a rate of one tank per 1000 ft^2. A total of 79.5 gallons (300.9 liters) of each, Roundup and Surflan was used. Roundup was also applied separately along Swenson Farm Road, at various areas in the Main Ring, at the Kirk Road boundary, along south Kautz Road, east Wilson Road, at the Butterfield Road boundary, and between Wilson and Batavia Roads. It was applied as a 2.6 oz/gal. mix with water. The total amount applied was 1 quart (0.95 liter).

A pesticide named 2,4-D Amine (EPA #1386-43-534) Dimethylamine salt of 2,4-Dichlorophenoxyacetic acid, 47.2% was applied once to 28 acres of the Bison pasture. It was applied at a rate of 2 pints per acre. The total amount applied was 15 gallons (56.8 liters). Garlon 3A (EPA #62719-176) Trichlopyr (((3,5,6-trichloro-2-pyridinyl)oxy)acetic acid) butoxy ethyl ester, 16.7% and Garlon 4 (EPA #62719-40) Trichlorpyr (((3,5,6-trichloro-2-pyridinyl)oxy)acetic acid)butoxy ethyl ester, 61.6% were applied to the stumps of brush and trees on the Main Ring berm, in the woods between the Education Center and Swan Lake, and in the field west of Meson between Wilson Road and Batavia Road. It was also used on poison ivy at the Education Center and the berm at the Tagged Photon Lab (TPL).

Trimec Classic (EPA #2217-543), 2,4-Dichlorophenoxyacetic acid, 21.54%, 2-(2-methyl-4-chlorophenoxy) propionic acid, 11.45%, 3,6,-dichloro-O-anisic acid, 2.29%, Dimethylamine (DMA), 7.26%, was applied to approximately 15 - 30 acres in the vicinity of the Village Pool, Wilson Hall, Model Airfield, Industrical Center, Feynman Computing Center, Experimental Area Operations Center, Central Helium Liquifier, Lederman Science Center, and Site 37 to eliminate thistle growing in the turf. It was applied at a rate of 4 pints per acre with a hand-held spray gun and boom sprayer. The total amount applied was 0.69 gallons (2.6 liters)

6.3.3 Miscellaneous Pest Control

A licensed contract exterminator was retained during CY-1993 for miscellaneous pest control in kitchens, laboratories, and living areas throughout the site. Table 15 summarizes the pesticides applied by this contractor.

Cythion ULV (EPA #241-208AA), Malathion [S-(1,2-Dicarbethoxyethyl)-0,0-dimethyl-dithio phosphate], 91.0%, was applied at Fermilab during CY-1993 for the purpose of mosquito control.

Applicators avoided lakes, streams, ponds, and those areas with high concentrations of motor vehicles. It was applied as an ultra low volume fog at a rate of 2 ounces per minute at a vehicle speed of 10 mph. The total amount applied was 5 gallons (18.9 liters). Biomist 3+15 ULV (EPA #8329-33), Permethrin (3-Phenoxyphenyl)methyl (+/-) cis, trans-3-(2,2,-dichlorethenyl)-2,2-dimethylcyclopropane-carboxylate, 3%, Piperonyl Butoxide technical equivalent to 80% (butylcarbityl) (6-propylpiperonyl) ether and 20% related compounds, 15%, was also applied at Fermilab for the purpose of mosquito control. Applicators avoided lakes, streams, ponds, and those areas with high concentrations of motor vehicles. It was applied as an ultra-low volume fog at a rate of 6 ounces per minute at a vehicle speed of 10 mph. The total amount applied was 10 gallons (37.9 liters).

6.3.4 Agricultural Pest Control Program

During CY-1993 Fermilab leased 1680.8 acres (6.8 km^2) of land to farmers for agricultural production (Figure 6). The leasees hired subcontractors to perform their pesticide applications. The pesticides applied are summarized in Tables 16 and 17.

6.4 Chlorides in CUB Tile Field

Chloride levels in water extracted from monitoring wells in the CUB Tile Field in CY-1993 exceeded the IEPA Groundwater Quality Standard (I191). High chloride concentrations were released to the CUB Tile Field Class V injection well with the CUB regeneration process effluent. The levels seen in CY-1993 are not unlike those seen for the past four years. Chlorides plumes and concentrations will be studied further. Efforts are underway to divert this process wastewater to Batavia municipal sewer system.

6.5 SARA Title III Chemical Inventory

Fermilab conducted a sitewide chemical inventory in accordance with the reporting requirements for CY-1993 for SARA Title III. Additional information on quantities and onsite locations was also collected to facilitate reporting for:

Section 304:	Emergency Notification;
Sections 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) and 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 Material Safety Data Sheets (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, is in progress. 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-1993 can be found in Table 18. Section 313 chemicals stored/used in CY-1993 will be reported by July 1, 1994. Database tracking systems for chemical management are being evaluated.

6.6 Environmental Occurrences

There were no reportable environmental occurrences in CY-1993.

7.0 QUALITY ASSURANCE IN CY-1993

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-1993, 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.

The Fermilab Quality Assurance Program (FQAP) was issued in April 1992. Implementation of this program required the creation of numerous Specific Quality Implementation Plans (SQIPs). A SQIP for Environmental Monitoring, (Wa94), Radionuclide Air Emissions Monitoring (Cu92), and Offsite Chemical Analysis (Is94), have been completed.

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.

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Most chemical analysis samples taken by other groups at Fermilab 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. 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 Quality Assurance/Quality Control (QA/QC) results and compared with regulatory limits for acceptability. These reviews include inspection of chain-of-custodies, sample stewardship, sampling handling and transport, and sampling protocols. 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 QA/QC. 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 is used to test the vendor's ability to achieve the required sensitivity for each parameter and their reliability in detecting accelerator-produced radionuclides at or below the concentration guide standards (Table 10). 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. Specific Quality Implementation Plans have been written for offsite chemical analysis (Is94) and for radionuclide analysis by offsite vendors (Cu94). A SQIP has also been developed for the operation of the Activation Analysis Laboratory (Cu94).

Fermilab and TMA results in the DOE Environmental Measurements Laboratory (EML) quality assurance program are found in Tables 19, 20, and 21. The results of both TMA/Eberline and the AAL in Fermilab's radiochemical spike quality assurance program can be found in Table 22.

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 10) 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.

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 (Il93 and Il92). The waters onsite were considered to be in the "general use" category.

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.

Cu89 Cupps, V., "Determination of the Site Boundary Dose Due to Railhead Radionuclide Storage at Fermilab," Radiation Physics Note #77, March 1989.

Cu93 Cupps, V., "Radionuclide Air Emissions"/ES&H Section, Specific Quality Implementation Plan, EP.2, November, 1993.

Cu94 Cupps, V., "Operation of the Activation Analysis Laboratory"/ES&H Section, Specific Quality Implementation Plan RPS.2, April 1994.

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).

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 1992.

Du94 Duncker, J. United States Department of the Interior, Geological Survey, 102 East Main St., Urbana, Illinois 61801, April 1994.

El88a 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.

El88b Muons from C0 at Butterfield Road, memo to Sam Baker, March 18, 1988.

EMP Environmental Monitoring Plan, Fermilab, October 1991.

EPPM Environmental Protection Procedures Manual, Fermilab, October 1991.

FCAP93 Fermilab Corrective Action Plan, September 1993.

GPMP Groundwater Protection Management Plan, Fermilab, October 1991.

Gr93 Grobe, D. W., Fermi National Accelerator Laboratory Site Environmental Report for Calendar Year 1992, Fermilab Report 93/293, May 1993.

Il91 Illinois Rules and Regulations, Title 35 Illinois Administrative Code Section 620, Groundwater Quality Standards, Pollution Control Board, November 1991.

Il92 Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution, Pollution Control Board, August 1992.

Il93 Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle B: Air Pollution, Chapter I: Pollution Control Board, October 1993.

Is94 Isakson, K., "Offsite Chemical Analysis"/ES&H Section, Specific Quality Implementation Plan, HS.2, January 1994.

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

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.

Ma93 Malensek, A.J., et al., "Groundwater Migration of Radionuclides at Fermilab", Internal Report TM1851, August 1993.

NOAA93 Local Climatological Data Monthly Summaries, January - December 1993, 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.

Nu93 Nuzzo, V., Plant Community Composition and Impact of White-Tailed Deer Herbivory on the Vegetation of the Fermi National Accelerator Laboratory, Batavia, Illinois, 1993.

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

1993

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.

Sa93 Sanderson, C. G. and C. S. Klusek, Semiannual Report of the Department of Energy, Office of Environmental Restoration and Waste Management, Quality Assessment Program, U.S. DOE Environmental Measurements Laboratory Report EML-556, July 1, 1993.

Sa94 Sanderson, C. G. and C. S. Klusek, Semiannual Report of the Department of Energy, Office of Environmental Restoration and Waste Management, Quality Assessment Program, U.S. DOE Environmental Measurements Laboratory Reports EML-559, January 5, 1994.

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

Va93 Vaziri, K., et al., "AP0 Stack Monitor Calibration", RP Note 106, May 1993.

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.

Wa94 Walton, R., "Implementation of Environmental Monitoring Program"/ES&H Section, Specific Quality Implementation Plan, EP.1, January 1994.

We93 Wehmann, A.A., et al., "Data Collection for Groundwater Study", Internal Report TM1850, November 1993.

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.

Wo93 Woodward-Clyde Consultants, Summary of Radionuclide Transport Modeling for Ground Water at the Fermi National Accelerator Laboratory, Batavia, Illinois, Project 92C3073, Chicago, Illinois, August 1993.

9.0 ACKNOWLEDGMENTS

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TABLES

Table 1

Summary of Collective Dose Equivalent for CY-1993 Within a 50 mile (80 km) Radius of Fermilab

Source	Collective Dose Equivalent person-rem	person-Sv
Penetrating radiation from the Railhead	3.5×10^{-6}	3.5×10^{-8}
Airborne radioactivity from the target stations	1.46×10^{-2}*	1.46×10^{-4}*
Total	$\mathbf{1.46 \times 10^{-2}}$	$\mathbf{1.46 \times 10^{-4}}$

*Population dose from airborne radioactivity was calculated using CAP88-PC, version 1.0.

Table 2

Summary of Radioactivity Released to the Offsite Environment in CY-1993

Release Point	Pathway	Radionuclide	Half-Life	Release in (Ci)	(Bq)
AP0 Beam Tunnel Ventilation Stack	Air	^{13}N	9.97 minutes	4.1	1.5×10^{11}
		^{11}C	20.38 minutes	6.5	2.4×10^{11}
		^{41}Ar**	1.83 hours	0.4	1.5×10^{10}
Unmonitored Releases from the AP0 Target Hall	Air	^{13}N	9.97 minutes	6.0	2.2×10^{11}
		^{11}C	20.38 minutes	4.6	1.7×10^{11}
		^{41}Ar**	1.83 hours	0.17	6.3×10^{9}
Debonding Oven	Air	^{3}H	12.3 years	0*	0*
Kress Creek Spillway	Water	^{3}H	12.3 years	0.578	2.1×10^{10}

* Not operated in CY1993 except for an emissions test

** ^{38}Cl and ^{39}Cl, with each comprising less than 1% of the emissions, are modelled as ^{41}Ar

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Table 3

List of Fermilab Environmental Permits

Issuing Agency Type, and No.	Description	Current Issue Date	Expiration Date
IEPA-Air Appl.#86020057	Gasoline Dispensing Tanks (Site 38)	10/19/90	10/16/95
IEPA-Air Appl.#87110096	5 Gas-Fired Hot Water Boilers 1 Grit Blaster	9/9/92	9/9/97
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)	3/16/93	3/16/98
IEPA-Air Appl.#79070012	Magnet Debonding Oven with Afterburner	2/28/94	3/5/98
IEPA-Air Appl.#89080089	Radionuclide Emissions from TeV Operations	6/22/94	6/22/99
IEPA-Open burn Appl.#B920829	Prairie/Land Ecological Management	8/4/93	10/23/94
IEPA-Open burn Appl.#B9404013	Fire Fighting Instruction	4/9/94	4/17/95
IEPA I.D. #890105010 USEPA IL #6890030046	RCRA Hazardous Waste Storage Facility	9/23/91	10/28/2001
IL Dept. of Public Works Permit No. 12170	Water intake from Fox River	1/7/69	12/31/2009
Warrenville Water Supply II Permit #0099	Operating Permit	2/1/91	Until Revoked
D0 Water Supply Construction/ Operating Permit	Operating Permit	11/12/88	Until Revoked
IEPA - NPDES Appl.# ILR100000	General Permit for Discharge of Stormwater Associated with Construction Activities	10/1/92	
IEPA - NPDES Appl.# IL0025941	For the Discharge of Non-Contact, Non-Process Cooling Water	Pending	
IEPA - Air Appl. #91030001, ID#043807AAI	Fermilab Main Injector Construction Permit for Radionuclide Emissions	1/21/92	4/1/93
IEPA - Air Appl #91100025, ID#043807AAI	Open Top Vapor Degreaser-Transfer Hall S. (Construction & Operating)	10/17/91 (Operating)	10/09/96
IEPA Permit - Water Pollution Permit #1993-EE-3841	Pretreatment of Demineralizer Regenerant Waste	9/21/93	9/1/95
OSFM Permit #2-022134 Application #9619-93REN	CUB Underground Tank Removal	8/3/93	2/3/94
IEPA Water Pollution Permit #1994-EB-467 Log # 4667-93	Construction of an Additional Recirculation Pond	1/18/94	1/18/97*
IEPA Air Appl. #94020002	Construction/Operation of a New Gasoline And Diesel Fuel Dispensing Facility	3/11/94	3/8/99

* Unless construction has been completed

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Table 4

Fermilab IEPA Air Pollution Permit Conditions

Application No.	Description	Special Conditions
B9212022	Open burning for firefighting instruction	Close abandoned water wells
B9208029	Open burning for prairie/land management	Notification and prior approval from the local fire protection district at least 24 hours prior to burn
86020057	Gasoline dispensing tanks	
87110096	5 gas-fired hot water boilers; 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)	Radionuclide emissions shall not exceed those that would cause an annual effective dose equivalent of 10 mrem/yr to any member of the public
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
94020002	Construction/Operation of a new gasoline and diesel fuel dispensing facility with Stage I and Stage II vapor recover	Emission sources shall not exceed nominal emission rates of 0.1 lb/hr and 0.44 ton/yr Amount of gasoline dispensed shall not exceed 10,000 gallons per month.

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

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Table 5

Kress Creek Chemical Analysis Results For 1993
(All results are in mg/L)

Parameter	General Use Standards* (mg/L)	Kress Creek On-Site (mg/L)	Kress Creek Off-Site (mg/L)	Fox River Inlet (mg/L)
oil-grease	**	<5.0	<5.0	<5.0
Cyanide	0.022	0.01	0.02	<0.010
Al	–	1.4	1.6	0.43
Ag	0.005	<0.010	<0.010	<0.010
Cd	0.05***(a)	<0.005	<0.005	<0.005
Cr (total)	4.0***(b)	<0.010	<0.010	<0.010
Cu	0.005***(c)	<0.025	<0.025	<0.025
Fe	1.0	2.2	2.4	0.80
Pb	0.3***(d)	<0.050	<0.050	<0.050
Mn	1.0	0.093	0.095	0.098
Ni	1.0	<0.030	<0.030	<0.030
Zn	1.0	0.025	0.031	0.028
PCB's	—	U	U	U

* From State of Illinois Rules and Regulations Title 35, Subtitle C, Chapter I, Part 302, Subpart B, as amended through August 1, 1992. Concentrations are the acute standard for these parameters. The acute standard for the listed chemical constituents shall not be exceeded at any time (Section 302.208).

** 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 + Bln(H)]
H = Hardness (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 = 0.9422

(d) A = -1.460
B = 1.273

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

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Table 6

CY-1993 CUB Tile Field Monitoring Results
(Post-purge)

Month	Parameter	Units	Class II GW Stds.	MWS1	MWS2	MWS3	MWS4	MWS5	MWD1	MWD2*
June	Ag	mg/l	NA	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Pb	mg/l	0.1	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
	Cu	mg/l	0.65	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Cl	mg/l	200	840	1600	660	19	2.3	203	4.2
	Cr Hex	mg/l	NA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Cr Total	mg/l	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	H-3	pCi/ml	NA	<0.361	0.414	0.439	<0.360	<0.361	<0.362	<0.361
September	Ag	mg/l	NA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Pb	mg/l	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.002
	Cu	mg/l	0.65	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Cl	mg/l	200	1400	1500	690	21	1.8	220	3.7
	Cr Hex	mg/l	NA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
	Cr Total	mg/l	1	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	0.019
	H-3	pCi/l	NA	<0.401	<0.400	<0.401	<0.400	<0.401	<0.400	<0.401

* Pre-purge values, well not purged due to high pH
NA - Not Applicable

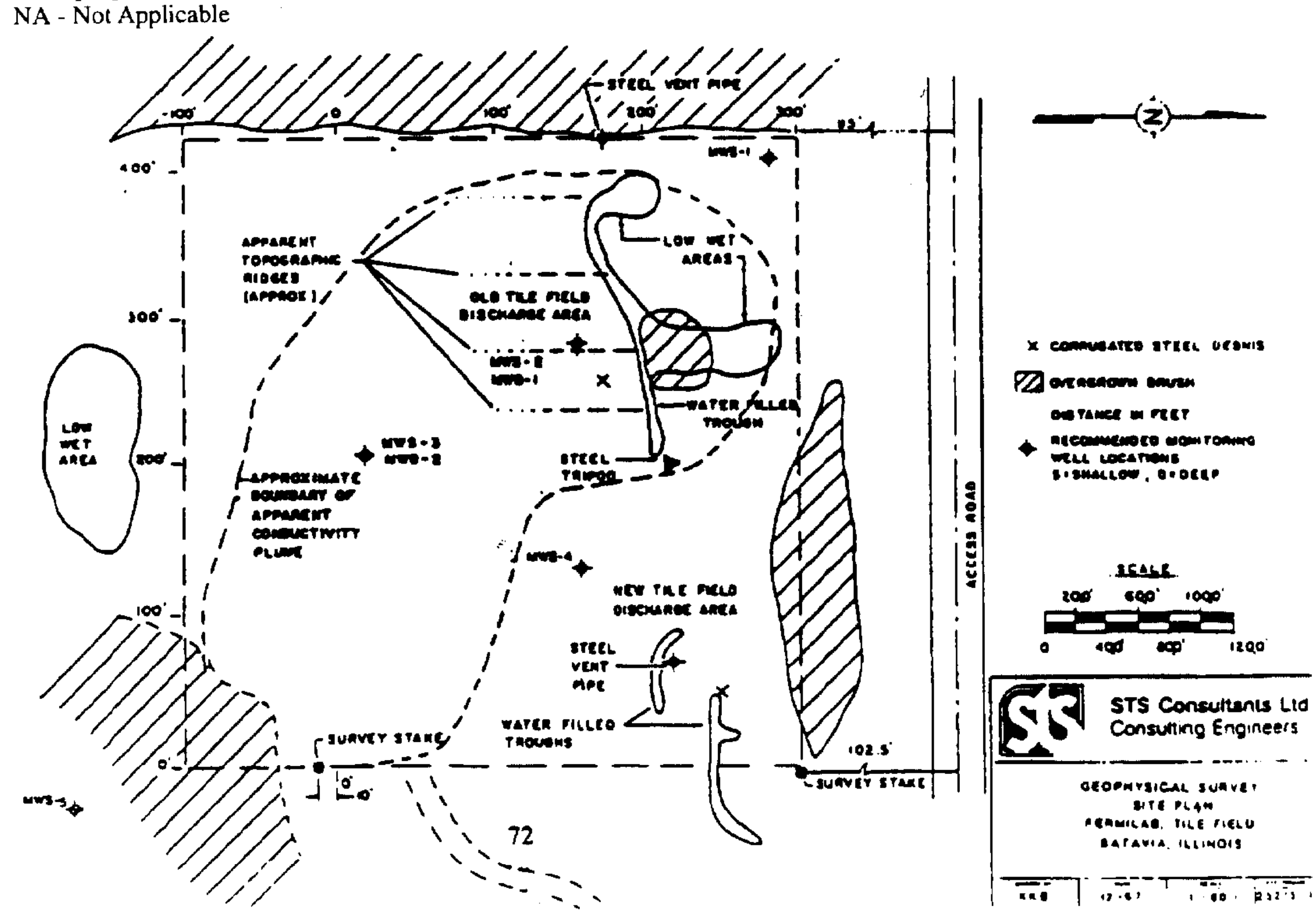

Table 7

Incremental Population Data in Vicinity of Fermilab, 1990 (Wi92)

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**
Cumulative Total	483325	1559479	4640660	7006622	7787830	8517006	8984119	9556503

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Table 8

National Environmental Research Park Projects at Fermilab

INVESTIGATOR(S)	INSTITUTION	PROJECT DESCRIPTION	DATES
J. Jastrow	Argonne National Laboratory	Plant-Soil Interactions in Prairie Ecosystems	1985 - Present
J. Mengler	U.S. Fish and Wildlife Service	Restoration, Management, and Monitoring of Woodlands within the Fermilab Environmental Research Areas	1988 - Present
J. Jastrow, M. Miller and R. Walton	Argonne National Laboratory and Fermilab	Establishment of a Chronosequence Representing Reconstructed Prairie, Old-field, and Non-native Grassland Systems as a Research Facility for the Fermilab National Environmental Research Park	1990 - Present
C. Whelan	Morton Arboretum	Effects of Smoke from Prairie Fires on Seed Germination	1992 - Present
J. Younger	Northern Illinois University	Biotic Interactions and the Control of Small Mammal Populations	1992 - Present
A. Weis	University of California, Irvine	Insect Herbivore Density and Variable Selection on Components of Plant Defense	1992 - Present
R. Kuperman	Private	Long Term Monitoring of Soil Invertebrates as Indicators of Changes in Ecological Conditions in the chronosequence of Prairie Restoration at the Fermi National Environment Research Park at Fermi National Accelerator Laboratory	1993 - Present
M. Bowles	Morton Arboretum	The Role of Hazel (Corylus americana) in the Open Forest Communities at Fermi National Accelerator Laboratory	1993 - Present
W. Sluis	University of Illinois - Chicago	Quantitative Study of Prairie Succession at Fermilab's Prairie Restoration Project	1993 - Present
L. Beck	Northern Illinois University	Resource Selectivity of Canis Iatrans and Vulpes vulpes in Response to Within-year Prey Fluctuations	1993 - Present
H. Howe	University of Illinois - Chicago	Experimental Prairie Communities: Effects of Burn Season, Granivory and Herbivory	Proposed
M. Bowles	Morton Arborteum	Restoration Potential for the Federally Threatened Eastern Prairie Fringed Orchid at Fermilab	Proposed
M. Payne	Miami University	Evolutionary Trends in the Social Organization of White-tailed Deer	Proposed

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Table 9

Airborne Radioactivity Released Due to Accelerator Operations During CY-1993

Stack Monitor	Activity Released (Curies)	Activity Released (Becquerel x 10^{11})
Antiproton Source	11.00	4.07
Unmonitored Releases from AP0 Target Hall and Service Building	10.77	3.99
Total	**21.77**	**8.06**

Table 10

Specifications for the Analyses of Accelerator-Produced Radionuclides in Water

		CONCENTRATION GUIDE FOR POPULATION (pCi/ml)		SPECIFIED SENSITIVITY AND PRECISION* (pCi/ml)	
Radionuclide	Half-Life	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

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Table 11
Tritium Detected in Sump Water Samples (CY-1993)

Collection Point	Number of Samples	Units	Maximum Concentration*	Minimum Concentration**	Mean Concentration***	Percentage of Concentration Guide (%)****
AP0 Prevault	4	pCi/ml	6.20E+00	<4.15E-01	2.82E+00	1.41E-01
		Ci/ml	6.20E-12	<4.15E-13	2.82E-12	
		Bq/ml	2.29E-01	<1.54E-02	1.04E-01	
C1	2	pCi/ml	1.54E+01	7.70E+00	1.14E+01	5.70E-01
		Ci/ml	1.54E-11	7.70E-12	1.14E-11	
		Bq/ml	5.69E-01	2.85E-01	4.22E-01	
F15	1	pCi/ml	4.60E-01	4.60E-01	4.60E-01	2.30E-02
		Ci/ml	4.60E-13	4.60E-13	4.60E-13	
		Bq/ml	1.70E-02	1.70E-02	1.70E-02	
M01SP2	4	pCi/ml	7.72E+00	1.34E+00	4.71E+00	2.36E-01
		Ci/ml	7.72E-12	1.34E-12	4.71E-12	
		Bq/ml	2.86E-01	4.97E-02	1.74E-01	
M01SP3	6	pCi/ml	3.24E+01	2.60E+01	2.87E+01	1.44E+00
		Ci/ml	3.24E-11	2.60E-11	2.87E-11	
		Bq/ml	1.20E+00	9.62E-01	1.06E+00	
N01RP1	6	pCi/ml	1.98E+01	7.46E+00	1.20E+01	6.02E-01
		Ci/ml	1.98E-11	7.46E-12	1.20E-11	
		Bq/ml	7.33E-01	2.76E-01	4.46E-01	
N01SP1	3	pCi/ml	9.82E-01	5.36E-01	6.85E-01	3.43E-02
		Ci/ml	9.82E-13	5.36E-13	6.85E-13	
		Bq/ml	3.63E-02	1.98E-02	2.53E-02	
N01SP3	2	pCi/ml	3.59E+00	3.41E+00	3.50E+00	1.75E-01
		Ci/ml	3.59E-12	3.41E-12	3.50E-12	
		Bq/ml	1.33E-01	1.26E-01	1.30E-01	
N01SP4	6	pCi/ml	2.20E+02	4.94E+01	1.10E+02	5.51E+00
		Ci/ml	2.20E-10	4.94E-11	1.10E-10	
		Bq/ml	8.13E+00	1.83E+00	4.08E+00	
NM1SP	4	pCi/ml	4.59E+00	2.77E+00	3.78E+00	1.89E-01
		Ci/ml	4.59E-12	2.77E-12	3.78E-12	
		Bq/ml	1.70E-01	1.02E-01	1.40E-01	
NM2SP2	3	pCi/ml	6.69E-01	4.63E-01	5.47E-01	2.74E-02
		Ci/ml	6.69E-13	4.63E-13	5.47E-13	
		Bq/ml	2.48E-02	1.71E-02	1.40E-13	
NM2SP3	2	pCi/ml	1.50E+00	6.92E-01	1.10E+00	5.48E-02
		Ci/ml	1.50E-12	6.92E-13	1.10E-12	
		Bq/ml	5.55E-02	2.56E-02	4.06E-02	
NM3	2	pCi/ml	1.40E+00	7.89E-01	1.10E+00	5.48E-02
		Ci/ml	1.40E-12	7.89E-13	1.10E-12	
		Bq/ml	5.18E-02	2.92E-02	4.05E-02	
NMK	2	pCi/ml	7.17E-01	<3.83E-01	5.50E-01	2.75E-02
		Ci/ml	7.17E-13	<3.83E-13	5.50E-13	
		Bq/ml	2.65E-02	<1.42E-02	2.04E-02	
NTSBSP1	4	pCi/ml	1.15E+01	6.18E-01	5.47E+00	2.74E-01
		Ci/ml	1.15E-11	6.18E-13	5.47E-12	
		Bq/ml	4.26E-01	2.29E-02	2.03E-01	

* 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 E-9 Ci/ml (74 Bq/ml).
Percentage is calculated from the mean concentration.

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Table 12

Tritium Detected in Sump Water Samples (CY-1993)

Collection Point	Number of Samples	Units	Maximum Concentration*	Minimum Concentration**	Mean Concentration***	Percentage of Concentration Guide (%)****
NTSBSP2	4	pCi/ml	1.76E+00	1.05E+00	1.39E+00	6.94E-02
		Ci/ml	1.76E-12	1.05E-12	1.39E-12	
		Bq/ml	6.52E-02	3.88E-02	5.13E-02	
NW4SP1	5	pCi/ml	6.14E+01	2.62E+01	3.85E+01	1.92E+00
		Ci/ml	6.14E-11	2.62E-11	3.85E-11	
		Bq/ml	2.27E+00	9.70E-01	1.42E+00	
NW4SP2	2	pCi/ml	1.86E+00	<3.67E-01	1.11E+00	5.57E-02
		Ci/ml	1.86E-12	<3.67E-13	1.11E-12	
		Bq/ml	6.87E-02	<1.36E-02	4.12E-02	
PC4SP1	2	pCi/ml	1.31E+00	9.99E-01	1.16E+00	5.79E-02
		Ci/ml	1.31E-12	9.99E-13	1.16E-12	
		Bq/ml	4.86E-02	3.70E-02	4.28E-02	
PC4SP2	2	pCi/ml	1.29E+00	6.45E-01	9.68E-01	4.84E-02
		Ci/ml	1.29E-12	6.45E-13	9.68E-13	
		Bq/ml	4.77E-02	2.39E-02	3.58E-02	
PE3SP2	2	pCi/ml	2.20E+00	1.57E-00	1.88E+00	9.42E-02
		Ci/ml	2.20E-12	1.57E-12	1.88E-12	
		Bq/ml	8.13E-02	5.81E-02	6.97E-02	
PW5SP3	2	pCi/ml	9.59E-01	7.65E-01	8.62E-01	4.31E-02
		Ci/ml	9.59E-13	7.65E-13	8.62E-13	
		Bq/ml	3.55E-02	2.83E-02	3.19E-02	
PW6SP1	2	pCi/ml	1.44E+00	<3.81E-01	9.10E-01	4.55E-02
		Ci/ml	1.44E-12	<3.81E-13	9.10E-13	
		Bq/ml	5.32E-02	<1.41E-02	3.37E-02	
PW6SP2	2	pCi/ml	2.30E+00	8.84E-01	1.59E+00	7.97E-02
		Ci/ml	2.30E-12	8.84E-13	1.59E-12	
		Bq/ml	8.51E-02	3.27E-02	5.89E-02	
PW6SP3	2	pCi/ml	7.33E+00	1.27E+00	4.30E+00	2.15E-01
		Ci/ml	7.33E-12	1.27E-12	4.30E-12	
		Bq/ml	2.71E-01	4.70E-02	1.59E-01	

* 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 E-9 Ci/ml (74 Bq/ml). Percentage is calculated from the mean concentration.

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Table 13

CY-1993 Soil/Sediment Results

LOCATION	UNITS**	Be-7	Na-22	Co-60	H-3
			RADIONUCLIDE*		
Indian Creek	μCi/g Bq/g	ND	ND	ND	NA
Kress Creek on-site	μCi/g Bq/g	ND	ND	ND	NA
Kress Creek off-site	μCi/g Bq/g	ND	ND	ND	NA
Ferry Creek	μCi/g Bq/g	ND	ND	ND	NA
CUB Tile Field	μCi/g Bq/g	1.13E-06 4.18E-02	ND	3.10E-07 1.15E-02	NA
AP0 Stack	μCi/g Bq/g	1.35E-06 5.00E-02	ND	ND	1.50E-06 5.55E-02
M05 Stack	μCi/g Bq/g	ND	ND	ND	1.87E-06 6.92E-02
NM2 Stack	μCi/g Bq/g	ND	ND	ND	9.44E-06 3.49E-01
NW8 Stack	μCi/g Bq/g	ND	ND	ND	3.81E-06 1.41E-01
PB4 Stack	μCi/g Bq/g	ND	ND	ND	1.04E-05 3.83E-01
M01SP3	μCi/g Bq/g	ND	ND	2.60E-07 9.62E-03	NA
N01SP4	μCi/g Bq/g	ND	6.20E-07 2.29E-02	ND	NA
NW4SP1	μCi/g Bq/g	1.46E-06 5.40E-02	ND	ND	NA
Site 12 Background	μCi/g Bq/g	ND	ND	ND	ND

*H-3 Analyzed at the Fermilab Activation Analysis Laboratory
Be-7, Na-22, Mn-54, Co-57, Co-60 Analyzed at TMA Eberline
**H-3 values are reported as μCi/ml and Bq/ml of soil moisture
NA - Not Available.
ND - Not Detected.

1993

Table 14

Pesticide Applications to Surface Waters at FNAL in CY-1993

Treatment Area	Acres	Cutrine Plus: # of Applications	Cutrine Plus: Total Applied (L)	Aquazine: # of Applications	Aquazine: Total Applied (lbs)
East Reflecting Pond	1.5	1	5.7	1	11.5
Center Reflecting Pond	1.3	1	22.7	1	15.0
Booster Pond	1.6	1	26.5	0	0
Swan Lake	7.8	1	117.3	0	0
West Pond	1.3	1	10.2	0	0

Table 15

Pesticides Applied by Licensed Contractor in CY-1993

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%

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Table 16

Pesticides Applied to Leased Farm Tracts CY-1993

Pesticide	EPA Reg. No.	Active Ingredient
Low Vol 4	34704-124	Isoocyyl (3-ethylhexyl) ester of 2,4-Dichloropheneoxyacetic acid
Accent	352-534	Nicosulfuron 3-pyridimecarboxamide,2[[(4,6-dimethoxypyrimidin-2-yl))amino-carbonyl]aminosulfony]-N,N-dimethyl 75%
Lasso	524-314	Alachlor [2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide] 45.1%
Buctril/Artazine	264-477	Octanoic acid ester of bromoxynil (3,5 dibromo-4-hydroxybenzonitrile Atrazine (2-chloro-4-ethylamino-6-isopropylamino-S-triazine)
Force	10182-130	Tefluthrin (2,3,5,6-tetrafluoro-4-methylphenyl)-methyl-(1α,3α)-(Z)-(±)-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate 1.7%
Bullet	524-418	Alachlor [2-chloro-2,6-diethyl-N-1 (methoxymetyl acetanilide] Atrazine (2-chloro-4-ethylamino-6-isopropylamian-S-triazine)
Pinnacle	352-525	Methyl 3-[[[[(4-methlyoxy-6-methly-1,35 triazin-2yl) amino] carbonyl] -amino] sulfonyl] -2-thiophenecarboxylate
Banvel	55947-1	Dimethylamine salt of dicamba (3,6-dichloro-0-ansic acid) Dimethyl salts of related acids
Pursuit	241-310	Imazethapyr [Ammonium Salt of (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]] 21%
Roundup	524-308	Isopropylamine Salt of [N-(phosphonomethylglycine)] Glyphosate, 41.0%
Basagran	7969-45	Sodium salt of bentazon (3-(1-methylethyl)-1H-2,1,3-benzothiadiazin-4 (3H)-one 2,2 dioxide) 42%

Table 17

1993 Pesticide Application Summary for Leased Farm Tracts at Fermilab

Tract #	Acres	Farmer	Crop(s)	Pesticide	RUP	Application Rate units/acre	Acres Treated	Total Applied
B1	110.7	T. Flanders	Beans	Pursuit Plus	N	4 oz	85	340 oz
				Basagran	N	1 pt	85	85 pt
C	305.7	R. Mueller	Corn	Low Vol 4 Ester	N	0.5 pt	300	150 pt
				Accent	N	0.66 oz	100	66 oz
				Lasso	Y	2 qt	300	600 qt
				Force	Y	9 lb	300	2700 lb
C-2	34.2	R. Mueller	Corn	Low Vol 4 Ester	N	0.5 pt	34.2	17.1 pt
				Accent	N	0.66 oz	34.2	22.572 oz
				Lasso	Y	2 qt	34.2	68.4 qt
				Force	Y	9 lb	34.2	307.8 lb
C-3	66.5	R. Mueller	Beans	Pursuit	N	4 oz	66.5	266 oz
				Lasso	Y	2 qt	66.5	133 qt
				Roundup	N	1.5 qt	66.5	99.75 qt
C-4	135.1	R. Mueller	Corn	Low Vol 4 Ester	N	0.5 pt	135.1	67.55 pt
				Accent	N	0.66 oz	30	19.8 oz
				Lasso	Y	2 qt	135.1	270.2 qt
				Force	Y	9 lb	135.1	1215.9 lb
C-5	28.2	R. Mueller	Beans	Pursuit	N	4 oz	28.2	112.8 oz
				Lasso	Y	2 qt	28.2	56.4 qt
				Roundup	N	1.5 qt	28.2	42.3 qt
C-6	11.9	R. Mueller	Beans	Pursuit	N	4 oz	11.9	47.6 oz
				Lasso	Y	2 qt	11.9	23.8 qt
				Roundup	N	1.5 qt	11.9	17.85 qt
CA-1A	86.8	M. Pitstick	Soybeans	Pursuit	N	4 oz	86.8	347.2 oz
				Roundup	N	1 pt	86.8	86.8 pt
				Low Vol 4 Ester	N	1 pt	86.8	86.8 pt
				Pinnacle	N	0.25 pt	86.8	21.7 pt
CA-1B	82.1	M. Pitstick	Corn	Accent	N	0.66 oz	82.1	54.186 oz
				Bullet	Y	4 qt	82.1	328.4 qt
				Buctril/Atrazine	Y	1 pt	82.1	82.1 pt
N-1	181.6	T. Flanders	Corn	Lasso	Y	3 qt	181.9	545.7 qt
				Banvel	N	1 pt	181.6	181.6 pt
D-6	56.0	T. Flanders	Corn	Lasso	Y	3 qt	56	168 qt
				Banvel	N	1 pt	56	56 pt
N-2	283.1	M. Pitstick	Soybeans	Pursuit	N	4 oz	178.1	712.4 oz
			(west)	Roundup	N	1 pt	178.1	178.1 pt
				Low Vol 4 Ester	N	1 pt	178.1	178.1 pt
				Pinnacle	N	0.25 pt	178.1	44.525 pt
			Corn	Accent	N	0.66 oz	105.0	69.3 oz
			(east)	Bullet	Y	4 qt	105.0	420 qt
				Buctril/Atrazine	Y	1 pt	105.0	105 pt
D-2	69.6	M. Pitstick	Soybeans	Pursuit	N	4 oz	29.6	118.4 oz
				Roundup	N	1 pt	29.6	29.6 pt
				Low Vol 4 Ester	N	1 pt	29.6	29.6 pt
				Pinnacle	N	0.25 pt	29.6	7.4 pt
N-3	229.3	M. Pitstick	Corn	Accent	N	0.66 oz	229.3	151.338 oz
				Bullet	Y	4 qt	229.3	917.2 qt
				Buctril/Atrazine	Y	1 pt	229.3	229.3 pt

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Table 18

LARGE QUANTITY CHEMICAL MATERIALS IN THE SARA TITLE III INVENTORY FOR CY-1993

Material Category	Amount (in pounds)
Heat Transfer/Antifreeze Liquids	> 10,000
Ethylene glycol	
Flammable Gases	
Ethane	> 10,000
Argon/Ethane (50/50)	> 1,000
Propane	> 100,000
Oxidizers	
Oxygen Gas (Compressed)	61,990 SCF
Compressed Gas	
Argon/CO_2	> 10,000
Argon/CO_2/CF4	> 10,000
Nitrogen	> 50,000,000
Argon	> 10,000
Helium	> 10,000
Liquified Gases	
Argon	> 10,000
Nitrogen	> 100,000
Helium	> 10,000
Corrosives	
Hydrochloric Acid	> 10,000
Sodium Hydroxide	> 10,000
Toxics (extremely hazardous)	
Chlorine	> 1,000
Polychlorinated Biphenyls	> 1,000
Scintillatio n Fluid (contains ~34% 1,2,4-Trimethyl Benzene)	> 10,000
Other Ozone-Depleting Substances	
Halon 1301	> 10,000
Freon 11	> 10,000
Other	
Asbestos	> 10,000

1993

Table 19

EML Quality Assurance Program Results for Fermilab Activation Analysis Lab (Sa93)

Sample Date	Sample Type	Isotope	Ser	Reported Value	% Error	EML Value	Ratio Rp/EML	+/-	Units
03/93	Air	^{7}Be	1	0.271E+02	15	0.274E+02	0.99	0.15	Bq/filter
"	"	^{7}Be	2	0.321E+02	14	0.274E+02	1.17	0.17	"
"	"	^{54}Mn	1	0.104E+02	8	0.117E+02	0.89	0.08	"
"	"	^{54}Mn	2	0.985E+01	10	0.117E+02	0.84	0.09	"
"	"	^{57}Co	1	0.224E+01	8	0.271E+01	0.83	0.08	"
"	"	^{57}Co	2	0.232E+01	10	0.271E+01	0.86	0.09	"
"	"	^{60}Co	1	0.155E+01	10	0.170E+01	0.91	0.12	"
"	"	^{60}Co	2	0.178E+01	11	0.170E+01	1.05	0.14	"
"	"	^{134}Cs	1	0.245E+01	13	0.196E+01	1.25	0.18	"
"	"	^{134}Cs	2	0.246E+01	9	0.196E+01	1.26	0.13	"
"	"	^{137}Cs	1	0.327E+01	18	0.307E+01	1.07	0.20	"
"	"	^{137}Cs	2	0.369E+01	11	0.307E+01	1.20	0.15	"
"	"	^{144}Ce	1	0.154E+02	9	0.193E+02	0.80	0.08	"
"	"	^{144}Ce	2	0.163E+02	11	0.193E+02	0.84	0.10	"
"	Soil	^{40}K	1	0.294E+03	10	0.321E+03	0.92	0.11	Bq/kg
"	"	^{137}Cs	1	0.923E+03	9	0.923E+03	1.00	0.10	"
"	"	^{241}Am	1	0.222E+01	40	0.650E+01	0.34	0.14	"
"	"	^{238}U	1	0.502E+02	41	0.376E+02	1.34	0.55	"
"	Veg.	^{40}K	1	0.379E+03	11	0.383E+03	0.99	0.11	"
"	"	^{137}Cs	1	0.262E+02	10	0.246E+02	1.07	0.12	"
"	Water	^{3}H	1	0.919E+02	7	0.970E+02	0.95	0.07	Bq/liter
"	"	^{54}Mn	1	0.107E+03	10	0.105E+03	1.02	0.10	"
"	"	^{60}Co	1	0.480E+02	7	0.453E+02	1.06	0.08	"
"	"	^{134}Cs	1	0.496E+02	5	0.424E+02	1.17	0.08	"
"	"	^{137}Cs	1	0.566E+02	10	0.508E+02	1.11	0.11	"
"	"	^{144}Ce	1	0.773E+02	10	0.836E+02	0.92	0.10	"
09/93	Air	^{54}Mn	1	0.147E+02	14	0.154+02	0.95	0.15	Bq/filter
"	"	^{57}Co	1	0.162E+02	6	0.173E+02	0.94	0.07	"
"	"	^{60}Co	1	0.194E+02	7	0.205E+02	0.95	0.08	"
"	"	^{125}Sb	1	0.183E+02	9	0.174E+02	1.05	0.12	"
"	"	^{134}Cs	1	0.129E+02	9	0.122E+02	1.06	0.11	"
"	"	^{137}Cs	1	0.187E+02	6	0.188E+02	0.99	0.08	"
"	"	^{144}Ce	1	0.363E+02	8	0.403E+02	0.90	0.08	"
"	Soil	^{40}K	1	0.217E+02	33	0.286E+02	0.76	0.26	Bq/kg
"	"	^{137}Cs	1	0.110E+02	10	0.114E+02	0.96	0.11	"
"	"	^{238}U	1	0.588E+02	50	0.255E+02	2.31	1.16	"
"	Veg.	^{40}K	1	0.853E+03	10	0.842E+02	1.01	0.11	"
"	"	^{60}Co	1	0.657E+01	9	0.645E+01	1.02	0.10	"
"	"	^{137}Cs	1	0.872E+02	10	0.892E+02	0.98	0.10	"
"	Water	^{3}H	1	0.244E+03	4	0.270E+03	0.90	0.09	Bq/liter
"	"	^{54}Mn	1	0.123E+03	9	0.109E+03	1.13	0.11	"
"	"	^{60}Co	1	0.114E+03	7	0.996E+02	1.14	0.08	"
"	"	^{134}Cs	1	0.668E+02	5	0.561E+02	1.19	0.06	"
"	"	^{137}Cs	1	0.848E+02	10	0.755E+02	1.12	0.11	"
"	"	^{144}Ce	1	0.188E+02	8	0.173E+02	1.09	0.09	"

1993

Table 20

EML Quality Assurance Program Results for TMA/Eberline (Sa93)

Sample Date	Sample Type	Isotope	Ser	Reported Value	% Error	EML Value	Ratio Rp/EML	+/-	Units
03/93	Air	^{7}Be	1	0.357E+02	12	0.274E+02	1.30	0.16	Bq/filter
"	"	^{54}Mn	1	0.148E+02	6	0.117E+02	1.26	0.09	"
"	"	^{57}Co	1	0.322E+01	7	0.271E+01	1.19	0.10	"
"	"	^{60}Co	1	0.191E+01	14	0.170E+01	1.12	0.18	"
"	"	^{90}Sr	1	0.277E+00	33	0.152E+00	1.82	0.62	"
"	"	^{134}Cs	1	0.227E+01	11	0.196E+01	1.16	0.14	"
"	"	^{137}Cs	1	0.404E+01	9	0.307E+01	1.32	0.14	"
"	"	^{144}Ce	1	0.214E+02	6	0.193E+02	1.11	0.08	"
"	"	^{238}Pu	1	0.307E-01	17	0.363E-01	0.85	0.15	"
"	"	^{239}Pu	1	0.230E-01	19	0.234E-01	0.98	0.20	"
"	"	^{241}Am	1	0.373E-01	14	0.414E-01	0.90	0.14	"
"	"	^{234}U	1	0.346E-01	25	0.220E-01	1.57	0.40	"
"	"	^{238}U	1	0.223E-01	36	0.240E-01	0.93	0.34	"
"	Soil	^{40}K	1	0.202E+03	11	0.321E+03	0.63	0.08	Bq/kg
"	"	^{90}Sr	1	0.414E+02	18	0.417E+02	0.99	0.19	"
"	"	^{137}Cs	1	0.647E+03	5	0.923E+03	0.70	0.04	"
"	"	^{239}Pu	1	0.103E+02	17	0.116E+02	0.89	0.17	"
"	"	^{241}Am	1	0.474E+01	24	0.650E+01	0.73	0.18	"
"	"	^{234}U	1	0.389E+02	14	0.378E+02	1.03	0.16	"
"	"	^{238}U	1	0.356E+02	16	0.376E+02	0.95	0.16	"
"	Veg.	^{40}K	1	0.279E+03	17	0.383E+03	0.73	0.13	Bq/kg
"	"	^{90}Sr	1	0.503E+03	13	0.237E+03	2.12	0.43	"
"	"	^{137}Cs	1	0.196E+02	15	0.246E+02	0.80	0.13	"
"	"	^{238}Pu	1	0.124E+01	23	0.114E+01	1.09	0.60	"
"	"	^{239}Pu	1	0.370E+00	40	0.323E+00	1.15	0.46	"
"	"	^{241}Am	1	0.315E+00	46	0.231E+00	1.36	0.65	"
"	Water	^{3}H	1	0.101E+03	14	0.970E+02	1.04	0.16	Bq/liter
"	"	^{54}Mn	1	0.111E+03	6	0.105E+03	1.06	0.06	"
"	"	^{55}Fe	1	0.285E+02	11	0.237E+02	1.20	0.14	"
"	"	^{60}Co	1	0.487E+02	6	0.453E+02	1.08	0.08	"
"	"	^{90}Sr	1	0.145E+01	25	0.103E+01	1.41	0.38	"
"	"	^{134}Cs	1	0.461E+02	6	0.424E+02	1.09	0.08	"
"	"	^{137}Cs	1	0.560E+02	6	0.508E+02	1.10	0.07	"
"	"	^{144}Ce	1	0.905E+02	7	0.836E+02	1.08	0.08	"
"	"	^{238}Pu	1	0.507E+00	13	0.494E+00	1.03	0.15	"
"	"	^{239}Pu	1	0.893E+00	12	0.828E+00	1.08	0.14	"
"	"	^{241}Am	1	0.478E+00	11	0.440E+00	1.09	0.30	"
"	"	^{234}U	1	0.166E+00	38	0.151E+00	1.10	0.43	"
"	"	^{238}U	1	0.141E+00	48	0.147E+00	0.96	0.47	"

Table 21

EML Quality Assurance Program Results for TMA/Eberline (Sa94)

Sample Date	Sample Type	Isotope	Ser	Reported Value	% Error	EML Value	Ratio Rp/EML	+/-	Units
09/93	Air	^{54}Mn	1	0.199E+02	2	0.154E+02	1.29	0.06	Bq/filter
"	"	^{57}Co	1	0.210E+02	1	0.173E+02	1.21	0.05	"
"	"	^{60}Co	1	0.252E+02	2	0.205E+02	1.23	0.06	"
"	"	^{90}Sr	1	0.782E+00	18	0.762E+00	1.03	0.20	"
"	"	^{125}Sb	1	0.230E+02	4	0.174E+02	1.32	0.09	"
"	"	^{134}Cs	1	0.150E+02	2	0.122E+02	1.23	0.06	"
"	"	^{137}Cs	1	0.247E+02	2	0.188E+02	1.31	0.06	"
"	"	^{144}Ce	1	0.470E+02	2	0.403E+02	1.17	0.06	"
"	"	^{238}Pu	1	0.117E+00	12	0.129E+00	0.91	0.12	"
"	"	^{239}Pu	1	0.774E-01	14	0.800E-01	0.97	0.15	"
"	"	^{241}Am	1	0.685E-01	15	0.654E-01	1.05	0.20	"
"	"	^{234}U	1	0.659E-01	16	0.650E-01	1.01	0.18	"
"	"	^{238}U	1	0.628E-01	17	0.650E-01	0.97	0.18	"
"	Soil	^{40}K	1	0.255E+02	10	0.286E+02	0.89	0.11	Bq/kg
"	"	^{90}Sr	1	0.593E+01	24	0.540E+01	1.10	0.27	"
"	"	^{137}Cs	1	0.114E+02	17	0.114E+02	1.00	0.18	"
"	"	^{239}Pu	1	0.344E+01	13	0.152E+01	2.26	0.59	"
"	"	^{241}Am	1	0.204E+00	***	0.248E+00	0.82	***	"
"	"	^{234}U	1	0.255E+02	0	0.248E+02	1.03	0.04	"
"	"	^{238}U	1	0.283E+02	12	0.255E+02	1.11	0.14	"
"	Veg.	^{40}K	1	0.115E+04	4	0.842E+03	1.37	0.08	"
"	"	^{60}Co	1	0.996E+01	25	0.645E+01	1.54	0.40	"
"	"	^{90}Sr	1	0.227E+03	14	0.221E+03	1.03	0.20	"
"	"	^{137}Cs	1	0.122E+03	3	0.892E+02	1.37	0.05	"
"	"	^{238}Pu	1	0.296E+00	50	0.463E+00	0.64	0.32	"
"	"	^{239}Pu	1	0.870E+00	25	0.965E+00	0.90	0.23	"
"	"	^{241}Am	1	0.463E+00	23	0.465E+00	1.00	0.32	"
"	Water	^{3}H	1	0.141E+03	11	0.170E+03	0.83	0.10	Bq/liter
"	"	^{54}Mn	1	0.123E+03	2	0.109E+03	1.13	0.03	"
"	"	^{55}Fe	1	0.127E+03	3	0.133E+03	0.95	0.06	"
"	"	^{60}Co	1	0.108E+03	2	0.996E+02	1.08	0.03	"
"	"	^{90}Sr	1	0.265E+01	19	0.252E+01	1.05	0.21	"
"	"	^{134}Cs	1	0.625E+02	3	0.561E+02	1.11	0.04	"
"	"	^{137}Cs	1	0.853E+02	2	0.755E+02	1.13	0.04	"
"	"	^{144}Ce	1	0.199E+03	3	0.173E+03	1.15	0.05	"
"	"	^{238}Pu	1	0.111E+01	10	0.114E+01	0.97	0.10	"
"	"	^{239}Pu	1	0.335E+00	14	0.338E+00	0.99	0.15	"
"	"	^{241}Am	1	0.130E+01	10	0.139E+01	0.94	0.10	"
"	"	^{234}U	1	0.114E+01	9	0.106E+01	1.08	0.11	"
"	"	^{238}U	1	0.113E+01	9	0.108E+01	1.05	0.10	"

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Table 22

Fermilab QA Program Results for TMA/Eberline and Fermilab AAL

Sample Number	Radionuclide	*AAL $T_{1/2}$ conc. (pCi/ml)	*TMA $T_{1/2}$ conc. (pCi/ml)	TMA Conc. (pCi/ml)	AAL Conc. (pCi/ml)	Ratio of Prepared to TMA	Ratio of Prepared to AAL
9301	H-3	12.26	12.28	14.053	12.00	1.14	0.98
	Na-22	0.08	0.08	0.063	ND	0.79	NA
	Mn-54	0.23	0.23	0.238	0.31	1.03	1.35
	Co-60	0.15	0.15	0.164	ND	1.09	NA
9302	H-3	6.1	6.11	7.213	9.80	1.18	1.61
	Na-22	8.65	8.64	7.860	8.34	0.91	0.96
	Mn-54	4.3	4.32	4.433	4.34	1.03	1.01
	Co-60	3.03	3.02	2.903	2.84	0.96	0.94
9303	H-3	2.42	2.43	3.150	2.80	1.30	1.16
	Na-22	0.42	0.42	0.382	0.46	0.91	1.10
	Mn-54	0.4	0.4	0.414	0.47	1.04	1.18
	Co-60	0.74	0.74	0.725	0.96	0.98	1.30
9313	H-3	2.42	2.43	2.870	2.80	1.18	1.16
	Na-22	0.42	0.42	0.379	0.52	0.90	1.24
	Mn-54	0.4	0.4	0.422	0.37	1.06	0.93
	Co-60	0.74	0.74	0.737	0.77	1.00	1.04
9304	H-3	48.41	48.51	48.808	43.20	1.01	0.89
	Na-22	0.66	0.66	0.574	0.78	0.87	1.18
9314	H-3	48.41	48.51	49.419	44.00	1.02	0.91
	Na-22	0.66	0.66	0.545	0.55	0.83	0.83
9305	H-3	96.33	96.54	104.786	86.40	1.09	0.90
9315	H-3	96.33	96.54	102.301	86.60	1.06	0.90
9306	H-3	11.97	11.99	10.392	10.90	0.87	0.91
	Na-22	1.57	1.57	1.299	1.65	0.83	1.05
	Mn-54	0.97	0.98	0.973	1.19	0.99	1.23
	Co-60	0.28	0.28	0.267	0.42	0.95	1.50
9316	H-3	11.97	11.99	12.087	11.20	1.01	0.94
	Na-22	1.57	1.57	1.379	1.64	0.88	1.04
	Mn-54	0.97	0.98	0.948	1.04	0.97	1.07
	Co-60	0.28	0.28	0.279	0.33	1.00	1.18
9307	H-3	476.88	477.97	487.932	427.80	1.02	0.90
9317	H-3	476.88	477.97	483.108	426.40	1.01	0.89
9308	H-3	4.74	4.76	5.160	4.40	1.08	0.93
9318	H-3	4.74	4.76	4.922	4.30	1.03	0.91
9309	H-3	472.93	474.04	495.375	418.20	1.05	0.88
9319	H-3	472.93	474.04	492.279	419.80	1.04	0.89
9310	H-3	2.35	2.35	2.581	2.40	1.10	1.02
9320	H-3	2.35	2.35	2.860	2.20	1.22	0.94
9311	H-3	46.88	46.99	47.746	41.30	1.02	0.88
9321	H-3	46.88	46.99	48.551	40.30	1.03	0.86
9312	H-3	11.66	11.69	11.000	10.70	0.94	0.92
	Na-22	0.69	0.69	0.440	0.77	0.64	1.12
	Mn-54	0.67	0.67	0.300	0.80	0.45	1.19
	Co-60	0.27	0.27	0.220	0.33	0.81	1.22
9322	H-3	11.66	11.69	11.000	10.20	0.94	0.87
	Na-22	0.69	0.69	0.430	0.80	0.62	1.16
	Mn-54	0.67	0.67	0.300	0.72	0.45	1.07
	Co-60	0.27	0.27	0.220	0.35	0.81	1.30

ND - Not Detected
* The AAL and TMA/Eberline use slightly different half-lives ($T_{1/2}$)

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Table 23

1993 Radiochemical Results for 45-Degree Boring Holes at Fixed Target Beamline Activation Areas

			H-3				Na-22			
			pCi/ml		Bq/ml		pCi/ml		Bq/ml	
Boring Hole	Sample Date	Purge	Result	Error	Result	Error	Result	Error	Result	Error
S-1059	5-May	Pre	3.76E+01	2.66E+00	1.39E+00	9.83E-02	0.00E+00	1.30E-02	0.00E+00	4.81E-04
	10-May	Post	2.42E+01	1.79E+00	8.97E-01	6.61E-02	0.00E+00	1.30E-02	0.00E+00	4.81E-04
	17-Jun	Pre	2.71E+01	1.97E+00	1.00E+00	7.30E-02	0.00E+00	1.30E-02	0.00E+00	4.81E-04
	22-Jun	Post	2.04E+01	1.54E+00	7.56E-01	5.69E-02	0.00E+00	1.20E-02	0.00E+00	4.44E-04
	4-Aug	Pre	2.31E+01	1.71E+00	8.56E-01	6.34E-02	0.00E+00	2.30E-02	0.00E+00	8.51E-04
	6-Aug	Post	1.71E+01	1.36E+00	6.34E-01	5.03E-02	0.00E+00	2.60E-02	0.00E+00	9.62E-04
	1-Oct	Pre	2.11E+01	1.58E+00	7.80E-01	5.84E-02	0.00E+00	1.20E-02	0.00E+00	4.44E-04
	4-Oct	Post	1.61E+01	1.25E+00	5.95E-01	4.63E-02	0.00E+00	1.10E-02	0.00E+00	4.07E-04
S-1062	6-May	Pre	4.24E-01	2.51E-01	1.57E-02	9.29E-03	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	6-May	Post	6.31E-01	3.62E-01	2.33E-02	1.34E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	6-Aug	Pre	0.00E+00	3.78E-01	0.00E+00	1.40E-02	0.00E+00	2.70E-02	0.00E+00	9.99E-04
	6-Aug	Post	5.19E-01	2.59E-01	1.92E-02	9.58E-03	0.00E+00	2.59E-01	0.00E+00	9.58E-03
S-1087	5-May	Pre	1.41E+00	3.12E-01	5.20E-02	1.15E-02	0.00E+00	9.50E-03	0.00E+00	3.52E-04
	10-May	Post	7.56E-01	2.71E-01	2.80E-02	1.00E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	4-Aug	Pre	4.80E-01	2.56E-01	1.78E-02	9.47E-03	0.00E+00	2.70E-02	0.00E+00	9.99E-04
	6-Aug	Post	5.64E-01	2.60E-01	2.09E-02	9.62E-03	0.00E+00	2.80E-02	0.00E+00	1.04E-03
S-1088	6-May	Pre	6.43E+00	6.38E-01	2.38E-01	2.36E-02	0.00E+00	1.40E-02	0.00E+00	5.18E-04
	10-May	Post	5.20E+00	5.58E-01	1.92E-01	2.06E-02	0.00E+00	1.30E-02	0.00E+00	4.81E-04
	4-Aug	Pre	3.58E+00	4.49E-01	1.33E-01	1.66E-02	0.00E+00	2.90E-02	0.00E+00	1.07E-03
	6-Aug	Post	2.90E+00	4.06E-01	1.07E-01	1.50E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
S-1089	5-May	Pre	3.01E+00	4.13E-01	1.11E-01	1.53E-02	0.00E+00	1.30E-02	0.00E+00	4.81E-04
	4-Aug	Pre	4.04E+00	4.78E-01	1.49E-01	1.77E-02	0.00E+00	2.70E-02	0.00E+00	9.99E-04

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Table 24

EIS/ODIS Activity (mCi of H-3) Summary Report for Liquid Releases in CY 1989 - 1993

		CY 93	CY 92	CY 91	CY 90	CY 89
M01SP3	DISCHARGE	46	39	79	46	28
	EFFLUENT	30	12	59	37	17
N01SP4	DISCHARGE	721	499	447	245	273
	EFFLUENT	462	160	300	174	194
NW4SP1	DISCHARGE	106	78	134	1650	612
	EFFLUENT	72	23	87	1370	432
N01SP1	DISCHARGE	35	–	–	–	–
	EFFLUENT	14	–	–	–	–

Table 25

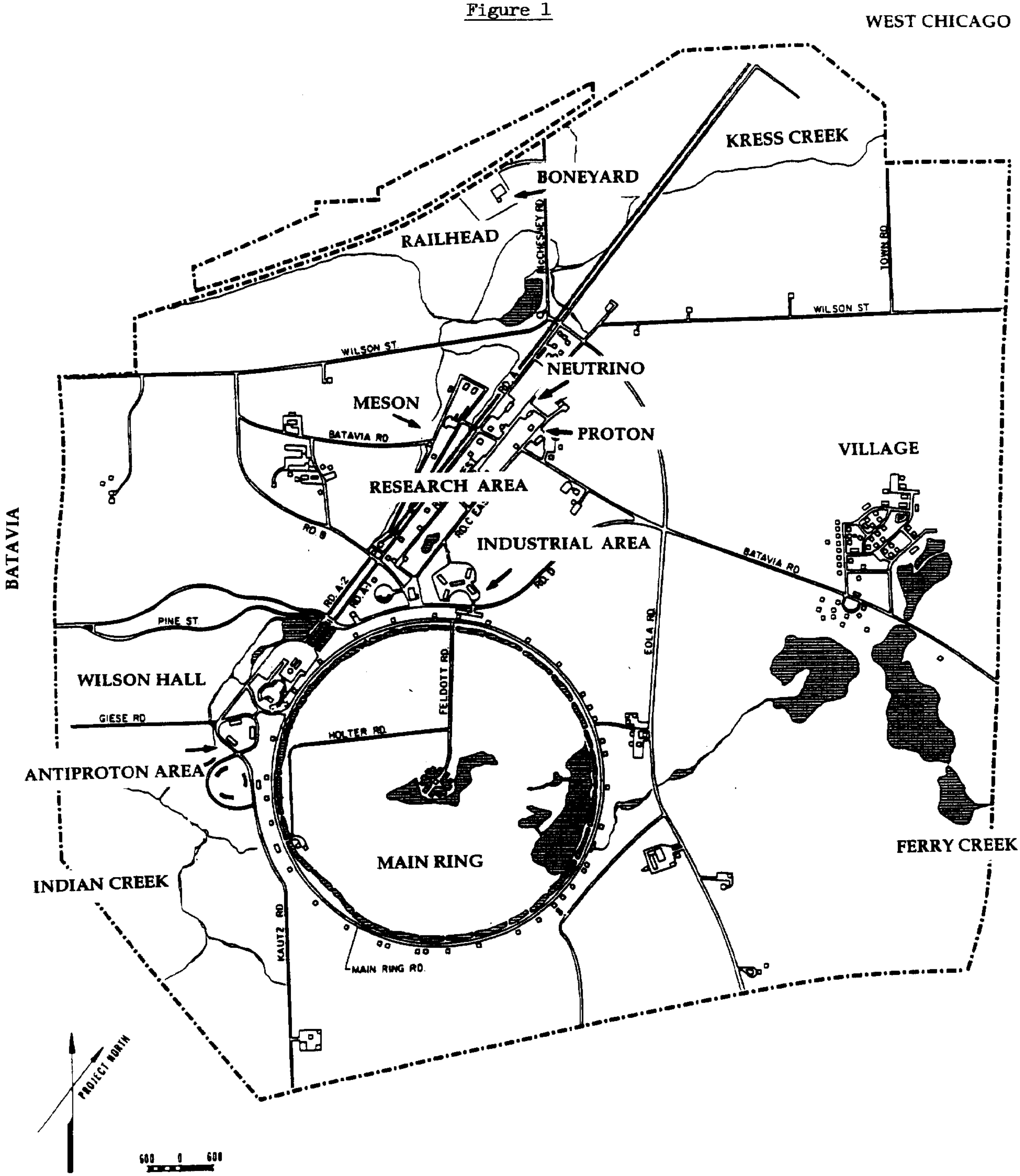
CY-1992 and CY-1993 Annual (Criteria Pollutant) Air Emissions Reported to the IEPA

Pollutant	Allowable Emissions (tons/year)	Reported Emissions for 1992 (tons/year)	Reported Emissions for 1993 (tons/year)
Carbon Monoxide	2.7216	0.7875	0.7875
Nonvolatile Organic Material	0.7900	0	0
Nitrogen Oxides	16.7964	3.9509	3.6675
Particulate Matter	0.0480	0	0.0009
Volatile Organic Material	0.1000	0.0325	0.0333

1993

FIGURES

Figure 1



GENERAL FEATURES

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Figure 2

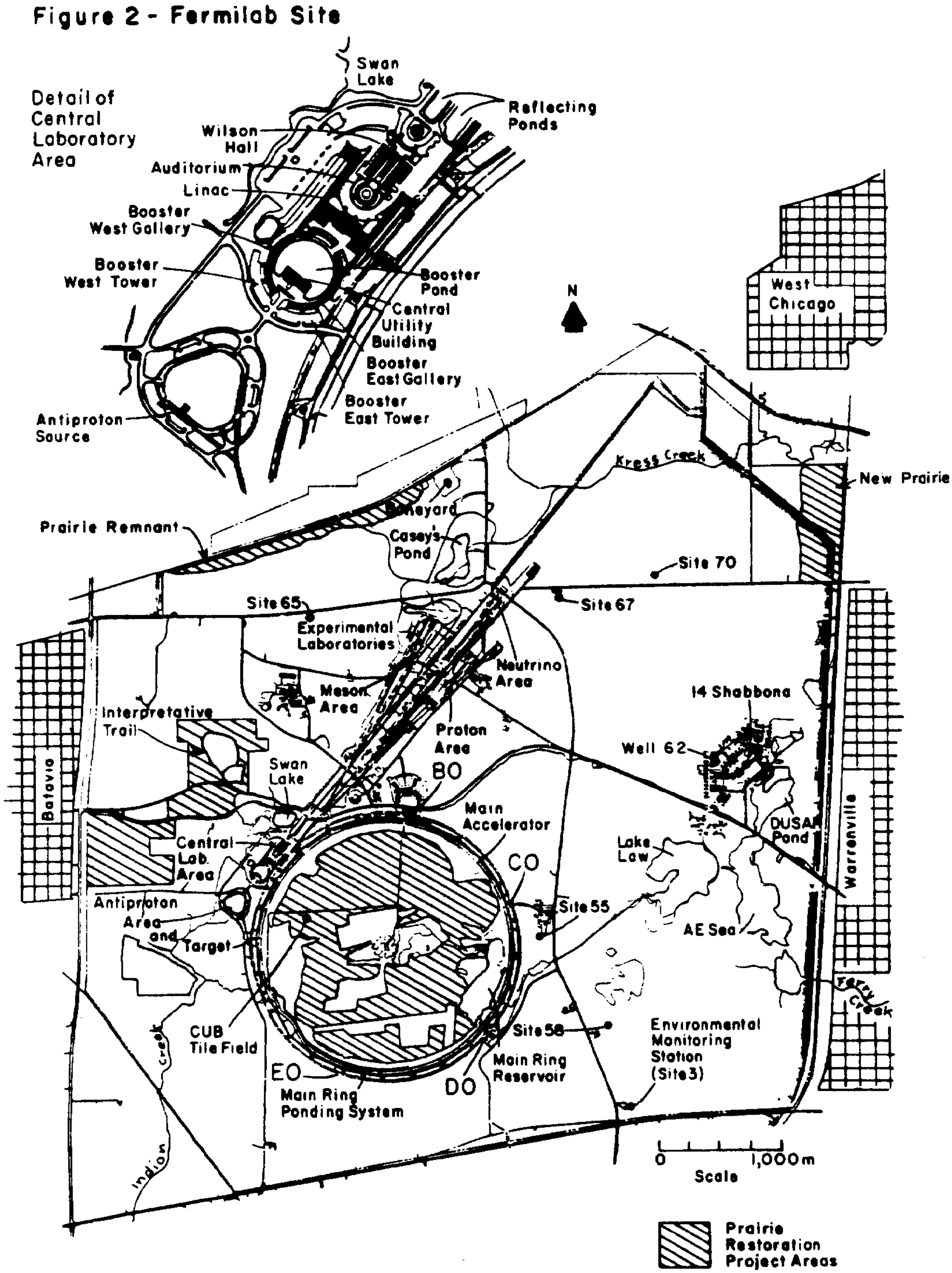
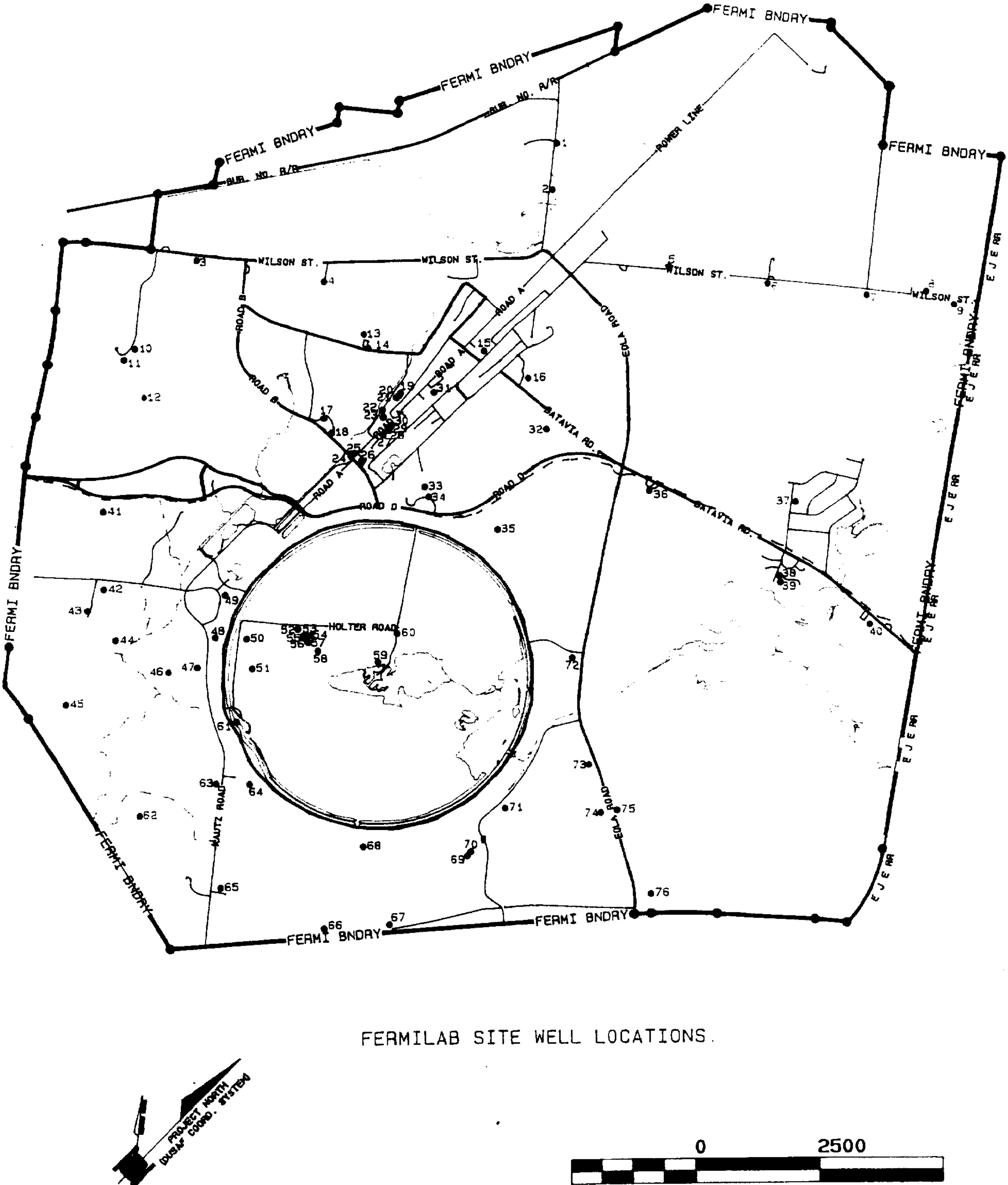


Figure 2 - Fermilab Site
Detail of Central Laboratory Area
Swan Lake
Reflecting Ponds
Wilson Hall
Auditorium
Linac
Booster West Gallery
Booster West Tower
Booster Pond
Central Utility Building
Booster East Gallery
Booster East Tower
Antiproton Source
N
West Chicago
Kress Creek
New Prairie
Prairie Remnant
Casey's Pond
Site 70
Site 65
Site 67
Experimental Laboratories
Neutrino Area
Meson Area
14 Shabbona
Interpretative Trail
Proton Area
Well 62
Swan Lake
BO
Batavia
Main Accelerator
DUSAF Pond
Central Lab. Area
Lake Law
CO
Warrenville
Antiproton Area and Target
Site 55
AE Sea
Ferry Creek
CUB Tile Field
Site 58
Environmental Monitoring Station (Site3)
EO
Main Ring Reservoir
DO
Main Ring Ponding System
Indian Creek
0
1,000m
Scale
Prairie Restoration Project Areas

Figure 3



FERMILAB SITE WELL LOCATIONS.

PLOT SITE WELLS, 8X11 SIZE, 2500 SCALE - 5545[0,3]PF: UG3WEL 15100 14-Sep-93 02:53 PM / 4007

Key for Figure 3

Fermilab Wells

Well #	Map Number	County	Use	Depth (ft)
3	76	DuPage	Monitoring	120
5	69	DuPage	Monitoring	110
7	67	DuPage	Monitoring	122
8	66	DuPage	Monitoring	68
12	65	DuPage	Monitoring	80
16	64	DuPage	Monitoring	90
19	51	DuPage	Monitoring	115
20	50	DuPage	Monitoring	120
39	14	DuPage	Monitoring	170
43	34	DuPage	Monitoring	100
45	60	DuPage	Monitoring	100
49	15	DuPage	Monitoring	95
50	16	DuPage	Sealed 8/24/93	80
57	74	DuPage	Monitoring	66
59	36	DuPage	Monitoring	80
62	37	DuPage	Sealed 6/23/93	261
64	40	DuPage	Monitoring	90
65	4	DuPage	Sealed 12/8/93	165
69	6	DuPage	Monitoring	120
72	7	DuPage	Monitoring	90
73	8	DuPage	Monitoring	120
74	9	DuPage	Monitoring	85
75	1	DuPage	Monitoring	80
76	2	DuPage	Monitoring	75
78	23	DuPage	Monitoring	160
79	22	DuPage	Monitoring	81.5
80	26	DuPage	Monitoring	71
39d	13	DuPage	Monitoring	25
61b	39	DuPage	Monitoring	70
61c	38	DuPage	Monitoring	243
B56	68	DuPage	Monitoring	63
B59	35	DuPage	Monitoring	82
MSS 5S	24	DuPage	Monitoring	16
MSS 5D	24	DuPage	Monitoring	40
MSS B6	25	DuPage	Monitoring	28
MWD1	56	DuPage	Monitoring	43
MWD2	57	DuPage	Monitoring	41
MWS1	52	DuPage	Monitoring	15
MWS2	55	DuPage	Monitoring	17
MWS3	54	DuPage	Monitoring	16
MWS4	53	DuPage	Monitoring	15
MWS5	58	DuPage	Monitoring	15
S-1058	27	DuPage	Monitoring	60
S-1059	28	DuPage	Monitoring	62
S-1060	31	DuPage	Monitoring	62
S-1061	21	DuPage	Monitoring	57
S-1062	20	DuPage	Monitoring	60
S-1063	19	DuPage	Monitoring	66
S-1087	28	DuPage	Monitoring	61
S-1088	29	DuPage	Monitoring	22
S-1089	30	DuPage	Monitoring	32
S35	59	DuPage	Monitoring	83
SSC2	70	DuPage	Monitoring	317,417,517
W-2	33	DuPage	Monitoring	326
W-4	18	DuPage	Monitoring	1432
23	41	Kane	Monitoring	110
30	3	Kane	Monitoring	135
31	12	Kane	Monitoring	210
24a	42	Kane	Monitoring	100
24b	43	Kane	Monitoring	80
B54	10	Kane	Monitoring	117
BH13	48	Kane	Monitoring	70
BH15	46	Kane	Monitoring	55
S-1111	62	Kane	Sealed 1/13/94	27
S-1115	45	Kane	Sealed 1/12/94	30
S-1118	47	Kane	Sealed 1/12/94	33.5
S-1124	63	Kane	Sealed 1/13/94	50
S-1126	44	Kane	Sealed 1/12/94	42.5
W-3	17	DuPage	NCNT	222
W-5	71	DuPage	NCNT	220
W-1	49	Kane	NCNT	224
17	61	DuPage	Semi-private	114
52	32	DuPage	Semi-private	100
55	72	DuPage	Semi-private	145
56	73	DuPage	Semi-private	174
58	75	DuPage	Semi-private	140
68	5	DuPage	Semi-private	169
29	11	Kane	Semi-private	130

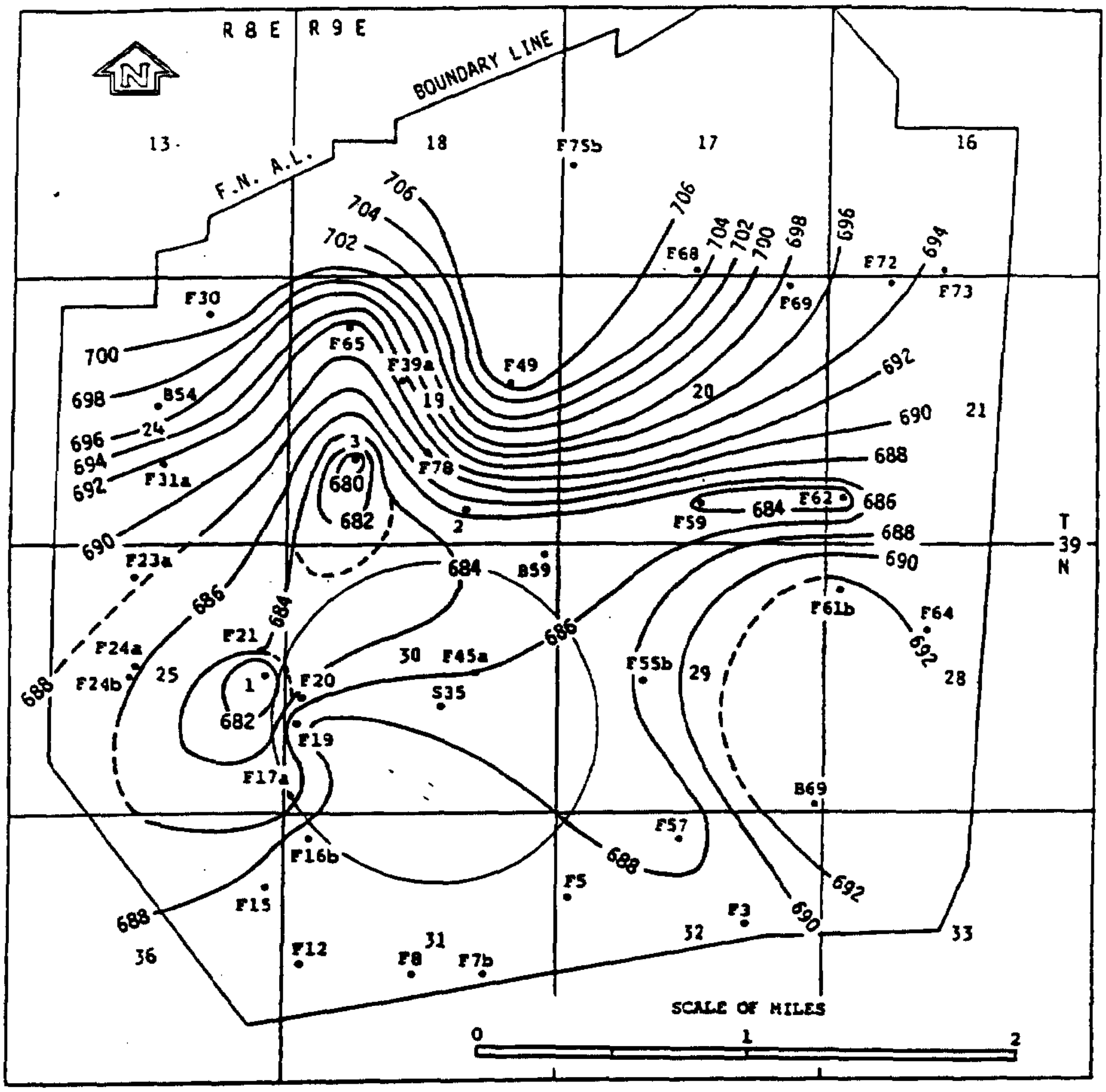
NTNC = Non-Community, Non-Transient

1993

Figure 4

FERMI NATIONAL ACCELERATOR LABORATORY

DuPage & Kane Counties, Illinois



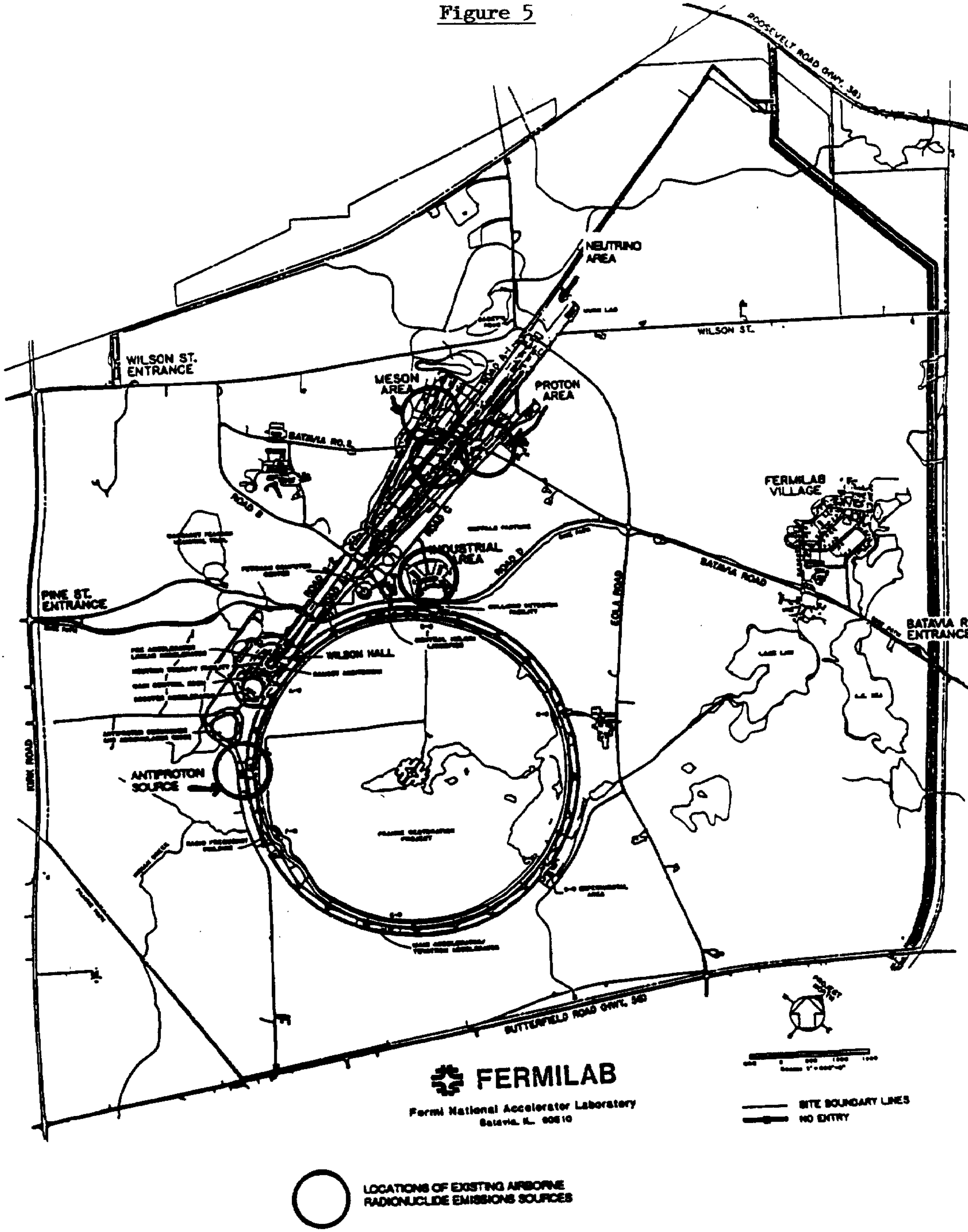
SHALLOW DOLOMITE AQUIFER

PIEZOMETRIC SURFACE

Elevations in feet above mean sea level

Illinois State Water Survey
June 1978

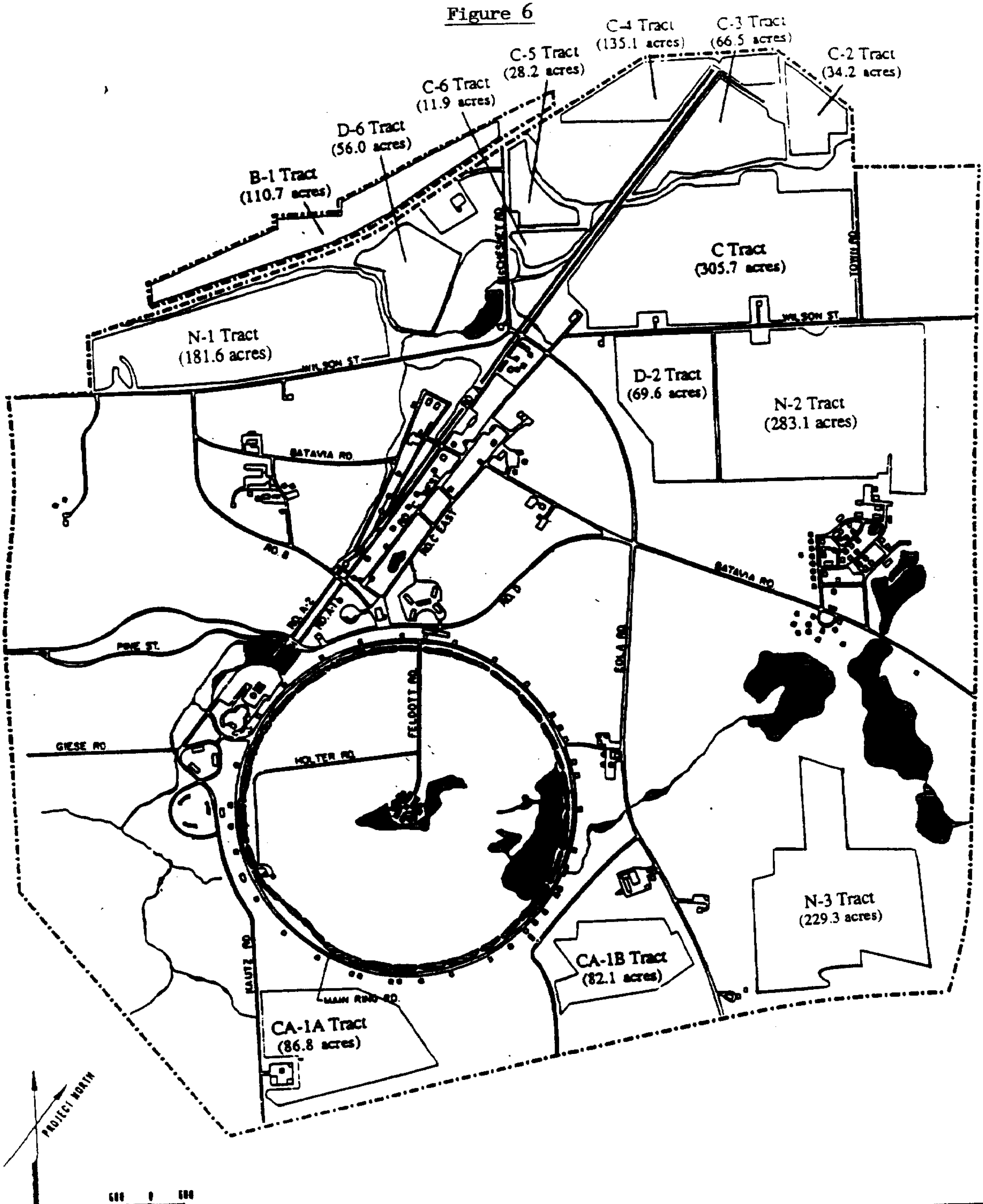
Figure 5



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

1993

Figure 6



Leased Farm Tracts CY 1993
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
COE	Corps of Engineers
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
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
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

Appendix C

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
RMMA	Radioactive Materials Management Area
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SPCC	Spill Prevention Control and Countermeasures
SQIP	Specific Quality Implementation Plan
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