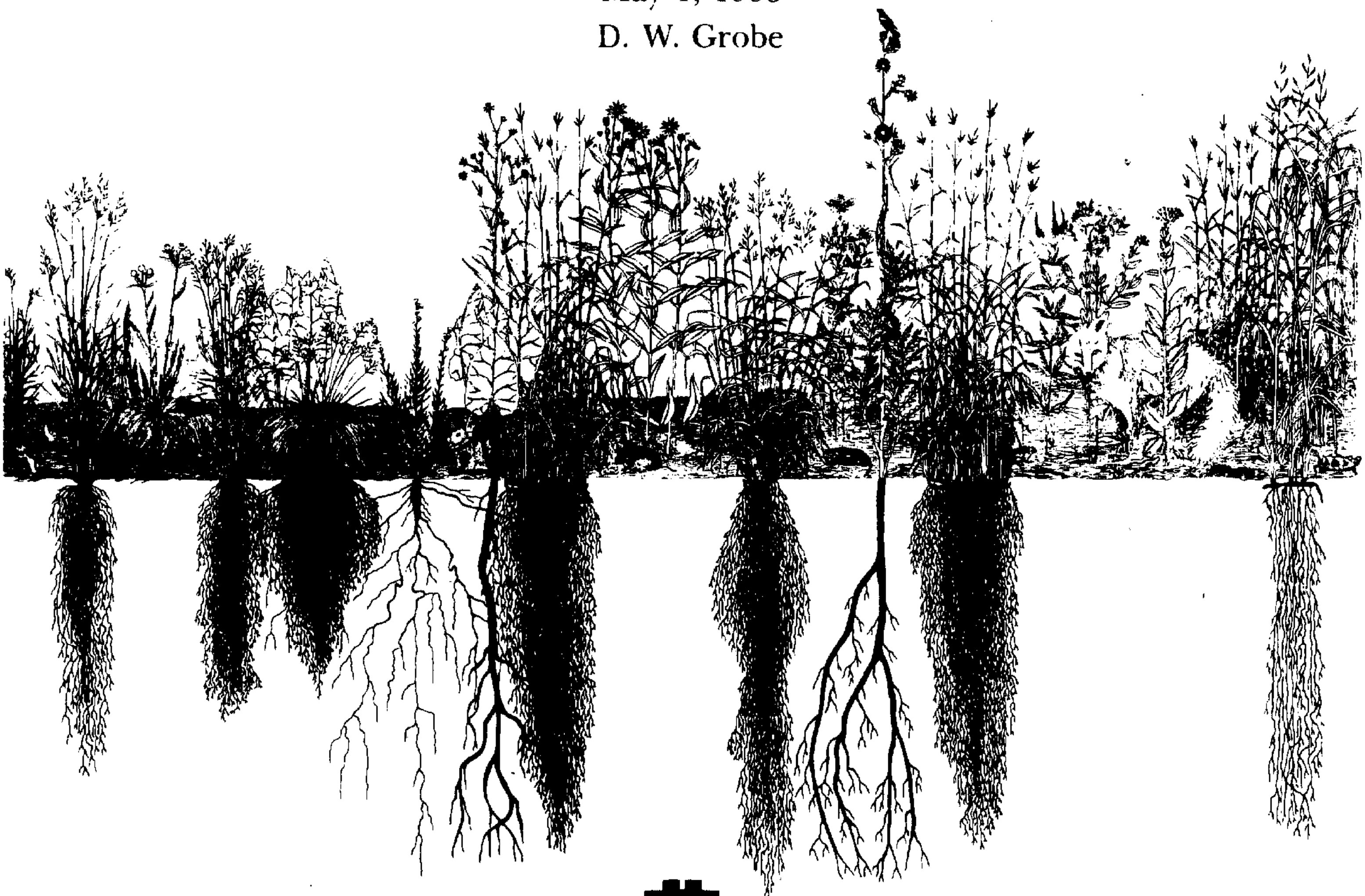
Site Environmental Report

For Calendar Year 1994

May 1, 1995

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,
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FERMILAB

SITE ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1994

by

D. W. Grobe, Editor

May 1, 1995

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1.0 EXECUTIVE SUMMARY FOR CY-1994

This report summarizes the environmental status of Fermi National Accelerator Laboratory (Fermilab) for Calendar Year 1994 (CY-1994). 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 practicable.

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-1994. 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 are analyzed and compared to applicable guidelines and standards. Surface water, air, ground water, and soil/sediment samples are monitored for radionuclide concentrations. Surface waters are also monitored for potential chemical constituents. External penetrating radiation and airborne emissions are estimated, providing information about the potential radiation doses to off-site populations. The results of the environmental surveillance program are interpreted and compared with environmental standards where applicable. The status of environmental protection activities and the progress on environmental restoration and corrective action activities are discussed in this report.

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1.3 Environmental Radiological Surveillance Information

The total potential radiation dose equivalent to the general offsite population from operations during CY-1994 was 2.55×10^{-2} person-rem (2.55×10^{-4} person-Sv). A summary can be found in Table 1. This is comparable to the estimate of 1.46×10^{-2} person-rem (1.46×10^{-4} person-Sv) for CY-1993 due to the continued operation of the accelerator in the Collider mode and the resultant decrease in muon production compared to the Fixed Target mode. 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-1994 will be the same as the effective dose equivalent received in CY-1994 reported here. Table 2 provides a summary of radioactivity released to the offsite environment in CY-1994.

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 to the atmosphere from operating target stations in the Fixed Target and in the Antiproton Source areas. During Calendar Year 1994 the Antiproton Source area was the only area to receive beam and thus was the sole emissions source for accelerator-produced airborne radioactivity. The operation of the Magnet Debonding Oven resulted in insignificant ^{3}H releases during CY-1994.

The AP0 Stack released approximately 34 Ci (1.26×10^{12} Bq) during CY-1994. 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 stack. The extremely low concentration of ^{82}Br was difficult to observe and was seen only on an activated charcoal filter placed in the sampling line. Previous unmonitored releases from the AP0 target hall and service building were eliminated by sealing leaks.

The current air pollution permit application on file with the Illinois Environmental Protection Agency (IEPA) states that our releases will average 100 Ci/year (3.70×10^{12} Bq) with a maximum of 900 Ci/year (3.33×10^{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 0.00869 mrem (8.69×10^{-5} mSv) in Calendar Year 1994. This is well below the Environmental Protection Agency (EPA) standard of 10 mrem/year (1×10^{-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-1994 was calculated to be 2.55×10^{-2} person-rem (2.55×10^{-4} person-Sv).

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1.3.2 Penetrating Radiation Summary

Operation of the Fixed Target and Collider areas potentially produces ionizing radiation in the form of muons. The Fixed Target areas did not operate in CY-1994. The Collider running mode was operative this year. During the CY-1994 Collider run, the potential muon sources were the C0 Abort and the AP0 target. A record of protons aborted at C0 was used to estimate the effective dose equivalent at the site boundary at 3.97 x 10^{-4} mrem (3.97 x 10^{-6} mSv) for CY-1994. No muon fields above background were observed downstream of the C0 abort. A muon dose equivalent rate of 30 mrem/hr was measured approximately 330 feet downstream of AP0. This corresponds to a negligible offsite dose since the site boundary is approximately 7000 feet downstream of AP0.

The maximum site boundary dose (fence line assuming 24 hr/day exposure) from the radioactive material stored at the Railhead (Figure 1) was 0.390 mrem (3.9 x 10^{-3} mSv) for CY-1994. 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 0.081 mrem (8.1 x 10^{-4} mSv) during CY-1994.

1.3.3 Summary of Radioactive Discharges to Surface Water

The offsite release of tritium (^3H) in surface water totaled approximately 98 mCi (3.6 x 10^9 Bq), compared to 578 mCi (2.14 x 10^{10} Bq) in CY-1993 (Gr94). The decrease was the result of less water from reportable discharges leaving the site during CY-1994. Water left the site via the Kress Creek spillway for 24% of the year in CY-1994 compared with 57.5% 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-1994 from this area is essentially from operations before CY-1983.

1.4 Environmental Non-Radiological Surveillance Program Information

1.4.1 Airborne Emissions

Conventional air pollutant emissions 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 significant source of air pollutants. Air pollution permits at Fermilab include 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 in 1994 at the Magnet Debonding Oven in conjunction with its refurbishment. There were no instances of non-compliant emissions in CY-1994. Tables 3 and 4 summarize environmental permits held by Fermilab.

1.4.2 Surface Waters

In August 1994 Fermilab received a NPDES (National Pollution Discharge Elimination System) permit from the Illinois Environmental Protection Agency (IEPA) to release commingled non-process, non-contact cooling water and stormwater runoff to surface waters at three outfalls. As a condition of the NPDES permit, surface waters have been sampled for pH, temperature and flow at all three outfalls with the addition of total residual chlorine at two outfalls. Reported results for 1994 and the first quarter of 1995 are included in Table 26. Annual samples of surface water are also taken from selected bodies of water onsite and analyzed for trace metals and selected organics. Analysis parameters are selected based on contaminants from possible, though improbable, onsite sources. In CY-1994 surface water monitoring for chemical contaminants was limited to Kress Creek and the Fox River Inlet to Kress Creek. Table 5 summarizes sampling results for chemicals in surface waters. 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 for iron. The sample taken from Kress Creek at the point where it leaves the site did not exceed general water quality standards for iron.

1.4.3 Ground Water

Water samples from wells used to monitor for chlorides and chromates in an old perforated pipe field yielded measurable levels of total chromium, chloride, and tritium in CY-1994. Chloride concentrations continue to exceed the Illinois Ground Water Quality Standards (I191) for Class II ground water. 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 received chloride-laden waste from the Central Utility Building (CUB) regeneration process was the source of the chloride until those releases were terminated in May 1994 and the regeneration effluent was rerouted to the City of Batavia sewer system. A Phase II Workplan is being developed for the CUB Tile Field as part of the RFI (RCRA Facility Investigation).

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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 studies 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 in CY-1994, 66 MeV protons from the linear accelerator (Linac) were used to produce neutrons for cancer patient treatment at the Neutron Therapy Facility (NTF).

During CY-1994, operation of the high-energy accelerators at Fermilab consisted of a Collider run using 900 GeV beams of protons and antiprotons. This period of operations which began in November 1993, continued with beam being delivered to these areas through the end of CY-1994.

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) as of CY-1994, 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 1975, 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 prehistoric and historic cultural resources have 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 remains thirty-two.

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 5.28 x 10^8 gallons (2.00 x 10^9 liters) per day as measured at Algonquin, IL in CY-1994. The West Branch of the DuPage River flowed south at an average rate as measured near Warrenville of 7.29 x 10^7 gallons (2.76 x 10^8 liters) per day for the same period. Kress Creek, which flows to the West Branch of the DuPage River, averaged 1.01 x 10^7 gallons (3.82 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 (Du95). The rainfall in the vicinity of Fermilab, taken at O'Hare International Airport, during 1994 was 29.6 inches (75.2 cm) (NOAA 94). 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

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(MSL) is near the western boundary. The lowest point, with an elevation of 715 ft (218 m) above MSL, is in the southeast. There are three watersheds that collect water onsite: Kress Creek (to the north), Indian Creek (in the southwest), and Ferry Creek (in the southeast). Kress and Ferry Creeks are tributary to the West Branch of the DuPage River, while Indian Creek flows to the Fox River.

2.4.1 Industrial Cooling Water Ponding Systems

There are several water systems used for cooling magnets and for fire protection:

The Industrial Cooling Water (ICW) System includes 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 supplemented by pumping water from the Fox River. The pond holds approximately 50,000,000 gallons (1.89×10^8 liters).

The Swan Lake/Booster Pond System (Figure 2) is used for cooling at the Central Utility Building (CUB). Water is pumped from the Booster Pond into a ditch that runs by way of West Pond into Swan Lake. The water then flows to the Booster Pond through a return ditch. Water to be used for cooling is also pumped from Swan Lake to NS1 Service Building and then returned by a ditch. This pond system can also receive water from the ICW System. It overflows into Indian Creek (Figure 2).

The Main Ring Ponding System consists of a large reservoir pond and a series of interconnected canals that completely encircle the interior of the Main Ring (Figure 2). The water in this system runs through heat exchangers in service buildings and is utilized for cooling the Main Ring magnets. The Main Ring Ponding 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 sewage from the Fermilab Village was treated onsite in the Village Oxidation Pond. This required an NPDES (National Pollutant Discharge Elimination System) permit. In December 1986, the Village sewer system was connected to the City of Warrenville Sewer/Naperville (Springbrook Treatment Plant) system. The IEPA terminated the NPDES permit for the Village Oxidation Pond on May 12, 1987. 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 to pretreat demineralizer regenerant waste prior to its discharge to the City of Batavia sewer system. The first discharge to the Batavia Sanitary Sewer System occurred on May 20, 1994. The total volume of effluent released was 3,400 gallons (12,869 liters). Consequently, this was also the date the first monthly composite sample was collected. A total of 46 discharges occurred from May 1994 through December 1994, resulting in an estimated release of 147,908 gallons (559,832 liters) of pretreated effluent to the Batavia sewer system. See Table 2. The total radioactivity released to the Batavia sewer system was included in the Fermilab 1994 Effluent Information and Onsite Discharge System (EIS/ODIS) report submitted to DOE.

2.6 Drinking Water Supplies

The source for the primary drinking water supply at Fermilab is 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 D-Zero (D-0). 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 Well W-1 is chlorinated at the Central Utility Building (CUB). The alternate supply source, Well W-3, has its own reservoir and chlorinator. The drinking water supply at D-0 is also a chlorinated system. The chlorine level in both drinking water supplies is tested each workday. The average daily use from Well W-1 and Well W-3 combined was approximately 65,688 gallons (248,629 liters) during CY-1994. Well-5 supplied an average of 1265 gallons/day (4788 liters) to D-0, while an average of 32,460 gallons (122,861 liters) was purchased daily from Warrenville for the Fermilab Village. The chlorine gas equipment used to treat drinking water from Wells W-1 and W-3 are scheduled to be replaced in 1995 with new systems utilizing sodium hypochlorite.

In 1993, traces of benzene were detected in the private well water supply of the C-Zero (C-0) Main Ring Service Building. Upon further investigation, it was determined that neither the well which supplied the building with potable water (Well 55), nor possible cross-connections inside the building were the sources of the benzene. The origin could not be determined. Consequently, the service connection to C-0 Service Building from Well 55 was disconnected and a new private well was installed. Installation of the well was completed in August 1994.

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

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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 may lie immediately above 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 majority of the site. Figure 4 is a piezometric contour map for this aquifer. 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 D-0 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 ground water 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 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 for migration of radionuclides in ground water at Fermilab. To aid in their investigation they hired a consultant to evaluate geologic, hydrologic, and geochemical conditions using existing site data and to evaluate the migration of ground water 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 would be potential soil radioactivation 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) Head for his review in late CY-1993. In 1994 recommendations were made to the Directorate to modify the model used to determine the migration of radionuclides from activation areas through the subsurface. Proposed procedures to employ the use of a new model to perform ground water radioactivation calculations were documented in Environmental Protection Note #8. The Single Resident Well Model which was historically used to calculate the expected dose to a single user at a water supply has been replaced by the Concentration Model which determines the concentration of a radionuclide adjacent to the source area and determines the attenuation of the radioactivation as it migrates through the glacial deposits to Class I ground water.

2.8 Demography

Fermi National Accelerator Laboratory is located in the densely populated Chicago area. There are about eight million people living within 50 mile (80 km) of the site. There are 483,325 people within 10 miles (16 km) of the center of the Main Ring Accelerator, based on the 1990 census results. The detailed distribution of population as a function of distance and direction from Fermilab is given in Table 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 three air pollution permits covering nine non-radiological and four radiological emission sources onsite. Table 4 summarizes Fermilab air pollution permits. Eight existing air pollution permits were consolidated into one permit issued in October 1994. Applications to renew open burn air pollution permits were submitted in CY-1994 and early CY-1995. The 1993 and 1994 Annual Air Emission Reports for Fermilab were submitted to the Illinois Environmental Protection Agency (IEPA) in April 1994 and April 1995 respectively (Table 25). There were no instances of noncompliant air emissions on or offsite in CY-1994.

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. In 1994 a Fermilab Employee Commuting Options Team developed recommendations for a program that would 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. However, the implementation of those recommendations and the ECO program have been delayed due to Governor Edgar's announcement on March 12, 1995 that the Illinois Department of Transportation should

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indefinitely suspend implementation of the Employee Commute Options (ECO) program in the Chicago Metropolitan area due to concerns regarding the cost effectiveness of this program.

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 an Illinois Environmental Protection Agency (IEPA) operating permit 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 measurement requirements. In CY-1994, the only radionuclide air emissions at Fermilab were those related to the operation of the Collider antiproton source and the Magnet Debonding Oven. The releases from the Anti-Proton stack were continuously monitored. A program of confirmatory measurements is planned for the next Fixed Target 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.

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 non-process cooling water, storm, and certain treated waters to regulated surface waters. Accordingly, Fermilab obtained an NPDES permit (No. IL0026123) from the state of Illinois in August of 1994. As part of the permit conditions, water temperature and pH are monitored at three outfalls (see Figure 7) and reported to IEPA on a monthly basis. Chlorine content is measured at the Kress and Indian Creek outfalls. Due to the presence of a RCRA-permitted (Resource Conservation and Recovery Act) facility onsite, an NPDES permit was also required for stormwater discharges pursuant to regulations at 40 CFR 122.26. This permit was included in the terms of the sitewide permit. As a condition of the sitewide NPDES permit, Fermilab completed a Storm Water Pollution Prevention Plan within 180 days of the effective date of that permit. The plan provides descriptions of locations identified through the RCRA Part B permitting process as having the potential to contribute additional pollutants to stormwater discharges. These locations have been identified as Solid Waste Management Units (SWMUs) in the facility RCRA Facility Investigation (RFI). The plan requires compliance by August 1995 and addresses training and implementation of spill prevention and response plans, sediment and erosion control measures, and annual inspections of facilities identified in the RFI. Results of inspections will be transmitted to the IEPA in an annual report, along with documentation of any event that required inspection and/or corrective action.

In October 1992, Illinois published a General NPDES Permit for discharge of stormwater associated with construction activities that involved more than five acres. 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 updated periodically 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 Army Corps of Engineers (USACE). Approximately 10.3 acres of new wetlands have been constructed to replace the wetlands that were lost in the FMI construction.

A NPDES pretreatment permit was issued to Fermilab by the IEPA in September 1993, allowing the release of a treated effluent from the Central Utility Building (CUB) 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, made it possible to discharge this effluent to the sanitary sewer beginning in May 1994. This alternative disposal option allowed the discontinuation of releases to the Class V underground injection well that formerly received the effluent. The pretreatment permit requires the collection and analysis of composite process effluent samples for metals. During CY-1994, the effluent was also sampled and analyzed for accelerator-produced radionuclides prior to each discharge. These samples were conservatively taken at the process release point rather than at the site boundary where Fermilab actually discharges to the municipal sewers. Analytical results were submitted to the IEPA. During CY-1994, samples from the process effluent were never in exceedance of the Batavia Sanitary Sewage Ordinance Discharge Limits at the site boundary.

Necessary permits for the construction of an additional recirculation cooling pond that will discharge to Kress Creek were obtained in 1994. The permits include a permit to construct from IEPA, and an approval from United States Army Corp of Engineers (USACE) and the Illinois Department of Transportation (IDOT).

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, the Safe Drinking Water Act (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 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 plan was accepted by USEPA in April 1994 and the remediation work began at the site in May 1994. Work was completed and a final inspection was conducted by USEPA in March 1995.

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-1994.

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, "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. A public notice, "Floodplain Involvement Notification for the Proposed Casey's Pond Improvement Project," was published in the Federal Register on April 28, 1995.

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.

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Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) - This act applies to storage and use of herbicides 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-1994, the use of pesticides/herbicides at Fermilab was handled in accordance with FIFRA.

The Migratory Bird Treaty Act - Monitoring continues at the former site of the great blue heron colony near the Main Injector construction site. Since 1993, there has been no heron activity at that site. Since 1993 great blue herons have periodically nested in small numbers in the middle of the Main Ring, an area that remains relatively undisturbed by human activity.

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). The Department of Energy issued regulations (DOE NEPA Implementing Procedures, 10 CFR 1021) to supplement the Council on Environmental Quality (CEQ) NEPA regulations in April 1992. Fermilab responded to the requirements in these regulations by implementing a program of reviewing all of its activities for NEPA compliance. Thirty-three (33) requests for Categorical Exclusions (CXs) were submitted to DOE during CY-1994. Of these, twenty-seven (27) were approved with the remainder under review or having been recalled by Fermilab. The Environmental Assessment (EA) prepared for the Low-level Radioactive Waste Handling Building resulted in a Finding of No Significant Impact (FONSI). An Environmental Assessment prepared for the Casey's Pond Improvement Project and submitted to the Chicago Operations Office remains under review.

National Historic Preservation Act (NHPA), Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 - Compliance with these Acts was accomplished through the NEPA review process which included an evaluation of all proposed land-disturbing projects in CY-1994 to assess any potential impacts on historical resources. No compliance issues were identified in CY-1994.

Resource Conservation and Recovery Act of 1976 (RCRA) - This act provides for the safe storage, treatment, and disposal of hazardous waste and regulated hazardous waste management practices for generators, transporters, 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 regulated 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. Because the interim status storage buildings WS-1 and WS-2 at Site 55 were never intended for permitted storage, 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 Solid Waste Management Units (SWMUs) located onsite that were identified by the IEPA. 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 Phase I sampling activities began in late November 1993 and concluded in July 1994. An RFI Phase I sampling report was submitted to the IEPA in August 1994. In accordance with RCRA Part B permit requirements, the IEPA was notified of four newly identified SWMUs, bringing the total number of SWMUs to be investigated to eighteen. In April 1994 the IEPA was notified of low level chemical contamination discovered in soil during construction activities in the Industrial Center Complex. Construction activities were suspended to allow for sampling and consultation with the IEPA. Sample results confirmed low levels of contamination at the site, but the IEPA determined that the construction could proceed after implementing some constraints. In addition to requiring the reporting of newly identified SWMUs, the RCRA permit also requires IEPA be notified of any changes to a previously identified SWMU. In February 1995, the IEPA was notified that the Railhead Storage Yard might contain lead contamination not originally identified. A plan to investigate this concern is being prepared for submittal to IEPA .

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 following screening of the waste for surface contamination and radioactivation. The moratorium was lifted in October 1993 when Fermilab's procedures were approved. The RMMA Procedures approved by DOE have not yet been fully implemented due to the need to first install radiation check sources on portable radiation detectors.

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. The final report (45 days report supplement) was submitted in December 1994. The report requested concurrence with site-specific cleanup objectives for this site. Fermilab is still awaiting a response from the IEPA.

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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, D-0, and Main Site public water supplies on May 20, 1992. The engineer found the D-0 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 in progress.

Fermilab public water supplies were sampled for bacteriological and chemical contaminants in CY-1994. The initial round of lead/copper (Pb/Cu) samples were collected for all three water supplies in CY-1993. The Village water supply did not exceed the lead or copper Action Levels during the two initial rounds of monitoring and, therefore, has been placed on a reduced monitoring program. Two supplies, D-0 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. Public Education Summary Report Forms were submitted to the IEPA for both the Main Site and D-0 water supplies as verification that the required public education materials were distributed to all users of the Fermilab public water supplies. In addition, an Optimum Corrosion Control Treatment (OCCT) recommendation was submitted to the IEPA for the Main Site and D-0 public water supplies. The plan recommends identification and removal of lead-containing materials rather than chemical treatment of the water. This plan is currently under IEPA review. Meanwhile, Fermilab has taken a proactive approach at D-0 by conducting lead swab tests on suspect solder joints, faucets, and fixtures within the distribution system. Sections of copper piping were replaced with PVC piping in an effort to reduce elevated copper levels believed to have originated from corrosion of the piping at the chlorination injection point.

In October 1994 Fermilab submitted applications to participate in the IEPA Phase II and V monitoring waiver programs for the Main Site and D-0 water supplies. Upon approval, sampling waivers would allow either elimination or reduction of sampling for the parameters required under Phase II and V of the USEPA 40 CFR Part 141 - National Primary Drinking Water Regulations.

In response to an earlier IEPA recommendation, new domestic water main flushing hydrants were installed at fifteen (15) locations. These will be utilized to flush the site domestic water mains on a semi-annual basis.

During 1994, a detailed sitewide survey for potential cross-connections in Fermilab's domestic water system was completed by Fermilab and an EPA licensed contractor. A backflow preventer certification and survey program was instituted. This program includes requirements to survey the Fermilab domestic water distribution system at least every 2 years and to annually test and certify all installed backflow prevention assemblies.

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, state, and local officials with an annual accounting of hazardous chemicals and extremely hazardous chemicals used or stored onsite in quantities greater than a given threshold. Annual reports are submitted to the EPA as required. The CY-1994 inventory (Table 18) was submitted to state and local emergency services and disaster agencies in early CY-1995.

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 (pre-TSCA) sampling procedures to verify that dielectric properties had not deteriorated. A characterization study was conducted at two of the buildings in FY 1989-1991. A consultant was hired in FY-1991 to conduct a risk assessment to support Fermilab and EPA Region V decisions regarding cleanup criteria and 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 where public access is restricted. In February 1993, Fermilab transmitted the consultant's risk assessment report to EPA, proposing to decontaminate the service building transformer sites at a rate of about two buildings per year. This 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 CERCLA Preliminary Assessment (PA) for the Main Ring Service Building PCB Contamination, which also supported a conclusion of minimal risk, was submitted in November 1993. With EPA's concurrence, all soil contaminated at or above the 10-ppm EPA PCB Spill Cleanup Policy criterion for unrestricted use was removed from the transformer yards at two service buildings (B3 and C2) and disposed of offsite (also in CY 1993). Cleanup at two more buildings was initiated in the summer 1995 shutdown.

Fermilab continues to phase out PCBs in the Main Ring pulsed power transformers and to eliminate them as potential PCB spill sources through retrofilling and/or chemical detoxification . The formal reclassification of the last PCB-contaminated transformer as non-PCB received EPA approval in 1994. Two PCB transformers failed and were disposed of during 1994, reducing the number of pulsed power transformers containing greater than 50 ppm PCBs to six. These will continue in service until the long shutdown for connection of the Main Injector (mid-1997), when they will be removed for offsite disposal. In another effort to decrease the presence of PCB-contaminated electrical equipment, a spare oil switch containing PCB-contaminated oil was retrofilled with non-PCB oil during October 1994.

In January 1995, it was discovered that the large capacitors in the Linac radiofrequency (rf) modulators contain PCBs. These items have been in service since the commissioning of the Linac and had been thought to be non-PCB, based on

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information received from the manufacturer pursuant to an inquiry in 1979. Forty-four of these capacitors had been removed from two modulators rendered surplus by a recent upgrade. In preparation for shipping the capacitors to the warehouse for storage as spares, a Linac technician contacted the manufacturer again to verify the nature of the dielectric oil, and, contrary to the earlier information, was told that the units almost certainly contained PCBs. Sampling subsequently confirmed that the oil was 100% PCB.

Immediately after verification of their PCB content, the 44 capacitors were labeled, dated, and shipped to an approved storage facility at the Fermilab Hazardous Waste Storage Facility to await disposal. The remainder of the capacitors were individually labeled during the February 1995 shutdown. PCB caution labels were placed on the exterior of the modulator cabinets. The newly-identified capacitors (176 remaining in service plus the 44 from the decommissioned stations) were added to Fermilab's PCB inventory/annual document log. Additional response actions under way include: development of a plan to replace the remaining capacitors, necessary to operation of the Linac, with non-PCB equipment; temporary improvements to the containment afforded by the modulator cabinets to improve compliance; sampling of the interior of the modulator cabinets to detect contamination from any historical or current leakage; and a search for 7 spares whose location, as nominally non-PCB units, was not carefully tracked over the years.

3.1 Appraisals and Assessments

The Tiger Team Assessment Report identified a total of 193 findings and concerns. Three of these were classified as Category II findings by the Safety and Health Team and as so were prioritized for quicker response action. The total set of findings and concerns were addressed by 246 tasks in a comprehensive Corrective Action Plan (CAP). DOE approved the CAP in CY-1993 (FCAP93) and as of March 1995, 95 of the tasks had been completed .

From April 26th through May 7th 1993, DOE/CH conducted a multidisciplinary 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. Only the industrial safety finding remains open.

The IEPA conducted a RCRA inspection at Fermilab on February 10, 1994 and again on January 19, 1995. They included a review of waste manifests, annual reports, training records, the contingency plan , the closure plans, the Part B permit, and operating records. Satellite waste accumulation areas and the Hazardous Waste Storage Facility were visited. No deficiencies were cited.

The USEPA conducted a TSCA inspection for compliance with PCB regulations on July 21, 1994. On December 13, 1994 Fermilab received a Notice of Noncompliance (NON) regarding potential leaks observed from three transformers during the inspection. Deficiencies noted in the NON were corrected and the EPA was notified.

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The Environment, Safety, and Health Section Environmental Protection Group (ES&H EP Group) audited the Main Injector NPDES Storm Water Pollution Prevention Plan (SWPPP) on August 19, 1994. The auditors reviewed documentation and inspected the Enclosure Project Area 6-6-7 storm water controls. A total of five findings resulted from the audit. Two of the findings pertained to specific storm water controls and three findings pertained to procedural inadequacies. All findings are currently open.

The Environment, Safety, and Health Division of the Chicago Operations Office of DOE conducted a review of Fermilab's Environmental Protection Program as part of a Multidisciplinary Appraisal September 19-30, 1994. The appraisal resulted in a rating of "good" with three findings and four recommendations in the area of environmental protection. Only two findings remain open.

Recent inspections by IEPA and the USEPA have identified no noncompliances with any permit conditions.

3.2 Environmental Permits

Most of Fermilab's air pollution permits were consolidated into one permit this year. This permit covers radionuclide emissions associated with the operation of the Tevatron, the FMI, and the operation of the magnet debonding oven; the operation of boilers used for heating buildings; vapor recovery systems on fuel dispensing tanks; and the use of 2 vapor degreasers, and a grit blaster. Fermilab also has two 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 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. Permits are summarized in Tables 3 and 4.

A NPDES permit was received in August 1994 to discharge non-process, non-contact cooling water to regulated surface waters. 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.

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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 ground water 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 ground water contamination. Monitoring results are also reported for nonradioactive pollutants.

4.2 Summary of Environmental Monitoring Performed in CY-1994

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 which is responsible for the routine environmental monitoring program at Fermilab.

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Fermilab performed extensive environmental monitoring in CY-1994 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 concentrations released. Surface water and ground water 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 surface 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 Information System and Onsite Discharge Information System (EIS/ODIS).

Monitoring results during operations in CY-1994 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-1994. Airborne radionuclide concentrations at the site boundary were so low as to be immeasurable. Low levels of tritium (<1.0 pCi/ml) are periodically detected 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-1994. 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.

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

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. The IEPA consolidated Fermilab's several air pollution permits into one permit in CY-1994. This permit now includes the operation of 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), a grit blaster at Industrial Building #2, a natural gas fired hot water boiler at Lab A (Neutrino Area) and one at the Meson Detector Building, an open top vapor degreaser at Industrial Building #3 in the Industrial Area, an open top vapor degreaser in the Transfer Hall South, and the magnet debonding oven and its associated afterburner. The permit also covers operation of equipment at the old Fermilab gas dispensing facility utilizing Emco Wheaton coaxial vapor recovery systems and the new gas dispensing

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facility with Stage I and Stage II vapor recover systems. The consolidated permit also covers radionuclide emissions associated with accelerator operations and construction/operation of the FMI.

Fermilab has obtained a separate IEPA air pollution open burning permit for prairie and land management. During CY-1994, burning was conducted on a number of the prairie tracts, but 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 fires causes no offsite problems. Fermilab also holds an open burn permit to allow burning of one gallon of motor fuel per session of firefighting instruction.

Fermilab has a Part B permit under the Resource Conservation and Recovery Act (RCRA) to operate an onsite Hazardous Waste Storage Facility. Regulated chemical wastes, as well as a limited quantity of radioactive "mixed" waste, are stored at this facility. Typical regulated chemical wastes handled at this facility include 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. The permitted storage unit is building WS-3. Low level radioactive mixed waste, RCRA hazardous waste, and PCB waste are stored at this facility.

In 1991 a permit was received from the IEPA to construct a second water supply line from Warrenville to the Fermilab Village. In 1988, a construction/operating permit was obtained for the public water supply at D-0.

No permit was needed for the septic field installed near D-0 (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. Fermilab holds a permit to pretreat demineralizer regeneration waste at the CUB prior to release to the City of Batavia sewers.

Fermilab has 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. Additionally, the Lab has a permit from the Illinois Department of Public Works that allows water to be taken from the Fox River to supplement surface waters onsite. A water pollution control permit has also been received for the construction of an additional recirculation pond for cooling water .

A permit was issued to Fermilab by 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 Mitigation Action Plan (MAP) approved by the USACE.

In CY-1994 the FMI project created no unanticipated environmental consequences. Progress on the development of the created wetland area is monitored on a regular basis by a sub-contractor (Consoer Townsend Envirodyne, CTE). The requirements of the Mitigation Action Plan (MAP) and the USACE permit have been met or exceeded in each year of reporting. The primary performance standard used is the percent of ground covered by vegetation. USACE and MAP criteria for success differ, the standards set by the MAP being somewhat more stringent.

	Year 1	Year 2
USACE Standard	15%	30%
Mitigation Plan Standard	---	60%
Fermilab Performance	40%	70%

In addition to ground coverage criteria, USACE requires that a certain percentage of planted species be recovered in surveys, depending on the years since establishment of the wetland. Species recovery percentages required and observed are as follows:

	Year 1	Year 2
USACE Standard	10%	20%
Fermilab Performance	48%	48%

The FMI is scheduled for completion in 1999.

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. Used oil, one of the Laboratory's largest waste streams (>4000 gallons/year), is being recycled instead of incinerated as secondary fuel. 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.

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Divisions and Section began process waste assessments in CY-1993. Halon 1301 systems have been put on manual control to reduce fugitive emissions.

Source reduction, recycling, and waste minimization activities were included, as required in the annual Hazardous Waste Report submitted to the IEPA. The annual Waste Minimization/Pollution Prevention Report was submitted to DOE Headquarters.

4.6 National Environmental Research Park (NERP)

No new activities were undertaken in connection with the Fermilab NERP in 1994 due to the lack of funding for the program. Six environmental research projects supported by external funding continued during the year with minimal assistance from the laboratory. One project was completed and two were terminated due to the lack of funding. In addition, three pending proposals were terminated due to lack of funding. One project remains inactive. See Table 8.

4.7 Environmental Training

Eighteen Fermilab employees were trained in waste minimization and pollution prevention as part of site-wide waste management training in CY-1994. These eighteen people were then responsible under Fermilab procedure to provide waste specific-need training to people under their jurisdiction.

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 and in accordance with the OSHA requirements in 29 CFR 1910.120.

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 thirty-nine soil samples and forty-seven quality assurance samples were collected. Six piezometers were installed around the Meson

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Landfill. Preparation of the Phase I report began in early 1994 and was submitted to the IEPA in late July 1994. An RFI Quarterly Report was transmitted to the IEPA for the fourth quarter of CY-1993 in January 1994. Quarterly reports were sent to IEPA for all four quarters of 1994. The IEPA was notified of four newly identified SWMUs in accordance with regulations.

4.9 Deer Studies

The Lab is currently in the third 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 at Fermilab: 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-1994, 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 thermoluminescent dosimeters (TLDs) were exchanged and read each quarter, providing additional information on radiation levels sitewide and at the site boundaries.

During CY-1994, the Tevatron was operated in the Collider mode. Because above ground muon fields during Collider operations are minimal, the primary contribution to offsite radiation exposure in CY-1994 was due to 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-1994 was determined using measurements made with TLDs and the large volume ion chamber (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 0.390 mrem (3.9 X 10^{-3} mSv) for CY-1994. The maximum dose to the individual living closest to that point on the site boundary would have been 0.081 mrem (8.1 X 10^{-4} mSv) for CY-1994, 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).

Muon measurements were performed 1300 feet downstream of the C0 abort on Swenson Road using the Mobile Environmental Radiation Laboratory (MERL). Data was accumulated for 50 minutes (approximately 190 bunches) during injection, when the muon rate due to aborts should be the highest. Though no muon fields above background were observed, the effective dose equivalent at the site boundary due to this source was estimated to be 3.97 x 10^{-4} mrem (3.97 X 10^{-4} mSv) by using a record of protons aborted to calculate a potential dose based upon fluence measurements conducted previously. Muon measurements were also performed downstream of the AP0 target using the MERL, a chipmunk and TLDs. Measurements were taken while stacking antiprotons, when the AP0 target is being bombarded with protons, and thus the dose rate is expected to be highest. All three measurements agreed, giving a muon dose rate of 30 mrem/hr approximately 330 feet downstream of AP0. This corresponds to a negligible offsite dose since the site boundary is approximately 7000 feet downstream of AP0.

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 sections where the protons and secondary particles must travel through air. This is the reason 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-1994, protons were focused onto a target (Antiproton Source in Figure 5) to produce antiprotons. This target and the magnet debonding oven were the only radioactive air emission sources. Because the 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 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) Studies conducted in CY-1992 indicated 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 during CY-1994.

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-1994 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-1994 Fermilab radioactive air emissions was determined to be 0.00869 mrem (8.69 X 10^{-5} mSv). This value amounts to 0.087% of the 10 mrem/year (1 X 10^{-1} mSv/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-1994 airborne radionuclide emissions was calculated to be 2.55 x 10^{-2} person-rem (2.55 x 10^{-4} person-Sv).

5.3 Ground Water 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 ground water contamination. Many of the ground water 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 ground water 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

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those moving horizontally in sand lenses or in layers within the till. Ground water monitoring for radiochemicals has been improved by adding shallow ground water monitoring in the two areas where soil radioactivation could be a potential source for ground water contamination (Table 23). Fermilab's ground water protection strategies are documented in the Fermilab Ground Water Protection Management Plan (GPMP).

A site survey to document and classify the current monitoring well network locations was completed in CY-1994. An updated inventory was then submitted to the State and County Health Departments. Field and documentation investigations of old boring holes onsite continue. Five monitoring wells located in the Fermilab Main Injector construction area were properly abandoned during CY-1994.

Water samples from approximately 40 onsite supply/monitoring wells 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 ground water 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).

No measurable (Table 10) concentrations of these radionuclides have ever been confirmed in ground water samples taken from the upper dolomite aquifer. 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, EPA Regulations set forth in 40 CFR 141, and IEPA Regulations set forth in 35 IAC Section 611. 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 24% of the year in CY-1994.

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 four liquid effluent releases were reported for CY-1994. The sumps/retention pits reported as contributing to these discharge points were M01SP3, N01SP4, NW4SP1, and NTSBSP1. The reported discharge points for the sump water were the ditches receiving the waters from these sumps and emptying into Kress Creek. The regenerant waste is discharged to onsite sewers that are tributary to the City of Batavia Sewer System. 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-1994, these sumps released an estimated total of 98 mCi (3.6×10^{9} Bq) of tritium offsite. This is an decrease over the 578 mCi (2.14×10^{10} Bq) of tritium reported in CY-1993. The decreased release can be somewhat attributed to an appreciable decrease in water leaving the site in CY-1994 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-1994. 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

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surrounding communities is taken from wells rather than from the creeks receiving the discharge. Hence, the dose from these releases is negligible.

Emissions from the AP0 beamline tunnel ventilation stack and the Magnet Debonding Oven were reported as EIS/ODIS air effluents in CY-1994.

A new liquid effluent was added to the report this year for the pretreated regenerant waste sent to the City of Batavia sewer system. This release began in May 1994.

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-1994 the radiochemical composition of soil/sediment was measured at 10 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-1994 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-1994 results showed no unexpected depositions.

5.7 Monitoring Radioactivity in Effluent from the Central Utilities Building (CUB)

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 treated to remove suspended solids and along with these, most of the radioactivity, before it is discharged to the Batavia sewer system in accordance with a pretreatment permit received from the IEPA. The effluent is sampled for a number of parameters including radionuclide concentrations. Prior to May 1994, this effluent was discharged to a clay tile field (Class V underground injection well) inside the Main Ring (see Section 6.4 and Figure 2). Here the discharge percolated into the soil about 2 ft. (60 cm) below the surface. Though significant gains were made over the past several years in improving the CUB resin regeneration process and in cleaning up the effluent, trace amounts of accelerator-produced radionuclides continued to be detected in the 1994 CUB Tile Field soil samples (Table 13).

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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 0.390 mrem (3.9×10^{-3} mSv) during CY-1994 but decreased to only 0.081 mrem (8.1×10^{-4} 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 0.00869 mrem (8.69×10^{-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-1994 was approximately 2.55×10^{-2} person-rem (2.55×10^{-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-1994 (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 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, non-volatile organic material (NONVOM), particulates, sulfur dioxide, nitrogen oxide, and volatile organic material (VOM) emissions from permitted Fermilab sources were reported in April 1994 for CY-1993 and in April 1995 for CY-1994. Table 25 gives these reported emissions.

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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. Three thousand one hundred and thirty-two pounds of chlorine were used in CY-1994.

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-1994, a total of 2420 gallons (9160 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-1994.

Although it was also necessary to chemically treat some waters to control the growth of algae and weeds during CY-1994, 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. Algaecide applications to surface waters in CY-1994 are listed in Table 14.

6.3 Pesticides

Pesticides were used on-site during CY-1994 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-1994.

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 algaecide 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 six surface water bodies to control algae in CY-1994. 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 31 gallons (117.6 liters) was applied in CY-1994. See Table 14.

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 landscape maintenance: Fermilab Village and Sauk Circle, East Gate Area, Batavia Road, D Road, Pine Street, Wilson Hall, Colliding Detector Facility, Industrial Areas, D-0 Assembly Building, Central Helium Liquifier, 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. A mixture of 2.6 oz. of Roundup and 3 oz. of Surflan A.S. was applied at a rate of one tank per 1000 ft^2. A total of 113.5 gallons (429.6 liters) of each, Roundup and Surflan was used.

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, Industrial 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 0.03 gallons (0.1 liter)

Rodeo herbicide (EPA #524343), Isopropyl amine salt of Glyphosate, was applied to cooling water and drainage ditches near the Proton, Meson, Neutrino, and Muon beamlines and along Ring, Indian, and Kautz Roads. It was applied by a hand held spray gun for the purpose of eliminating cattails and small

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willows which were obstructing the flow of cooling water running through the drainage ditches. A $^3/4$% solution of Rodeo and $^1/4$% solution on non-ionic surfactant were mixed on a tank and applied on a "sprayed to wet" basis. The total amount of Rodeo applied was 0.6 gallon (2.4 liters).

Banvel herbicide (EPA #55947-1), Dimethylamine salt of dicamba, was applied to areas at Site 37, along Giese Road and in the Main Ring for control of Teasel. The application was done only at times when the wind velocity was low so that drift was minimized. It was applied at a rate of 1 - 2 pints per acre with a hand compression sprayer as spot treatment. The total amount of Banvel applied was 0.07 gallon (0.3 liter).

A fungicide, Bayleton (EPA #3125-318) 1-(4-chloropenoxy) -3,3-dimethyl-1-(1H-1,2,4 triazol-1-y)-2-butanone, was applied to the Village soccer field for landscape management purposes to control rust disease. The application was done only at times when the wind velocity was low so that drift was minimized. It was applied at a rate of 1 - 2 ounces per 1000 ft^2 with a hand spray gun or boom sprayer. The total amount of Bayleton applied was 13.6 lb (6 kg).

Garlon 4+ (EPA #464-554), Triclopyr ((3,5,6-trichloro-2-pyridinlyl)oxy) acetic acid, 61.6% and Garlon 3A (EPA #62719-37),Triclopyr ((3,5,6-trichloro-2-pyridinlyl)oxy) acetic acid, 44.4%, herbicides were applied as spot treatments to stumps of brush and trees to prevent resprouting after cutting. The total amount of Garlon 4+ applied was 0.5 gallons (1.9 liters). The total amount of Garlon 3A applied was 4.75 gallons (18 liters).

6.3.3 Miscellaneous Pest Control

A licensed contract exterminator was retained during CY-1994 for miscellaneous pest control in kitchens, laboratories, and living areas throughout the site. Table 15 summarizes the pesticides that the contractor proposed for use.

Biomist 3+15 ULV (EPA #8329-33), Permethrin (3-Phenoxyphenyl)methyl (+/-) cis, trans-3-(2,2-dichlorethenyl)-2,2 dimethylcyclopropanecarboxylate, 3% Piperonyl Butoxide, and a technical equivalent to 80% (butylcarbityl) (6-propylpiperonyl) ether and 20% related compounds, 15%, was applied at Fermilab during CY 1994 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 of Biomist 3+15 ULV applied was 30 gallons (113.6 liters).

6.3.4 Agricultural Pest Control Program

During CY-1994 Fermilab leased 1680.8 acres (6.8 km^2) of land to farmers for agricultural production of soybeans and corn (Figure 6). Land leased for farming is divided into 14 separate tracts. These tracts vary from 11 to 306 acres in size. The leasee's hired subcontractors to perform their pesticide applications. The pesticides that were proposed for application in CY-1994 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-1994 exceeded the IEPA Ground Water Quality Standard (II91). High chloride concentrations were released to the CUB Tile Field Class V injection well with the CUB regeneration process effluent prior to May 1994 when the effluent was diverted to the City of Batavia sewer system. The chloride levels seen in CY-1994 are not unlike those seen for the past four years. Chlorides plumes and concentrations will be studied further.

6.5 SARA Title III Chemical Inventory

Fermilab conducted a sitewide chemical inventory in accordance with the reporting requirements for CY-1994 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-1994 can be found in Table 18. Section 313 chemicals stored/used in CY-1994 were reported by July 1, 1995. Database tracking systems for chemical management are being evaluated.

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6.6 Environmental Occurrences

There were no reportable environmental occurrences in CY-1994.

7.0 QUALITY ASSURANCE IN CY-1994

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

In CY-1994, 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 and revised in December 1993. Implementation of this program required the creation of numerous Specific Quality Implementation Plans (SQIPs). A SQIP for Environmental Monitoring, (Wa94), Radionuclide Air Emissions Monitoring (Cu93), 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.

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

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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, CEP, Inc., 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).

Fermilab and CEP results in the DOE Environmental Measurements Laboratory (EML) quality assurance program are found in Tables 19, 20, and 21. The results of both CEP 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 ground water 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

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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.

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

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EPPM Environmental Protection Procedures Manual, Fermilab, October 1991.

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Gr94 Grobe, D. W., Fermi National Accelerator Laboratory Site Environmental Report for Calendar Year 1993, Fermilab Report 94/105, May 1994.

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9.0 ACKNOWLEDGMENTS

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TABLES

Table 1

Summary of Collective Dose Equivalent for CY-1994 Within a 50 mile (80 km) Radius of Fermilab

Source	Collective Dose Equivalent person-rem	person-Sv
Penetrating radiation from the Railhead	1.9×10^{-6}	1.9×10^{-8}
Airborne radioactivity from AP0 stack and Debonding Oven	2.55×10^{-2}	2.55×10^{-4}
Total	$\mathbf{2.55 \times 10^{-2}}$	$\mathbf{2.55 \times 10^{-4}}$

*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-1994

Release Point	Pathway	Radionuclide	Half-Life	Release in (Ci)	(Bq)
AP0	Air	^{13}N	9.97 minutes	13.0	4.8×10^{11}
Beam Tunnel		^{11}C	20.38 minutes	20.0	7.4×10^{11}
Ventilation Stack		^{41}Ar*	1.83 hours	1.2	4.4×10^{10}
Debonding Oven	Air	^{3}H	12.3 years	1.6×10^{-3}	5.9×10^{7}
Discharge to	Water	^{3}H	12.3 years	4.4×10^{-4}	1.6×10^{7}
Batavia		^{7}Be	53.3 days	2.7×10^{-4}	10.0×10^{6}
Sanitary Sewers		^{22}Na	2.6 years	2.2×10^{-6}	8.1×10^{4}
Kress Creek Spillway	Water	^{3}H	12.3 years	9.8×10^{-2}	3.6×10^{9}

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

Table 3

List of Fermilab Environmental Permits

Issuing Agency Type, and No.	Description	Current Issue Date	Expiration Date
IEPA-Air Appl.#79070012	Gasoline Dispensing Tanks (Site 38)	5/22/95	6/22/99
IEPA-Air Appl.#79070012	Gas-Fired Hot Water Boilers at CUB & WBL 1 Grit Blaster	5/22/95	6/22/99
IEPA-Air Appl.#79070012	2 Gas-Fired Hot Water Boilers (Lab A & Meson Detector Building)	5/22/95	6/22/99
IEPA-Air Appl.#79070012	Open Top Vapor Degreaser (IB-3)	5/22/95	6/22/99
IEPA-Air Appl.#79070012	Magnet Debonding Oven with Afterburner	5/22/95	6/22/99
IEPA-Air Appl.#79070012	Radionuclide Emissions from TeV Operations	5/22/95	6/22/99
IEPA-Air Appl.#B9408022	Open Burn Prairie/Land Ecological Management	9/22/94	10/23/95
IEPA-Air Appl.#B9503077	Open Burn Fire Fighting Instruction	5/2/95	5/01/96
IEPA - Air Appl #79070012	Open Top Vapor Degreaser-Transfer Hall South. (Construction & Operating)	5/22/95 (Operating)	6/22/99
IEPA - Air Appl. #91030001	Fermilab Main Injector Construction Permit for Radionuclide Emissions	1/21/92	4/01/93
IEPA Air Appl. #79070012	Construction/Operation of a New Gasoline and Diesel Fuel Dispensing Facility	5/22/95	6/22/99
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
D-0 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	10/01/92	
IEPA - NPDES Appl.# IL0025941	For the Discharge of Non-Contact, Non-Process Cooling Water	Pending	
IEPA Water Pollution Permit #1994-EB-467 Log # 4667-93	Construction of an Additional Recirculation Pond	1/18/94	1/18/97*
IEPA Permit - Water Pollution Permit #1995-EE-4381	Pretreatment of Demineralizer Regenerant Waste	8/7/95	8/01/00
OSFM Permit #2-022134 Application #9619-93REN	CUB Underground Tank Removal	8/03/93	2/03/94

* Unless construction has been completed

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Table 4

Fermilab IEPA Air Pollution Permit Conditions

Application No.	Description	Special Conditions
B9503077	Open burning for firefighting instruction	Close abandoned water wells
B9408022	Open burning for prairie/land management	Notification and prior approval from the local fire protection district at least 24 hours prior to burn
79070012	Old Gasoline dispensing facility (Site 38)	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.
79070012	5 gas-fired hot water boilers; 1 grit blaster	WBL boilers restricted to <1.2 tons/yr nitrogen oxides
79070012	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
79070012	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
79070012	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
79070012	Fermilab Main Injector 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
79070012	Radionuclide emissions TeV operations	25 mrem/yr whole body* 75 mrem/yr critical organ to any member
79070012	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

CY-1994 Surface Water Chemical Results

PARAMETER	General Use Standards (mg/l)	Kress Creek Onsite (mg/l)	Kress Creek Offsite (mg/l)	Fox River Inlet (mg/l)
Oil-Grease	**	<5.0	<5.0	<5.0
Cyanide	0.022	<0.01	<0.01	<0.01
Al	-	0.75	0.43	0.39
Ag	0.005	<0.01	<0.01	<0.01
Cd	0.05***(a)	<0.005	<0.005	<0.005
Cr (total)	4.0***(b)	<0.01	<0.01	<0.01
Cu	0.05***(c)	<0.025	<0.025	<0.025
Fe	1.0	1.1	0.53	0.77
Pb	0.3***(d)	0.012	<0.003	0.0039
Mn	1.0	0.43	0.29	0.076
Ni	1.0	<0.03	<0.03	<0.03
Zn	1.0	<0.02	<0.02	<0.02
PCB's	-	U	U	U

* From State of Illinois Rules and Regulations Title 35, Subtitle C, Chapter I, Part 302, Subpart B, 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 except as provided (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 (300 mg/l), was used to calculate the acute standard concentration of these parameters.

$\exp[A+B\ln(H)]$
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 Aroclor 1016, 1221, 1232, 1242, and 1248.
<0.001 mg/l for Aroclor 1254 and 1260.

Table 6

CY-1994 CUB Tile Field Monitoring Well Results (post-purge)

Month	Parameter	Units	Class II GW Stds.	MWS1	MWS2	MWS3	MWS4	MWS5	MWD1	MWD2*
June										
	Cr Total	mg/l	1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Cl	mg/l	200	640	910	660	19	<3.0	260	3.1
	3-H	pCi/ml	NA	1.05	1.04	<1.0	<1.0	<1.0	<1.0	<1.0
Sept.										
	Cr Total	mg/l	1	0.018	<0.01	<0.01	0.019	<0.01**	<0.01	<0.01
	Cl	mg/l	200	1300	1600	680	140	3.5**	210	3.8
	3-H	pCi/ml	NA	<1.3	<1.3	<1.3	<1.3	<1.3**	<1.3	<1.3

* Pre-purge values, well was not purged due to high pH
**Pre-purge values, well did not recharge for a post-purge sample

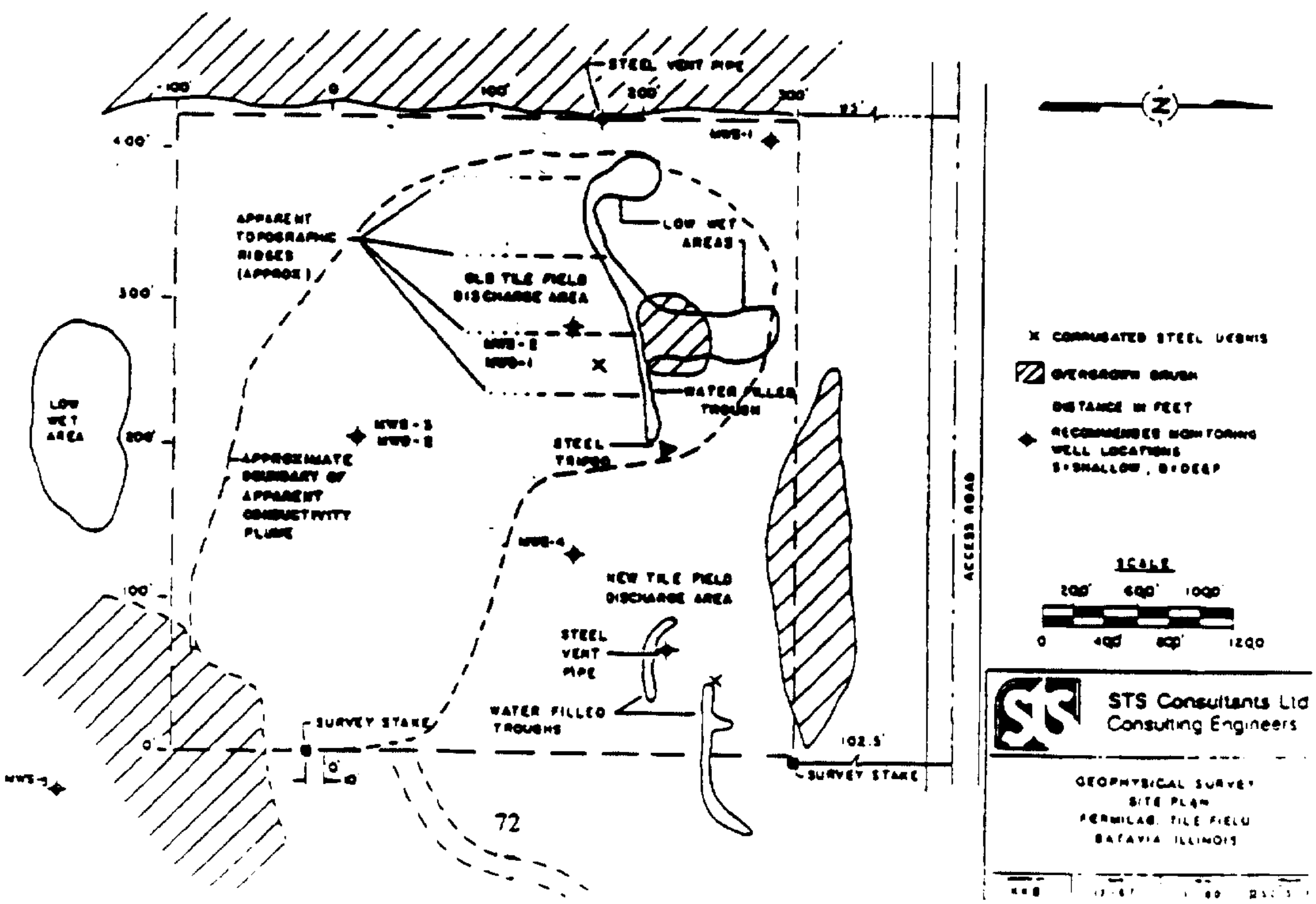

Table 7

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

Latitude = 41°, 50 minutes, 0 seconds
Longitude = 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

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 (inactive)
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 - 1994 (terminated)
C. Whelan	Morton Arboretum	Effects of Smoke from Prairie Fires on Seed Germination	1992 - 1994
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 - 1994 (terminated)
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 (terminated)
M. Bowles	Morton Arboretum	Restoration Potential for the Federally Threatened Eastern Prairie Fringed Orchid at Fermilab	Proposed (terminated)
M. Payne	Miami University	Evolutionary Trends in the Social Organization of White-tailed Deer	Proposed (terminated)

Table 9

Airborne Radioactivity Released Due to Accelerator Operations During CY-1994

Stack Monitor	**Activity Released** (Curies)	(Becquerel)
Antiproton Source	34.2	1.27×10^{12}
Magnet Debonding Oven	0.0016	5.92×10^{7}
Total	**34.2**	**1.27**

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	Ground water	Surface Water	Ground water
^{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

1994

Table 11

Tritium Detected in Sump Water Samples (CY 1994)

Collection Point	Number of Samples	Units	Concentration Maximum*	Minimum**	Mean***	Percentage of Concentration Guide (%)****
AP0 Prevault	5	pCi/ml	1.89E+01	2.15E+00	7.35E+00	3.68E-01
		Ci/ml	1.89E-11	2.15E-12	7.35E-12	
		Bq/ml	6.99E-01	7.96E-02	2.72E-01	
AP0 Transport	2	pCi/ml	2.40E-01	< 1.00E+00	1.20E-01	6.00E-03
		Ci/ml	2.40E-13	1.00E-12	1.20E-13	
		Bq/ml	8.88E-03	3.70E-02	4.44E-03	
AP 50	1	pCi/ml	5.20E-01	5.20E-01	5.20E-01	2.60E-02
		Ci/ml	5.20E-13	5.20E-13	5.20E-13	
		Bq/ml	1.92E-02	1.92E-02	1.92E-02	
M01SP3	6	pCi/ml	2.49E+01	1.77E+01	2.09E+01	1.05E+00
		Ci/ml	2.49E-11	1.77E-11	2.09E-11	
		Bq/ml	9.21E-01	6.55E-01	7.73E-01	
N01RP1	6	pCi/ml	2.15E+01	5.12E+00	1.54E+01	7.70E-01
		Ci/ml	2.15E-11	5.12E-12	1.54E-11	
		Bq/ml	7.96E-01	1.89E-01	5.70E-01	
N01RP2	5	pCi/ml	3.90E+02	3.21E+01	1.79E+02	8.95E+01
		Ci/ml	3.90E-09	3.21E-10	1.79E-09	
		Bq/ml	1.44E+01	1.19E+00	6.62E+00	
N01SP3	2	pCi/ml	6.80E+00	1.80E+00	4.30E+00	2.15E-01
		Ci/ml	6.80E-12	1.80E-12	4.30E-12	
		Bq/ml	2.52E-01	6.66E-02	1.59E-01	
N01SP4	6	pCi/ml	1.28E+02	2.17E+01	5.05E+01	2.53E+00
		Ci/ml	1.28E-10	2.17E-11	5.05E-11	
		Bq/ml	4.74E+00	8.03E-01	1.87E+00	
NM1SP	4	pCi/ml	5.20E+00	1.35E+00	2.61E+00	1.31E-01
		Ci/ml	5.20E-12	1.35E-12	2.61E-12	
		Bq/ml	1.92E-01	5.00E-02	9.66E-02	
NM2RP	2	pCi/ml	8.15E+01	4.14E+00	6.14E+01	3.07E+00
		Ci/ml	8.15E-11	4.14E-12	6.14E-11	
		Bq/ml	1.92E-13	5.00E-14	9.66E-14	
NM2SP3	2	pCi/ml	1.03E+00	< 1.00E+00	5.13E-01	2.57E-02
		Ci/ml	1.03E-12	1.00E-12	5.13E-13	
		Bq/ml	3.81E-02	3.70E-02	1.90E-02	
NM3	1	pCi/ml	1.03E+00	1.03E+00	1.03E+00	5.15E-02
		Ci/ml	1.03E-12	1.03E-12	1.03E-12	
		Bq/ml	3.81E-02	3.81E-02	3.81E-02	
NTSBSP1	3	pCi/ml	5.75E+01	2.30E+00	2.09E+01	1.05E+00
		Ci/ml	5.75E-11	2.30E-12	2.09E-11	
		Bq/ml	2.13E+00	8.51E-02	7.73E-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 10E-9 Ci/ml (74 Bq/ml). Percentage is calculated from the mean concentration.

Table 12

Tritium Detected in Sump Water Samples (CY-1994)

Collection Point	Number of Samples	Units	Concentration Maximum*	Concentration Minimum**	Concentration Mean***	Percentage of Concentration Guide (%)****
NTSBSP2	3	pCi/ml	3.80E+00	< 1.00E+00	1.23E+00	6.15E-02
		Ci/ml	3.80E-12	1.00E-12	1.23E-12	
		Bq/ml	1.41E-01	3.70E-02	4.55E-02	
NW4RP	5	pCi/ml	2.77E+01	1.75E+01	1.43E+02	7.15E+00
		Ci/ml	2.77E-11	1.75E-11	1.43E-10	
		Bq/ml	1.02E+00	6.48E-01	5.29E+00	
NW4SP1	5	pCi/ml	3.83E+01	1.70E+01	2.92E+01	1.46E+00
		Ci/ml	3.83E-11	1.70E-11	2.92E-11	
		Bq/ml	1.42E+00	6.29E-01	1.08E+00	
PC4SP1	2	pCi/ml	7.41E+01	< 1.00E+00	3.70E+00	1.85E-01
		Ci/ml	7.41E-11	1.00E-12	3.70E-12	
		Bq/ml	2.74E+00	3.70E-02	1.37E-01	
PE3SP2	2	pCi/ml	3.40E+00	1.09E+00	2.25E+00	1.13E-01
		Ci/ml	3.40E-12	1.09E-12	2.25E-12	
		Bq/ml	1.26E-01	4.03E-02	8.33E-02	
PW5SP3	1	pCi/ml	1.70E+00	< 8.11E-01	8.50E-01	4.25E-02
		Ci/ml	1.70E-12	8.11E-13	8.50E-13	
		Bq/ml	6.29E-02	3.00E-02	3.15E-02	
PW6SP1	2	pCi/ml	1.68E+00	< 1.00E+00	8.40E-01	4.20E-02
		Ci/ml	1.68E-12	< 1.00E-12	8.40E-13	
		Bq/ml	6.22E-02	< 3.70E-02	3.11E-02	
PW6SP2	2	pCi/ml	2.00E+00	1.24E+00	1.62E+00	8.10E-02
		Ci/ml	2.00E-12	1.24E-12	1.62E-12	
		Bq/ml	7.40E-02	4.59E-02	5.99E-02	
PW6SP3	2	pCi/ml	1.32E+00	1.30E+00	1.31E+00	6.55E-02
		Ci/ml	1.32E-12	1.30E-12	1.31E-12	
		Bq/ml	4.88E-02	4.81E-02	4.85E-02	

* 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 10E-9 Ci/ml (74 Bq/ml).
Percentage is calculated from the mean concentration.

1994

Table 13

CY-1994 Soil/Sediment Results

		Radionuclide					
LOCATION	**UNITS**	**Be-7**	**Na-22**	**Mn-54**	**Co-57**	**Co-60**	**H-3***
Indian Creek	uCi/g	ND	ND	ND	ND	ND	NA
	Bq/g						
Kress Creek on-site	uCi/g	ND	ND	ND	ND	ND	NA
	Bq/g						
Kress Creek off-site	uCi/g	ND	ND	ND	ND	ND	NA
	Bq/g						
Ferry Creek	uCi/g	ND	ND	ND	ND	ND	NA
	Bq/g						
CUB Tile Field	uCi/g	ND	ND	ND	ND	2.90E-07	ND
	Bq/g					1.07E-02	
AP0 Stack	uCi/g	ND	ND	ND	ND	ND	8.60E-06
	Bq/g						3.18E-01
M01SP3	uCi/g	ND	ND	ND	ND	3.00E-07	NA
	Bq/g					1.11E-02	
N01SP4	uCi/g	1.62E-06	2.90E-07	ND	ND	ND	NA
	Bq/g	5.99E-02	1.07E-02				
NW4SP1	uCi/g	ND	1.30E-06	ND	ND	1.11E-06	NA
	Bq/g		4.81E-02			4.10E-02	
SITE 12 BACKGROUND	uCi/g	ND	ND	ND	ND	ND	ND
	Bq/g						

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

Table 14

Pesticide Application to Surface Waters at FNAL in CY-1994

Surface Water Body	Total Cutrine Plus Applied (liters)
Swan Lake	49.2
Swan Lake Back Canal	7.8
Center Reflecting Pond	15.1
East Reflecting Pond	5.7
Booster Pond	37.9
Ditch CP-1	1.9

1994

Table 15

Pesticides Proposed for Application by Contractor in CY-1994

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%

1977

Table 16

Pesticides Applied to Leased Farm Tracts CY-1994

Pesticide	EPA Reg. #	Active Ingredients
Accent	352-534	2-(((((4,6-Dimethoxypyrimidin-2-yl)aminocarbonyl)) aminosulfonyl))-N,N-dimethyl-3-pyridinecarboxamide
Buctril	264-437	Octanoic acid ester of bromoxynil (3,5-dibromo-4-hydroxybenzonitrile)
Bullet	524-418	Alachlor, [2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide] and Atrazine, [2-chloro-4-ethylamino-6-isopropylamino-5-triazine]
Frontier	55947-140	Dimethenamid; 2-chloro-N-(2,4-dimethyl-3-thienyl)-N-(2-methoxy-1-methylethyl)acetimide
Galaxy	7969-77	Sodium salt of Bentazon Sodium salt of Acifluorfen
Marksman	55947-39	Potassium salt of dicamba (3,6-dichloro-o-ansic acid) and Atrazine (2-chloro-4-ethylamino-6-isopropyl-amino-s-trazine)
Pinnacle	352-525	Methyl 3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]-amino]sulfonyl]-2-thiophenecarboxylate
Poast	7969-58	2-{1-ethoxyimino)butyl}-5-{2-(ethylthio)propyl}-3-hydroxy-2-cyclohexen-one#
Pursuit	241-310	Ammonium salt of imazethapyr (+/-)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid
Roundup	524-445	Glyphosate, N-(phosphonomethyl) glycine, in the form of its isopropylamine salt
Weedone	264-20	2,4-Dichlorophenoxyacetic acid, butoxyethyl ester

Table 17

1994 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	Corn	Frontier	N	25 oz	110	2750 oz
				Marksman	Y	3.5 pt	110	385 pt
C	305.7	R. Mueller	Corn	Harness	Y	3.4 pt	305	1037 pt
				Aatrex 4L	Y	1 lb	305	305 lb
				DyFonate II	N	8.7 lb	305	2653.5 lb
C-2	34.2	R. Mueller	Beans	Pursuit	N	4 oz	34	136 oz
				Roundup	N	0.5 pt	34	17 pt
C-3	66.5	R. Mueller	Corn	Harness	Y	3.4 pt	66	224.4 pt
				Aatrex 4L	Y	1 lb	66	66 lb
				DyFonate II	N	8.7 lb	66	574.2 lb
C-4	135.1	R. Mueller	Corn	Harness	Y	3.4 pt	60	204 pt
				Aatrex 4L	Y	1 lb	60	60 lb
				DyFonate II	N	8.7 lb	60	522 lb
			Beans	Pursuit	N	4 oz	70	280 oz
				Roundup	N	0.5 pt	70	35 pt
C-5	28.2	R. Mueller	Corn	Harness	Y	3.4 pt	28	95.2 pt
				Aatrex 4L	Y	1 lb	28	28 lb
				DyFonate II	N	8.7 lb	28	243.6 lb
C-6	11.9	R. Mueller	Corn	Harness	Y	3.4 pt	11	37.4 pt
				Aatrex 4L	Y	1 lb	11	11 lb
				DyFonate II	N	8.7 lb	11	95.7 lb
CA-1A	85.0	M. Pitstick	Corn	Bullet	Y	1 gal	85.0	85 gal
				Buctril	N	1.5 pt	85.0	127.5 pt
				Accent	N	0.66 oz	85.0	56.1 oz
CA-1B	82.1	M. Pitstick	Beans	Weedone	N	1 pt	82.1	82.1 pt
				Roundup	N	1 pt	82.1	82.1 pt
				Pursuit	N	4 oz	82.1	328.4 oz
				Pinnacle	N	0.1 oz	82.1	8.21 oz
N-1	181.6	T. Flanders	Beans	Roundup	N	1 pt	181.0	181 pt
				Poast	N	1.5 pt	181.0	271.5 pt
				Galaxy	N	2 pt	181.0	362 pt
D-6	59.0	T. Flanders	Beans	Roundup	N	1 pt	59.0	59 pt
				Poast	N	1.5 pt	59.0	88.5 pt
				Galaxy	N	2 pt	59.0	118 pt
N-2	286.0	M. Pitstick	Beans	Pursuit	N	4 oz	125.0	500 oz
				Roundup	N	1 pt	125.0	125 pt
				Weedone	N	1 pt	125.0	125 pt
				Pinnacle	N	0.1 oz	125.0	12.5 oz
			Corn	Accent	N	0.66 oz	161.0	106.26 oz
				Bullet	Y	1 gal	161.0	161 gal
				Buctril	N	1.5 pt	161.0	241.5 pt
D-2	69.6	M. Pitstick	Beans	Pursuit	N	4 oz	40.0	160 oz
				Roundup	N	1 pt	40.0	40 pt
				Weedone	N	1 pt	40.0	40 pt
				Pinnacle	N	0.1 oz	40.0	4 oz
			Corn	Bullet	Y	1 gal	29.0	29 gal
				Buctril	N	1.5 pt	29.0	43.5 pt
				Accent	N	0.66 oz	29.0	19.14 oz
N-3	230.0	M. Pitstick	Corn	Accent	N	0.66 oz	190.0	125.4 oz
				Bullet	Y	1 gal	190.0	190 gal
				Buctril	N	1.5 pt	190.0	285 pt
			Beans	Pursuit	N	4 oz	40.0	160 oz
				Roundup	N	1 pt	40.0	40 pt
				Weedone	N	1 pt	40.0	40 pt
				Pinnacle	N	0.1 oz	40.0	4 oz

Table 18

Large Quantity Chemical Materials in the SARA Title III Inventory for CY-1994

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)	>50,000 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
Scintillation 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

1994

Table 19

EML Quality Assurance Program Results for Fermilab Activation Analysis Lab (Sa94;Sa95)

Sample Date	Sample Type	Isotope	Ser	Reported Value	% Error	EML Value	Ratio Rp/EML	+/-	Units
3/94	Air	^{54}Mn	1	0.289E+02	10	0.335E+02	0.86	0.10	Bq/Filter
"	"	^{57}Co	1	0.982E+01	10	0.125E+02	0.79	0.10	"
"	"	^{60}Co	1	0.625E+02	7	0.702E+02	0.89	0.07	"
"	"	^{125}Sb	1	0.225E+02	6	0.233E+02	0.97	0.08	"
"	"	^{137}Cs	1	0.355E+02	10	0.400E+02	0.89	0.10	"
"	"	^{144}Ce	1	0.919E+02	10	0.128E+03	0.72	0.09	"
9/94	"	^{54}Mn	1	0.698E+01	9	0.669E+01	1.04	0.10	"
"	"	^{57}Co	1	0.121E+02	6	0.129E+02	0.94	0.06	"
"	"	^{60}Co	1	0.112E+02	6	0.102E+02	1.10	0.08	"
"	"	^{125}Sb	1	0.303E+02	5	0.253E+02	1.20	0.07	"
"	"	^{134}Cs	1	0.250E+02	5	0.211E+02	1.18	0.06	"
"	"	^{137}Cs	1	0.114E+02	9	0.104E+02	1.10	0.10	"
"	"	^{144}Ce	1	0.740E+02	8	0.814E+02	0.91	0.08	"
3/94	Soil	^{40}K	1	0.392E+03	10	0.337E+03	1.16	0.12	Bq/kg
"	"	^{137}Cs	1	0.160E+03	10	0.141E+03	1.13	0.12	"
"	"	^{238}U	1	0.242E+02	5	0.271E+02	0.89	0.10	"
9/94	"	^{40}K	1	0.372E+03	10	0.428E+03	0.87	0.08	"
"	"	^{137}Cs	1	0.265E+03	10	0.280E+03	0.95	0.14	"
"	"	^{238}U	1	0.176E+02	6	0.330E+02	0.53	0.02	"
3/94	Veg.	^{40}K	1	0.821E+03	10	0.923E+03	0.89	0.09	Bq/kg
"	"	^{60}Co	1	0.361E+02	7	0.340E+02	0.93	0.08	"
"	"	^{137}Cs	1	0.420E+03	10	0.461E+03	0.91	0.10	"
"	"	^{241}Am	1	0.327E+01	28	0.257E+01	1.27	0.39	"
9/94	"	^{40}K	1	0.881E+03	10	0.808E+03	1.09	0.11	"
"	"	^{60}Co	1	0.101E+02	9	0.107E+02	0.94	0.09	"
"	"	^{137}Cs	1	0.157E+03	10	0.148E+03	1.06	0.11	"
"	"	^{241}Am	1	0.329E+01	35	0.816E-03	4.03	1.46	"
3/94	Water	^{3}H	1	0.197E+03	3	0.187E+03	1.05	0.04	Bq/liter
"	"	^{54}Mn	1	0.989E+02	10	0.982E+02	1.01	0.10	"
"	"	^{60}Co	1	0.112E+03	7	0.101E+03	1.11	0.08	"
"	"	^{134}Cs	1	0.175E+03	6	0.154E+03	1.14	0.08	"
"	"	^{137}Cs	1	0.108E+03	10	0.937E+02	1.15	0.12	"
9/94	"	^{3}H	1	0.121E+03	12	0.113E+03	1.07	0.15	"
"	"	^{54}Mn	1	0.102E+03	10	0.108E+03	0.94	0.09	"
"	"	^{60}Co	1	0.356E+03	7	0.317E+03	1.12	0.08	"
"	"	^{134}Cs	1	0.563E+02	6	0.530E+02	1.06	0.07	"
"	"	^{137}Cs	1	0.525E+02	10	0.466E+02	1.13	0.12	"
"	"	^{144}Ce	1	0.410E+03	10	0.491E+03	0.84	0.08	"

1994

Table 20

EML Quality Assurance Program Results for Controls For Environmental Pollution (Sa94)

Sample Date	Sample Type	Isotope	Ser	Reported Value	% Error	EML Value	Ratio Rp/EML	+/-	Units
3/94	Air	^{54}Mn	1	0.348E+02	10	0.335E+02	1.04	0.13	Bq/filter
"	"	^{57}Co	1	0.118E+02	11	0.125E+02	0.94	0.13	"
"	"	^{60}Co	1	0.716E+02	7	0.702E+02	1.02	0.08	"
"	"	^{90}Sr	1	0.684E+00	14	0.716E+00	0.96	0.18	"
"	"	^{125}Sb	1	0.234E+02	5	0.233E+02	1.00	0.08	"
"	"	^{137}Cs	1	0.408E+02	10	0.400E+02	1.02	0.12	"
"	"	^{144}Ce	1	0.120E+03	12	0.128E+03	0.94	0.13	"
"	"	^{241}Am	1	0.538E+00	32	0.391E+00	1.38	0.44	"
3/94	Soil	^{40}K	1	0.347E+03	23	0.337E+03	1.03	0.24	Bq/kg
"	"	^{137}Cs	1	0.180E+03	10	0.141E+03	1.28	0.14	"
"	"	^{238}Pu	1	0.129E+02	9	0.112E+02	1.15	0.13	"
"	"	^{239}Pu	1	0.797E+01	11	0.356E+01	2.24	0.27	"
"	"	BQU	1	0.238E+02	14	0.542E+02	0.44	0.09	"
3/94	Veg.	^{40}K	1	0.954E+03	15	0.923E+03	1.03	0.16	Bq/kg
"	"	^{60}Co	1	0.362E+02	12	0.340E+02	1.06	0.14	"
"	"	^{90}Sr	1	0.716E+03	2	0.575E+03	1.25	0.15	"
"	"	^{137}Cs	1	0.481E+03	10	0.461E+03	1.04	0.12	"
3/94	Water	^{3}H	1	0.256E+03	9	0.187E+03	1.37	0.13	Bq/liter
"	"	^{54}Mn	1	0.920E+02	14	0.982E+02	0.94	0.13	"
"	"	^{55}Fe	1	0.522E+03	8	0.933E+03	0.56	0.05	"
"	"	^{60}Co	1	0.103E+03	7	0.101E+03	1.02	0.08	"
"	"	^{90}Sr	1	0.473E+02	4	0.286E+02	1.65	0.21	"
"	"	^{134}Cs	1	0.151E+03	7	0.154E+03	0.98	0.07	"
"	"	^{137}Cs	1	0.975E+02	10	0.937E+02	1.04	0.11	"
"	"	^{238}Pu	1	0.194E+01	30	0.941E+00	2.06	0.63	"
"	"	^{239}Pu	1	0.131E+01	35	0.956E+00	1.37	0.48	"
"	"	BQU	1	0.109E+01	20	0.105E+01	1.04	0.21	"

Table 21

EML Quality Assurance Program Results for Controls For Environmental Pollution (Sa95)

9/94	Air	^{54}Mn	1	0.734E+01	14	0.669E+01	1.10	0.16	Bq/filter
"	"	^{57}Co	1	0.120E+02	12	0.129E+02	0.93	0.11	"
"	"	^{60}Co	1	0.102E+02	12	0.102E+02	1.00	0.12	"
"	"	^{125}Sb	1	0.914E+02	12	0.253E+02	3.61	0.44	"
"	"	^{134}Cs	1	0.215E+02	18	0.211E+02	1.02	0.18	"
"	"	^{137}Cs	1	0.114E+02	19	0.104E+02	1.10	0.21	"
"	"	^{144}Ce	1	0.738E+02	11	0.814E+02	0.91	0.10	"
"	"	^{238}Pu	1	0.283E+00	11	0.720E-01	3.93	0.48	"
"	"	^{239}Pu	1	0.326E+00	9	0.648E+00	0.50	0.05	"
"	"	^{106}Ru	1	0.527E+01	28	0.575E+01	0.92	0.30	"
"	"	^{90}Sr	1	0.249E+01	7	0.133E+01	1.87	0.15	"
"	"	BQU	1	0.258E+00	20	0.230E+00	1.12	0.23	"
9/94	Soil	^{40}K	1	0.504E+03	22	0.428E+03	1.18	0.28	Bq/kg
"	"	^{137}Cs	1	0.356E+03	13	0.280E+03	1.27	0.17	"
"	"	^{241}Am	1	0.444E+01	30	0.173E+01	2.57	0.78	"
"	"	^{90}Sr	1	0.444E+01	33	0.330E+01	1.35	0.47	"
"	"	BQU	1	0.869E+02	16	0.670E+02	1.30	0.22	"
9/94	Veg.	^{40}K	1	0.978E+03	13	0.808E+03	1.21	0.16	Bq/kg
"	"	^{137}Cs	1	0.163E+03	13	0.148E+03	1.10	0.14	"
"	"	^{60}Co	1	0.132E+02	35	0.107E+02	1.23	0.27	"
"	"	^{239}Pu	1	0.941E+00	16	0.125E+01	0.75	0.15	"
"	"	^{90}Sr	1	0.249E+03	2	0.535E+03	0.47	0.11	"
9/94	Water	^{3}H	1	0.140E+03	25	0.113E+03	1.24	0.32	Bq/liter
"	"	^{54}Mn	1	0.105E+03	11	0.108E+03	0.97	0.11	"
"	"	^{144}Ce	1	0.457E+03	11	0.491E+03	0.93	0.11	"
"	"	^{60}Co	1	0.340E+03	10	0.317E+03	1.07	0.11	"
"	"	^{134}Cs	1	0.478E+02	13	0.530E+02	0.90	0.12	"
"	"	^{137}Cs	1	0.532E+02	14	0.466E+02	1.14	0.16	"
"	"	^{238}Pu	1	0.216E+01	10	0.106E+01	2.04	0.27	"
"	"	^{239}Pu	1	0.486E+00	14	0.602E+00	0.81	0.14	"
"	"	^{90}Sr	1	0.609E+02	3	0.686E+02	0.89	0.05	"
"	"	BQU	1	0.321E+01	12	0.226E+01	1.42	0.17	"

Table 22
CY-1994 Radiochemical Spikes

Spike Number	Radionuclide	AAL T1/2 conc. (pCi/ml)*	CEP T1/2 conc. (pCi/ml)*	CEP Conc. (pCi/ml)	AAL Conc. (pCi/ml)	Percent Recovery CEP	Percent Recovery AAL
9401**	H-3	11.60	11.63	11.000	10.8	0.95	0.93
	Na-22	0.13	0.13	0.094	0.14	0.72	1.08
	Mn-54	0.20	0.20	0.200	0.24	1.00	1.20
	Co-60	0.26	0.26	0.240	0.28	0.92	1.08
9402**	H-3	11.60	11.63	11.000	11.0	0.95	0.95
	Na-22	0.13	0.13	0.110	ND	0.85	—
	Mn-54	0.20	0.20	0.230	0.20	1.15	1.00
	Co-60	0.26	0.26	0.240	0.28	0.92	1.08
9403	H-3	11.52	11.51	8.376	10.1	0.73	0.88
	Na-22	3.30	3.30	3.026	3.07	0.92	0.93
	Mn-54	3.78	3.80	3.821	3.81	1.01	1.01
	Co-60	6.63	6.63	6.596	6.96	0.99	1.05
9404	H-3	11.52	11.51	8.207	10.4	0.71	0.90
	Na-22	3.30	3.30	2.819	3.40	0.85	1.03
	Mn-54	3.78	3.80	3.645	4.14	0.96	1.10
	Co-60	6.63	6.63	6.361	6.84	0.96	1.03
9405	H-3	4.58	4.58	3.69	6.0	0.81	1.31
	Na-22	0.51	0.51	0.51	0.73	1.00	1.43
	Mn-54	0.70	0.70	0.89	0.80	1.27	1.14
	Co-60	1.04	1.04	1.13	1.07	1.09	1.03
9406	H-3	4.58	4.58	3.63	6.0	0.79	1.31
	Na-22	0.51	0.51	0.44	0.57	0.86	1.12
	Mn-54	0.70	0.70	0.79	0.77	1.13	1.10
	Co-60	1.04	1.04	1.10	1.03	1.06	0.99
9407	H-3	45.71	45.64	39.6	50.4	0.87	1.10
	Na-22	0.50	0.50	0.65	0.58	1.30	1.16
9408	H-3	45.71	45.64	40.2	50.7	0.88	1.11
	Na-22	0.50	0.50	0.49	0.40	0.98	0.80
9409	H-3	90.97	90.83	79.8	100	0.88	1.10
9410	H-3	90.97	90.83	79.1	97.0	0.87	1.07
9411	H-3	9.05	9.04	7.98	11.1	0.88	1.23
	Na-22	1.21	1.21	1.26	1.26	1.04	1.04
	Mn-54	1.16	1.17	1.43	1.24	1.22	1.07
	Co-60	0.508	0.508	0.58	0.63	1.14	1.24
9412	H-3	9.05	9.04	8.14	10.9	0.90	1.20
	Na-22	1.21	1.21	1.62	1.21	1.34	1.00
	Mn-54	1.16	1.17	1.76	1.22	1.50	1.05
	Co-60	0.508	0.508	0.73	0.53	1.44	1.04
9413	H-3	541.01	540.12	487	584	0.90	1.08
9414	H-3	541.01	540.12	498	582	0.92	1.08
9415	H-3	8.95	8.94	8.6	9.7	0.96	1.08
9416	H-3	8.95	8.94	9.3	9.4	1.04	1.05
9417	H-3	8.92	8.91	8.17	9.7	0.92	1.09
9418	H-3	8.92	8.91	7.1	10.0	0.80	1.12
9419	H-3	1.78	1.78	ND	1.9	—	1.07
9420	H-3	1.78	1.78	ND	2.0	—	1.12
9421	H-3	17.73	17.70	17.26	19.10	0.98	1.08
9422	H-3	17.73	17.70	14.43	19.30	0.82	1.09
9423	H-3	22.06	22.02	20	24.40	0.91	1.11
	Na-22	2.14	2.14	2.1	1.84	0.98	0.86
	Mn-54	0.40	0.40	0.47	0.52	1.18	1.30
	Co-60	4.79	4.79	5.01	4.48	1.05	0.94
9424	H-3	22.06	22.02	20.29	24.80	0.92	1.12
	Na-22	2.14	2.14	2.24	2.04	1.05	0.95
	Mn-54	0.40	0.40	0.49	0.45	1.23	1.13
	Co-60	4.79	4.79	5.84	5.11	1.22	1.07

ND - Not Detected

* Vendors use slightly different half-lives (T1/2)

**Analyzed at TMA/Eberline, Albuquerque, NM

1994

Table 23

RADIOCHEMICAL RESULTS FOR 45-DEGREE MONITORING WELLS AT THE FIXED TARGET BEAMLINE ACTIVATION AREAS 1994

WELL	SAMPLE DATE	PURGE	H-3 pCi/ml Result	H-3 pCi/ml Error	H-3 Bq/ml Result	H-3 Bq/ml Error	Na-22 pCi/ml Result	Na-22 pCi/ml Error	Na-22 Bq/ml Result	Na-22 Bq/ml Error
S-1058	19-Apr	Pre	1.10E+00	8.00E-01	4.07E-02	2.96E-02	0.00E+00	4.00E-02	0.00E+00	1.48E-03
	22-Apr	Post	2.20E+00	8.00E-01	8.14E-02	2.96E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
S-1059	16-May	Pre	1.70E+01	1.10E+00	6.29E-01	4.07E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	1-Jun	Post	1.31E+01	1.00E+00	4.85E-01	3.70E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	27-Jun	Pre	1.30E+01	1.00E+00	4.81E-01	3.70E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
	1-Jul	Post	1.01E+01	1.00E+00	3.74E-01	3.70E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
	19-Aug	Pre	1.21E+01	1.00E+00	4.48E-01	3.70E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	26-Aug	Post	1.01E+01	1.00E+00	3.74E-01	3.70E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	17-Oct	Pre	1.44E+01	5.00E-01	5.33E-01	1.85E-02	0.00E+00	2.00E-02	0.00E+00	7.40E-04
	1-Nov	Post	1.19E+01	1.00E+00	4.42E-01	3.70E-02	0.00E+00	2.00E-02	0.00E+00	7.40E-04
S-1087	19-Apr	Pre	4.10E-01	7.60E-01	1.52E-02	2.81E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
	22-Apr	Post	2.90E+00	8.00E-01	1.07E-01	2.96E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
	19-Aug	Pre	3.00E+00	8.00E-01	1.11E-01	2.96E-02	0.00E+00	2.00E-02	0.00E+00	7.40E-04
	26-Aug	Post	1.60E+00	8.00E-01	5.92E-02	2.96E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
S-1088	19-Apr	Pre	1.01E+01	9.00E-01	3.74E-01	3.33E-02	0.00E+00	2.00E-02	0.00E+00	7.40E-04
	22-Apr	Post	9.00E+00	9.00E-01	3.33E-01	3.33E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
	19-Aug	Pre	5.10E+00	9.00E-01	1.89E-01	3.33E-02	0.00E+00	3.00E-02	0.00E+00	1.11E-03
	26-Aug	Post	4.10E+00	9.00E-01	1.52E-01	3.33E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04
S-1089	19-Apr	Pre	3.80E+00	8.00E-01	1.41E-01	2.96E-02	0.00E+00	2.00E-02	0.00E+00	7.40E-04
	19-Aug	Pre	3.80E+00	9.00E-01	1.41E-01	3.33E-02	0.00E+00	1.00E-02	0.00E+00	3.70E-04

1994

Table 24

EIS/ODIS Activity (mCi of H-3) Summary Report for Liquid Releases in CY 1990-1994

		CY 94	CY 93	CY 92	CY 91	CY 90
M01SP3	DISCHARGE	24	46	39	79	46
	EFFLUENT	8	30	12	59	37
N01SP4	DISCHARGE	250	721	499	447	245
	EFFLUENT	47	462	160	300	174
NW4SP1	DISCHARGE	54	106	78	134	1650
	EFFLUENT	16	72	23	87	1370
NTSBSP1	DISCHARGE	0.4	--	--	3,600	--
	EFFLUENT	0.2	--	--	3,200	--
CUB Regeneration Effluent to Batavia Sewers		4.4×10^{-1}	*	*	*	*

Water was released offsite an estimated 89 days or 24% of the year in CY-1994.

An estimated total of 71.2 mCi of activity, as H-3, was reported released offsite by liquid effluent in CY-1994.

* Not Operational

1694

Table 25

CY-1992/1993/1994 Annual Air Emissions from Permitted Sources as Reported to the IEPA

Pollutant	Allowable Emissions (tons/year)	Reported Emissions for 1992 (tons/year)	Reported Emissions for 1993 (tons/year)	Reported Emissions for 1994 (tons/year)
Carbon Monoxide	30.9776	0.7875	0.7875	0.4880
Nonvolatile Organic Material	1.4725	0	0	0.1297
Nitrogen Oxides	41.3068	3.9509	3.6675	1.2815
Particulate Matter	16.2643	0	0.0009	0.2045
Volatile Organic Material	12.5244	0.0325	0.0333	0.0371
Sulfur Dioxide	40.9221	0	0	0.0090

1994

Table 26

Reported NPDES Values

Month/ Year	Outfall 001 FERRY CREEK			Outfall 002 KRESS CREEK				Outfall 003 INDIAN CREEK			
	pH	Flow (MGD)	Temp. (F)	pH	Flow (MGD)	Temp. (F)	Chlorine (mg/l)	pH	Flow (MGD)	Temp. (F)	Chlorine (mg/l)
Aug-94	8.35	0.3	73	7.52	0.02	63	0.03	8.68	1.1	79	0.08
Sep-94	8.86	0.2	64	NF	NF	NF	NF	8.21	0.6	72.5	0.08
Oct-94	8.95	0.03	48	NF	NF	NF	NF	8.51	1.0	56	0.03
Nov-94	8.49	5.7	48.6	7.86	4.7	59	0.02	7.91	0.7	62.2	0.05
Dec-94	8.55	4.1	37.2	7.93	0.97	39.7	0.02	8.14	0.5	47.8	0.04
Jan-95	8.83	5.7	34.9	7.3	0.5	36	0.03	8.07	1.29	48.2	0.02
Feb-95	8.1	4.5	40.8	7.6	0.48	33.6	0.02	8.56	0.88	46.4	0.00
Mar-95	8.28	4.5	50.7	7.9	1.14	59.7	0.08	8.71	1.2	66.4	0.12

NF = No Flow

1994

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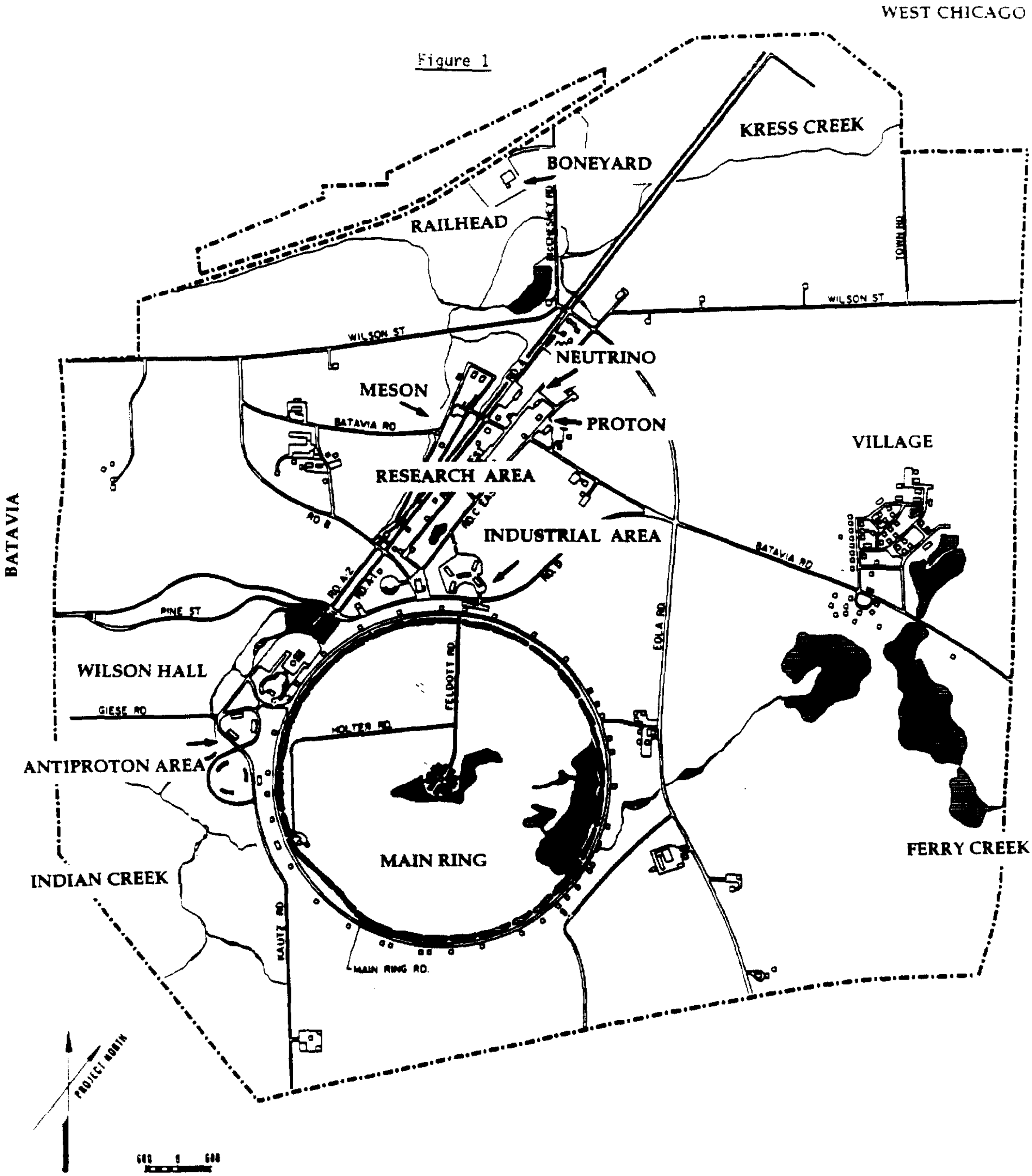
1994

FIGURES

Figure 1



GENERAL FEATURES

Figure 2 - Fermilab Site

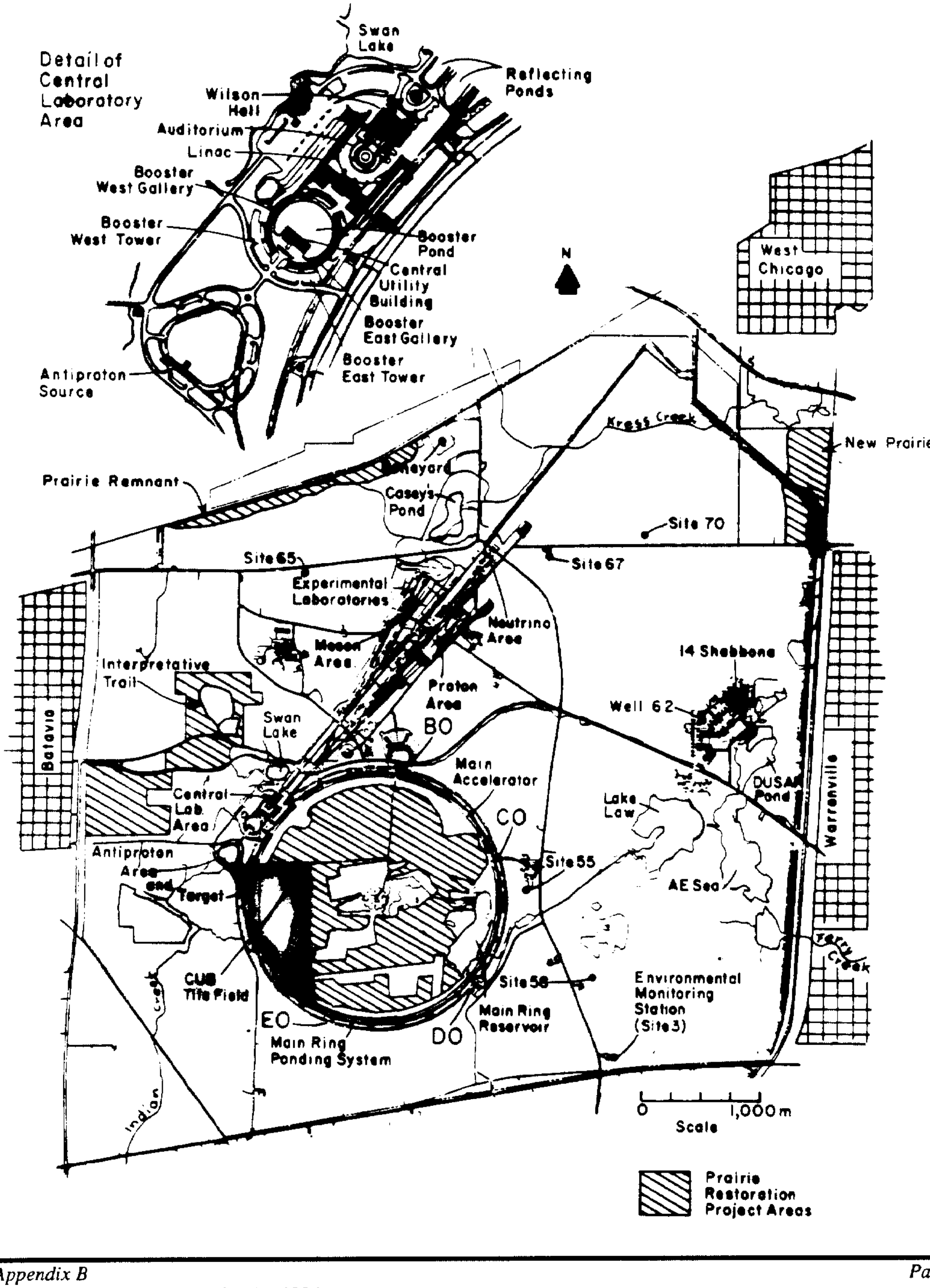
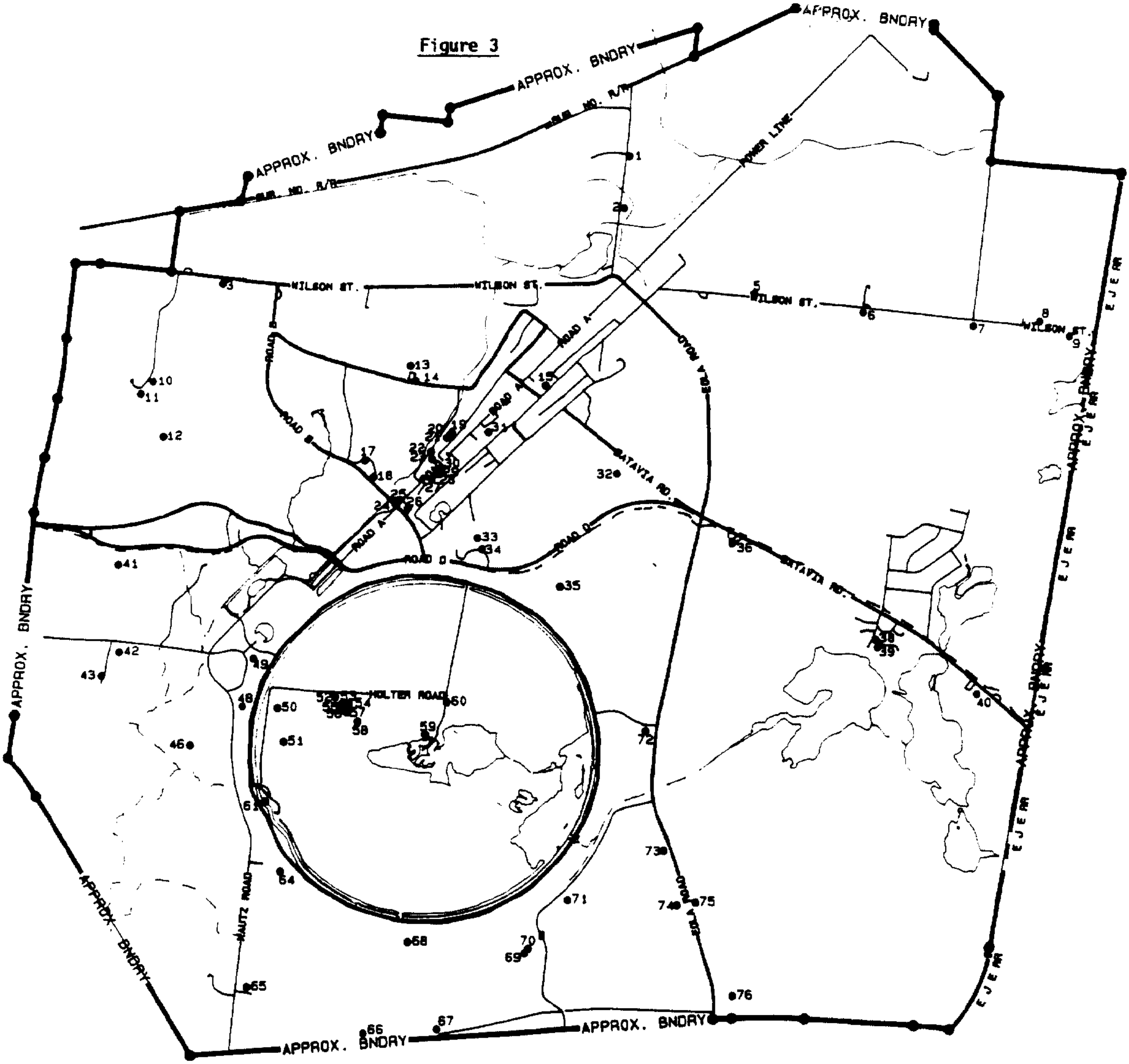
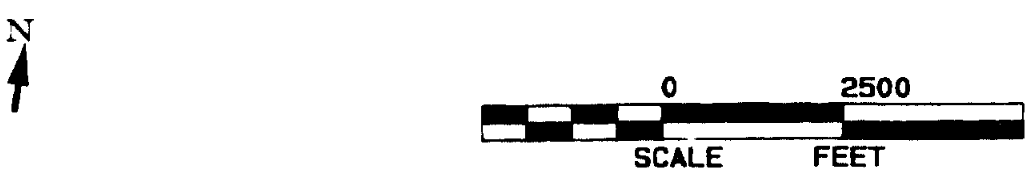


Figure 3



FERMILAB SITE WELL LOCATIONS.



Fermilab Wells 1994

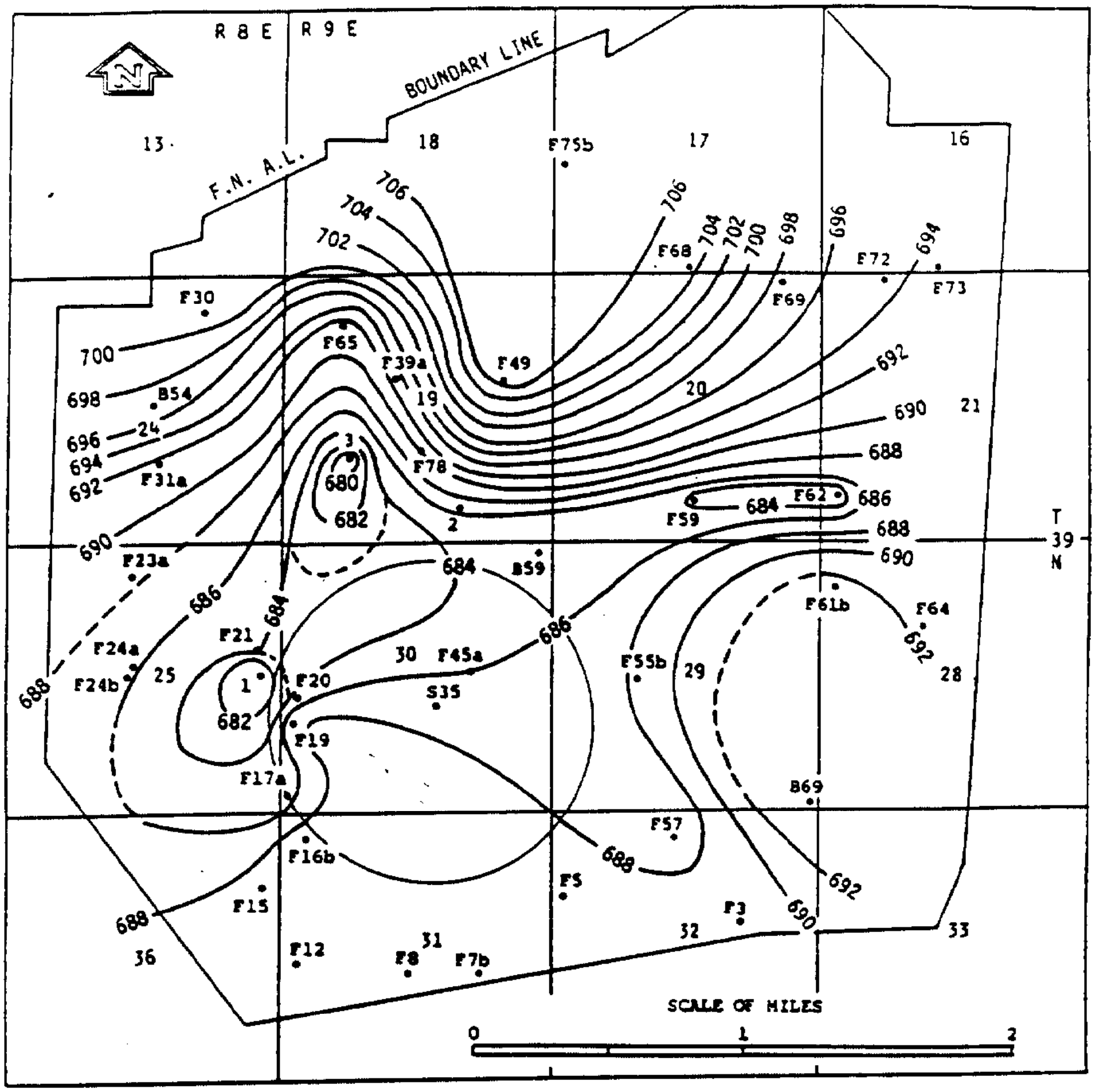
Well #	Map Number	County	Use	Depth (ft)
3	76	DuPage	Monitoring	120
5	69	DuPage	Monitoring	110
7	67	DuPage	Monitoring	122
8	66	DuPage	Monitoring	68
12	65	DuPage	Monitoring	80
16	64	DuPage	Monitoring	90
19	51	DuPage	Monitoring	115
20	50	DuPage	Monitoring	120
39	14	DuPage	Monitoring	170
43	34	DuPage	Monitoring	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 8/23/93	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	65
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
B58	35	DuPage	Monitoring	82
MSS SS	24	DuPage	Monitoring	18
MSS SD	24	DuPage	Monitoring	40
MSS BS	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	NTNC	222
W-6	71	DuPage	NTNC	220
W-1	49	Kane	NTNC	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
66	5	DuPage	Semi-private	169
29	11	Kane	Semi-private	130

NTNC = Non-Transient, Non-Community

Figure 4

FERMI NATIONAL ACCELERATOR LABORATORY

DuPage & Kane Counties, Illinois



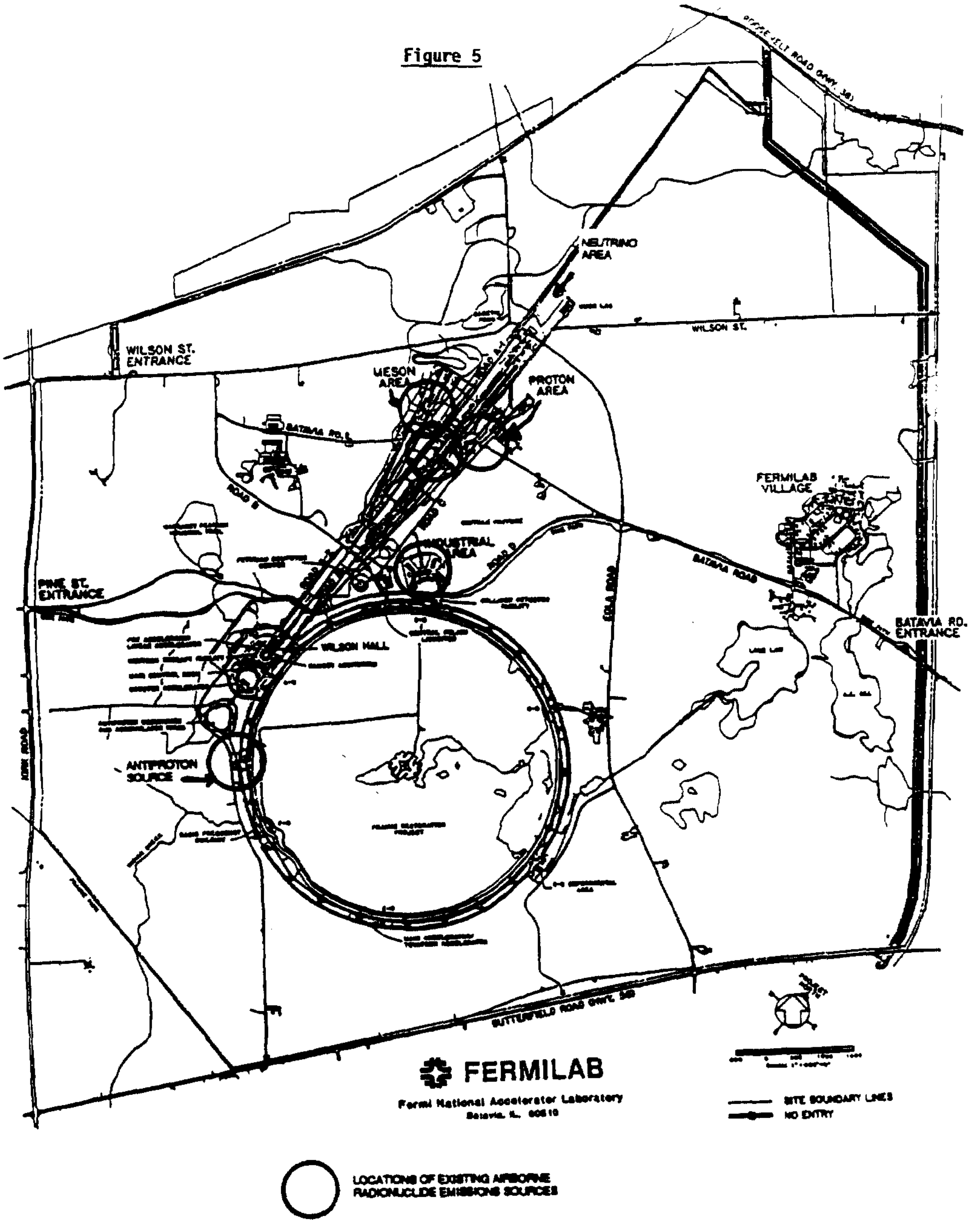
SHALLOW DOLOMITE AQUIFER

PIEZOMETRIC SURFACE

Elevations in feet above mean sea level

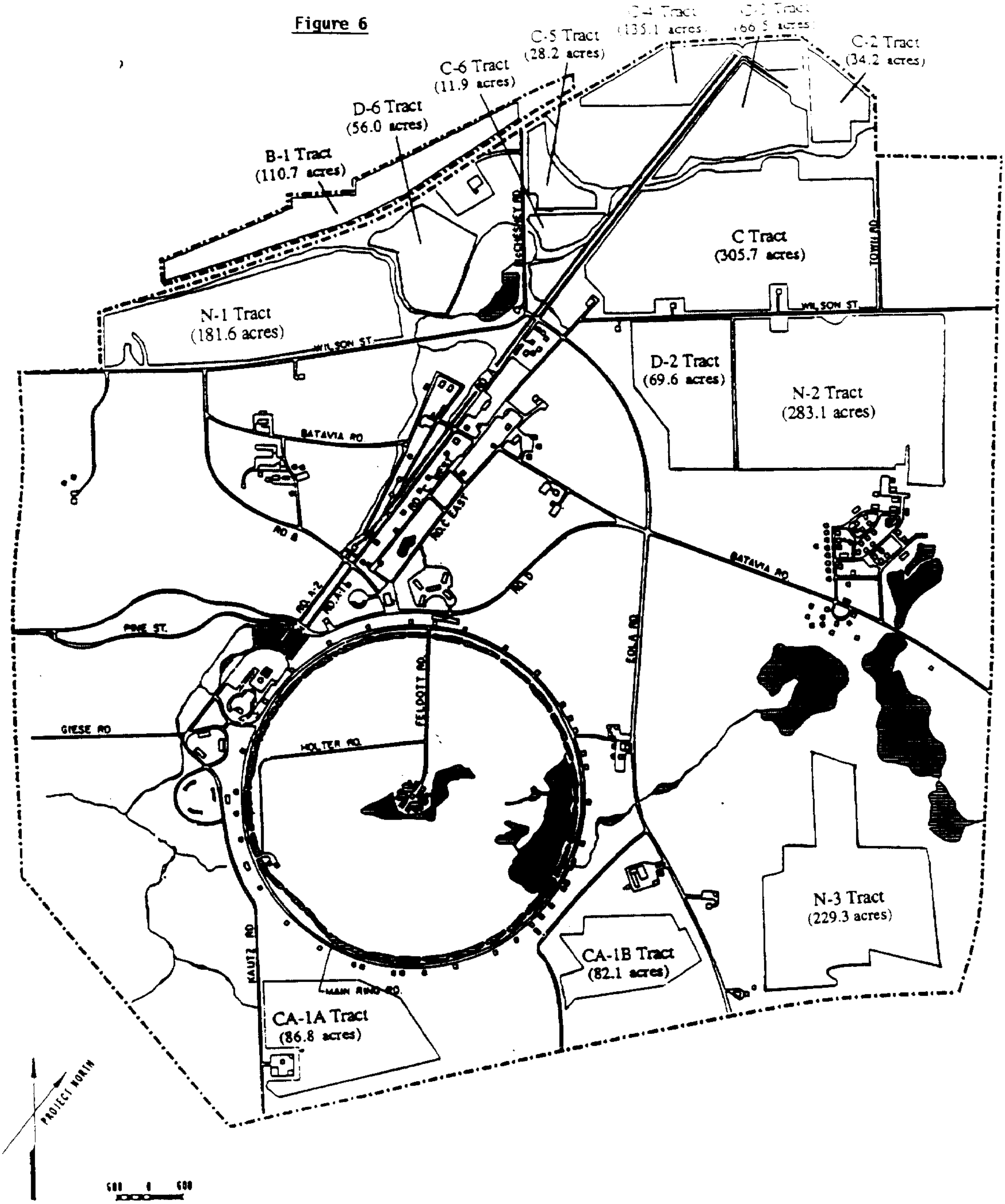
Illinois State Water Survey
June 1978

Figure 5



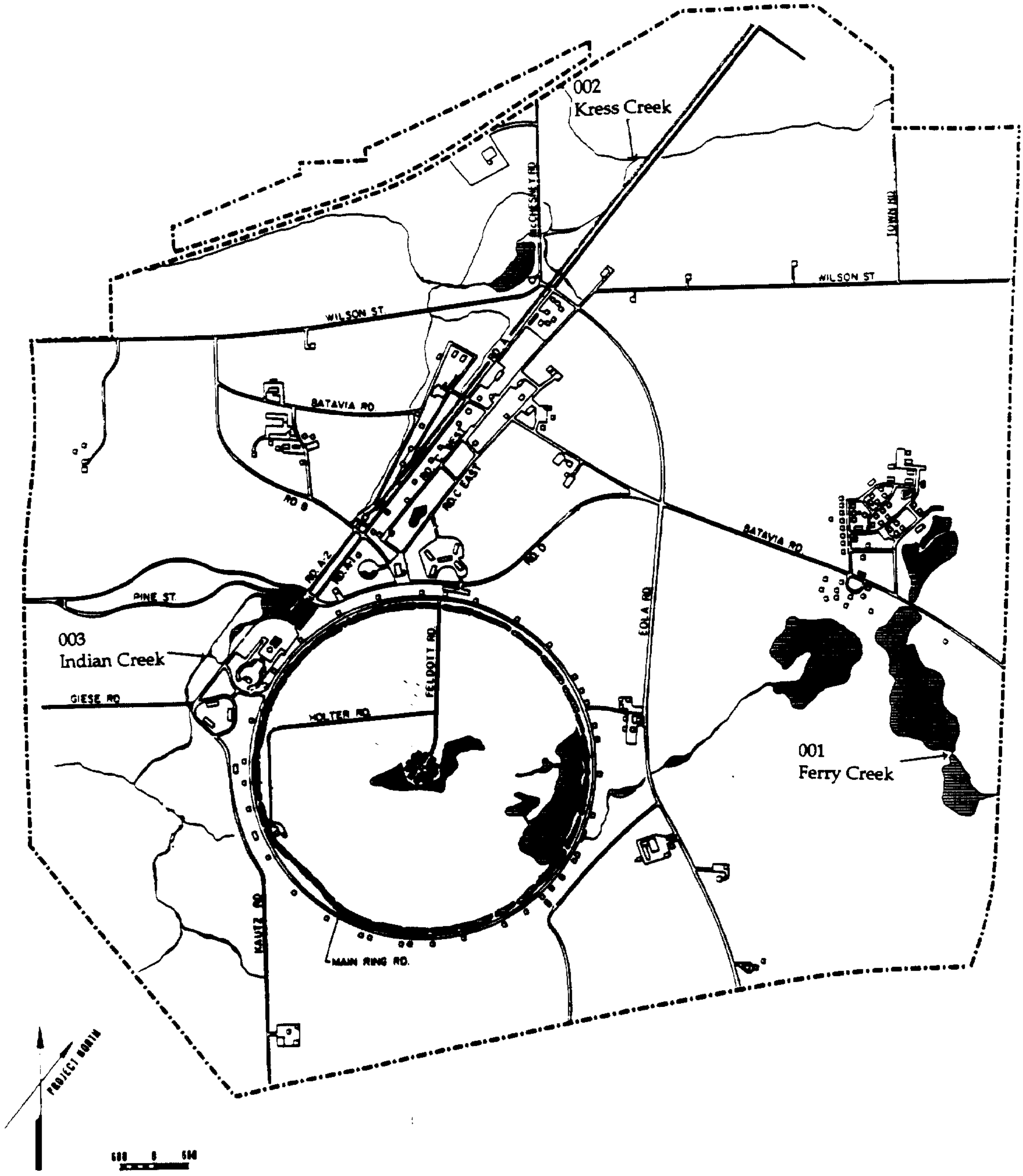
Map of the Fermilab site showing existing facilities including locations of existing sources of radionuclide emissions.

Figure 6



Leased Farm Tracts CY 1994
Fermi National Accelerator Laboratory

Figure 7



NPDES Outfall Locations

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
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COD	Chemical Oxygen Demand
CUB	Central Utilities Building
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guides
DOE	U.S. Department of Energy
EA	Environmental Assessment
ECO	Employee Commute Options
EE	Environmental Evaluation
EIS	Environmental Impact Statement
EIS/ODIS	Effluent Information System/Offsite Discharge Information System
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
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
FMI	Fermilab Main Injector
FONSI	Finding of No Significant Impact
FWS	Fish and Wildlife Service
GPMP	Ground Water Protection Management Plan

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
IDOT	Illinois Department of Transportation
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
LUST	Leaking Underground Storage Tank
MAP	Mitigative Action Plan
MCL	Maximum Contaminant Level
MERL	Mobile Environmental Radiation Laboratory
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
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
NON	Notice of Noncompliance
NPDES	National Pollutant Discharge Elimination System
NPDWR	National Primary Drinking Water Regulations
NTF	Neutron Therapy Facility
NTNC	Nontransient-Noncommunity
OCCT	Optimum Corrosion Control Treatment
OSHA	Occupational Safety and Health Act
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyls
PRP	Potentially Responsible Party
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
SWPPP	Storm Water Pollution Prevention Plan
TLD	Thermoluminescent Dosimeter
TSCA	Toxic Substances Control Act
UIC	Underground Injection Control Well
URA	Universities Research Association, Inc.
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
VOM	Volatile Organic Materials
WQP	Water Quality Parameters