FERMILAB

Report to the Director on the Fermilab Environment CY2005

1.0 Introduction

Environmental stewardship continued to be a guiding principle at Fermilab in 2005. That principle was translated into a working reality through the effective deployment of the environmental protection program. The environmental protection program (EPP) establishes policies and procedures to ensure compliance with regulatory requirements imposed by Federal, State and local agencies and with Department of Energy (DOE) orders. In addition, the EPP provides for the measurement and interpretation of the impact of Fermilab operations on the public and the environment via its comprehensive environmental monitoring and surveillance program.[1]

Surveillance and monitoring tasks are conducted to confirm compliance with standards and permit limits as well as ensure early detection of an unplanned pollutant release. The location and frequency of sampling are based on established routines, operational considerations and historic levels of pollutants found in each location. Sampling points are selected based on the potential for adverse impacts.

To evaluate the effects of Fermilab operations on the environment, samples of effluents and environmental media such as soil and groundwater are collected on the site and at the site boundary. These samples are analyzed and results are compared to applicable guidelines and standards. The status of environmental protection activities and the progress on environmental restoration, waste management and corrective action activities are discussed in this report. In 2005 there was an anomalous occurrence that impacted the public and the environment[2]; minute levels of tritium were detected for the first time at the site boundary in Indian Creek (further details are provided in Section 2.0 Significant Environmental Activities).

2.0 Significant Environmental Activities

- In September of 2005 Fermilab's Environmental Management System (EMS) was evaluated by a three member assessment team comprised of individuals from the DOE Chicago Operations Office (CH), the DOE Argonne Site Office, and Argonne National Laboratory, to provide the Fermilab Site Office (FSO) with a basis for formally declaring that Fermilab had implemented the EMS related requirements contained in EO 13148 and DOE Order 450.1. The assessment included review of the following: FESHM Chapter 8010 which documents the Lab's EMS program; Fermilab's Management and Operations contract with DOE, including all environmentally related contractual performance measures; and the merging of EMS and ISM into a fully assimilated 'Integrated ES&H Management System.' The conclusion of the assessment was that the EMS program documentation and structure had been adequately developed, that the EMS program implementation was progressing satisfactorily, and that it was reasonable to expect Fermilab to meet the EMS implementation deadline. In addition, the review team issued a positive recommendation to the FSO Manager concerning the EMS Self-Declaration Process for Fermilab. In December of 2005, the FSO Manager stated, in a letter to Ray Orbach, DOE Office of Science Director, that "Fermilab fully conforms to the EMS requirements of DOE Order 450.1."

- Numerous sumps collect and drain water from building footings and from under beamline tunnels in the Tevatron, Main Injector and the Experimental Areas. Water collected by these sumps often contains detectable concentrations of radionuclides (primarily tritium, ^{3}H) that have been leached by rainwater from radioactive soil near beam targets and absorbers or released accidentally to sumps from beamline cooling water systems. These sumps discharge to ditches and ponds onsite. Surface water monitoring conducted during 2005 showed tritium concentrations to be well within the Department of Energy Derived Concentration

Guides for allowable radionuclide releases to surface waters (2000 pCi/ml); however, in November 2005, during routine surface water surveillance monitoring, Fermilab detected, for the first time, low levels of tritium in Indian Creek. Upon the discovery of tritium, an investigation was begun to determine the cause and extent of this radionuclide in surface waters. The highest level of tritium discovered in Indian Creek was 3.4 pCi/ml. Low level concentrations of tritium were also found in the Main Injector cooling ponds and several other ponds associated with the Industrial Cooling Water (ICW) system. To address potential concerns, in early December 2005, Fermilab voluntarily notified, by letter, our immediate downstream neighbors in the Savannah Subdivision of the tritium detected in Indian Creek. Together DOE and Fermilab authorities also notified by phone the U.S. Environmental Protection Agency (EPA), Illinois EPA, and the Illinois Emergency Management Agency (IEMA) concerning the detection of tritium in the creek. In mid December, at the Lab's invitation, IEMA took samples, to confirm the presence of tritium, from Indian Creek and the Fermilab cooling ponds. An investigation to identify the source and extent of the tritium in the creek and cooling ponds was initiated.

- To date, the investigation of impacts on groundwater from the Neutrinos at the Main Injector (NuMI) tunnel has shown no adverse effects on the potentiometric (electromotive force) surface of groundwater in the Class I resource beyond the Fermilab boundary. There have, however, been localized impacts to site operations in the area of the tunnel. During the majority of 2005, domestic water for supply to the west campus area at Fermilab was pumped from two relatively shallow wells that draw groundwater from the dolomite aquifer. One of these wells (W-1) is located approximately 1000 feet from the centerline of the NuMI beamline and has experienced a marked reduction in capacity due the changed hydrogeologic conditions and subsequent equipment incompatibility (pumps and other well infrastructure were designed for different hydrogeologic conditions). Ground motion studies within the 8 GeV line (from Booster to Main Injector) conducted during 2001 and 2002 showed that flows greater than 100 gallons per minute from well W-1 would adversely impact beam quality. Therefore, the well was operated at very low flow during 2004 and supply well W-3, which had previously been used for backup purposes, became the primary supply of drinking water. In late 2005 the source of domestic drinking water was altered from onsite supply wells to purchased water from the City of Warrenville. As a result of this change, the two previously active onsite supply wells (W-1 and W-3) were disconnected from the domestic water supply system and now serve only to supplement the Industrial Cooling Water (ICW) system.

- Fermilab continued through 2005 to implement corrective actions in response to an oil spill that occurred in August of 2004 resulting from the failure of a heat exchanger associated with a Central Helium Liquefier (CHL) Coldbox-2. Approximately 27 gallons of mineral oil were released into Bull Rush Pond where it was confined and cleaned-up. The details of the corrective actions can be found in Section 4.15, Oil Spill Prevention.

2.1 Other Environmental Issues

Fourteen National Environmental Research Park (NERP) projects were conducted during 2005. The projects along with the name of the sponsoring institution are listed below:

- Assessment of the Impact of Biological Controls on Garlic Mustard (*Alliara petiolata*) and on Non-target Species in Forest Communities, Argonne National Laboratory
- Assessment of the Impact of Biological Controls on Garlic Mustard (*Alliara petiolata*) and on Non-target Species in Forest Communities, Cornell University
- Bird Surveys at Fermilab, Fermilab
- Feedbacks between Plants, Mycorrhizal Fungi, and Soil Nutrient Dynamics, Argonne Nationa Laboratory
- Effects of Tree Removal on Recovery of Ground Cover in Big Woods at Fermilab, Fermilab
- Bat House Project at Fermilab, National Speleological Society
- Translocation of Silver-bordered Fritillary, Bolaria selene at Fermilab, Peggy Notaebart Museum
- Assessing Carbon Cycling in Restored Grasslands using Stable Isotopes, Argonne National Laboratory
- Investigation of Carbon Dioxide and Nitrogen Fluxes in Terrestrial Ecosystems at Fermilab, Argonne National Laboratory

- Insect community restoration assessment within the Fermilab Prairie Restoration project, Northeastern Illinois University
- Long term ecological studies at Fermilab, Argonne National Laboratory
- Distribution and relative abundace of gray fox, *Urocyon cinereoargenteus* in northeastern Illinois and possible interaction with coyotes, Ohio State University and Max McGraw Wildlife
- Hydrologic and plant community Controls on soil carbon accreal after cessation of agriculture, Argonne National Laboratory
- Ascomycete fungi in bison dung from the Fermilab bison herd, The Field Museum

The Laboratory's Ecological Land Management Plan[3] was updated in 2005. The plan can be viewed at www-esh.fnal.gov/ELM/ELM_Plan_2005.htm. Existing prairie tracts were enriched with forbs and burned or mowed to discourage intrusion of brush, trees and exotic plants.

The moratorium, issued by the Secretary of Energy in July 2000, on recycling of scrap metals from posted radiological or radioactive materials areas, remained in effect throughout 2005. Measures continued to be taken throughout the year at Fermilab to separate materials subject to this moratorium. Due to this, materials that were considered non-radioactive according to Fermilab's DOE-approved release criteria and which had been recycled prior to the moratorium continued to be amassed.

Fermilab carries out wildlife management to the extent necessary to protect the primary mission of the Laboratory and to preserve the Fermilab ecosystem. The Lab has a "nuisance animal" permit issued by the Illinois Department of Natural Resources (IDNR) that allows for the trapping and elimination of these nuisance animals. During 2005, six animals were destroyed. In addition, Fermilab intensively manages the population of whitetail deer on site to preserve the ecosystem. Fermilab contracts with the U.S. Department of Agriculture Wildlife Services Group to reduce the herd to an optimum number annually. This activity requires approval and permitting from IDNR; during 2005, 79 whitetail deer were removed.

2.2 Environmental Management Systems (EMS)

Executive Order (EO) 13148, *Greening the Government through Leadership in Environmental Management*, requires each Federal agency to implement an Environmental Management System (EMS) at its facilities by December 31, 2005. Subsequently, the DOE issued Order 450.1 to ensure execution of EO 13148 at all DOE facilities. An EMS is a continuous cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve compliance, pollution prevention, and continuous environmental improvement goals. In addition, a comprehensive EMS will assimilate the principles of the Integrated Safety Management System (ISMS) into an Integrated ES&H Management System (IES&HM), addressing facility operations hazards that have the potential to impact individuals and/or the environment.

In late 2003, the DOE Office of Environment, Safety and Health (EH) distributed a memorandum that requested follow-up information from area offices regarding the status of implementation of EMS's at all Office of Science (SC) sites. The request included a matrix implementation schedule spanning from FY2003 through FY2005 for seven EMS elements; the matrix was expanded to include eight EMS elements in early FY2004. Fermilab completed all of the FY2005 scheduled implementation items, which included the following: instituting a formal ongoing program to ensure the conducting of facility-wide EMS awareness training, establishing all EMS procedures, implementing EMS, and completing the EMS self declaration protocol.

During April of 2005, Joe DiMatteo of the DOE Chicago Office (CH), Safety and Technical Services, reviewed the implementation status and progress of EMS at Fermilab. The assessment concluded that Fermilab was on course to allow the Fermilab Site Office (FSO) to self-declare to the Program Secretarial Office that EMS implementation had been achieved. The timely initiation of the self-declaration process was a result of finalizing the draft FESHM Chapter 8010 and the completion of EMS training for Fermilab personnel.

Again in July of 2005, another status review was conducted by Joe DiMatteo. In addition to assessing implementation progress, this review also appraised the elements of Fermilab's EMS. Specifically, the following

were reviewed: the gap analysis, conformity of Fermilab's EMS to the DOE Guide (G) 450.1-2, integration linking EMS and ISMS, and the effectiveness of previously implemented EMS mechanisms and processes. The conclusion of the review was that Fermilab should be able to meet the scheduled EMS implementation completion date of 12/31/2005 provided that the future efforts toward commitments to the FSO were analogous to that exhibited thus far.

Also in July of 2005, Fermilab held its first Management Review for the EMS through the Self-Assessment process. The assessment team was lead by Jed Brown, Associate Director of Operations Support, with participation from the FSO and the ES&H Section. The management review focused on the EMS status audit (conducted by Joe DiMatteo and described above) results; the continuing suitability of the EMS policy; environmental objectives, targets and performance; and revision of the senior management Individual Training Needs Assessment (ITNA) to require an EMS training module tailored for senior managers. No findings were generated as a result of this audit. Noted action items were addressed and corrections were employed during the audit.

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3.0 Environmental Monitoring and Surveillance

The goal of the Fermilab Environmental Monitoring Program (EMP) is to assist Laboratory management in decision-making by providing data relevant to impacts that Fermilab operations have on the surrounding environment. The EMP consists of effluent monitoring to confirm compliance with permits, generally at a particular point. Environmental surveillance is conducted at various locations to intercept the pathway of potential pollutants to receptors such as plants, animals or members of the public. Fermilab collects environmental data for reporting purposes or whenever it is necessary or useful in conducting the business of the Laboratory. Line organizations have the responsibility to recognize and understand the environmental aspects of their operations and to conduct their work in an environmentally sound manner.

The pathways available for movement of radioactive materials and chemicals from Fermilab operations to the public are the atmosphere, surface water and groundwater. Environmental surveillance consists of collecting and analyzing samples of various media and measuring penetrating radiation within and at the site boundaries.

Ground and surface waters are sampled at locations near operating areas, potential contamination sources and along potential transport pathways. In addition to air and water surveillance, samples of soil are collected and analyzed for radioactivity to ascertain whether there is build-up of radioactive materials in the environment due to long-term operations.

Surface water, air, groundwater, soil and sediment samples are analyzed for radionuclide concentrations. Surface waters are also monitored for potential chemical constituents. While levels of penetrating radiation are measurable near operational areas on the site, the levels decrease rapidly with distance from the sources. External penetrating radiation and airborne emissions are normally below instrument detection levels at the site boundary and must be estimated to provide information about the maximum potential radiation doses to offsite populations. The results of the environmental surveillance program are interpreted and compared with environmental standards where

applicable. The Fermilab Environmental Monitoring Plan, which is maintained by the ES&H Section, provides more details.

The DOE advocates that sites address radiological protection of aquatic and terrestrial biota and has recommended that facilities review their monitoring programs for opportunities to improve and communicate their results. In response, Fermilab has used DOE's technical guidance (DOE-STD-1153-2002) and companion tool, the RAD-BCG Calculator, to evaluate the Laboratory's effect on both aquatic and terrestrial biota. On an annual basis soil and sediment samples are collected throughout the site in conjunction with water samples collected from sumps, ditches, and creeks according to routine sampling schedules. For the calendar year 2005, all locations analyzed passed the site screens. Thus, the radiological protection of biota is considered to be adequate.

3.1 Air Quality

Fermilab's Lifetime Operating Air Pollution permit issued by the Illinois Environmental Protection Agency (IEPA) under the Clean Air Act includes a *National Emissions Standards for Hazardous Air Pollutants* or NESHAPs element, which covers airborne radionuclides. In addition, the permit takes into account those criteria pollutants such as particulate matter, nitrogen oxides, carbon monoxide, volatile organic materials and sulfur oxides associated with the operation of various pieces of equipment.

Airborne radionuclides are normally released to the atmosphere from operating target stations. Measures, to keep these releases as low as reasonably achievable (ALARA), are incorporated into the operating processes and procedures at these facilities. Monitoring is conducted at targeting areas where air emissions are considered a significant contributor to the overall transport of radioactive materials offsite. In addition, a small quantity of airborne radionuclides is contributed by the operation of the Magnet Debonding Oven. The air permit was revised in 1991 by the IEPA to include the Main Injector as a source of radioactivation at Fermilab. The air permit application stated that total activity released from the Lab would average no greater than 2000 Ci/year with a maximum of 9000 Ci/year.

The radiation doses potentially received by the offsite public due to Fermilab operations are calculated from data gathered through environmental surveillance of the onsite sources. Selected vent stacks are monitored directly with stack monitors and indirectly by taking soil samples in the vicinity of the stacks. The dose for the air pathway is calculated using a Gaussian plume computer simulation model called Clean Air Assessment Package-1988 (CAP-88PC2). This model was created by the USEPA to predict the movement of airborne radionuclides and its use is dictated by regulations governing hazardous air pollutants at 40 CFR 61. Maximum calculated concentrations offsite are predicted to be below the level that could be detected by direct monitoring.

Fermilab is not a significant source of chemical air pollution. The permits cover emissions caused by open burning conducted for prairie/land management and fire extinguisher and firefighter training, a magnet debonding oven, a fuel dispensing facility, a vapor degreaser, a 2200 horsepower emergency standby diesel fuel fired generator, and the operation of several natural gas-fired boilers. Pollutant levels are estimated based on the knowledge of the processes that generate them and the characteristics of individual pollutants. The results are submitted to the Illinois Environmental Protection Agency in an annual air emissions report.

3.1.1 Radioactive Air Emissions

Operation of the debonding oven, while radioactive components are being burned, is a potential source of tritium. In 2005 the debonding oven did not burn any radioactive magnets (there were other magnets burned); therefore there was no release of tritium from this source. The Anti-Proton Area stack, used in Colliding Beam operations, and the MiniBooNE and NuMI stacks are estimated to have released a total of approximately 50.05 Curies in 2005. These radioactive air emissions were approximately 2.5% of the annual average (2000 Curies) expected from operations as acknowledged in the current air pollution permit application on file with the Illinois Environmental Protection Agency (IEPA). No detectable levels of radionuclides reached the site boundaries. Doses to the public from emissions in 2005 continued to be well below the Environmental Protection Agency (EPA) standard of 10 mrem/year and also

much less than the EPA's continuous monitoring threshold of 0.1 mrem/year. Using the CAP-88PC2 gaussian dispersion model, the highest dose equivalent to any member of the public was estimated to be 0.0216 mrem.

Fermilab's 2005 Radionuclide Air Emissions Annual Report was submitted to the DOE FSO in May 2006. The report is distributed by the DOE FSO to the USEPA and IEPA.

3.1.2 Non-Radioactive Air Emissions

The IEPA decided in late 1996 that the level of air emissions at the Laboratory did not warrant the issuance of a Federally Enforceable State Operating Permit (FESOP) and therefore issued a Lifetime Operating Permit to Fermilab in 1999 that included all air pollution sources existing at that time. In 2000, the permit was revised to add a vapor degreaser to the previously permitted air pollution sources and again in 2004 to include a 2200 horsepower emergency standby diesel fuel fired generator located at the Feynman Computing Center. The current permit covers the magnet debonding oven, three natural gas-fired boilers at the Central Utility Building (CUB), a 12,000-gallon gasoline storage tank with a stage 1 and stage 2 vapor balance system, accelerator tunnel ventilation stacks, a vapor degreaser at Industrial Building 3 and the standby diesel generator. Permit conditions require the monthly logging of fuel consumption for covered fuel combustion sources and solvent usage at the degreaser. Source operations were reviewed by Fermilab personnel again this year to ensure that permitted equipment continued to operate and be maintained in accordance with permit conditions. The Annual Air Emission Report for 2005, an estimate of criteria pollutant emissions, was submitted to the Illinois Environmental Protection Agency (IEPA) in May 2006.

3.2 Penetrating Radiation

Operation of the Fermilab accelerator and associated beamlines produce ionizing radiation such as muons. Beamlines and experiments are designed so that most of the radiation has ranged out before reaching the ground surface. The remaining radiation that emerges above the surface presents a small potential for radiation dose. Small muon fields have been measured in conjunction with the operation of the Fixed Target beamlines in the past. These beamlines were not operated in 2005. Since the removal of the Main Ring from the Tevatron tunnel, the A0 beam absorber replaced the C0 beam absorber as the primary absorber. Unlike the C0 absorber, the Tevatron beam has to be bent down into the ground to be directed to the A0 absorber. Due to this beamline feature, the ground absorbs the muons emerging from the A0 absorber. Therefore, no muons are detected from its operation. Both the MiniBooNE and NuMI experiments have the potential to produce measurable muon flux; however, the 8 GeV energy protons used in MiniBooNE are too low in energy to produce muons that can escape the bulk shielding surrounding the experiment. The NuMI beamline bends the beam down so that the muons produced are absorbed deep underground.

Storage of radioactive materials at a centralized onsite location, known as the Railhead, resulted in another potential exposure to ionizing radiation. These sources of penetrating radiation were monitored continuously in 2005 by a large ionization chamber located in the Railhead colloquially called a 'Hippo.' The Hippo measurements are supplemented by periodic onsite surveys. Based on measurements made in 2005, it is estimated that radioactive materials stored at the Railhead contributed a dose equivalent at the site boundary in 2005 of approximately 0.152 mrem. The maximum radiation dose equivalent to an individual at the nearest offsite house was similarly estimated to be approximately 0.027 mrem in 2005.

3.3 Surface Water Quality

Fermilab discharges liquid effluent to surface water bodies and to sanitary sewers. The Lab holds National Pollutant Discharge Elimination System (NPDES) permits that govern discharges to surface water from stormwater runoff, cooling water, and effluents from various onsite construction projects. In addition to monitoring for the physical and chemical parameters required by NPDES permits, samples of surface water are taken annually from selected water bodies and analyzed for radionuclides. These surface waters are sampled for radionuclides based upon their potential for contamination. Aqueous process wastewaters are directed to sanitary sewers and ultimately discharged

to publicly owned treatment works (POTWs) in Batavia and Warrenville. Wastewater discharges are controlled by criteria set forth in the Fermilab Environment, Safety, and Health Manual Chapter 8025.

3.3.1 Radioactive Releases to Surface Water

Numerous sumps collect and drain water from building footings and from under beamline tunnels in the Tevatron, Main Injector and the Experimental Areas. Water collected by these sumps often contains detectable concentrations of radionuclides (primarily tritium, ^{3}H) that have been leached by rainwater from radioactive soil near beam targets and absorbers or released accidentally to sumps from beamline cooling water systems. These sumps discharge to ditches and ponds onsite. Surface water monitoring conducted during 2005 showed tritium concentrations to be well within the Department of Energy Derived Concentration Guides for allowable radionuclide releases to surface waters (2000 pCi/ml); however in November 2005, during routine surface water surveillance monitoring, Fermilab detected, for the first time, low levels of tritium in Indian Creek. Upon the discovery of tritium, an investigation was begun to determine the cause and extent of this radionuclide in surface waters. The highest level of tritium discovered in Indian Creek was 3.4 pCi/ml. Low level concentrations of tritium were also found in the Main Injector cooling ponds and several other ponds associated with the Industrial Cooling Water (ICW) system. To address potential concerns, in early December 2005, Fermilab voluntarily notified, by letter, our immediate downstream neighbors in the Savannah Subdivision of the tritium detected in Indian Creek. The DOE and Fermilab also notified by phone the U.S. Environmental Protection Agency (EPA), Illinois EPA, and the Illinois Emergency Management Agency of the tritium in the creek. In mid December, at the Lab's invitation, IEMA took samples to confirm the presence of tritium from Indian Creek and the Fermilab cooling ponds. An investigation to identify the source and extent of the tritium in the creek and cooling ponds was initiated.

3.3.2 Non-Radioactive Releases to Surface Water

Monitoring for non-radiological chemical constituents in surface water was limited to NPDES permit parameters (temperature, flow, TSS, TDS pH, chlorine, chloride and sulfate) this year. Discharge Monitoring Reports for six different outfalls were submitted monthly to the IEPA. In 2005 there were no exceedances of discharge limits to *waters of the state*.

3.3.2.1 Cooling Water System

An NPDES permit authorizes the discharge of commingled cooling water and stormwater runoff to surface waters through outfalls to Kress, Indian and Ferry Creeks. Due to the presence of the RCRA-permitted (Resource Conservation and Recovery Act) Hazardous Waste Storage Facility onsite, the NPDES permit also regulates stormwater discharges from designated solid waste management units (SWMUs). The Stormwater Pollution Prevention Plan required by this NPDES permit is periodically modified to reflect changes that occur as part of the RCRA Facility Investigation (RFI) of the SWMU sites. Fermilab's site-wide NPDES permit dictates that water temperature, pH, and flow be monitored at all three outfalls; chlorine concentration be monitored at the Kress and Indian Creek outfalls; and total dissolved solids, chlorides and sulfates be monitored at the Indian Creek outfall. The monitoring results are reported to the IEPA on a monthly basis.

Near record drought conditions in 2005 required Fermilab to completely drain several larger cooling pond reservoirs in order to provide adequate cooling for accelerator operations. Over the course of the year, Fermilab received only 65% of the normal precipitation that typically falls onto the site. Normally, precipitation is collected and stored in the site drainage and Industrial Cooling Water (ICW) pond system and constitutes a significant portion of the make up water used to replenish the ICW system. Consequently in order to make up for lack of precipitation, a significant volume of water was drawn from onsite supply wells and piped from the Fox River.

3.3.2.2 Releases to Sanitary Sewers

Another NPDES permit allows Fermilab to pre-treat and release effluent from the Central Utility Building (CUB) regeneration process to the City of Batavia sanitary sewer system. The pretreatment permit for the effluent generated by this process requires the collection and analysis of composite process effluent samples for specified metals on a quarterly basis. Samples are also collected and analyzed from each discharge for accelerator-produced radionuclides in order to confirm that amounts of radioactivity released meet DOE guidelines. In 2005, samples from the process effluent were in compliance with the specified levels in the Batavia Sanitary Sewage Ordinance and the Department of Energy Derived Concentration Guide. A total of 52,550 gallons of process wastewater were discharged to the Batavia sewer system; approximately 0.070 mCi of tritium and 211 uCi of ^{7}Be were released to the sanitary sewer from the CUB during 2005.

Monitoring stations, located at the site boundary, sample sewer discharges to the municipalities of Batavia and Warrenville. The discharge at these locations is a mixture of all effluents contributing to that sanitary sewer system. Analytical results are compared to municipal discharge limits to track compliance. In the past year, the Batavia sewer sampler revealed three exceedances of the iron discharge limit of 5.0 mg/l. The maximum level measured was 9.89 mg/l. These excursions are likely the result of the aging pipe infrastructure and are of minimal impact to the Batavia treatment works. Beginning with the August 1st sample, composited during the month of July, tritium was first detected at the Batavia monitoring station. Detections continued for the remainder of the year with a maximum activity of 4.1 pCi/ml measured from a grab sample collected in September.

3.4 Groundwater Quality

The Illinois Environmental Protection Agency (IEPA) publishes groundwater quality standards[4] and defines Class I groundwater as a non-degradable resource, which is to be highly protected. The water that is located in or near the dolomite aquifer 50 to 70 feet below the ground surface of Fermilab is Class I groundwater according to criteria published by the IEPA.[5] Water in the overlying till has been demonstrated to be Class II water and therefore has less stringent standards.

Four background monitoring wells that are upgradient to Fermilab operations continued to be utilized to obtain representative samples of the upper Class I groundwaters for chemical and radiochemical analysis. Ten wells at the Central Utility Building (CUB) Tile Field, four at the Meson and Neutrino Experimental Areas, and seven at Meson Hill were sampled as part of ongoing RCRA Facility Investigation (RFI) corrective actions at these locations. Over forty piezometers (pore-water pressure measuring instrument) were used to gather information on the direction of groundwater flow sitewide. The information collected is used in modeling the transport of potential contaminants from past and present operational areas of concern. Piezometers that had been installed as part of the Neutrinos at the Main Injector (NuMI) site characterization were monitored to assist Fermilab in planning for groundwater protection at that facility. One location is used to monitor for NuMI operational impacts to the Class I aquifer. Fermilab continues to analyze groundwater issues associated with this project that involved construction within the dolomite aquifer.

To date, the investigation of impacts on groundwater from the NuMI tunnel has shown no adverse effects on the potentiometric (electromotive force) surface of groundwater in the Class I resource beyond the Fermilab boundary. There have, however, been localized impacts to site operations in the area of the tunnel. During the majority of 2005, domestic water for supply to the west campus area at Fermilab was pumped from two relatively shallow wells that draw groundwater from the dolomite aquifer. One of these wells (W-1) is located approximately 1000 feet from the centerline of the NuMI beamline and has experienced a marked reduction in capacity due the changed hydrogeologic conditions and subsequent equipment incompatibility (pumps and other well infrastructure were designed for different hydrogeologic conditions). Ground motion studies within the 8 GeV line (from Booster to Main Injector) conducted during 2001 and 2002 showed that flows greater than 100 gallons per minute from well W-1 would adversely impact beam quality. Therefore, the well was operated at very low flow during 2004 and supply well W-3, which had previously been used for backup purposes, became the primary supply of drinking water. In late 2005 the source of domestic drinking water was altered from onsite wells to purchasing water from the City of Warrenville. As a result of this change, the two previously active onsite supply wells (W-1 and W-3) were disconnected from the domestic water supply system and now serve only to supplement the Industrial Cooling Water (ICW) system.

Thirty-six of one hundred-two-onsite groundwater monitoring locations was sampled during the year for radionuclide or chemical parameters. The remainder was available for water level monitoring.

3.4.1 Groundwater Characterizations

No groundwater characterizations were conducted during 2005.

3.4.2 Monitoring Well Modification and Abandonment Activities

There were no monitoring well modifications or abandonment activities during 2005.

3.4.3 Radionuclides in Groundwater

The Department of Energy groundwater concentration guide and the Illinois Class I groundwater standard for tritium is 20 pCi/ml. Quarterly samples were taken at one Solid Waste Management Unit (SWMU) per the conditions of the RCRA RFI (see Section 4.12.1, RFI Activities). Outside of the RFI, 15 samples were taken from 13 locations for analysis. Radionuclides were not detected in any samples taken during 2005 in Class I groundwater.

3.4.4 Chemicals in Groundwater

Two rounds of groundwater samples were collected for chemical analysis in 2005 at two Solid Waste Management Units (SWMUs) under the RCRA RFI. (See Section 4.12.1 RFI Activities.)

4.0 Compliance with Specific Environmental Regulations

Below is a summary of Fermilab compliance with key environmental regulations.

4.1 Clean Air Act

Open burn permits to allow prairie/land management burning, maintenance of Meson Hill and fire extinguisher training were renewed by the IEPA in 2005. The annual air emissions report for 2005 was submitted to the IEPA in April 2006 and the annual radionuclide emissions report was submitted to the USEPA in June 2006.

An estimated 50.05 Curies were released in conjunction with the operation of the Fermilab Anti-Proton Areas stack in 2005 and the MiniBooNE Project (a Fixed Target experiment) stack. The magnet debonding oven, a potential source of tritium, did not burn any radioactive magnets in 2005. The CAP-88PC2 dispersion model calculated the maximum dose equivalent delivered to a member of the public (at the boundary of the lab) to be 0.0216 mrem/year due to 2005 Fermilab operations. This approximately 3-fold increase in the 2004 offsite dose equivalent of 0.00772 mrem/year was due to the NuMI exhaust stacks being brought into full operation and a 2-fold increase in targeted protons. The collective effective dose equivalent for 2005 was estimated to be 0.0794 person-rem.

Fermilab is registered with the Clean Fuel Fleet Program (CFFP); one of several programs the IEPA has implemented to help improve air quality in the Chicago ozone non-attainment area.

4.2 Underground Storage Tanks

No compliance issues were identified in 2005. The three Underground storage tanks (USTs) in use at the Fermilab Site 38 Fuel Dispensing Facility were operated and maintained per current UST standards prescribed by the USEPA (40 CFR 280.80) and the Illinois State Fire Marshall.

4.3 The Endangered Species Act of 1973

No compliance issues were identified in 2005.

4.4 Executive Order 11988, "Floodplain Management"

No compliance issues were identified in 2005.

4.5 Clean Water Act Section 404 (and Executive Order 11990, "Protection of Wetlands")

Pre-evaluation of Fermilab activities in wetlands continued to be accomplished through the NEPA review process and construction design reviews. The Lab continues to use task manager/construction coordinator training to instruct participants regarding how to ensure that potential work areas are screened for the presence of wetlands and to be aware of all aspects of environmental compliance management.

During 2005, Fermilab held permits under Section 404 of the Clean Water Act for the NuMI project, to construct an access road from the Lederman Center west to the MiniBooNE parking lot, and for the MiniBooNE experiment, to reroute a portion of Indian Creek to allow the construction. A representative from the U.S. Army Corps of Engineers inspected the areas of both permits in June, 2005. It was agreed that the permit for the mini-BooNE project should be terminated as complete. The NuMI-related permit will remain active in case a decision is made to undertake construction on the access road.

4.6 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

In 2005, the use of pesticides and herbicides at Fermilab was handled in accordance with FIFRA.

4.7 Illinois Department of Natural Resources "Rules for Construction and Maintenance of Dams"

Fermilab holds an Illinois Department of Natural Resources (IDNR) issued permit that classifies the Main Injector berm as a small *Class III* dam. The dam provides limited flood control to areas downstream from the Lab in the Indian Creek watershed. On a five-year cycle Fermilab is required to perform a comprehensive inspection and file a detailed report on the condition of this structure. The last comprehensive inspection was conducted in April of 2003. Only minor maintenance issues were discovered at that time and all of those were addressed then. In addition, there is an annual visual examination of the Class III dam. No action items were identified during the 2005 examination.

4.8 The Migratory Bird Treaty Act

Fermilab maintains a permit from IDNR (acting for U.S. Fish and Wildlife Service) to destroy nests of Canada geese in the vicinity of the Children's Center only if they become a safety hazard. The permit allows destruction of up to ten nests each year. During 2005, one nest containing a total of three eggs was destroyed.

4.9 National Environmental Policy Act (NEPA)

Fermilab met the requirements of this Act by continuing to implement a program of reviewing all activities for compliance as set forth in the Fermilab Environment, Safety and Health Manual (FESHM) Chapter 8060. FESHM Chapter 8060 – NEPA Review Procedure – was revised in 2003 to clarify when NEPA review was required and

specifically what the review should entail; the approach to determining NEPA applicability was refined and several definitions were improved upon. DOE approved ten projects for Fermilab as being categorically excluded (CXs) from further review in 2005.

4.10 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 that included an evaluation of all proposed land-disturbing projects in 2005 to assess any potential impacts on historic resources. No compliance issues were identified in 2005.

A DOE requested Cultural Resources Management Plan (CRMP) following guidelines outlined in DOE Publication DOE/EH-0501, was prepared and completed for Fermilab in 2002. The CRMP assures continued compliance with the above listed Acts by providing a comprehensive overview for the locations and status of all archaeological resources within the Fermilab site boundaries thereby facilitating future NEPA reviews.

4.11 National Pollutant Discharge Elimination System (NPDES)

Fermilab held four IEPA issued National Pollutant Discharge Elimination System (NPDES) permits in 2005. The four permits are the following:

1. General (covers several facilities that have the same type of discharge and are located in a specific geographic area) NPDES permit covering non-coal mine discharges associated with the NuMI tunnel construction project.
2. General NPDES permit covering discharges associated with stormwater management at construction sites greater that one acre. This permit covers stormwater management and erosion control for the construction of a domestic water supply connection to the City of Warrenville.
3. Individual (specifically tailored to an individual facility) NPDES permit for combined stormwater and non-contact cooling water discharges associated with industrial activities; there are three outfalls linked with this permit (Outfall 001 to Ferry Creek, Outfall 002 to Kress Creek, and Outfall 003 to Indian Creek).
4. Individual NPDES pre-treatment permit that allows Fermilab to discharge wastewater effluent from operations occurring at the Central Utilities Building (CUB) to the city of Batavia sanitary sewer treatment works.

4.12 Resource Conservation and Recovery Act of 1976 (RCRA)

The Annual Hazardous Waste and Illinois Generator Non-Hazardous Special Waste Reports for 2005 were submitted to the DOE Fermi Site Office in January and February 2006 respectively. DOE subsequently submitted these reports to IEPA.

The following volumes of non-radioactive waste were generated by Fermilab and managed for disposal by the Hazard Control Technology (HCT) Team of the Safety and Environmental Protection Group in 2005.

27.0 m^3	Non-Routine Hazardous Waste (RCRA + TSCA)
5.1 m^3	Routine Hazardous Waste (RCRA + TSCA)
1.1 m^3	Non-Routine Non-Hazardous (Special) Waste
37.2 m^3	Routine Non-Hazardous (Special) Waste

8,996.0 m^3 Dumpster/Landfill Waste

4.12.1 RFI Activities

As a condition of the Lab's RCRA Part B permit, the IEPA required Fermilab to undertake a RCRA Facility Investigation (RFI). The purpose of the RFI was to investigate whether hazardous constituents had been released to the environment from identified solid waste management units (SWMUs) located onsite. In addition to requiring the reporting of newly identified SWMUs, RCRA also required that IEPA be notified of any changes to previously identified SWMUs. A total of three SWMUs are still being addressed in accordance with the corrective action requirements of Fermilab's RCRA permit: the CUB Pipe and Clay Tile Field, the Meson and Neutrino Experimental Areas, and Meson Hill. Further investigation is not required at the Village Machine Shop, the Railhead Storage Yard, and the IB2 Industrial Building so long as institutional controls remain in place.

IB2 Industrial Building

A paper trail and chronological investigation for this area was conducted as part of the permit renewal process for the Laboratory's RCRA Part B permit.

Village Machine Shop (SWMU# 5)

No new information was requested or generated at this unit during 2005.

CUB Tile Field (SWMU# 12)

The CUB Tile Field has previously been removed along with all chromate-contaminated soil and gravel. The soil was properly disposed of and the surrounding soil sampled and analyzed. Fermilab continues to monitor all of the CUB Tile Field wells semi-annually. Monitoring wells at SWMU 12 were sampled during the 2nd, and 4th quarters of the calendar year. Wells MWS1, MWS2, MWS3, MWS4, MWD1, and MW7B were dry during the 2nd quarter round of sampling and Well MW7B was dry during the 4th quarter round of sampling.

Meson Hill (SWMU# 13)

Closure activities for Meson Hill were completed in 1998. This included moving concrete, grading, installing a clay cap, placing topsoil on the clay cap, hydroseeding the top of the hill, and a site inspection. Fermilab continues sampling of all monitoring wells installed at this unit on a semi-annual frequency. Analysis of groundwater from the monitoring wells screened within the upper Quaternary deposits has shown elevated concentrations of total dissolved sulfate and associated total dissolved solids above the 99% confidence level and Class II groundwater standards.

An Assessment Monitoring Plan was developed, reviewed and accepted by the IEPA in 2001 as a result of the continued monitoring results of elevated concentrations of total dissolved sulfates and associated total dissolved solids, and implemented and reported to the IEPA during 2002. The plan was developed to determine the source of the increase, concentrations and extent of sulfate migration, and assess any potential threat to human health and the environment. Results from the study indicated natural conditions were the source of the detected sulfate concentrations and that there was no potential threat to human health and the environment.

Monitoring wells at SWMU 13 were sampled during the 2nd, and 4th quarters of 2005. Statistical analyses confirmed that the concentrations of total dissolved sulfates in samples from monitoring wells G101, G102, G103, G104, G105 and G106 have continued to exceed the 99% confidence level. Concentrations of total dissolved sulfate in monitoring well G101 also exceeded the Class II groundwater standard during both quarters and G105 exceeded the standard during the second quarter sampling. Due to the elevated concentrations of sulfates and associated total dissolved solids, updated notifications of a "significant change in groundwater quality" were sent to the IEPA in conjunction with both 2005 semi-annual analytical reports.

A directive was received from IEPA in August 2002 requiring the replacement of the background monitoring well at the RCRA unit. A post closure modification request was developed and forwarded to IEPA detailing the investigation, installation and sample process for the proposed background-monitoring well. IEPA responded in January 2003 approving the post closure modification request with conditions and modifications. The new background monitoring well was installed on May 22, 2003. Sampling of this monitoring point began with the second quarter 2003 semi-annual monitoring and continued through the fourth quarter 2004. New 99% confidence level were proposed in a modification request for Fermilab's post-closure care plan during 2005.

Railhead Storage Yard (SWMU #14)

No information was requested or generated at this unit during 2005.

Meson/Neutrino Soil Activation Areas (SWMU #15)

Fermilab continues to sample four monitoring wells at this unit on a quarterly schedule for accelerator-produced radionuclides. The results of samples from the Class I groundwater along with flow directions in the upper dolomite are reported annually to IEPA. No radionuclides were reported in these monitoring wells above detection levels during 2005.

4.13 Safe Drinking Water Act

Fermilab provides drinking water to its employees through two Fermilab-operated public water supplies and a satellite supply connected to the City of Warrenville public water supply. Full jurisdiction for Fermilab's public water supplies was transferred from the Illinois Environmental Protection Agency (IEPA) to the Illinois Department of Public Health (IDPH) in 1996. Initially, this involved an IDPH review of the existing monitoring program, which determined that the program was compliant with their regulations.

During 2005, water samples were collected and analyzed for required parameters and at the prescribed frequencies in compliance with United States Environmental Protection Agency (USEPA) Regulations and the Drinking Water Systems Code (DWSC) adopted by the Illinois Department of Public Health. All results were acceptable with the exception of copper in the Main Site Supply, which exceeded the *action level* as defined in the DWSC. While the *action level* was exceeded, no action was deemed necessary by IDPH.

During September 2005, Fermilab discontinued the use of onsite wells for domestic drinking water and secured a connection to the City of Warrenville public water supply.

4.14 SARA TITLE III or Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA)

Under these regulations Fermilab is required to provide the EPA, State, and local officials with an annual accounting of hazardous, toxic, and extremely hazardous chemicals used or stored onsite in quantities greater than a given threshold. Fermilab filed a Toxic Chemical Release Inventory Report (TRI) for 2005 with the USEPA and IEPA in June 2006. Copper was the only toxic chemical processed or used at Fermilab at threshold activity levels defined by SARA Title III Section 313. As required by Section 312 of SARA Title III, Fermilab also submitted a Tier II Emergency and Hazardous Chemical Inventory (2005) to State and local emergency services and disaster agencies in February 2006.

4.15 Oil Spill Prevention

Oil inventory at Fermilab consists of numerous oil-filled electrical transformers ranging in volume from 4 gallons to 17,300 gallons. There are no above ground oil storage tanks at Fermilab. Potential onsite oil spill sources are

located such that surface water discharge spillways can be effectively used to prevent any oil spills from leaving the site and entering regulatory defined *state waters*. The only exception is the transformer at Giese Road (1695 gallons) near Indian Creek. This transformer was previously located downstream of the Indian Creek outfall to *state waters*. Even though the outfall has been moved to a location further downstream in Indian Creek, this transformer still has the potential to spill into regulated waters because there is no in-stream mechanism to prevent a discharge from making it to *waters of the state*. As an added precaution, the Giese Road transformer and others onsite utilize secondary containment. In accordance with 40 CFR 110-112, Fermilab maintains a Spill Prevention Control and Countermeasures plan (SPCC) for the Giese Road transformer; this plan is periodically reviewed and revised as necessary.

Fermilab continued through 2005 to implement corrective actions in response to an oil spill that occurred in August of 2004 resulting from the failure of a heat exchanger associated with a Central Helium Liquefier (CHL) Coldbox-2. The heat exchanger utilizes industrial cooling water (ICW) to dissipate heat from its oil reservoir. Because the normal operating pressure of the oil side of the heat exchanger exceeds the ICW pressure, when a leak developed between the two, the oil began to contaminate the ICW. The cooling water from the heat exchanger discharges via a pipe to a manhole that is part of the site storm drainage/ICW system and eventually accumulates in Bull Rush Pond. Approximately 27 gallons of mineral oil were released into Bull Rush Pond prior to spill discovery, source identification, and equipment shut down. The oil was confined in Bull Rush Pond and clean-up efforts continued until November of 2004.

The following actions were taken or initiated in 2005:

1. A material testing laboratory examined one of the heat exchangers and determined that the failure was primarily due to de-zincification of the outlet tube sheet which caused the material to become porous. The CHL personnel initiated a program of inspecting the heat exchangers, for signs of deterioration and needed maintenance, during accelerator shutdowns.
2. The potential for corrosion, while the heat exchangers are in standby mode for extended periods, was greatly reduced by adding valves to the Coldbox-2 heat exchangers that allow a continuous dry nitrogen gas purge to be established for the water side. This reduces potential biological corrosion as well as de-zincification where high oxygen and carbon dioxide, as well as stagnant water, significantly contribute to such corrosion.
3. Equipment was purchased and installed in the manholes behind the CHL which allow for retention and recovery of any oil, spilled in the future, before it can reach the drainage ditch leading to Bull Rush Pond (the receptor for the 8/31/04 spill).
4. The CHL local spill control plan was revised to provide operators with better guidance on problem recognition and response and level monitoring was improved along with installation of more reliable level transmitters.
5. An environmental management program (EMP) was developed to address site-wide vulnerabilities. A subgroup of the Environmental Protection Subcommittee developed a database where all divisions/sections can record their efforts to inventory similar equipment and evaluate the risk to potential environmental receptors.

4.16 Toxic Substance Control Act (TSCA)

Over the course of several years (1993 – 2002), Fermilab conducted a clean up of Polychlorinated Biphenyl (PCB) contaminated soil resulting from past management practices at the transformer yards associated with various Tevatron service buildings. In April of 2003, groundwater, that had seeped into the excavations after the 2002 remedial activities at B1 and B4 service buildings, was collected, analyzed, and found to be above the standard for unrestricted release. Consequently, although these locations met the standard for soil cleanup, they could not be declared “clean” at that time. The groundwater from B1 and B4 was then removed and very little additional water reentered the excavations afterward. Sampling activities conducted in July of 2003 concluded that remediation at B1 could be declared complete. Conversely, the July 2003 samples from groundwater at the B4 excavation again indicated contamination was slightly above the standards.

When PCB-contaminated groundwater is encountered, EPA regulations dictate that the owner consult with the Agency and the Agency decide, based upon risk, whether further remediation is necessary. To obtain such a decision, Fermilab prepared a report on the results of its groundwater investigation and DOE transmitted it to the EPA on September 22, 2003. In the report, Fermilab concluded that the remaining contamination was very low-level and sufficiently localized that it did not pose any significant environmental threat. The Lab therefore, requested that the Agency classify the residual PCBs as "disposed in place." Discussions among EPA, Fermilab and Fermi Site Office staff have been held occasionally as necessary by phone; the most recent of which produced an EPA request for additional hydrogeological information. This was provided in October 2005, and Fermilab is currently awaiting a response.

4.17 Pollution Prevention and Waste Minimization

In 2005 ongoing Lab-wide pollution prevention efforts resulted in the enhancement of recycling programs and further waste minimization. Specifically, an average of 2.25 million pounds of material is recycled annually. Some new initiatives undertaken in 2005 include the following.

Rechargeable nickel metal hydride (NiMH) battery use and recycling
Each year Fermilab consumes thousands of single use batteries in order to power various types of portable equipment. To curtail the utilization of these single use batteries and thereby reduce the waste associated with disposing of them, the Lab made available the rechargeable NiMH batteries and battery chargers by providing them in the stock room. The NiMH batteries, besides being rechargeable, are also not considered a hazardous waste when disposed, as are many of the single use batteries. In addition to this, the NiMH batteries can be recycled when ultimately spent; a program to collect the NiMH batteries for recycling was also implemented in 2005. Finally, small scale pilot projects were undertaken to determine the viability of using these rechargeable batteries in portable telecommunications pagers, of which there are approximately 1000 units. The conclusion of the pilot projects has not yet been issued.

Electronic waste recycling
Fermilab became a member of the Federal Electronics Challenge (FEC) in 2005. The FEC is a voluntary partnership program that empowers Federal facilities to manage their obsolete electronics in an environmentally sound manner. There were two Fermilab Today newsletter articles published highlighting the electronic equipment recycling and the reuse of equipment (electronics and otherwise) by the Property Office. In 2005, Fermilab recycled just over 200,000 pounds of electronic waste.

Reuse of packing peanuts
The Business Services Section led an effort in 2005 to collect discarded packing peanuts from the generation point and return them to the Shipping and Receiving group for reuse in packages that are outbound from the Lab.

Environmental Management System
Beginning in February 2005, Fermilab began providing EMS training to employees. The training described the essential elements of the Lab's EMS program and included a short video, entitled *What You Re-Think Matters!,* highlighting a number of successful Waste Minimization and Pollution Prevention initiatives.

Sustainable Building Design
A pilot program was initiated in 2005 to install high efficiency hand dryers in a number of the high traffic Wilson Hall restrooms. It was estimated that each hand dryer would eliminate the generation of nearly 2 miles of paper towel trash annually.

5.0 Conclusion

The operations at Fermilab during 2005 had no significant adverse impact on the environment or on public safety.

[1] Details of the Fermilab Environmental Monitoring Program (FEMP) can be found on the ES&H home page.

[2] Supporting data are available upon request from the Fermilab ES&H Section.

[3] Fermilab Annual Ecological Land Management Plan for calendar year 2005.

[4] 35 IAC 620

[5] 35 IAC 620.210