# Princeton Plasma Physics Laboratory

PPPL-4039

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## Princeton Plasma Physics Laboratory
## Annual Site Environmental Report
## for Calendar Years 2002 and 2003

Prepared by: Virgina L. Finley

December 2004

PPPL
PRINCETON PLASMA PHYSICS LABORATORY

**Prepared for the U.S. Department of Energy under Contract DE-AC02-76CH03073.**

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PPPL
PRINCETON PLASMA PHYSICS LABORATORY

# ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEARS 2002 AND 2003


Princeton Plasma Physics Laboratory
P.O. Box 451
Princeton, New Jersey 08543

Prepared by: Virginia L. Finley
Operated by Princeton University
For the U.S. Department of Energy
Under Contract DE-AC02-76-CHO-3073
See http://www.pppl.gov

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## List of Acronyms

| | |
|---|---|
| AEA | Atomic Energy Act of 1954 |
| ALARA | as low as reasonably achievable |
| APEC | area of potential environmental concern |
| ARD | America Recycles Day (November 15$^{th}$ annually) |
| AST | above-ground storage tank |
| B1, B2 | Bee Brook 1 (upstream of DSN001) and 2 (downstream of DSN001) (surface water stations) |
| BPX | Burning Plasma Experiment |
| Bq | Becquerel |
| BTEX | Benzene, toluene, ethyl benzene, and xylenes |
| C | C site of James Forrestal Campus, part of PPPL site |
| CAA | Clean Air Act |
| CAAA | Clean Air Act Amendments of 1990 |
| CAS | Coil Assembly and Storage Building |
| CASL | Calibration and Service Laboratory |
| CDX-U | Current Drive Experiment – Upgrade (at PPPL) |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CEQ | Council on Environmental Quality |
| CFCs | chlorofluorocarbons |
| CFR | Code of Federal Regulations |
| Ci | Curie (3.7 $^{E10}$ Becquerel) |
| cm | centimeter |
| COD | chemical oxygen demand |
| CPO | chlorine produced oxidants as known as total residual chlorine |
| CS | C site Stellarator (PPPL) |
| CWA | Clean Water Act |
| CY | calendar year |
| D | deuterium |
| D&D | deconstruction and decontamination |
| D-D | deuterium-deuterium |
| D-T | deuterium-tritium |
| D-11, D-12 | detention basin monitoring wells number 11 and 12 |
| DATS | differential atmospheric tritium sampler |
| DMR | discharge monitoring report |
| DOE | Department of Energy |
| DOE-CH | Department of Energy - Chicago Operations Office |
| DOE-EH | Department of Energy – Environment, Safety and Health |
| DOE-EM | Department of Energy – Environmental Management |
| DOE-HQ | Department of Energy - Headquarters |
| DOE-OFES | Department of Energy - Office of Fusion Energy Sciences |
| DOE-PSO | Department of Energy - Princeton Site Office |
| D&R | Delaware & Raritan (Canal) |
| DRCC | Delaware & Raritan Canal Commission |
| DSN | discharge serial number |
| E1 | Elizabethtown Water (Potable water supplier – surface water station) |
| EA | Environmental Assessment |
| EDE | effective dose equivalent |
| EHS | Environment, Health & Safety |
| EIS | Environmental Impact Statement |
| EML | Environmental Monitoring Laboratory (DOE) |
| EMS | Environmental Management System |
| EO | Executive Order |
| EPA | Environmental Protection Agency (US) |
| EPCRA | Emergency Planning and Community Right to Know Act |
| ERDA | Energy Research and Development Agency, DOE predecessor agency |
| ESA | Endangered Species Act |
| ES&H | Environment, Safety, and Health |
| FABA | Former Annex Building Area |
| F&EM | Facilities and Environmental Management Division (PPPL) |
| FCPC | Field Coil Power Conversion Building |
| FFCA | Federal Facility Compliance Act |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| FONSI | Finding of No Significant Impact |
| FSAR | Final Safety Analysis Report |
| FSCD | Freehold Soil Conservation District (Middlesex and Monmouth Counties) |
| g | gram |
| GBq | giga Becquerel or $10^9$Bq |
| GCUA | Gloucester County Utility Authority |
| GP | General Permit (Wetlands) |

## List of Acronyms

| | |
|---|---|
| gdp | gallons per day |
| GPMP | Ground water Protection and Monitoring Program |
| GWPP | Ground Water Protection Plan |
| GW | ground water |
| H-3 | tritium |
| HAPs | Hazardous Air Pollutants |
| HMSF | Hazardous Material Storage Facility |
| HQ | Headquarters |
| HT | tritium (elemental) |
| HTO | tritiated water |
| HVAC | heating, ventilation, and air-conditioning |
| ICRF | Ion Cyclotron Radio Frequency |
| $IC_{25}$ | inhibition concentration 25 percent |
| ISM | Integrated Safety Management |
| ISO14001 | International Standards Organization 14001 (Environmental Management System – EMS) |
| JFC | James Forrestal Campus |
| km | kilometer |
| kV | kilovolt (thousand volts) |
| LEC | liquid effluent collection (tanks) |
| LEPC | Local Emergency Planning Committee |
| LSB | Lyman Spitzer Building (Formerly Laboratory Office Building) |
| LOI | Letter of Interpretation (Wetlands) |
| LLW | Low level waste (radiological waste) |
| m | meter |
| M1 | Millstone River (surface water station) |
| MC&A | Material Control & Accountability (nuclear materials) |
| MCHD | Middlesex County Health Department |
| MESD | Materiel & Environmental Services Division (PPPL) |
| MeV | million electron volts |
| MG | Motor Generator (Building) |
| mg/L | milligram per liter |
| MOU | Memorandum of Understanding |
| mrem | milli radiation equivalent man |
| mR/h | milliRoentgen per hour |
| MRX | Magnetic Reconnection Experiment |
| MSDS | Material Safety Data Sheet |
| m/s | meters per second |
| msl | mean sea level |
| mSv | milliSievert |
| MT | metric ton (equivalent to 2,204.6 pounds or 1.10 tons) |
| MW | monitoring well |
| n | neutron |
| N or N- | Nitrogen |
| NAAQS | National Ambient Air Quality Standards |
| NB | Neutral beam |
| NBPC | Neutral Beam Power Conversion building |
| NCSX | National Compact Stellarator Experiment |
| NEPA | National Environmental Policy Act |
| NESHAPs | National Emission Standards for Hazardous Air Pollutants |
| NHPA | National Historic and Preservation Act |
| NIST | National Institute of Standards and Technology |
| NJAC | New Jersey Administrative Code |
| NJDEP | New Jersey Department of Environmental Protection (prior to 1991 and after July 1994) |
| NJPDES | New Jersey Pollutant Discharge Elimination System |
| NOAA | National Oceanic and Atmospheric Administration |
| NOEC | no observable effect concentration |
| NOV | notice of violation |
| NOx | nitrogen oxides |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| NRC | National Response Center |
| NSTX | National Spherical Torus Experiment |
| nSv | nanoSievert |
| NTS | Nevada Test Site (DOE site) |
| OH | ohmic heating |
| OSHA | Occupational Safety and Health Agency |
| P1, P2 | Plainsboro 1 (Cranbury Brook) and 2 (Devil's Brook) (surface water stations) |

## List of Acronyms

| | |
|---|---|
| PBX-M | Princeton Beta Experiment - Modification |
| PCBs | polychlorinated biphenyls |
| PCE | perchloroethylene, tetrachloroethene, or tetrachloroethylene |
| pCi/L | picoCuries per liter |
| PEARL | Princeton Environmental. Analytical, and Radiological Laboratory |
| PFC | Princeton Forrestal Center |
| PLT | Princeton Large Torus |
| Pots | publicly owned treatment works |
| ppb | parts per billion |
| ppm | part per million |
| PPPL | Princeton Plasma Physics Laboratory |
| PSTP | Proposed Site Treatment Plan for the Federal Facility Compliance Act |
| PTE | potential to emit (air emissions) |
| RAA | Remedial Alternative Assessment |
| RACT | reasonably achievable control technology |
| RCRA | Resource Conservation and Recovery Act |
| REAM | remote environmental atmospheric monitoring (station) |
| REML | Radiological Environmental Monitoring Laboratory |
| RESA | Research Equipment Storage and Assembly Building |
| RI | Remedial Investigation |
| RMS | Remote Monitoring Station |
| RQ | reportable quantity |
| RWHF | Radiological Waste Handling Facility |
| S or S- | Sulfur |
| SAD | Safety Assessment Document |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SBRSA | Stony Brook Regional Sewerage Authority |
| SDWA | Safe Drinking Water Act |
| SERC | State Emergency Response Commission |
| $SF_6$ | sulfur hexafluoride |
| SPCC | Spill Prevention Control and Countermeasure |
| T | tritium |
| TBq | tera Becquerel or $10^{12}$Bq |
| TCA | trichloroethane |
| TCE | trichloroethene or trichloroethylene |
| TCLP | toxic characteristic leaching procedure (RCRA) |
| TDS | total dissolved solids |
| TFTR | Tokamak Fusion Test Reactor |
| TPH | total petroleum hydrocarbons |
| TRI | Toxic Reduction Inventory (CERCLA) |
| TPX | Tokamak Physics Experiment |
| TSCA | Toxic Substance Control Act |
| TSDS | tritium storage and delivery system |
| TSS | total suspended solids |
| TW | test wells |
| TWA | treatment works approval |
| UIC | underground injection control |
| USDA | US Department of Agriculture |
| USGS | US Geological Survey |
| USEPA | US Environmental Protection Agency |
| UST | underground storage tanks |
| VOCs | volatile organic compounds |
| $\chi$/Q | atmospheric dilution factor (NOAA) |
| $\mu$g/L | micrograms per liter |
| $\mu$Sv | microSievert |

## List of Exhibits Contained in the Text

| Exhibit # | Title | Page |
| --- | --- | --- |


**NOTE: Data tables are located in Appendix A beginning on page 78.**

**Princeton Plasma Physics Laboratory (PPPL)**
**Certification of Monitoring Data for**
**Annual Site Environmental Report for 2002 and 2003**

Contained in the following report are data for radioactivity in the environment collected and analyzed by Princeton Plasma Physics Laboratory's Princeton Environmental, Analytical, and Radiological Laboratory (PEARL). The PEARL is located on-site and is certified for analyzing radiological and non-radiological parameters through the New Jersey Department of Environmental Protection's Laboratory Certification Program, Certification Number 12471. Non-radiological surface and ground water samples are analyzed by NJDEP certified subcontractor laboratories – Accutest, Accredited Laboratory, QC, Inc. and Reliance Laboratory. To the best of our knowledge, these data, as contained in the "Annual Site Environmental Report for 2002 and 2003," are documented and certified to be correct.

**Signed:**

Virginia L. Finley,
Head, Environmental Compliance
Materiel & Environmental Services Division

Jerry D. Levine,
Head, Environment. Safety, & Health Division

**Approved:**

Robert S. Sheneman
Head, Materiel & Environmental Services Division

J.W. Anderson,
Head, ES&H and Infrastructure
Support Department

## EARTH DAY 2002-2003 at PPPL

**EARTH DAY 2002 PARTICIPATING STUDENTS**

**DR. ANDREW BOCARSLY – EARTH DAY SPEAKER 2003**

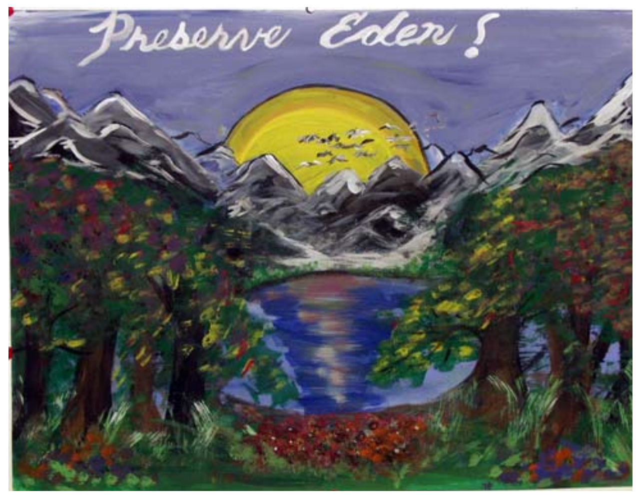
THANK YOU TO ALL WHO PARTICIPATED AND WHO REMEMBERED EARTH DAY

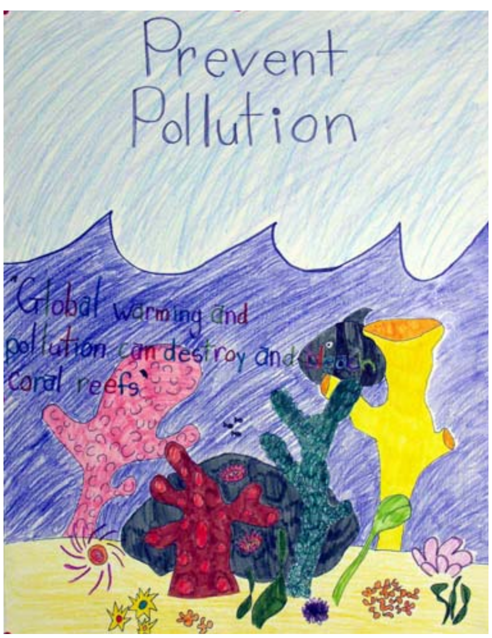
## 2002 Participating Schools

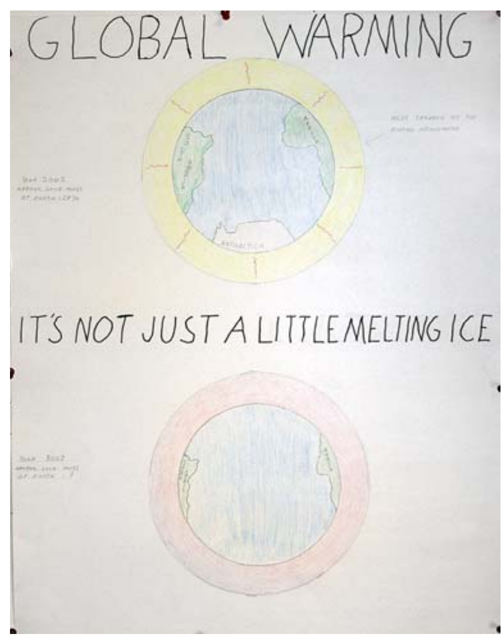
Central Elementary School, Trenton, NJ, 1st year
Corpus Christi School, Willingboro NJ, 5th year
Fisher Middle School, Ewing, NJ, 1st year
Grace N. Rogers School, East Windsor Reg. NJ, and 5th year
Parkway Elementary, Trenton NJ, 3rd year
St. Raphael School, Trenton, NJ, 1st year
Thomas Grover Middle School, West Windsor-Plainsboro, NJ, 2nd year

# EARTH DAY 2002-2003 at PPPL

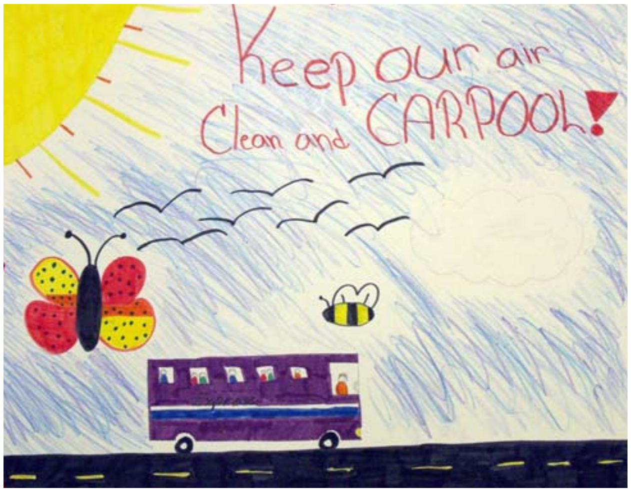


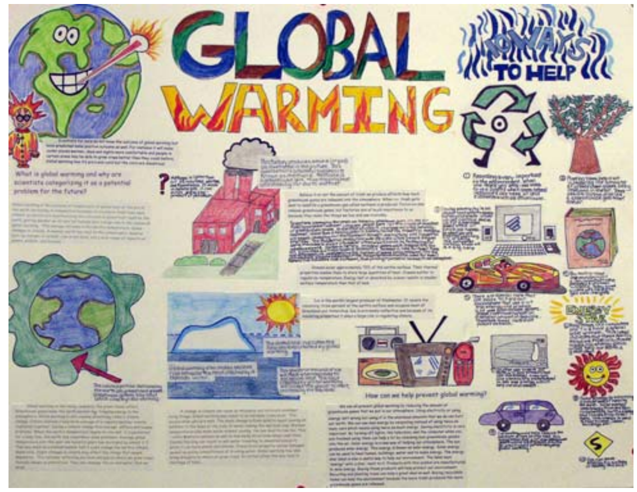



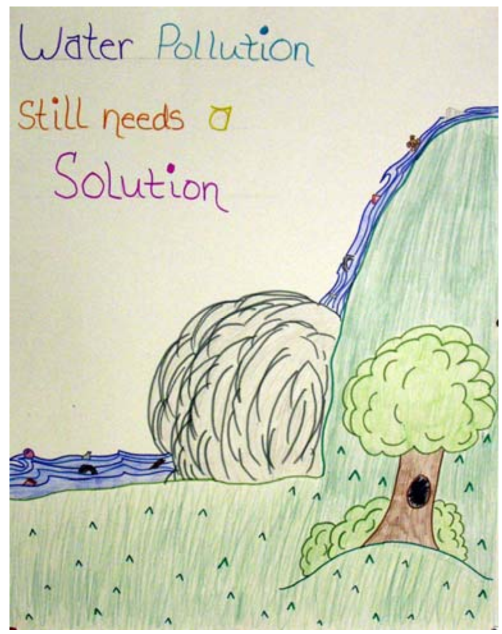



# EARTH DAY 2002-2003 at PPPL

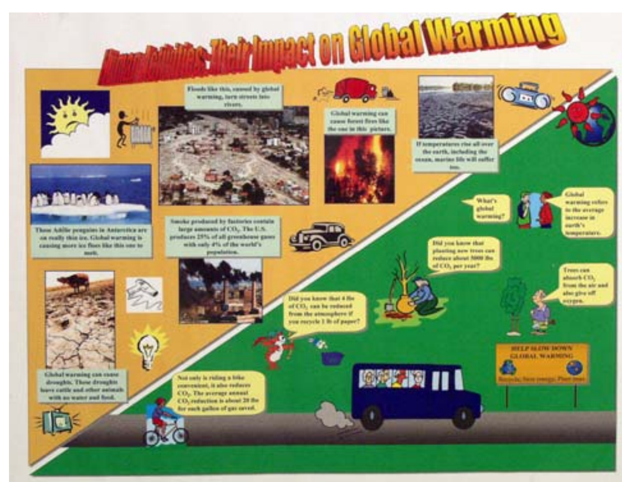


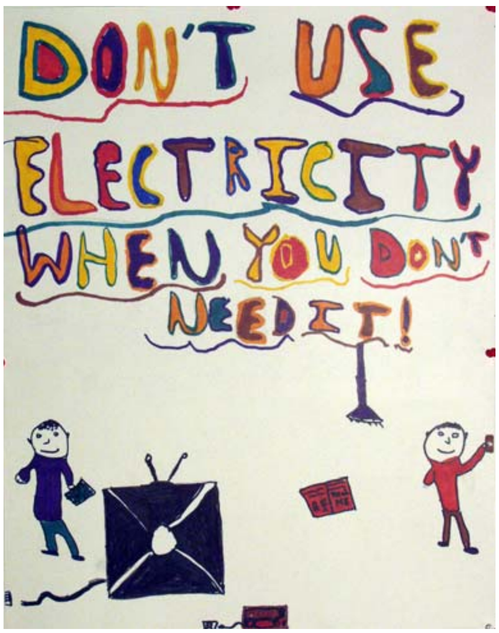




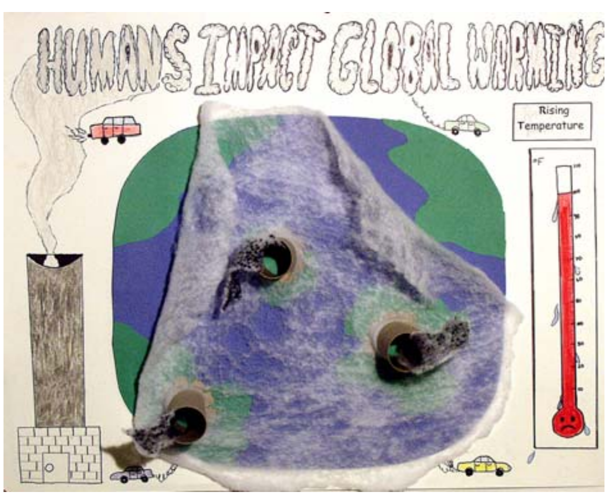




## EARTH DAY 2002-2003 at PPPL






Chapter 1

# Princeton Plasma Physics Laboratory

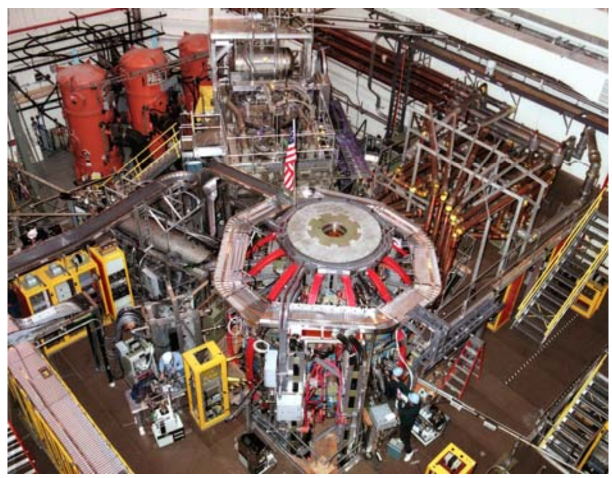
## Annual Site Environmental Report for Calendar Year 2002 and 2003

### Executive Summary

This report presents the results of environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Years 2002 and 2003. The report is prepared to provide the U.S. Department of Energy (DOE) and the public with information on the level of radioactive and non-radioactive pollutants, if any, that are added to the environment as a result of PPPL operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 2002 and 2003. The objective of the Annual Site Environmental Report is to document PPPL's efforts to protect the public's health and the environment through its environmental protection, safety, and health programs.

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951. The reaction occurring in our sun as well as in other stars is fusion. In a fusion reaction, the nuclei of hydrogen atoms, in a plasma state, fuse or join to form helium atoms, causing the release of neutrons and energy. Unlike the sun, PPPL's fusion reactions are magnetically confined within a vessel or reactor under vacuum conditions. The long-range goal of the U.S. Magnetic Fusion Energy Research Program is to develop and demonstrate the practical application of fusion power as a safe, alternative energy source.

**The National Spherical Torus Experiment Heated by Neutral Beam Injection**



Calendar Years 2002 and 2003 marked the fourth and fifth year of the National Spherical Torus Experiment (NSTX) operations and 2002 the third and final year of the Tokamak Fusion Test Reactor (TFTR) dismantlement.

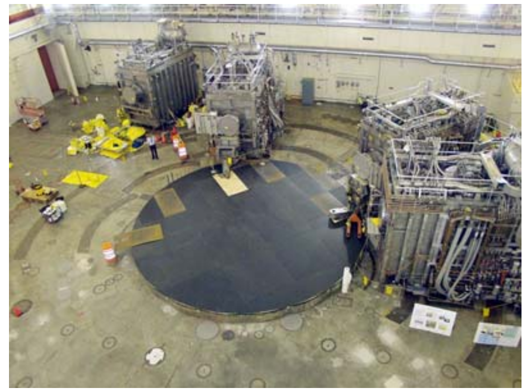
From groundbreaking in May 1998 to the creation of the first plasma on February 12, 1999, the National Spherical Torus Experiment (NSTX) was completed within budget and ahead of the target schedule. PPPL re-used the former TFTR Hot Cell of D-site to house NSTX, which contributed to the cost savings. For the NSTX collaborators, the project was a major effort to produce a smaller, more economical fusion reactor or volumetric neutron source.

The NSTX program is a national collaboration; the following institutions are NSTX research participants.

*Columbia University*
*Fusion Physics & Technology, Inc.*
*General Atomics*
*Johns Hopkins University*
*Lawrence Livermore National Laboratory*
*Los Alamos National Laboratory*
*Massachusetts Institute of Technology*
*Oak Ridge National Laboratory*
*Sandia National Laboratory*
*University of California at Davis*
*University of California at Los Angeles*
*University of California at San Diego*
*University of Washington at Seattle*

PPPL's TFTR was kept in a safe, shutdown mode following fifteen years of operation (1982-1997). In 1999, a multi-year project to dismantle TFTR began. Previous milestones of TFTR included achieving a world power record of approximately 10.7 million watts of controlled fusion power during the deuterium-tritium plasma (D-T) experiments.

In 2002, TFTR deconstruction and dismantlement (D&D) project was completed with, the vacuum vessel itself dismantled and removed. As seen in the photograph on this page, the circular, darkened area was once occupied by the vacuum vessel, and the neutral beam boxes remain for possible use on future devices.



**The Tokamak Fusion Test Reactor Test Cell Following D&D Operations - 2002**

The International Thermonuclear Experimental Reactor (ITER) project was again supported by the United States, joining with Canada, the European Union nations, Japan, and the Russian Federation following the formal announcement by Department of Energy Secretary, Spencer Abraham in January 2003 (See below picture).


**Department of Energy Secretary Abraham addresses PPPL staff in PPPL's Gottleib Auditorium on January 30, 2003**

To further strengthen the idea that fusion will provide an environmentally attractive and economically viable energy option for this century, PPPL continued experimentation and associated environmental monitoring programs.

**PPPL Director Rob Goldston shows NSTX to US Congressman Rush Holt, Energy Secretary Spencer Abraham, US Congressman Rodney Frelinghuyesen, DOE Office of Science Raymond Orbach, and Princeton University President Shirley Tilghman**

In 2002 and 2003, PPPL's radiological environmental monitoring program measured tritium in the air at on-site and off-site sampling stations. PPPL is capable of detecting small changes in the ambient levels of tritium by using highly sensitive monitors. The operation of an in-stack monitor located on D-site is a requirement of the National Emission Standard for Hazardous Air Pollutants (NESHAPs) regulations with limits set by the Environmental Protection Agency (EPA). Also included in PPPL's radiological environmental monitoring program, are precipitation, surface, ground, and wastewater monitoring.

The dose results of the radiological monitoring program for 2002 and 2003 were as follows:

1. Total maximum off-site dose from all sources—airborne and liquid releases—was 0.31 (2002) and 0.13 (2003) mrem/year.
2. Dose at the nearest business due to airborne releases was 0.30 (2002) and 0.13 (2003) mrem/year.
3. The collective effective dose equivalent for the population living within 80 kilometers was 2.26 (2002) and 0.74 (2003) person-rem.

The total maximum off-site dose for 2003 was the lowest since 1993, prior to D-T experiments. Both dose #1 and #2 are a small fraction of the 10-mrem/year PPPL objective and the 100-mrem/year DOE limit.

PPPL's 2002-2003 Pollution Prevention and Community Outreach Programs included Earth Day and America Recycles Day events. In April 2002, PPPL conducted a poster contest involving local middle school students (see Posters in Preface of this report). In November 2002 and 2003, PPPL celebrated America Recycles Day with the presentation of "Green Machine" awards that were given to staff members whose efforts have contributed greatly to the Laboratory's progress in Recycling and Buying Recycled Products. PPPL's Pollution Prevention Program results were based on:

1. Usage of recycled material *versus* non-recycled material;
2. Reducing hazardous waste disposal by 38.5% and 65% and solid waste by 75% and 74% in 2002 and 2003, respectively, through actively seeking recyclers for waste materials; and

3. Buying recycled rate of 85.3% in 2002 and 81% in 2003 (goal being 100%).

PPPL's Community Outreach Program included facilities tours given to school, governmental, service, and private groups, representation at numerous community events, Science on Saturday seminars for the general public, hosting the Regional competition of the New Jersey High School Science Bowl, and participation through the Science Education Program, in local schools and at professional meetings.

PPPL's non-radiological environmental monitoring program demonstrates compliance with applicable environmental requirements. The program includes monthly surface water monitoring and annual chronic toxicity testing. In 2002, quarterly ground-water sampling continued as a requirement of the Remedial Action Work Plan. Based on PPPL's results showing that the contaminants are biodegrading in the ground, the requirement was changed to annual monitoring in 2003. Since 1989, ground-water investigations have revealed volatile organic compound (VOC) contamination (most likely from solvents) at low levels in three locations. PPPL's remedial action work plan relies on existing building drains for containment and extraction and includes monitoring and reporting of quarterly sampling of selected wells.

An Occupational Safety and Health Administration (OSHA) Audit Team conducted a comprehensive compliance audit of PPPL in August 2003. The objective of the compliance audit was to identify those instances of non-compliance with current OSHA standards with sufficient detail to enable DOE and PPPL to determine methods and costs to come into compliance. The auditors identified 200 deficiencies, of which PPPL corrected over 50% before the end of calendar year 2003. PPPL continues to correct the remaining 50% as funding and labor availability allows with of goal of completing most by the end of fiscal year 2004.

The Laboratory is expected to continue excelling in ES&H as it has in its fusion research program. Efforts are geared not only to full compliance with applicable local, state, and federal regulations, but also to achieve a level of excellence in ES&H performance. PPPL is an institution that serves other research facilities and the nation with valuable information gathered from its fusion research program. ✵

*To view current activities and news about PPPL, visit* http://www.pppl.gov

# Chapter 2

## Introduction

### 2.1 Site Mission

The U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) is a Collaborative National Center for plasma and fusion science. Its primary mission is to develop scientific understanding and key innovations leading to an attractive fusion energy source [PPPL98a]. Related missions include conducting world-class research along the broad frontier of plasma science and providing the highest quality of scientific education and experimentation.

At PPPL, the National Spherical Torus Experiment (NSTX) is a collaborative project among 14 Department of Energy National Laboratories, universities, and institutions. Also located at PPPL are smaller experimental devices, such as the Magnetic Reconnection Experiment (MRX) and the Current Drive Experiment-Upgrade (CDX-U), which investigate plasma physics phenomena.

As a part of off-site collaborative projects, PPPL scientists assist fusion programs both in the United States and other countries. Particularly, PPPL collaborated with the Koreans in their K-Star program and with the European community at the Joint European Torus (JET) facility located in the United Kingdom, to further fusion science.

### 2.2 Site Location

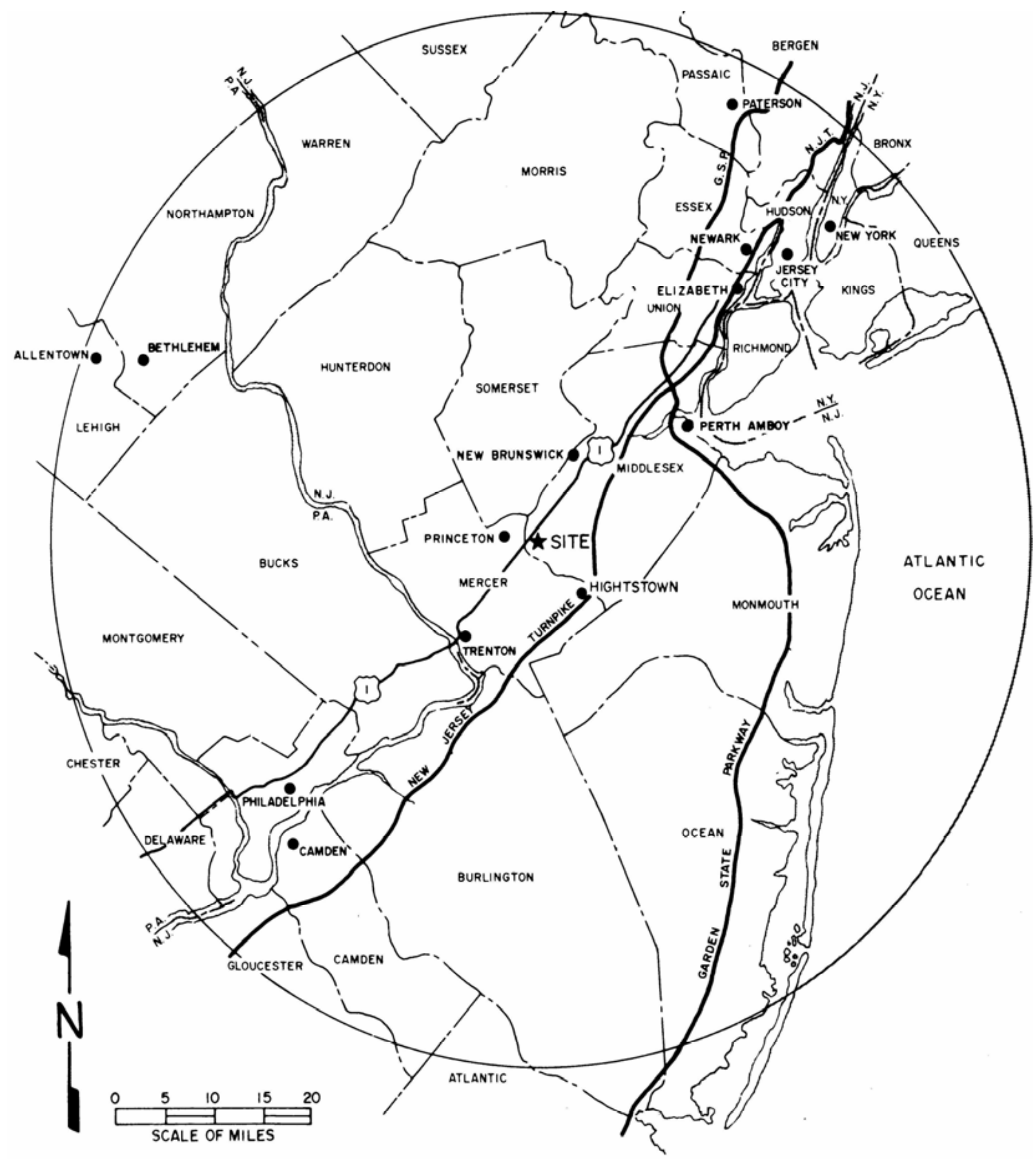
The Princeton Plasma Physics Laboratory site is in the center of a highly urbanized region of the Northeast region. The closest urban centers are New Brunswick, 14 miles to the northeast, and Trenton, 12 miles to the southwest. Major surrounding cities, including New York City, Philadelphia, and Newark, are within 50 miles of the site.

As shown in Exhibit 2-1, the site is located in Plainsboro Township within Middlesex County (central New Jersey), adjacent to the municipalities of Princeton, Kingston, West Windsor, and Cranbury, NJ. The Princeton area continues to experience a substantial increase in new businesses locating along the Route 1 corridor near the site. Also, the main campus of Princeton University, primarily located within the Borough of Princeton, is approximately three miles to the west of the site.

In the early 1950's, Dr. Lyman Spitzer's vision for plasma physics culminated in Project Matterhorn, which gained approval of the U.S. Atomic Energy Commission. Its mission was to contain and harness the nuclear burning of hydrogen at temperatures exceeding those found in the sun. Dr. Spitzer became known as the father of the "Stellarator" and was PPPL Director until 1961. Named for Dr. Spitzer's A, B, and C stellarators, PPPL was first located on A- and B-sites of the James Forrestal Campus; and in 1959, PPPL moved to its present location at C-site. In the late 1970's, D-site became the home of the Tokamak Fusion Test Reactor (TFTR), which is currently being dismantled, and is also the home of the National Spherical Torus Experiment (NSTX) (Exhibit 2-2).

Undisturbed areas surrounding the site include upland forest, wetlands, open grassy areas, cultivated fields, and a minor stream (Bee Brook), which flows

**Exhibit 2-1. Region Surrounding PPPL (50-mile radius shown)**



along its eastern boundary. These areas are designated as open space in the JFC site development plan. The following aerial photo (Exhibit 2-3) shows the general layout of the facilities at the C- and D-sites of Forrestal Campus as viewed from the north; former TFTR and NSTX Test Cells are located at D-site (on the left side of photo).

**Exhibit 2-2. PPPL James Forrestal Campus, Plainsboro, NJ**

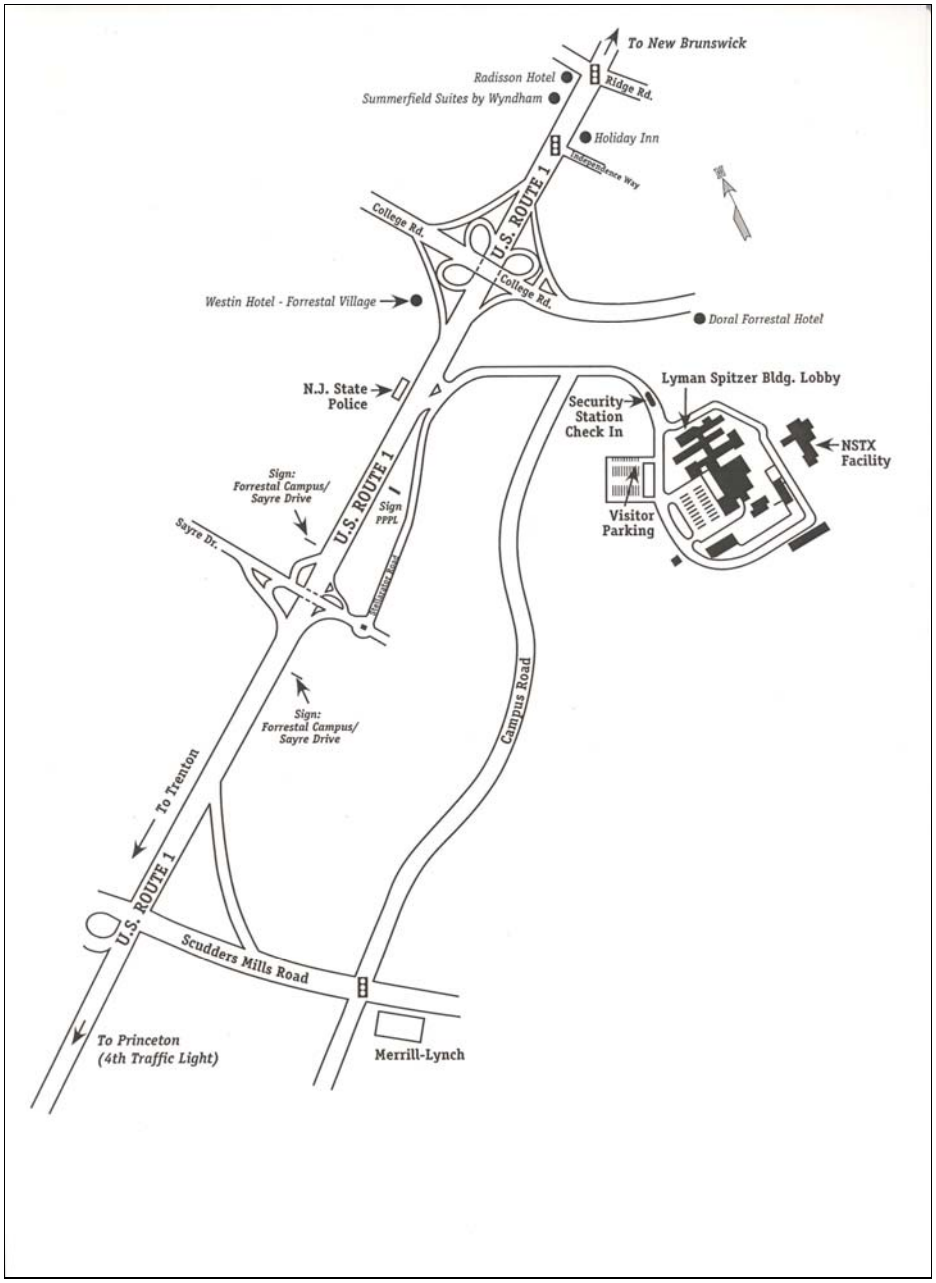


**Exhibit 2-3. Aerial View of PPPL**

D-site is fully surrounded with a barbed -wire, chain-linked fence for security purposes. PPPL openly operates C-site, allowing the public access for educational purposes. This free access to C-site warranted a thorough evaluation of on-site discharges, as well as the potential for off-site releases of radioactive and non-radioactive effluents. To maintain free access to C-site, PPPL instituted an extensive monitoring program that was expanded in recent years. The PPPL radiological environmental monitoring program generally follows the guidance given in two DOE reports; A Guide for: Environmental Radiological Surveillance at U.S. Department of Energy Installations [Co81] and Environmental Dose Assessment Methods for Normal Operations at DOE Nuclear Sites (PNL-4410) [St82].

## 2.3 General Environmental Setting

The climate of central New Jersey is classified as mid-latitude, rainy climate with mild winters, hot summers, and no dry season. Temperatures range from below zero to above 100 degrees Fahrenheit (°F), -17.8°Celsius (C) to 37.8° C; extreme temperatures typically occur once every five years. Approximately half the year, from late April until mid-October, the days are freeze-free.

Normally, the climate is moderately humid with a total average precipitation of 46.5 inches (118 cm) evenly distributed throughout the year. Droughts typically occur about once every 15 years [PSAR78]. In 2002 and 2003, the annual rainfall totals, 47.92 inches (122 cm) and 54.73 inches (139 cm), respectively, were well above the average rainfall for central

New Jersey. These above-average levels were primarily due to wet weather in the autumn months (September - December) for both years, with monthly totals exceeding 6 inches (15.3 cm) of precipitation at least once during that period (Appendix A, Tables 2 & 3) [Ch03 and Ch 04].

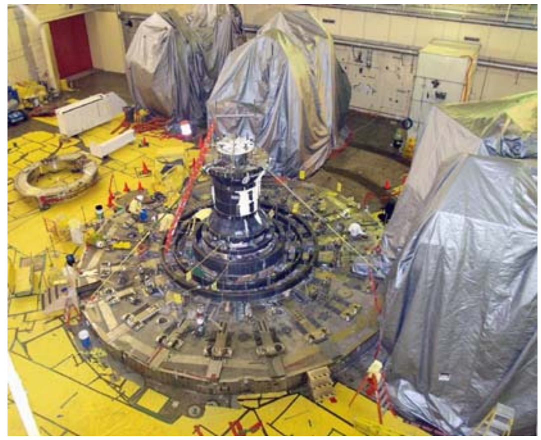
An archaeological survey was conducted in 1978 as part of the TFTR site environmental assessment study. From historical records, personal interviews, and field investigations one projectile point and a stone cistern were found. Apparently, the site had limited occupation during prehistoric time and has only in recent times been actively used for farming. There are examples of prehistoric occupation in areas closer to the Millstone River, which are within a mile of the site [Gr77].

## 2.4 Primary Operations and Activities

The fusion experiments, such as NSTX, MRX, or CDX-U, currently in operation at PPPL, do not generate tritium releases. Having used tritium in its experiments from 1994 to 1997, TFTR is the tritium source that is being monitored in air and water samples. Dismantling activities for TFTR continued in 2002 resulting in periodic releases to the stack (Ex. 2-4). In 2003, TFTR was fully dismantled and the area is presently vacant, availing its Test Cell for a new device. Many of the TFTR support systems are secured for future use.

Next door to the TFTR Test Cell is the NSTX Test Cell. Since its start-up in February 1999, NSTX has consistently exceeded its target milestones.

**Exhibit 2-4. The TFTR Pedestal before its removal in 2002**



NSTX produced one million amperes of plasma current, setting a new world record for a spherical torus device. This device is designed to test the physics principles of spherical-shaped plasmas forming a sphere with a hole through its center. Plasma shaping is an important parameter to plasma stability and performance ultimately enabling viable fusion power.

**Exhibit 2-5. The PBX-M vacuum vessel, loaded on a flat bed truck, is taken from PPPL in August 2003**

Insert show workers securing the vessel for its journey.

In 2003, Princeton Beta Experiment – Modified, PBX-M, was dismantled on

C-site (Ex. 2-5). The combination of the test cells of the former Princeton Large Torus (PLT) and PBX-M will be home to PPPL's newest device, the National Compact Stellarator Experiment, NCSX. NCSX is in the final design stages, with plan to begin construction in FY2004 and completion by FY2007.

"The success of the most widely studied magnetic fusion concept, the tokamak, has shown the advantage of bending the plasma into a torodial, or doughnut, shape for achieving reactor-level plasma parameters for a short time. …The 'bootstrap current' (theoretically predicted self-generating current) can be used to make the tokamak into a continuously sustained 'advance tokamak' configuration, but up to 20% of the plant's output power would still have to be re-circulated to drive active plasma controls needed to prevent the disruption of a tokamak plasma." [PPPL01b]. In Exhibit 2-6, the uniquely twisted shape of the vacuum vessel is shown in purple in this cut-away view. The scale of the device is about six-feet (two meters) above the floor where the vessel sits on its pedestals.

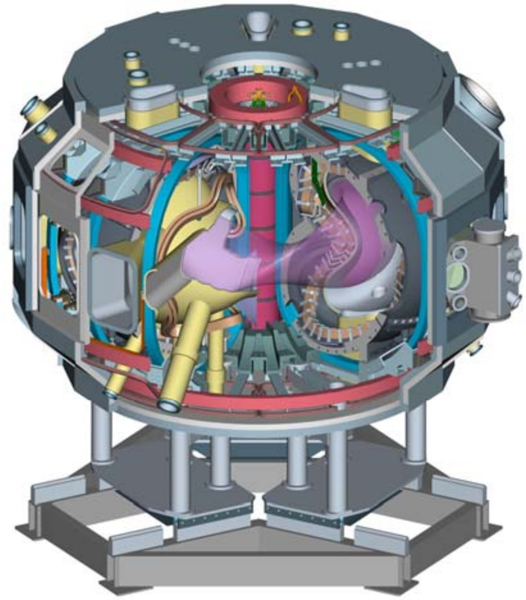


**Exhibit 2-6. The National Compact Stellarator Experiment (NCSX)**

## 2.5 Relevant Demographic Information

A demographic study of the surrounding 31.1 miles (50 kilometers) was completed in 1987 as part of the Environmental Assessment for the proposed Burning Plasma Experiment (BPX), which was also known as Compact Ignition Tokamak (CIT) [Be87a]. Other information gathered and updated from previous TFTR studies include socioeconomic information [Be87b] and an ecological survey [En87], which were studies describing pre-TFTR conditions.

Chapter 3

# 2002 and 2003 COMPLIANCE SUMMARY

## 3.1 Materiel and Environmental Services (formerly Environmental Restoration and Waste Management)

Princeton Plasma Physics Laboratory's (PPPL) environmental goal is full compliance with all applicable state, federal, and local environmental regulations. As a part of PPPL's Project Mission Statement, PPPL initiates actions that enhance its compliance efforts and fully documents meeting the requirements. The process of compliance with each applicable federal, state, and local environmental statute or regulation, and executive and DOE orders [DOE03a &b] are discussed in this chapter.

Department of Energy-Princeton Site Office (DOE-PSO) annually performs a review of one aspect of PPPL's Environmental Permitting Program. [DOE-PSO]. The conclusion of the review conducted in 2002 and 2003 was that the overall environmental permitting process was well defined and functioning without difficulty. Future actions included listing of current permits on PPPL's web page to be updated annually; hard copies of monitoring data loaded into an electronic database; electronic submittals of data when such applications are developed; and the procedure for Environmental Permits completed and posted on the Materiel & Environmental Service Division web page.

### 3.1.1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

During 2002 and 2003, PPPL had no involvement with CERCLA-mandated cleanup actions. Resulting from the 1991 assessment by Department of Energy – Headquarters' (DOE-HQ) environmental team, known as the Tiger Team, an action plan was developed to conduct a more comprehensive documentation of past CERCLA hazardous substances releases. A CERCLA inventory was completed in 1993 [Dy93], and no further CERCLA actions were warranted.

### 3.1.2 Resource Conservation and Recovery Act (RCRA) and Solid Waste

The Laboratory complies with all the requirements of a hazardous waste generator. In 2002, PPPL shipped off site approximately 15.68 tons (14.22 metric tons, MT) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 9.81 tons (8.90 MT) to recycling facilities [Pu03b]. In 2003, PPPL shipped off site approximately 4.71 tons (4.27 MT) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 8.70 tons (7.89 MT) to recycling facilities [Pu04b] Summaries of PPPL's annual hazardous waste generation rates and waste reduction/recycling efforts are presented in Exhibits 3-1 to 3-3.

**Exhibit 3-1. Hazardous Waste Quantity Comparisons 1998-2003 (3 largest quantities)**

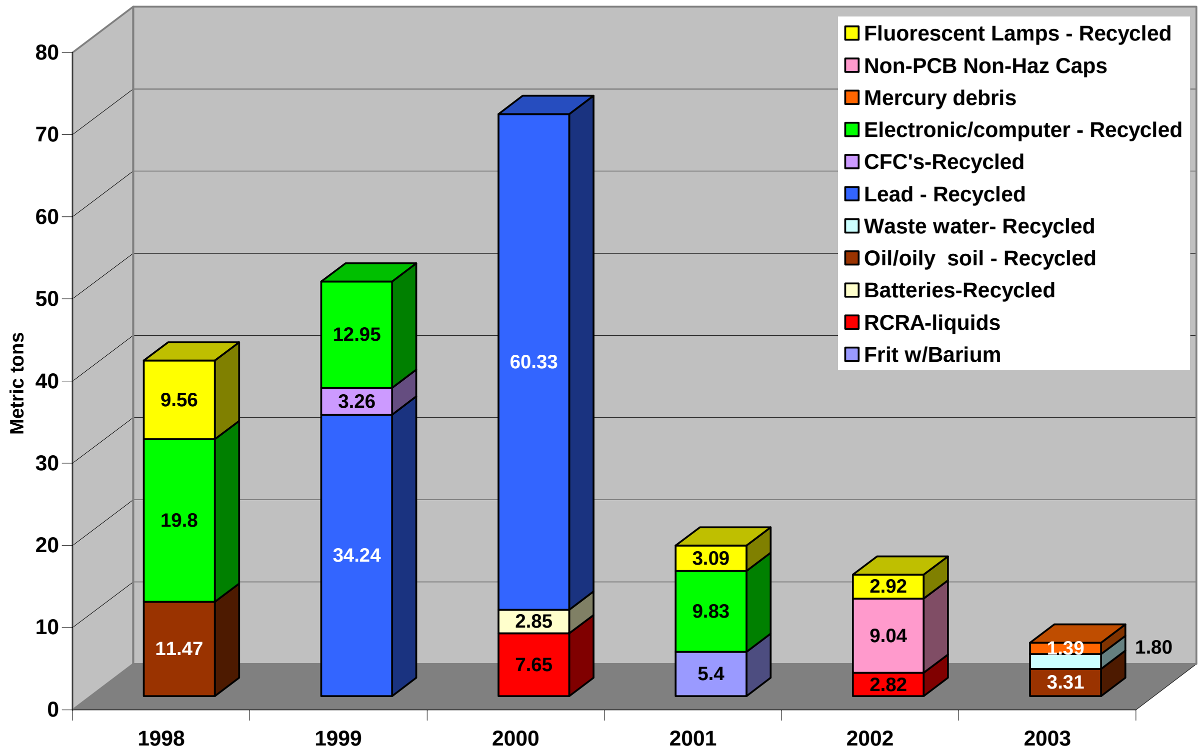



**Exhibit 3-2. 2002 Waste Reduction**

**View PPPL Pollution Prevention accomplishments @http://tis.eh.doe.gov/p2/wastemin/RecycleRpt.Asp**

**Metric ton equals 2,205 pounds or 1.10 tons**

| Type | Source | Amount | Fate |
|---|---|---|---|
| Hazardous | Oil and oily debris | 0.44 MT | Recycled |
| Waste | Lab wastes, solvents | 2.82 MT | Incinerated |
| | Batteries - lithium | 0.03MT | Incinerated |
| | Batteries (includes lead acid ) | 2.52 MT | Recycled |
| | Lead debris | 0.54 MT | Incinerated |
| | Non-PCBs Non-Haz. Capacitors | 9.04 MT | Incinerated |
| | Fluorescent lamps (contain Hg) | 2.92 MT | Recycled |
| | Mercury debris | 0.16 MT | Incinerated |
| | Mercury | 0.49 MT | Recycled |
| | Oily debris | 0.21 MT | Incinerated |
| | Oily debris | 0.91 MT | Land-filled |
| | Refrigerant oil | 0.20 MT | Incinerated |
| | Waste water | 1.76 MT | Recycled |
| | Waste sludge | 0.26 MT | Incinerated |
| | **Recycled / Total Hazardous Waste** | **38.48 %** | |

**Exhibit 3-2 2002 Waste Reduction (continued)**

| Type | Source | Amount | Fate |
|---|---|---|---|
| TSCA | Asbestos | 0 cu. yds. | Land-filled |
| Waste | PCB capacitors and debris | 0.05 MT | Incinerated |
| | Ballasts incl. Ballasts (PCBs) | 0.41 MT | Recycled |
| Municipal | Front end trash | 119.85 MT | Land-filled |
| Solid | Construction waste - wood | 18.80 MT | Recycled |
| Waste | CFCs | 44.07 MT | Recycled |
| (MSW) | Office Waste Stream: | | |
| | Paper (mixed) | 22.08 MT | Recycled |
| [Kin02a] | Cardboard | 49.97 MT | Recycled |
| | Aluminum & glass (bottles & cans) | 19.96 MT | Recycled |
| | Industrial Waste Stream: | | |
| | Metals – aluminum & stainless steel | 192.72 MT | Recycled |
| | copper & wiring & iron | | Recycled |
| | Batteries | 0.96 MT | Recycled |
| | Computer/electronic scrap | 6.53 MT | Recycled |
| | Electronic Media | 1.34 MT | Recycled |
| | **Recycled + Reused / Total MSW** | **75.06%** | **MT/ MT * 100** |

**Exhibit 3-3. 2003 Waste Reduction**

**View PPPL Pollution Prevention accomplishments @http://tis.eh.doe.gov/p2/wastemin/RecycleRpt.Asp**

| Type | Source | Amount | Fate |
|---|---|---|---|
| Hazardous | Oil | 3.31 MT | Recycled |
| Waste | Lab wastes, solvents | 0.58 MT | Incinerated |
| | Batteries - lithium | 0.02MT | Incinerated |
| | Batteries (includes lead acid ) | 1.28 MT | Recycled |
| | Lead debris | 0.19 MT | Incinerated |
| | Non-PCBs Non-Haz. Capacitors | 0.85 MT | Incinerated |
| | Fluorescent lamps (contain Hg) | 0.76 MT | Recycled |
| | Mercury debris | 1.39 MT | Incinerated |
| | Mercury | 0.01 MT | Recycled |
| | Oily debris | 0.83 MT | Land-filled |
| | Waste water | 1.80 MT | Recycled |
| | Waste sludge | 0.41 MT | Incinerated |
| | **Recycled / Total Hazardous Waste** | **64.89 %** | |
| TSCA Waste | Asbestos | 80 cu. yds. | Land-filled |
| Municipal | Front end trash | 93.0.00 MT | Land-filled |
| Solid | Construction waste - wood | 12.70 MT | Recycled |
| Waste | Office Waste Stream: | | |
| (MSW) | Paper (mixed) | 21.77 MT | Recycled |
| | Cardboard | 48.98 MT | Recycled |
| Industrial | Aluminum & glass (bottles & cans) | 15.42 MT | Recycled |
| Waste | Metals – aluminum & stainless steel | 492.52 MT | Recycled |
| Stream: | copper & wiring & iron | | |
| | Batteries | 3.57 MT | Recycled |
| | Computer/electronic scrap | 13.22 MT | Recycled |
| [Kin03a] | **Recycled + Reused / Total MSW** | **83.73%** | **MT/ MT * 100** |

PPPL is also in compliance with the requirements of the RCRA-mandated Underground Storage Tank (UST) Program. In 1995, PPPL placed all underground storage tanks out of service. PPPL submitted a Site Assessment Report as part of the Remedial Investigation and Remedial Alternative Assessment (RI/RAA) Report in March 1997 [HLA97]. NJDEP issued a "No Further Action" determination for the UST closure in a letter to Princeton University, dated March 28, 2000. All UST-related actions have been completed.

### 3.1.3 Federal Facility Compliance Act (FFCA)

The Federal Facility Compliance Act (FFCA) requires the Department of Energy (DOE) to prepare "Site Treatment Plans" for the treatment of mixed waste, which is waste containing both hazardous and radioactive components. Based on the possibility of the site generating mixed waste, which could require treatment on site, PPPL was identified on the list of DOE sites that would be included in the FFCA process [PPPL95]. In 1995, PPPL prepared its proposed "Site Treatment Plan (STP) for Princeton Plasma Physics Laboratory (PPPL)." PPPL does not currently generate mixed waste and has no future plans to generate mixed waste.

PPPL developed an approach where any potential mixed waste would be treated in the original accumulation container within 90 days of generation of the hazardous waste. This treatment option was discussed with the State of New Jersey and Environmental Protection Agency (EPA) Region II regulators, who were in agreement with this approach. Based on their agreement, this approach keeps PPPL in compliance with the applicable Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions. DOE provides the state and EPA with annual updates and keeps the regulators apprised of activities. If mixed wastes were generated that could not be treated in original accumulation containers, PPPL would notify the regulators and provide them with a revised "Site Treatment Plan" [PPPL95].

### 3.1.4 National Environmental Policy Act (NEPA)

Thirty-four (34) PPPL activities in 2002, and forty-four (44) PPPL activities in 2003, received NEPA reviews. All but one of these activities were determined to be categorical exclusions (CX) in accordance with the NEPA regulations and guidelines of the Council on Environmental Quality (CEQ) and DOE, or covered in a previously approved environmental assessment (EA). An EA was completed for the proposed National Compact Stellarator Experiment (NCSX) in 2002, and DOE issued a Finding of No Significant Impact (FONSI) for this proposed action on October 25, 2002. [Lev04b].

### 3.1.5 Toxic Substance Control Act (TSCA)

PPPL complies with the terms and conditions of TSCA for the protection of human health and the environment by requiring that specific chemicals be controlled and regulations restricting use are implemented. The last PPPL polychlorinated biphenyl (PCB) transformers were removed from the site in 1990.

In September 1998, 640 regulated capacitors were removed from the total inventory of 645 capacitors. At the end of 2002 and 2003, only 5 PCB capacitors that met the regulation criteria remained at PPPL [Pu04a].

### 3.1.6 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Certified subcontractors, who meet all the requirements of FIFRA, performed the application of herbicides, pesticides, and fertilizers. The PPPL Maintenance & Operations Division (M&O) monitors this subcontract. The following list of herbicides were used on the PPPL site in 2002 and 2003 [Kin03b and 04b].

**Herbicides:**

Used in 2002:
Dimension (5.5 gallons)
Roundup (6.25 gallons)
Momentum (15.6 gallons)

Used in 2003:
Roundup (15.4 gallons)
Malathion (1.69 gallons)

### 3.1.7 Spill Prevention Control and Countermeasure (SPCC)

PPPL maintains a Spill Prevention Control and Countermeasures (SPCC) plan as a requirement of 40 CFR 112 "Oil Pollution Prevention" regulations. [PPPL03e]. The SPCC Plan was updated in 2003 to address new regulatory requirements. There are numerous transformers containing non-PCB mineral oil as well as fuel oil tanks (25,000 and 15,000 gallon aboveground storage tanks) for supplying fuel to the boilers and generators located on-site. Smaller vehicle refueling tanks and equipment oil storage tanks containing petroleum products are included in PPPL's SPCC plan.

The most recent NJDEP inspection of the facility was conducted in June 1998. Under New Jersey regulations, NJDEP classified PPPL as a non-major facility [NJDEP98a]. The threshold of 200,000 gallons of petroleum (not in transformers) is not exceeded. PPPL has reporting obligations under these regulations. These obligations include notification of discharges and discharge confirmation reporting to NJDEP. PPPL is considered a minor facility and therefore, the Discharge Prevention Control and Containment (DPCC) plan and Discharge Cleanup and Reporting plan (DCR) requirements do not apply.

## 3.2 Radiation Protection

### 3.2.1 DOE Order 5400.5, "Radiation Protection of the Public and the Environment"

For radiation protection of the public and the environment, PPPL follows the requirements documented in the Radiological Plan contained in PPPL's Environmental Monitoring Plan [PPPL99b]; the Plan meets the requirements stated in DOE Order 5400.5 [DOE93a].

Through its monitoring program, the Plan provides assurance that the release of radioactive material on-site or off-site will be within regulatory limits and PPPL's policy of all radiation exposures "As Low As Reasonably Achievable" (ALARA). The order pertains to permissible dose equivalents and concentration guides as well as giving guidance on maintaining exposures to ALARA limits.

When 10 CFR 835, "Occupational Radiation Protection," became effective, PPPL made operational changes reflected in personnel monitoring requirements. Specific criteria for implementing the requirements are included in the NSTX Safety Assessment Document [PPPL01a]. These criteria are shown in Appendix A, Table 1.

The radiation monitoring program emphasizes exposure pathways appropriate to fusion energy projects at PPPL. These pathways include external exposure from direct penetrating radiation.

### Exhibit 3-4. Critical Pathways

| Path | Source and Pathway |
|---|---|
| A1 | Atmospheric ---> Whole Body Exposure |
| A2 | Atmospheric ---> Inhalation Exposure |
| A3 | Atmospheric ---> Soil & Vegetation Deposition---> Ingestion/Whole Body Exposure |
| L1 | Liquid Water Way ---> Drinking Water Supply --> Human |
| L2 | Liquid Water Way ---> External Exposure |
| L3 | Liquid Water Way ---> Fish ---> Human |

Following the end of TFTR deuterium and tritium (isotopes of hydrogen, D-T) experiments, internal exposure from radionuclides, such as tritium (HT and HTO) in air and water, was monitored. Tritium releases continue to be measured following TFTR shut down and during TFTR Decontamination and Decommissioning (D&D) Project. Six major critical pathways are considered as appropriate (see Exhibit 3-4).

The radiation monitoring program, described in the TFTR Final Safety Analysis Report [FSAR82], was updated to reflect the current environment around TFTR and D site (Exhibit 3-5).

PPPL's Environment, Safety & Health Directives (ESHD) 5008, Section 10, "Radiation Safety," Subpart L, "Release of Materials and Equipment from Radiological Areas," and Subpart P, "Radiological Environmental Monitoring Program," support the requirements for compliance with DOE 5400.5 {PPPL00d]. Monitoring of equipment and the environment ensures radiation protection for the employees and the public good.

### Exhibit 3-5. Radiation Monitoring Program Covering Critical Pathways

| Type of Sample | Critical Pathway | Sample Location | Sampling Frequency | Analysis |
|---|---|---|---|---|
| Surface Water | L1, L2, L3 & A3 | 1 – Basin Outfall (DSN001)<br>2 – Delaware & Raritan Canal (DSN003)<br>3 – Off-site (Bee, Cranbury, Devils Brooks, Millstone River) | 1 – Monthly<br>2 – Monthly<br>3 - Quarterly | All surface water samples –HTO |
| Rain Water | L1, L2, & L3 | 1– Within 250 and 500' radius of D-site stack (N,S,E, & W)<br>2 –Within 1 km radius (co-located with air monitoring stations) | Monthly (as filled) | HTO |
| Ground Water | L1, L2, & L3 | 1– Select ground water monitoring wells<br>2 –D-site sumps (Air shaft and MG basement) | 1 –Monthly<br>2 –Monthly | HTO |
| Sanitary Waste Water | L1 & L2 | Liquid effluent collection tanks (3 tanks each 15,000 gal. on D-site) | As required-dependent on fill rate | HTO<br>Gross beta |
| Air | A1, A2, & A3 | TFTR Test Cell | Continuously | HT and HTO |
| Air | A1, A2, & A3 | Tritium Vault | Continuously | HT and HTO |
| Air | A1, A2, & A3 | D-site Stack (HVAC) | Continuously | HT and HTO, Particulates |
| Direct & Air (on-site) | | 4 air monitoring trailers on D-site facility boundary | Continuously | g, n, HT and HTO, |
| Direct & Air (off-site) | | 6 locations off-site with 1 km radius | Continuously | HT and HTO |

HT = elemental tritium HTO = tritiated water Gross b = Gross beta g = gamma n = neutron

#### 3.2.2 DOE Order 435.1, "Radioactive Waste Management"

To comply with the requirements of DOE Order 435.1, PPPL manages its radioactive waste by two implementing documents [DOE99b]:

1. PPPL ESHD 5008, Section 7, "Waste Management" [PPPL00c]; and
2. Environmental Restoration/Waste Management (ER/WM), EM-CP-21, Low-level Radioactive and Mixed Waste Certification Plan [PPPL98c].

The first document discusses roles and responsibilities for the management of radioactive waste and describes the Radioactive Waste Handling Facility (RWHF) operations. The second document describes PPPL's organization and methodology for certifying, handling, and characterizing low-level radioactive and mixed waste that may be generated by PPPL. This plan includes transportation and subsequent burial at DOE's Hanford Burial Site in the state of Washington and the Nevada Test Site outside of Las Vegas, Nevada. Other ER/WM procedures provide specific instructions for sampling, packaging and preparing waste for shipment/disposal.

#### 3.2.3 Atomic Energy Act (AEA) of 1954

PPPL complies with the requirements of the Atomic Energy Act (AEA) of 1954 through the adherence to PPPL's plan developed for controlling radioactive material. PPPL's "Nuclear Materials Control and Accountability (MC&A) Plan" describes the system for control and accountability of nuclear materials in PPPL's custody [PPPL98d]. PPPL's management assures that nuclear material used at PPPL is properly controlled, inventoried, and accounted for as required in DOE Order 474.1 [DOE99c].

The objective of the MC&A program is to provide a basis for planning, implementing, and evaluating an information and control system. The system is a combination of checks and balances sufficient to detect and assist in the prevention of the unauthorized use and removal of nuclear materials from PPPL.

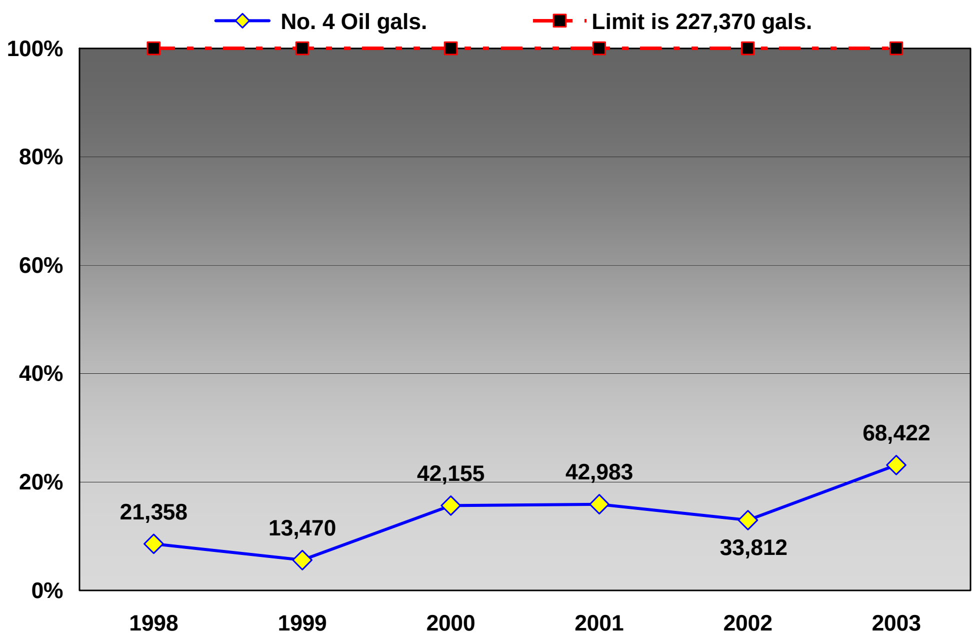
### 3.3 Air Quality and Protection

#### 3.3.1 Clean Air Act (CAA)

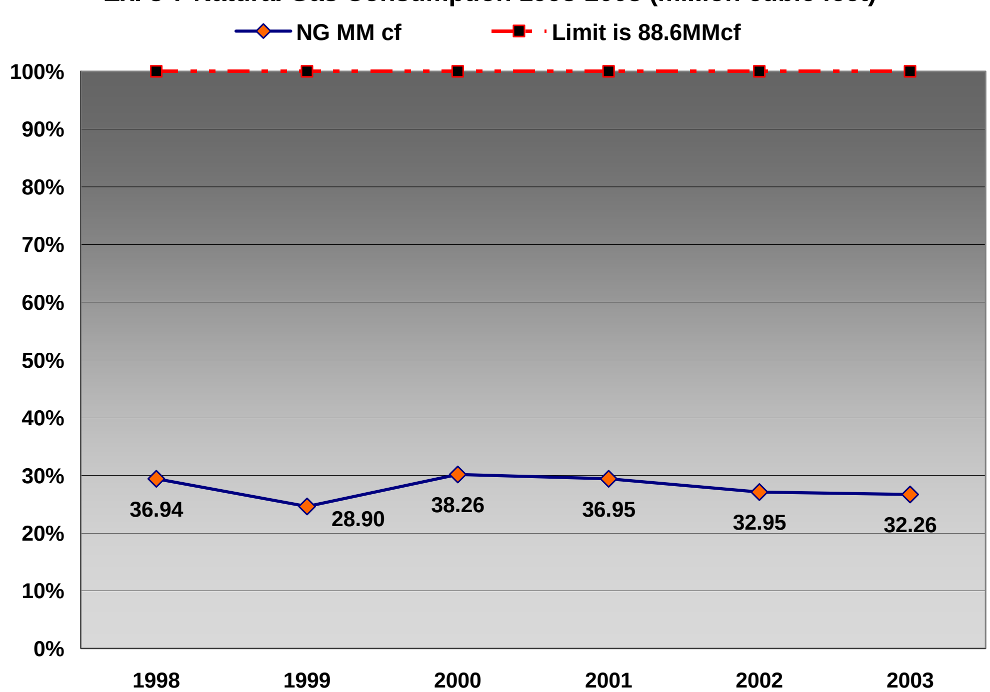
PPPL complied with the requirements of the CAA in 2002 and 2003. Under Title I, "Non-attainment Provisions," PPPL is located in a severe 17-ozone non-attainment area (ozone attainment to be reached 15 to 17 years following date of regulations, *i.e*. 2005 - 2007). This classification limits the threshold potential-to-emit (PTE) to 25 tons per year of nitrogen oxides ($NO_x$) and 10 tons per year of volatile organic compounds (VOCs). Formed during the burning of fossil fuels in boilers, generators, vehicle engines, etc., $NO_x$ and VOCs are precursors to ozone formation.

At PPPL, $NO_x$ is the only class of regulated air contaminant that could exceed PTE thresholds limit of greater than 25 tons per year. In order to meet this limit, PPPL calculated total fuel use for all four boilers and maximum hours of operations for the diesel generators. PPPL then requested from NJDEP the fuel limits (Exhibits 3-6 and 3-7) and hours of operations for the generators. NJDEP granted the request and imposed a maximum annual fuel (oil and natural gas) use limitation for the C-site boilers as a whole rather than the individual boiler fuel use limit. PPPL continues to operate successfully within the stated limitations (typically less than 30% of the limitations) [NJDEP96, Kir04a]. In 2002 and 2003, the four boilers actual emissions of $NO_x$ were calculated to be 4.75 and 4.76 tons, respectively.

Ex. 3-6. No. 4 Fuel Oil Consumption 1998-2003 (in gals.)




Ex. 3-7 Natural Gas Consumption 1998-2003 (million cubic feet)



As a requirement of New Jersey Administrative Code (NJAC) Title 7:27-21, "Emissions Statements," PPPL submitted the 1994 Air Emission Survey to NJDEP; this Emission Survey was the last survey submitted. In March 1996, the NJDEP approved PPPL's request for Annual Emission Statement Non-Applicability.

The CAA Title V, "Operating Permit Program," is implemented through the State of New Jersey. In August 1995, PPPL filed a negative declaration for the New Jersey Operating Permit Program. By reducing the annual operating hours from 500 to 200 for the (formerly TFTR) D-site emergency diesel generator, PPPL lowered the $NO_x$ potential to emit to below the 25 ton-per-year threshold. NJDEP granted approval in March 1996, effective November 29, 1995.

Under CAA Title VI, "Stratospheric Ozone Depletion," PPPL's use of certified refrigerant recovery units and trained technicians comply with Section 608 of the CAA, which prohibits the venting of ozone-depleting substances. PPPL maintains an inventory of Class I and II ozone-depleting substances (chlorofluorocarbons or CFCs).

PPPL safely disposes of equipment containing ozone-depleting substances by removing refrigerants to specified levels prior to disposal of equipment. PPPL employs trained and certified technicians to service and repair equipment containing ozone-depleting substances and to operate the four refrigerant recovery units. In March 2002, PPPL replaced three older chiller units with units operating with non-Class I and II refrigerants. These units supply facility air-conditioning and process cooling of NSTX.

In its efforts to track gases that contribute to global warming, NJDEP requested that PPPL determine the amount of sulfur hexafluoride ($SF_6$) released annually from TFTR. Prior to 1995, the amount of $SF_6$ needed to maintain the $SF_6$ systems ranged from 28,060 pounds to 36,340 pounds per year. During TFTR operations, $SF_6$ maintained high-voltage electrical equipment - modulator regulators, ion cyclotron radio frequency (ICRF), and neutral beam (NB) high voltage and ion source enclosures. Following TFTR shutdown in 1997, no additional $SF_6$ was purchased. PPPL removed the remaining inventory of $SF_6$ from those systems, and currently $SF_6$ is used only in NSTX's high voltage regulators.

### 3.3.2 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

PPPL has an in-stack sampler within the D-site stack to monitor tritium releases. The monitor has been independently verified as meeting NESHAPs radionuclide emission monitoring requirements. In August 1993, EPA concurred with this determination. In 2002, the levels of tritium released during operations were measured: 96.495 curies of tritiated water (HTO) and 13.761 curies of elemental tritium (HT) [Lev04c].

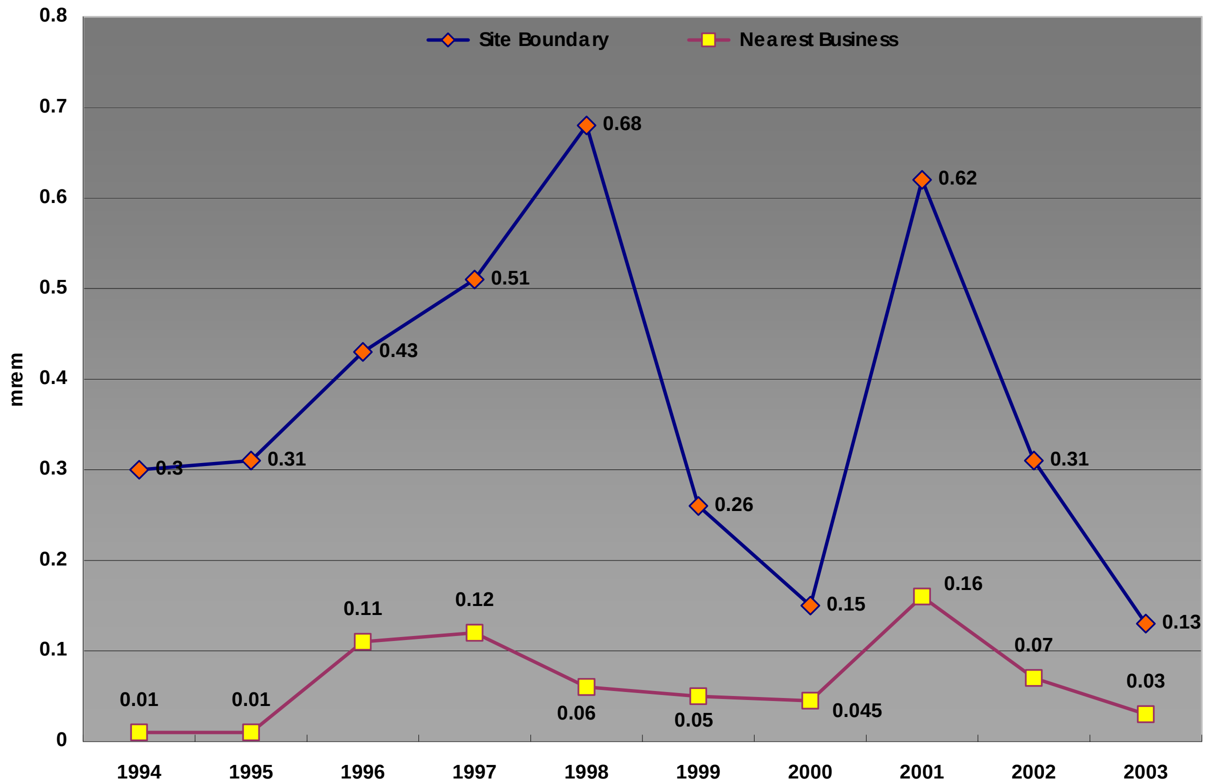
In 2003, the levels of tritium released during operations were: 34.329 curies of HTO and 1.789 curies of HT (Exhibit 3-8 and App. A, Tables 4 & 5 ). The decrease in the levels of tritium released was largely due to the end of TFTR D&D operations. This decrease is reflected also in the Site and Boundary dose calculations (Ex. 3-9).

**Exhibit 3-8. Total Air Releases from D-Site (formerly TFTR) Stack from 1994 to 2003**

| Calendar Year | HTO (Curies) | HT (Curies) | Total Curies (HTO + HT) | Activities |
|---|---|---|---|---|
| 1994 | 45.55 | 93.13 | 138.68 | D-T Operations |
| 1995 | 37.031 | 24.87 | 61.901 | D-T Operations |
| 1996 | 118.624 | 64.88 | 183.504 | D-T Operations |
| 1997 | 124.093 | 63.019 | 187.112 | TFTR shutdown |
| 1998 | 45.867 | 28.982 | 74.849 | TFTR shutdown |
| 1999 | 59.712 | 21.779 | 81.491 | TFTR D&D preparation |
| 2000 | 58.320 | 18.073 | 76.393 | TFTR D&D activities |
| 2001 | 221.242 | 38.742 | 259.984 | TFTR D&D activities |
| 2002 | 96.495 | 13.761 | 110.256 | TFTR D&D activities |
| 2003 | 34.329 | 1.789 | 36.118 | NSTX Operations |

Annual Limit is 500 Curie

**Exhibit 3-9. Estimated Dose (mrem) from PPPL Operations from 1994 to 2003**




The Annual Limit of 10 mrem/year applies to the estimated dose equivalent at the site boundary only.

In 2002 and 2003, the effective dose equivalent (EDE) to a person at the business nearest PPPL, due to radionuclide air emissions, was 0.072 mrem (0.72 μSv)and 0.027 mrem (0.27 μSv), respectively, which is significantly lower than the NESHAPs standard of 10 mrem/yr (Exhibit 3-9). During their most recent inspection of PPPL's facilities in March 1998, representatives from EPA Region II indicated that PPPL complied with NESHAPs requirements [Lev04c].

## 3.4 Water Quality and Protection

### 3.4.1 Clean Water Act (CWA)

PPPL complies with the requirements of the CWA. Based on an assessment of leaking underground storage tanks (USTs) that contained fuel oil, PPPL conducted quarterly ground water monitoring for petroleum hydrocarbons and VOCs until September 1997 (see Section 6.1.3). The data collected for 24 quarters (6 years) were consistent: trace or no petroleum hydrocarbons were detected and the former USTs were not contributing to ground water contamination.

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported 2 and 4 releases during CY 2002 and 2003, respectively [PPPL02a & b, & 03a,c,d,&f].

### 3.4.2 National Pollutant Discharge Elimination System (NPDES)

In 2002 and 2003, PPPL operated under the requirements of New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit (NJ0023922). The NJDEP issued the renewed surface water permit on April 29, 1999, with an effective date of June 1, 1999 [NJDEP99]. In December 2003, the permit renewal application was submitted to NJDEP 180 days prior to its expiration date (June 1, 2004) [PPPL03i].

In 2002, the monitoring locations designated in the permit are the detention basin outfall (DSN001), and the filter backwash discharge (DSN003) located at the Delaware & Raritan (D&R) Canal pump house. These two locations are designated as monthly sampling points. In 2002, the chlorine produced oxidants (CPO) permit limit was exceeded twice at DSN001; in 2003, the chemical oxygen demand (COD) limit was exceeded at DSN001 in once June and July and twice in November (see Section 3.7.2 for discussion).

PPPL maintains an inventory of wastewater streams (industrial discharges) that flow into the Stony Brook Regional Sewerage Authority (SBRSA) system. Under the requirements of the Discharge License from SBRSA, each month PPPL reports to SBRSA discharges from the D-site liquid effluent collection tanks (LEC).

**Exhibit 3-10. NJPDES Non-Compliances 2002-2003**

| Outfall No. | Para-meter | # Non-compliance | # Samples | #Compliant Samples | % Compliant | Date(s) Exceeded | Description/ Solution |
|---|---|---|---|---|---|---|---|
| DSN001 | CPO | 2 | 7 | 5 | 71 | 8/7/02 | Automated chlorination equipment installed. |
| DSN001 | COD | 4 | 19 | 15 | 79 | 6/6/03<br>7/1/03<br>11/7/03 | Basin cleaned & inspected; discharge closely monitored. |

### 3.4.3 Safe Drinking Water Act (SDWA)

The PPPL receives its drinking water from the Elizabethtown Water Company. While Elizabethtown is responsible for providing safe drinking water, PPPL periodically tests incoming water quality (App. A, Tables 23 & 32).

PPPL can switch from D & R Canal water (non-potable) to potable water for its non-contact water supply in the event of a fire or other emergency situation.

On a quarterly basis, PPPL inspects and pressure tests the back flow prevention equipment at both locations: the main potable water connection where Elizabethtown water enters C site and the cross-connect system beneath the elevated water tower. Back flow prevention equipment prevents contamination of the potable water supply *via* a large cross-connection. On an annual basis, these systems are completely disassembled, inspected, and tested in the presence of an Elizabethtown Water Company representative. These inspection reports are submitted to the NJDEP annually.

## 3.5 Other Environmental Statutes

### 3.5.1 Endangered Species Act (ESA)

In 2002 and 2003, PPPL occupied 88.5 acres of the Forrestal Campus of Princeton University. As documented in historical PPPL environmental assessments, no endangered species on-site have been indicated [ERDA75] [DOE92] [DOE93b] [Dy93].

In 1997, as part of the Remedial Investigation, Amy S. Greene Environmental Consultants, Inc. conducted a baseline ecological evaluation [Am98]. The New Jersey Audubon Society has visually verified and reported a pair of Cooper's Hawk (*Accipiter cooperii*) nesting within one mile of the PPPL property [NJB97]. Cooper's hawks are presently listed as threatened in the state of New Jersey [NJDEP97].

### 3.5.2. Migratory Bird Treaty Act

In 2002 and 2003, PPPL took no migratory bird species nor conducted any programs or actions that call for such activities as banding, marking or scientific collection, taxidermy and/or depredation control.

### 3.5.3 National Historic Preservation Act (NHPA)

There are no identified historical or archaeological resources at PPPL. No buildings or structures have been identified as historical [Gr77].

## 3.6 DOE Order 450.1 Environmental Protection Program

### 3.6.1 Pollution Prevention Activities

In 2002 and 2003, PPPL continued its efforts to pursue waste minimization and pollution prevention opportunities through active recycling efforts and through the purchasing of recycled-content products. A refined Dumpster Diving survey method of PPPL's solid waste stream document the amount of recycled versus waste materials. In 2003, a digital read-out for the large truck scale was installed to measure the weight of municipal solid waste and the recycled materials in the MSW stream taken from PPPL.

In 2003, the Princeton Beta Experiment-Modification (PBX-M) was dismantled and removed from its test cell on C-site. The test cell will be the home of the next device – National Compact Stellarator Experiment (NCSX). Approximately 352 tons of metal were recycled, including the 57,000 pound vacuum vessel.

### 3.6.2 Site Environmental Compliance and EMS Audits

In 2002, PPPL's Quality Assurance Division performed eleven audits of which two involved environmental topics: Hazardous Waste and Radiological Waste. Each audit is tracked through PPPL's internal QA Audit Database.

In 2003, PPPL's Quality Assurance Division performed seventeen audits of which four involved environmental topics or subcontractors: ONYX Environmental Services, Radiological Waste, Precision Testing Labs, and PPPL Environmental – Air.

EMS audits will be conducted upon adoption and full implementation of PPPL's EMS program in 2005.

### 3.6.3 Beneficial landscape

In 2002, PPPL modified the area adjacent to the detention basin, where over time, soil had been temporarily piled (Exhibit 3-11). As part of the landscaping management plan, the area was graded, seeded, and gravel laid down for vehicular traffic that serviced the basin and its equipment or for surveillance purposes drove in this area. The project disturbed greater than 5000 sq. ft. and required an approved Soil Erosion and Sediment Control Plan from the Freehold Soil Conservation District.

**Exhibit 3-11. Before Landscaping**

**Exhibit 3-12. After Landscaping**

In Exhibit 3-12, the grassed area was mowed and the area is no longer a magnet for unwanted materials, dirt, or other debris.

### 3.6.4 Progress on DOE Secretarial Goals Including Ozone-Depleting Substances Reduction

Exhibit 3-13, "PPPL's Progress in Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in 2002 and 2003," provides the status of PPPL's activities and accomplishments in pursing these fourteen goals.

**Exhibit 3-13. PPPL's Progress Toward Meeting Executive Order 13148 Pollution Prevention, Energy Efficiency, and Transportation Goals in 2002 and 2003**

| Pollution Prevention | Criteria | Baseline | 2005 Target | 2002 Data | 2003 Data |
|---|---|---|---|---|---|
| **Goal 1** metric tons(MT) | Hazardous Waste Generated (90% reduction of 1993 baseline) | 29 | 2.9 | 9.94 | 5.88 |
| cubic meters ($m^3$) | Mixed Waste Generated (80% reduction of 1993 baseline) | 2 | 0.4 | 0 | 0 |
| cubic meters ($m^3$) | Low Level Waste Generated (80% reduction of 1993 baseline) | 22 | 4.4 | 0 | 0 |
| cubic meters ($m^3$) | TRU/Mixed TRU Waste Generated (80% reduction of 1993 baseline) | 0 | 0 | 0 | 0 |
| **Goal 2** Pounds | TRI Chemical Releases (90% reduction of 1993 baseline) | 0 | 0 | 0 | 0 |
| **Goal 3** metric tons (MT) | Sanitary Waste Generated (75% reduction of 1993 baseline) | 1,410 | 352.5 | 120 | 93.1 |
| **Goal 4** Percent (%) | Sanitary Waste Recycled (45% recycle versus disposal) | N/A | 45% recycling rate in 2005 | 43.3% | 47.8% |
| **Goal 5** Metric tons (MT) | Waste Reduced from Cleanup /Stabilization (C/S) Activities (% of total waste from C/S activities) | N/A | Reduce 10% per year FY 2001 to FY 2005 (Note 1) | 0 | 0 |
| **Goal 6** Percent (%) | Purchases of EPA-designated items with Recycled Content (100% by recycled costs versus non-recycled) | N/A | 100% | 85% Adjusted 100% | 85% Adjusted 96% |
| **Goal 10** | Class I Ozone Depleting Substances Uses | N/A | N/A | N/A | N/A |
| **Energy Efficiency** | **Criteria** | **Baseline** | **2005 Target** | **2002 Data** | **2003 Data** |
| **Goal 7** BTUs/$Ft^2$ | Unit Energy Consumption (40% of 1985 baseline for building) | 249,007 | 149,404 | 150,600 | 175,300 |
| **Goal 8** Percent (%) | Request for bid packages for energy supply with clean energy provisions (% of requests with provisions versus those without) | N/A | 100% | 0% | 0% |
| Percent (%) | Purchase of electricity from less greenhouse gas-intensive sources (% of electricity from less greenhouse gas sources to total consumption) | N/A | | 0% | 0% |
| **Goal 9** Percent (%) | Replacement of chillers (% of total 150 ton or larger pre-1984 units with class I refrigerants replaced) | Five (5) units | 100% | 100% | 100% |
| **Goal 11** US tons | Greenhouse gas emission from energy use (25% reduction of greenhouse gas emission reduced relative to 1990 baseline) | 3,806 | 2,855 | 5,518 | 5,542 |
| **Transportation** | **Criteria** | **Baseline** | **2005 Target** | **2002 Data** | **2003 Data** |
| **Goal 12** gallons | Petroleum consumption by fleet vehicles (80% of petroleum fuel used in relation to FY00 baseline) | 8,076 | 6,461 | 7,966 | 9,082 |
| **Goal 13** Percent (%) | New alternative fuel light truck purchase (%of new truck purchase with alternative fuel capability) | N/A | 80% | 0 | 50% |
| **Goal 14** Percent (%) | Usage rate of alternative fuel vehicles (% use versus total availability) | N/A | 75% | 50% | 50% |

Hazardous waste and municipal solid waste reduction data are discussed in Section 3.1.2 (see Exhibits 3.1, 3.2, and 3.3)

In 2002, used and virgin Freon were sold to a recycler. Proceeds from the sale returned $95,000 to the Laboratory. The total pounds recycled were 9,459 lbs: R500 - Used 2,921 lbs, R 12-Used 5,242 lbs, R 12-virgin 400 lbs, and R 500-virgin 896 lbs.

## 3.7 Executive Orders (EO)

### 3.7.1 Executive Order (EO) 13148, "Greening the Government through Leadership in Environmental Management"

On Earth Day, April 21, 2000, President Clinton signed this EO, which set goals for all government agencies to achieve reductions in toxic chemicals, hazardous, and ozone-depleting substances, environmental compliance, environmental management systems, and environmentally and economically beneficial landscaping. Each agency develops a written implementation plan, which is submitted to EPA and annual progress reports on the progress achieved to meet the goals by the set deadlines.

PPPL will integrate the Environmental Management System (EMS) as part of the PPPL Integrated Safety Management System (ISMS) program that was developed in 1999 [PPPL99a]. The EO13148 requires that the EMS be implemented by the end of 2005.

### 3.7.2 Executive Order (EO) 11988, "Floodplain Management"

In 2002 and 2003, PPPL complied with EO 11988, "Floodplain Management." Delineation of the 500 and the 100-year floodplains was completed in February 1994. The 500-year and the 100-year floodplains are located at the 85-foot elevation and at the 80-foot elevation mean sea level (msl), respectively [NJDEP84] (Exhibit 3-14).

The 88.5-acre parcel that PPPL occupies is included in Princeton Forrestal Center's (PFC) Storm Water Management Plan-Phase I [PFC80]. The 88.5-acre parcel is part of the Bee Brook watershed included in the PFC storm water plan.

One condition of the PFC Storm Water Management Plan is that the average density of development cannot exceed a maximum of 60% impervious coverage of developable areas. PPPL meets the ≤60% impervious coverage limit. The Site-Wide Storm water Management Plan was completed in February 1996, and PPPL is in compliance with this Plan [SE96].

In 1997, PPPL prepared a Site-Wide Storm Water Pollution Prevention Plan. Incorporating the Storm Water Management Plan, Spill Prevention Control and Countermeasure (SPCC) Plan, and other best management practices, this plan was a summary of activities already in practice at PPPL. The plan will be reviewed and updated triennially or as site changes warrant.

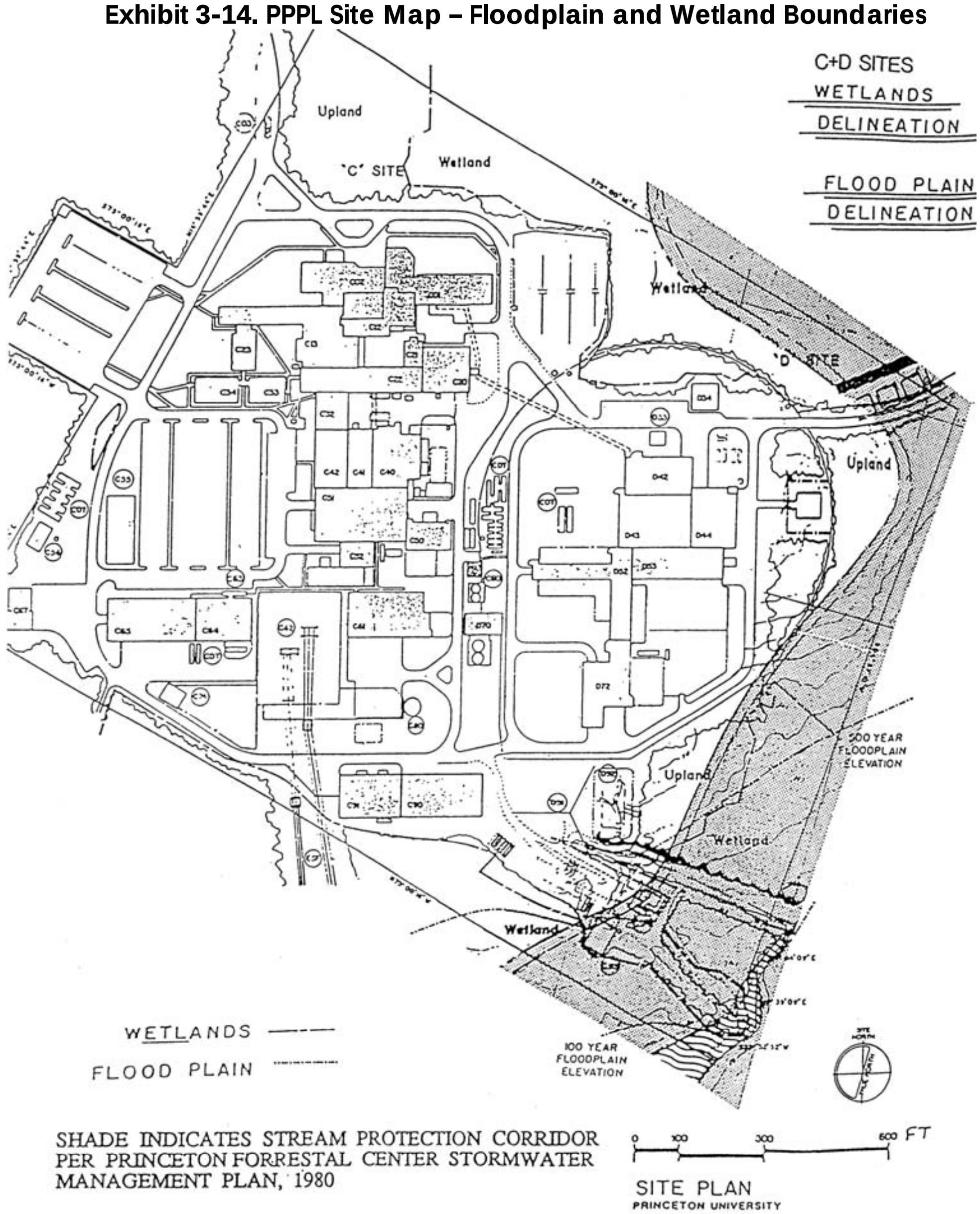
### 3.7.3 Executive Order (EO) 11990, "Protection of Wetlands"

In 2002 and 2003, PPPL complied with EO 11990, "Protection of Wetlands." The Land

Use Regulation Program within NJDEP continues to be the lead agency for establishing the extent of state and federally regulated wetlands and waters. The U.S. Army Corps of Engineers retains the right to re-evaluate and modify wetland boundary determinations at any time.

In 1994, PPPL received a "Letter of Interpretation" (LOI) from NJDEP for defining the wetland boundaries and wetlands classification. This LOI is needed before NJDEP issues wetlands permits for a site. The LOI is valid for a five-year period with the option to renew for an additional five years. In 1999 PPPL submitted a renewal application to NJDEP and was granted the five-year extension, beginning in January 1999 and valid until January 2004 (Exhibit 3-14).

**Exhibit 3-14. PPPL Site Map – Floodplain and Wetland Boundaries**



### 3.7.4 Executive Order (EO) 12856, "Federal Compliance with Right-to-Know and Pollution Prevention Requirements," and Superfund Amendments and Reauthorization Act (SARA) Title III, Emergency Planning and Community Right-to-Know Act (EPCRA)

Emergency Planning and Community Right-to-Know Act, Title III of the 1986 SARA amendments to CERCLA created a system for planning responses to emergency situations involving hazardous materials and for providing information to the public regarding the use and storage of hazardous materials. Under the reporting requirements of EO 12856 and SARA Title III, PPPL complied with the following:

PPPL submitted an annual chemical inventory in compliance with SARA Title III (EPCRA Section 312) in 2002 and 2003. This inventory reports the quantities of chemicals listed in the CERCLA regulations (Exhibit 3-15). Under SARA Title III, PPPL provides the following to the applicable emergency response agencies:

1. An inventory of hazardous substances stored on-site;
2. Material Safety Data Sheets (MSDS); and
3. SARA Tier I form.

PPPL completed the listing of each hazardous substance stored by users above a certain threshold planning quantity (typically 10,000 pounds, but lower for certain compounds). Exhibit 3-16 lists hazardous compounds at PPPL reported under SARA Title III for 2002 and 2003 [PPPL03b & PPPL 04]. These chemicals are found in 40 CFR Part 372, Subpart D, which lists names and chemical abstract system numbers for toxic chemicals.

Of the fifteen, eight chemicals are in their gaseous form and are therefore classified as sudden release of pressure hazards; five gaseous compounds are also classified as acute health hazards. There are eight liquid chemicals; nitrogen is used in both gaseous and liquid forms. Fuel oil, gasoline, and petroleum oil are flammables; trichlorotrifluoroethane (CFC-113) and sulfuric acid are the liquid compounds that are classified as acute health hazards; sulfuric acid is also reactive. PCBs and gasoline are listed as chronic health hazards.

**Exhibit 3-15. Summary of PPPL EPCRA Reporting Requirements**

| | YES | NO | NOT REQUIRED |
|---|---|---|---|
| EPCRA 302-303: Planning Notification | [ ✓ ] | [ ] | [ ] |
| EPCRA 304: EHS Release Notification | [ ] | [ ✓ ] | [ ] |
| EPCRA 311-312: MSDS/Chemical Inventory | [ ✓ ] | [ ] | [ ] |
| EPCRA 313: TRI Report | [ ] | [ ] | [ ✓ ] |

EHS – Extremely hazardous substances (No EHS are on-site at PPPL)
TRI – Toxic Release Inventory

Section 304 of SARA Title III requires that the Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC) be notified of accidental or unplanned releases of certain hazardous substances to the environment. To ensure compliance with such notification provisions, a Laboratory-wide procedure, ESH-013, "Non-Emergency Environmental Release—Notification and Reporting," includes SARA Title III requirements [PPPL98b]. The NJDEP administers SARA Title III reporting for the USEPA and has modified the Tier I form to include SARA Title III reporting requirements and NJDEP reporting requirements [PPPL03b & 04].

**Exhibit 3-16. Hazard Class of Chemicals at PPPL**

| Compound | Category |
|---|---|
| Bromochlorodifluoro-methane (Halon 1211) | Sudden release of pressure & Acute health effects |
| Bromotrifluoromethane (Halon 1301) | Sudden release of pressure & Acute health effects |
| Carbon dioxide | Sudden release of pressure & Reactive |
| Chlorine | Reactive |
| Chlorodifluoromethane (HCFC22) | Sudden release of pressure & Reactive |
| Dichlorodifluoro-methane (CFC 12) | Sudden release of pressure & Reactive |
| Fuel Oil | Fire |
| Gasoline | Fire & Chronic Health Hazard |
| Helium | Sudden release of pressure |
| Nitrogen | Sudden release of pressure |
| Petroleum Oil | Fire |
| Polychlorinated Biphenyls | Chronic Health Hazard |
| Sulfur Hexafluoride | Sudden release of pressure |
| Sulfuric acid | Acute Health Hazard & Reactive |
| Trichlorotrifluoroethane (CFC 113) | Reactive |

Because PPPL's use of chemicals listed on the Toxic Release Inventory (TRI) is below threshold amounts, PPPL is not required to submit the TRI. Following DOE's guidance, PPPL completed an annual submittal to DOE for 1997 that included the TRI cover page and laboratory exemption report. PPPL did not submit a TRI in 2002 or 2003 (not required).

## 3.8 Other Major Issues and Actions

### 3.8.1 Air Quality

Through PPPL's Air Environmental Permitting Program, PPPL applied to NJDEP for modifications to all four boilers to fire No. 2 fuel oil in addition to the existing permit provisions that allow for the burning of natural gas and No. 4 fuel oil. No. 2 fuel oil is a lighter and cleaner burning petroleum distillate and its use instead of No. 4 would lower the amount of nitrogen oxides ($NO_x$) emitted. In April 2003 PPPL received permission to burn No. 2 fuel oil in all four boilers, provided that a compliance plan was prepared to meet the permit requirements. A Compliance Plan was drafted, and records are being kept to meet those requirements.

### 3.8.2 Surface Water Quality

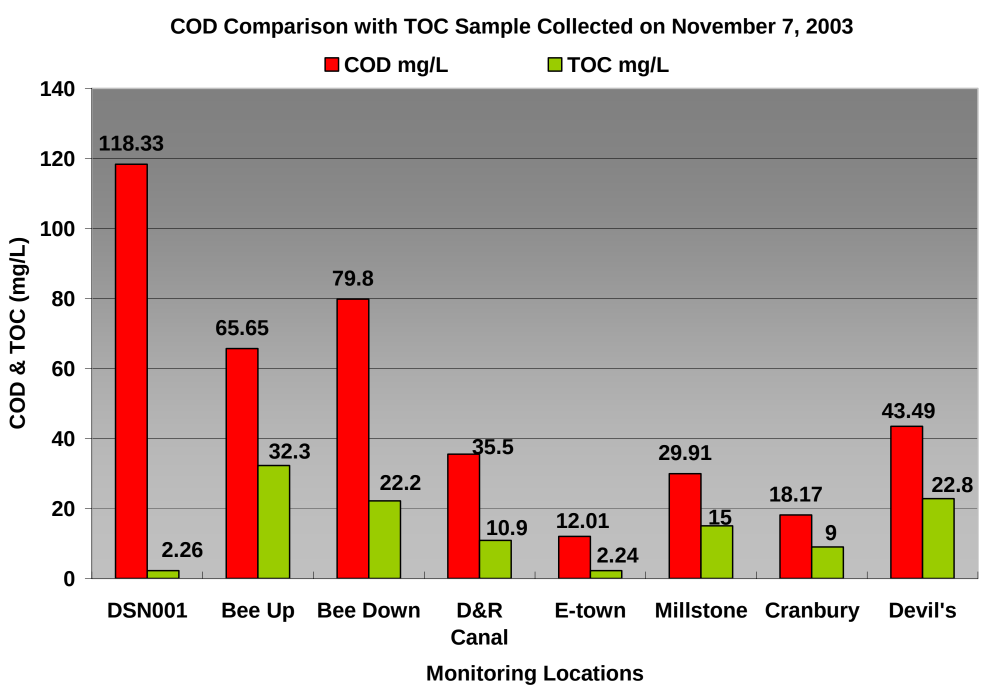
Under NJPDES requirements, PPPL eliminated chlorine-produced oxidants (CPO) from its discharges (basin outfall designate serial number, DSN001, and D&R Canal pump house outfall (DSN003). CPO is created by the reaction of chlorine combining with organic material in the water. Chlorine is added to prevent bio-fouling in water pipes and cooling tower equipment. CPO is generally harmful to biota in the receiving streams. PPPL installed an automated chlorine controller and a new metering system in the D&R Canal water system in 2002. A similar system was installed at the D-site cooling tower in 2003; the CPO limit was exceeded once prior to the operation of the new chlorine metering system. By reducing or limiting the amount of chlorine added to these systems, PPPL protects its water systems/equipment while also protecting the environment by reducing CPO in its surface water discharge.

In June 2003, elevated chemical oxygen demand (COD) concentrations (<50 mg/L monthly average) were reported in July (Noncompliance Report) and September 2003 (Response to a Notice of Violations) [PPPL 03]. PPPL determined the source to be accumulated fine organics that settled to the bottom of basin; the basin was cleaned and the liner inspected in August 2003. The COD concentrations returned to normal levels of less than 10 mg/L in September and October [PPPL03g].

In November, 2003, elevated COD concentrations at DSN001 as well as off-site monitoring locations were reported. At the off-site monitoring locations elevated COD concentrations were attributed to organic decomposition of leaves and other vegetation, based on the elevated total organic carbon (TOC) measurements. The elevated COD concentration at DSN001 did not appear attributable to higher organics concentration (TOC) (Exhibit 3-17).

PPPL's investigation was inclusive with no source of the elevataed COD identified. The COD concentration was lower in December 2003 (37.89 mg/L). PPPL did conclude that the probable

**Exhibit 3-17.**



source was an inorganic, not from basin organics – leaves and debris, which accumulated following the basin cleaning in August 2003, as the TOC concentration at DSN001 was low [PPPL04b].

### 3.8.3 Ground Water Quality

Under New Jersey's State program for NJPDES ground water discharges, PPPL's permit (NJ0086029) in May 2001, NJDEP issued the revised ground water discharge permit. The requirement to monitor groundwater from seven monitoring wells and two basin inflows was eliminated.

Beginning in 1993, PPPL and DOE-PSO have been monitoring ground water under a Memorandum of Understanding (MOU) signed by NJDEP, Princeton University and DOE-PSO. Princeton University agreed to investigate A- and B-sites while PPPL and DOE-PSO were to investigate C-and D-sites of the James Forrestal Research Campus. A summary of major project milestones is presented below:

**1993** Prepared specifications for Remedial Investigation and Remedial Alternative Assessment project (RI/RAA).

**1994** Harding Lawson Associates (HLA) began RI/RAA. Sampled existing wells, sumps, and soil borings. Soil beneath the Facilities Building and adjacent to C Site Cooling Tower removed.

**1995** HLA conducted ground water sampling; prepared RI/RAA report.; completed UST closure activities.

**1996** RI/RAA report submitted. Installed four new monitoring wells south of the CAS/RESA Building to delineate extent of contamination.

**1997** New area of potential environmental concern (APEC) near the former PPPL Annex Building identified by sampling ground water from eight new wells and soil borings. Report submitted.

**1998** Phase 3 RI report submitted to NJDEP in September 1998 [HLA98].

**1999** Phase 4 RI and Remedial Action Selection reports submitted in October. Ground water monitoring continued.

**2000** Remedial Action Work Plan submitted to NJDEP in May, quarterly ground water monitoring continued [Sh00, Sh01].

**2001** Remedial Action Monitoring Report submitted; quarterly monitoring continued [Sh01 & Sh03].

**2002** Remedial Action Monitoring Report submitted; quarterly monitoring continued [Sh01 & Sh03].

**2003** Remedial Action Monitoring continued; quarterly March and June 2003; first annual monitoring performed in October 2003. Fourteen monitoring wells permanently removed.

### 3.8.4 Outreach – 6th and 7th Annual Earth Day Celebration

In April 2002, the 6th annual Earth Day Celebration at PPPL involved local area middle schools and children of PPPL staff in a poster contest. Over 200 students, teachers, parents, and PPPL staff attended the celebration that included presentation of contest awards, a briefing on "Fusion Energy in the New Century" given by Dr. Rob Goldston, Director of PPPL, and a presentation by Richard Wetherald of the National Oceanographic and Atmospheric Administration's (NOAA) Geophysical Fluid Dynamics Laboratory (GFDL): "Greenhouse Gases & Global Warming."

In 2003, the 7th Earth Day at PPPL was celebrated with a presentation by Dr. Andrew Boscarsly, Princeton University, whose research topic was "Fuel Cells: Brining Hydrogen to the Marketplace." As part of PPPL's outreach program, neighboring middle school science teachers and the public were invited to hear this presentation. Also, participants in Earth Day activities at PPPL, were Eurest Dining Services, The Princeton Environmental Institute, Princeton University Water Watch, and Executive Business products.

### 3.8.5 Facility Improvements

In 2003, the elevated water tower that holds D&R Canal water for cooling and fire-protection was inspected, repaired, and painted. At 160 feet in height, the tower holds 250,000 gallons. Workers use safety equipment with a bucket that raises and lowers them from the ground to the desired elevation (Exhibit 3-18).

**Exhibit 3-18.**
**Worker Using Bucket with Safety Harness for Painting Elevated Water Tower Project**

### 3.8.6 Safety

PPPL's 2002 and 2003 performance with respect to worker safety were as follows [Lev04b]:

**2002**

**Total recordable case rate:** 2.83 per 200,000 hours worked
**Days away, restricted or transferred (DART) case rate**: 1.66 per 200,000 hours worked
**DART day rate:** 60.53 per 200,000 hours worked
**Number of radioactive contaminations (external):** 0
**Number of Safety Occurrence reports:** 0
(OSHA confined space, chemical exposure and lock out/tag out incidents)

**2003**

**Total recordable case rate:** 0.95 per 200,000 hours worked
**Days away, restricted or transferred (DART) case rate**: 0.76 per 200,000 hours worked
**DART day rate:** 12.72 per 200,000 hours worked
**Number of radioactive contaminations (external):** 0
**Number of Safety Occurrence reports:** 0
(OSHA confined space, chemical exposure and lock out/tag out incidents)

## 3.9 Continous Release Reporting

In 2002 and 2003, PPPL had no continuous releases to report.

## 3.10 Unplanned Releases

During CY2002 and 2003, two and four, respectively, unplanned releases of hazardous or petroleum substances occurred. In April and May 2002, PPPL reported to the NJDEP Hotline that PPPL released hydraulic oil from the L-wing elevator (~35 gallons) and D-site diesel generator (~2 quarts). The elevator hydraulic lift leaked sufficiently that it was taken out of service until repairs could be made; prior to repairs, the elevator shaft required clean-up of the hydraulic oil. A bio-based or vegetable-based oil replaced the petroleum-based hydraulic oil in the lift. The D-site diesel generator leaked hydraulic oil from a fuel line that spilled onto the concrete pad and adjacent gravel. PPPL cleanup the area and repaired the line.

In 2003, PPPL reported four releases to the NJDEP Hotline. Two involved lubricating oil – in February 2003, a heating, ventilation, and air conditioning unit (HVAC) line ruptured and released oil (~2 quarts) to the gravel and soil. In April 2003, the D-site diesel generator released lubricating oil (<2 gallons) onto the gravel and adjacent soil. The third release involved an employee's vehicle, which leaked gasoline (<2 gallons) onto the paved parking surface during a rain event in March 2003 causing the gasoline to runoff into a stormdrain. Lastly in September 2003, a subcontractor's backhoe ruptured a hydraulic line that released oil (~8 ounces) onto a grassed area. All of the above releases were cleaned up by PPPL personnel, and the contaminated gravel/soil was drummed and removed off-site by subcontractor waste removal company.

## 3.11 Current Issues and Actions

### 3.11.1 Environmental Management Systems

The benefits of comprehensive Environmental Management Systems (EMS) and the associated International Standard Organization (ISO) 14001 system are being reviewed. PPPL is evaluating the EO 13148 – "Greening the Government through Leadership in Environmental Management," - issued on April 22, 2000 (Earth Day) - to determine how best to implement an EMS inder the requirement of its DOE contract. Many of the elements of an EMS are presently instituted in plans, policies, and procedures at PPPL, however, integration into PPPL's ISM and recognition of the EMS approach and laboratory management procedures and policies are being revisited to fully comply with EO13148.

## 3.12 Summary of Environmental Permits

The following table (Exhibit 3-19) presents the different regulatory requirements/permits with which PPPL must comply. It is not solely a list of environmental permits, but rather a list that specifies the citation for environmental regulations, PPPL's requirement or permit, and where data reports may be found. A discussion of environmental permits required by the applicable statutes is found in Sections 5.0 and 6.0, "Environmental Radiological and Non-Radiological Program Information."

### Exhibit 3-19. PPPL Environmental Requirements

| Media | Regulatory Citation | Requirement/Permit | Data Reported |
|---|---|---|---|
| **Air** | 40 CFR 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPs) | Monitor D site stack for tritium | Reported in the annual Site Environmental Report (ASER) |
| | 40 CFR 82 – Protection of Stratospheric Ozone | Training & certification; Chillers, HVAC, fire suppression systems, cylinders | Ozone Depleting Substances (ODS) Inventory |
| | NJAC 7:27- – Air Pollution Control –Subchapter 8 Permits and Certificates | 4 Boiler stacks;<br>2 Storage tank vents;<br>3 Dust collectors;<br>2 Diesel generators. | Fuel use reported in ASER;<br>Generator hours recorded in logbook |
| **Asbestos** | 29 CFR 1910.1001, 1910.1200 – OSHA General Industry Standard | Identify locations prior to removal (roofing, tiles, walls, pipes, insulation, etc.) | Reporting to EPA prior to removal; Track generated quantities |
| **EPCRA** | 40 CFR 370 – Hazardous Chemical Reporting: Community Right-to-Know | SARA Title III listed substances above threshold amounts | Section 312 annual report to EPA in March; Also reported in ASER |
| **Laboratory Certification** | NJAC 7:18 - Regulations Governing Laboratory Certification and Environmental Measurements | Princeton Environmental, Analytical, and Radiological Laboratory (PEARL) – tritium, COD, and analyze immed. parameters | Annual application; semi-annual performance testing; results reported in ASER |
| **Land Use - Wetlands** | NJAC 7:7A – Freshwater Wetlands Protection Act Rules | Delineated wetlands; 26-kV tower maintenance, well installations | Status reported in quarterly updates; Also, reported in ASER |
| **Meteorology** | DOE Order 430.1A - Life Cycle Asset Management | Meteorological tower –<br>3 levels (10, 30, and 60 meters)<br><br>Rain gauge | Wind speed & direction, air temperature, dew point, precipitation. Precipitation reported in ASER |
| **Safe Drinking Water** | 40 CFR 141.16 –National Primary Drinking Water Regulations | Best Management Practices - Tritium analyzed in ground, surface, & rain water | 20,000 pCi/L or<br>4 mrem/year annual dose. Reported in ASER |
| **Soil** | NJAC 7:1E – Discharge of Petroleum and Other Hazardous Substances | Reporting discharge of petroleum or hazardous substances on soil/ unpaved areas/ water | 30-Day confirmation report to NJDEP;<br><br>Also reported in ASER |
| | Standards for Soil Erosion and Sediment Control Act Chapter 251 | Projects which create soil disturbance greater than 5,000 sq. feet | Quarterly status reported in updates |
| **SPCC** | NJAC 7:1E – Discharge of Petroleum and Other Hazardous Substances<br>40 CFR 110 – Discharge of Oil<br>40 CFR 112 – Oil Pollution Prevention | PPPL designated minor facility – no DPCC or DCR required;<br>Spill Prevention, Control, and Countermeasure Plan (SPCC) required | SPCC Plan required; Inspections, records, procedures |
| **TSCA** | 40 CFR 761- Polychlorinated Biphenyls (PCBs) | Label, inspect, records of polychlorinated biphenyls (PCBs) in capacitors | Inventory;<br>Disposal records;<br>Also reported in ASER |

**Exhibit 3-19. Environmental Requirements (cont.)**

| Media | Regulatory Citation | Requirement/Permit | Data Reported |
|---|---|---|---|
| **Waste - Hazardous** | 40 CFR 260 –279 – Resource Conservation and Recovery Act (RCRA)<br>NJAC 7:26-8 – Hazardous Waste Regulations | On-site 90 –day temporary storage;<br>EPA ID # NJ1960011152<br>Manifest records | Biennial report to NJDEP |
| **Waste - Medical** | NJAC 7:26-3A Regulated Medical Waste | Disposal of medical wastes generated from dispensary | Annual report to NJDEP |
| **Waste - Sanitary** | NJAC 7:28 – Bureau of Radiation Protection | Liquid effluent collection (LEC) tanks sampled for:<br>Tritium<br>Gross beta | Tritium concentrations not to exceed 1 Curie per year |
| | DOE Order 5400.5 – Radiation Protection of the Public and the Environment | LEC tank - Tritium<br>Gross beta | 2 million picoCuries/Liter per discharge limit |
| | Stony Brook Regional Sewerage Authority Industrial Discharge License (22-96-NC) | LEC tank sampled for:<br>Tritium & Gross beta<br>pH, temperature, Chemical oxygen demand (COD)<br>Quantity released | Monthly Discharge Report – Self Reporting Form to SBRSA<br>Also, reported in ASER |
| **Waste - Solid** | NJAC 7:26 – Solid Waste | Registered Solid waste hauler; recycling separation of materials | Recycle report for paper, cardboard, glass/aluminum, plastics, scrap metals, batteries, office waste, *etc.*;<br>Also reported in ASER |
| **Water - Ground** | NJAC 7:14A – The New Jersey Pollutant Discharge Elimination System (NJPDES) | Integrity testing of the liner once every 3 years. | |
| | NJAC 7:19 – Water Supply Allocation Rules | Two former production wells (Wells 4 & 5) quantities pumped not to exceed 100,000 GPD | Annual report to NJDEP |
| | NJAC 7:26E – Technical Requirements for Site Remediation | Investigation –quarterly - annually ground water monitoring, 12 wells, 2 sumps, and one surface water location | Remedial Investigation reports to NJDEP; Also , reported in ASER |
| **Water - Potable** | NJAC 7:10 – Safe Drinking Water Act | Quarterly inspection of back-flow preventors; annual internal inspection | Annual report to NJDEP & water purveyor |
| **Water – Storm** | NJAC 7:13 – Flood Hazard Area Control | Basin inspection & maintenance | Records |
| **Water - Surface** | NJAC 7:14A – The New Jersey Pollutant Discharge Elimination System (NJPDES) | Monthly surface water samples at two locations – DSN 001 and 003; annual chronic toxicity test @ DSN 001 | Monthly discharge monitoring reports to NJDEP; annual chronic toxicity test report to NJDEP;<br>Also, reported in ASER |

Chapter 4

## ENVIRONMENTAL PROGRAM INFORMATION

### 4.1 Environmental Management System (EMS) and Environmental Protection Programs (EPP) at PPPL

#### 4.1.1 EMS

In the EO 13148, "Greening of the Government through Leadership in Environmental Management," a requirement to prepare and implement an EMS program was placed upon all Federal Agencies, including Department of Energy (DOE) Laboratories and other facilities. In 2002, members of PPPL's Environmental Review Committee (ERC), DOE-Princeton Site Office (DOE-PSO), and other Divisions within PPPL formed the EMS subcommittee of the ERC. During 2002 and 2003 this subcommittee gathered information necessary to prepare an EMS Program, determined the extent of existing program documents, policies, and procedures, and identified those areas where actions were needed.

PPPL's EMS Program will be a part of the Site Integrated Safety Management System (ISMS). ISMS Program was implemented as required by DOE Policy 450.4, Safety Management System Policy in 2000.

#### 4.1.2 EPP

DOE Order 450.1, "Environmental Protection Program," was approved on January 15, 2003. As this Order requires the protection of air, water, land, and other natural and cultural resources that may be impacted by DOE and PPPL operations, the ERC subcommittee was similarly tasked with the action to spearhead the Laboratory's adoption of the Order's requirements. These requirements are to be implemented within 12 months of the inclusion of the Contractor Requirement Document (CRD) into the facility goals and contract, which occurred in May 2003.

Formalized programs are to be developed in order to fulfill CRD goals: environmentally and economically beneficial landscaping; supply specifications and acquisitions and operational assessments for pollution prevention projects; and ozone-depleting substance management. The integration of EMS into ISMS as well as revisions to implementing documents is under review.

Progress toward the CRD goals are discussed in Sections 3.3.1, Clean Air Act (CAA), 3.6.3, Beneficial Landscaping, and 3.6.4, Progress on DOE Secretarial Goals Including Ozone-Depleting Substances Reduction.

Since the announcement of the Clean Water Action Plan in January 1998, PPPL has actively pursued ways to improve water quality. The two surface water discharges are permitted under the New Jersey Pollutant Discharge Elimination System regulations with monthly monitoring occurring at both outfalls since 1992. Improvements include the following actions taken by PPPL: for the detention basin- real-time flow meter data, annual maintenance and triennial liner inspections, aeration with upgrades planned, and upgraded oil-detection instrumentation. PPPL has installed two new chlorine metering systems, one at the Delaware & Raritan Canal pump house and the other D-site cooling tower that lowered the amount of chlorine used. To improve stormwater quality, site-wide grounds clean-ups and landscaping of disturbed areas reduce or eliminate runoff. For water conservation, PPPL has replaced old water lines. These activities were reported in previous Annual Site Environmental Reports as wells as within this report. Annually, PPPL representatives meet with local officials to provide the current status of projects at the Laboratory; both experimental related and environmental topics are discussed.

## 4.2 Summary of Radiological Monitoring Programs

The monitoring for sources of potential radiological exposures is extensive. In 1981, real-time prompt gamma and/or neutron environmental monitoring on D-site began to establish baselines prior to TFTR operations. Exhibit 4-1 lists the air stations that were monitored for radiological parameters in 2002 and 2003.

Surface, ground, rain, and process water samples are collected at the same locations for both non-radiological and radiological (HTO) analysis (Exhibit 4-2).

**Exhibit 4-1. Radiological Air Monitoring Stations**

| Station Name | Number/Description | Exhibit # |
|---|---|---|
| Remote Environmental Air Monitoring (REAM)-off site | Stations *R 1- 6*: Tritium | 4-4 |
| Radiological monitoring system (RMS) on D site | Passive tritium monitors at *T 1-4*: | 4-3 |

**Exhibit 4-2. Radiological and Non-Radiological Water Monitoring Stations**

| Station # | Location/Exhibit # | Description |
|---|---|---|
| B1 | Off-site / 4-3 | Bee Brook Upstream of discharge from detention basin |
| B2 | Off-site / 4-3 | Bee Brook Downstream of discharge from detention basin |
| C1 | Off-site / 4-4 | Delaware & Raritan Canal (Plainsboro) |
| DSN001 | On-site / 4-3 | Surface Water Discharge from the detention basin |
| DSN003 | Off-site / 4-4 | Delaware & Raritan Canal pump house outfall |
| E1 | On-site / 4-3 | Elizabethtown Water Company - potable water supply |
| M1 | Off-site / 4-4 | Millstone River - Plainsboro & West Windsor boundary- Route 1 |
| P1 | Off-site / 4-4 | Plainsboro Surface Water - Millstone River |
| P2 | Off-site / 4-4 | Plainsboro Surface Water - Devils Brook |
| D-MG & TFTR | On-site /4-3 | Basement sumps that drain ground water to detention basin |
| D-11R & D-12 | On-site /4-3 | Ground water monitoring wells next to detention basin |
| TW-1,2,3,& 10 | On-site /4-3 | Ground water monitoring wells north of NSTX |
| LECT 1,2,or 3 | On-site /4-3 | Liquid effluent collection tanks north of NSTX |
| R Series R1S to R2N | On-site /4-3 | 8-Rain water monitoring locations for North, South, East, & West @ 250 & 500 ft. from stack |
| Rainwater R1-R6 | Off-site /4-3 | Rain water monitoring locations (5 co-located with air DATS) |

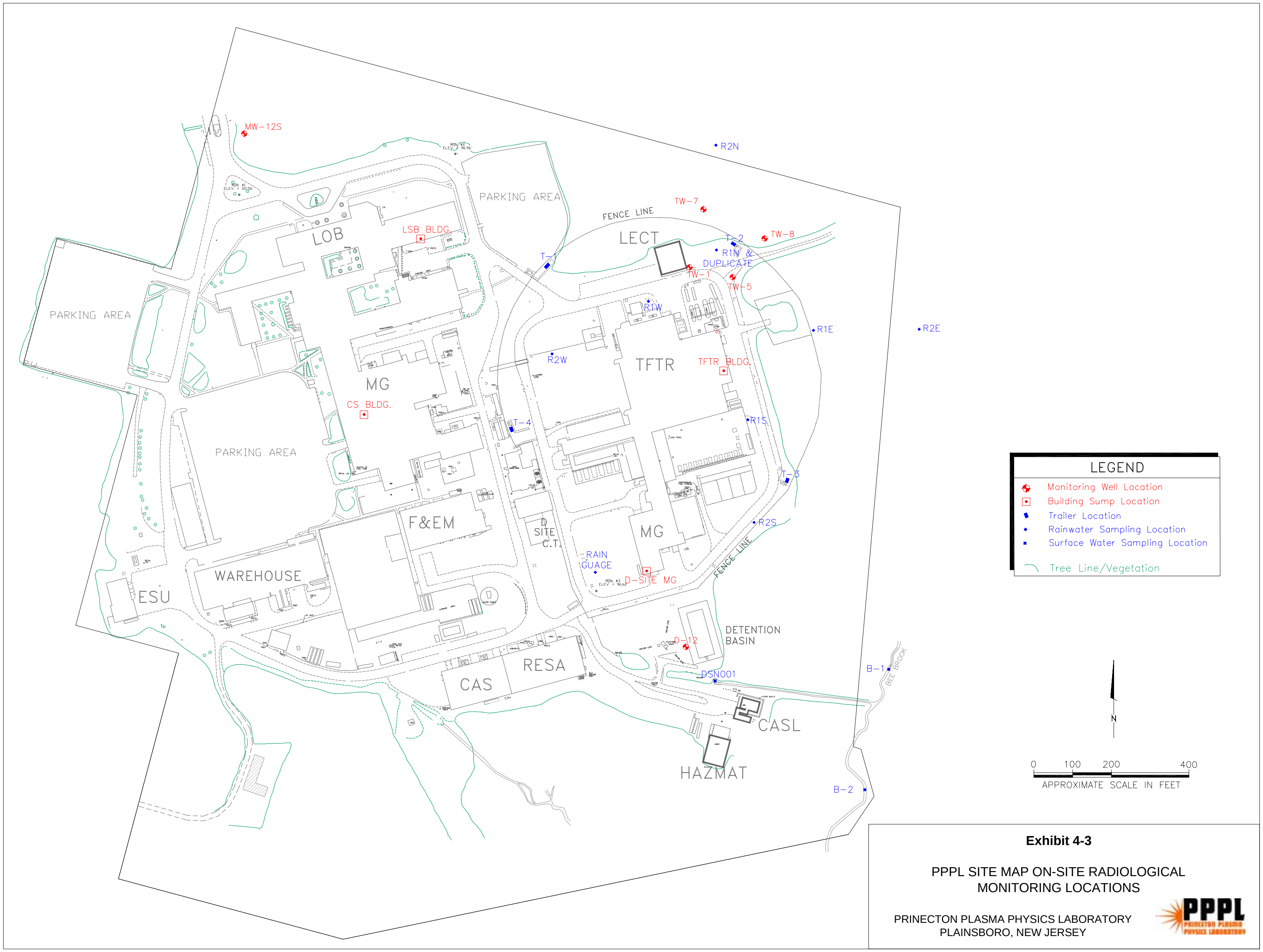
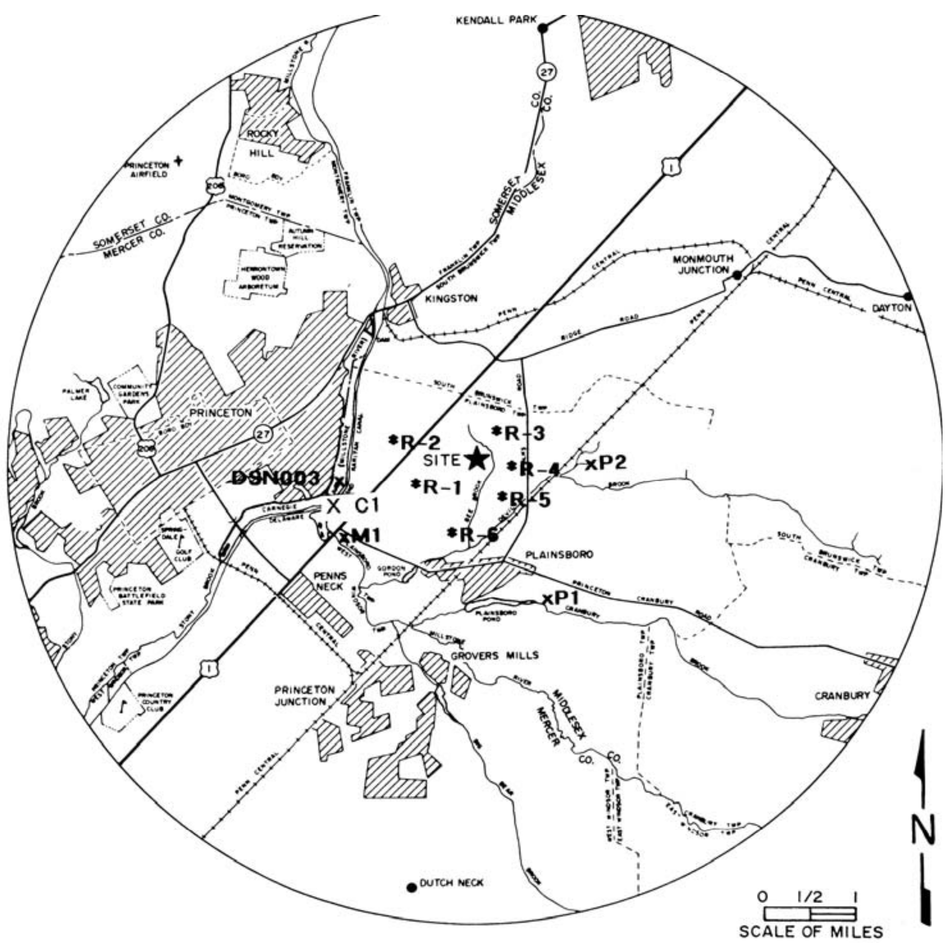



**Exhibit 4-3. PPPL Site Map On-site Radiological Monitoring Locations**

In the mid-1980's, the last comprehensive assessment of population distribution in the vicinity of PPPL was completed for the proposed Burning Plasma Experiment (BPX) Environmental Assessment (EA) [Be87a]. PPPL is situated in the metropolitan corridor between New York City to the northeast and Philadelphia to the southwest. Census data indicate that approximately 18 million people live within 50 miles radius (80 km) of the site and approximately 253,000 within 10 miles (16 km) of PPPL based on the 2000 population census.

The overall, integrated, effective-dose equivalent (EDE) from all sources (excluding natural background) to a hypothetical individual residing at the nearest business was calculated to be 0.0.31 mrem (3.10 μSv) for 2002 and 0.13 mrem (1.29 μSv) for 2003 (see Exhibits 5-1 & 5-2). Detailed person-rem calculations for the surrounding population was not performed, because the value would be insignificant in comparison to the approximately 100 mrem (1 mSv) that each individual receives from natural background, excluding radon, in New Jersey.

**Exhibit 4-4. Off-site Monitoring Locations**



## 4.3 Summary of Non-Radiological Monitoring Program

During 2002 and 2003, PPPL operated under New Jersey Pollutant Discharge Elimination System (NJPDES) surface water permit, number NJ0023922, effective on June 4, 1999. As stated in the permit conditions, PPPL monitored monthly the discharge of the detention basin, DSN001. Monthly data exists for this location dating back to 1984.

**Monthly water quality monitoring at DSN001:**
- Temperature, pH
- Petroleum hydrocarbon (TPH)
- Total suspended solids (TSS)
- Chemical oxygen demand (COD)
- Chlorine-produced oxidants (CPO)
- Flow

**Quarterly**:
- Total phosphate (Tot. P)
- Tetrachloroethylene (PCE)

**Annual:**
- Chronic Toxicity Testing

Monthly sampling for TPH, pH, and CPO continued at DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house. Quarterly monitoring included total suspended solids (TSS) at the discharge and intake (D&R Canal water designated as C1) without a limit for TSS (Exhibit 4-4).

As a requirement of the surface water permit, a chronic toxicity characterization study was conducted test the DSN001 effluent with the fathead minnow (*Pimephales promelas*) as the test organism. The annual study results were submitted for the September 2002 and October 2003 tests [PPPL02c & PPPL03h]. PPPL's discharge water and the control tests were the same – no mortality to the test specimens.

Ground water monitoring conducted under the Environmental Restoration program is discussed in Chapters 6.0 and 7.0.

## 4.4 Environmental Requirements

Environmental requirements, for which DOE and PPPL are held accountable, are listed in Exhibit 3-19 and are discussed in Chapters 3.0, "Environmental Compliance Summary" and 6.0, "Environmental Non-Radiological Program Information," of this report.

## 4.5 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements or Environmental Assessments were prepared in 2002 or 2003.

## 4.6 Summary of Significant Environmental Activities at PPPL

### 4.6.1 Regulatory Inspections/Audits

In July 2002, a NJDEP Enforcement Inspector conducted the annual inspection of the Discharge to Surface Water Permit (NJPDES NJ0023922) [NJDEP99]. After reviewing the records and visually inspecting the two permitted outfalls, the result was an acceptable rating based on compliance with the permit conditions and no permit limits were exceeded during 2002.

In July 2003, a NJDEP Enforcement Inspector conducted the annual inspection of the Discharge to Surface Water Permit (NJPDES NJ0023922) [NJDEP99]. During the records check, the inspector noted that in August 2002, the chlorine-produced oxidant (CPO) concentration exceeded the permit limit. PPPL installed the new chlorine controller system for the D-site cooling tower, which became operational shortly after the CPO measurement was made. In June 2003, the chemical oxygen demand (COD) permit limit was exceeded, due to an accumulation of sediments in the basin. In August 2003, the basin was cleaned, and the majority of the sediments removed. A Notice of Violation (NOV) was written as a result of the two limits that were exceeded at the basin outfall.

Stony Brook Regional Sewerage Authority representative conducted an audit in May 2002. The audit scope was the discharge from the liquid effluent collection tanks (LECT), which are monitored for pH, temperature, COD, tritium, and gross beta. Volume is also reported each month. The SBRSA triennial inspection concluded with no findings.

### 4.6.2 Basin Management

As a condition of the NJPDES Ground Water Discharge Permit (DGW), PPPL prepared an Operations and Maintenance (O&M) Manual for the detention basin. The basin collects flow from C-site (Boilers 2 and 3 blowdown, cooling tower blow-down, non-contact cooling water, ground water from basement sumps, and stormwater) and D-site (ground water from basement sumps and stormwater). At the outfall of the basin, an ultrasonic transducer measures the water level above a weir and the flow rate is monitored and logged into a recorder. A slide gate allows the basin to drain was replaced with a new gate that crank operates its open/closed position.

As noted in the previous section, 4.5.1, the basin was cleaned in August 2003. Following the cleaning, a representative from the liner manufacturer inspected the basin liner for any tears, holes, or other problems that would render the liner dysfunctional. The liner inspector indicated no defects were detected in the liner since its installation in late 1994.

**Exhibit 4-5. New Slide Gate**

**Exhibit 4-6. Basin Drained August 2003**

### 4.6.3 Tritium in the Environment

Since TFTR deuterium-tritium (D-T) operations began in 1994, PPPL has been monitoring tritium in environmental samples as well as in the test cell and related stack (vent). Five monitoring wells and two ground-water sumps, ten on-site and six off-site rainwater-monitoring stations and surface water at one on-site and one off-site station were sampled monthly from 1995 through 2003 (Exhibits 4-7 & 4-8) [Lev04c].

**Exhibit 4-7. 2002 Highest Tritium Concentrations in Environmental Samples**

| Media | Location | Highest HTO | Stack Data (Date) |
|---|---|---|---|
| Air | T3 (SE D-site) | 118pCi/m3 | 1.01 Ci HTO (Apr. 17) |
| | R5 (SE of PPPL) | 14.3 pCi/m3 | 7.56 Ci HTO (Jan. 30) |
| | D-site Stack | 8.21Ci | 8.21HTO (Nov. 20) |
| Well | TW-8 | 479 pCi/L | 7.56 Ci HTO( Jan. 30) |
| Rain water | R1S | 3,921pCi/L | 3.24 Ci HTO (Apr. 24) |
| | R2S | 1,590,pCi/L | 1.89 Ci HTO (Mat. 20) |
| Surface water | DSN001 | 2,090 pCi/L | 1.10 Ci HTO (Apr. 3) |

Ci = Curie pCi/L = picoCuries per Liter HTO = tritiated water

**Exhibit 4-8. 2003 Highest Tritium Concentrations in Environmental Samples**

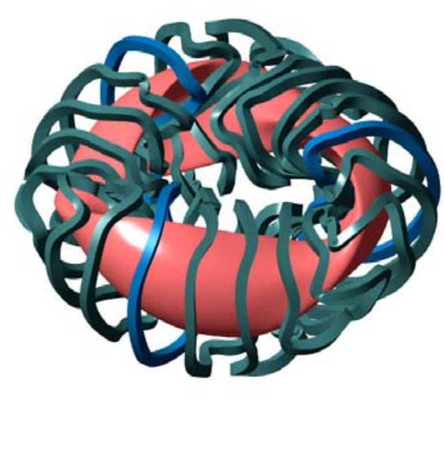
| Media | Location | Highest HTO | Stack Data (Date) |
|---|---|---|---|
| Air | T3 (SE D-site) | 20.5 pCi/m3 | 1.00 Ci HTO (Jun.4) |
| | R6 (S of PPPL) | 5.1 pCi/m3 | 0.67 Ci HTO (Jull 16) |
| | D-site Stack | 1.32 Ci | 1.32 Ci HTO (Jan. 15) |
| Well | MW-12S | 2,225 pCi/L | 0.21 Ci HTO( Oct. 22) |
| Rain water | R1E | 1,104pCi/L | 0.27Ci HTO (Nov. 5) |
| | R2E | 1,126,pCi/L | 0.56 Ci HTO (Sept. 17) |
| Surface water | DSN001 | 451pCi/L | 0.49Ci HTO (Sept. 3) |

Ci = Curie pCi/L = picoCuries per Liter HTO = tritiated water

### 4.6.4 TFTR and PBX-M Removal Make Way for NCSX

On D-site, the three year project to dismantle and remove the Tokamak Fusion Test Reactor (TFTR) came to its end in September 2002 being completed within budget and on-schedule. The ten segments of the vacuum vessel and its associated coils (magnets used for plasma containment) were wrapped and shipped to Hanford, Washington for burial as low-level radioactive waste. Having been emptied with the exception of Neutral Beam boxes (to be used in the future), the Test Cell was readied for its next assignment as the Coil Winding Facility for the National Compact Stellarator Experiment (NCSX).

**Exhibit 4-9. NCSX Plasma and Magnetic Coil Configuration**



On C-site, the device, Princeton Beta Experiment-Modified (PBX-M), which operated from 1989 to 1994, was dismantled and removed following the TFTR D&D. PBX-M started life as the Poloidal Divertor Experiment (PDX) and operated from 1978 to 1985, when it was modified and renamed Princeton Beta Experiment (PBX 1985-1989). Unlike the TFTR vacuum vessel and other components, the PBX-M vessel and its parts weighing more than 352 tons were shipped off-site for metal recycling. In 2003, the PDX/PBX-M and the Princeton Large Torus (PLT) device test cells were emptied and await the fabrication of NCSX. Similar to PBX-M, PLT was removed and recycled in 2000.

As the chapter is completed for one major device, in this case, two devices, the door opens and reveals a new device waiting in the wings. Through PPPL's efforts and resourcefulness, not only are parts of the devices recycled by others and by PPPL, but the facilities (both test cells) infrastructure and the talent of PPPL's employees are being utilized to further the research for fusion as a viable energy source.

### 4.6.5 Occupation Safety and Health Administration-(OSHA) Inspection

From August 11-15, 2003, the Occupational, Safety, and Health Administration (OSHA) Compliance Audit Team conducted a comprehensive inspection of PPPL's facilities. Nine of the DOE Office of Science (SC) non-defense laboratories were included in OSHA's inspection program. The major focus of the compliance audits was the potentially high hazard areas of the laboratories. Compliance with safety and health standards requires daily diligence in the management's safety culture, ensuring safety and health is incorporated in all operations, work practices, and training. In addition, preventive maintenance and good housekeeping play a pivotal role in preventing accidents and injuries.

At the conclusion of the compliance audit, the OSHA Team identified 200 deficiencies throughout the laboratory that were either in violation of current regulation or recommendations for improvement. The list of deficiencies provided to PPPL's management was acted upon and approximately 100 of those listed items were corrected by the end of 2003. Action on the remaining 100 items continues with status reports submitted to DOE-PSO and SC offices (Ru04).

### 4.6.6 Environmental Training and College Interns

In 2002 and 2003, PPPL employees were provided with the opportunity to attend the 40-hour training "Health and Safety for Hazardous Waste Site Investigation Personnel" (HAZWOPER), the 8-hour refresher course or OSHA HAZWOPER refresher, and the 8-hour course for Supervisors of Hazardous Waste Operations. Through a grant from the Department of Energy, instructors from the Environmental and Occupational Health Sciences Institute (EOHSI) of the University of Medicine & Dentistry of New Jersey provided these training courses.

**Exhibit 4-10. Drexel Intern Next to Slide Gate**

In 2002, PPPL and Drexel University (Philadelphia, PA) continued its successful co-operative internship program at the Laboratory. Those selected students majoring in science or engineering spend six months at PPPL working in a department related to their major. PPPL's Environmental Restoration Waste Management Division has provided opportunities for students to work in the environmental field while giving them guidance and instruction in various areas of environmental management. ✷

Chapter 5

# ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

## 5.1 Radiological Emissions and Doses

For 2002 and 2003, the releases of tritium in air and water and the total effective dose equivalent (EDE) contribution at the site boundary and for the population within 80 kilometers of PPPL are summarized in Exhibits 5-1 and 5-2 below. The calculated EDEs at the site boundary are three-tenths of one mrem for 2002, and less than three-twentieths of one mrem for 2003, far below the annual limit of 10 mrem per year [Lev04].

**Exhibit 5-1. Summary of 2002 Emissions and Doses from D Site Operations**

| Radionuclide & Pathway | Source | Source Term Curies (Bq) | EDE in mrem/yr (mSv/yr) at Site Boundary | Percent of Total | Collective EDE w/in 80 km in person-rem ( person-Sv) |
|---|---|---|---|---|---|
| Tritium (air) | D-site stack | HTO 96.495($3.57 \times 10^{12}$)<br>HT 13.761($5.09 \times 10^{11}$) | 0.2512000<br>($2.51 \times 10^{-3}$) | 81.03 | 2.2271000<br>($2.23 \times 10^{-2}$) |
| Tritium (air) | RWHF | 0.17855 ($6.61 \times 10^{9}$ )<br>0.60282 ($2.23 \times 10^{10}$) | 0.0490000<br>($4.90 \times 10^{-4}$) | 15.81 | 0.0158000<br>($1.58 \times 10^{-4}$) |
| Tritium (water) | LEC tank | 0.453 (HTO)<br>($1.68 \times 10^{10}$ ) | 0.0090600<br>($9.06 \times 10^{-5}$) | 2.92 | 0.0124000<br>($1.24 \times 10^{-4}$) |
| Tritium (water) | Surface<br>Ground | 2090 pCi/L (basin outfall)<br>479 pCi/L (Test Well (TW) 8) | 0.0007400<br>($7.40 \times 10^{-6}$) | 0.24 | 0.0010000<br>($1.00 \times 10^{-5}$) |
| Direct/Scattered neutron & Gamma Radiation | NSTX | $2.3 \times 10^{16}$ DD neutrons +<br>$4.6 \times 10^{14}$ DT neutrons | 0.0000268<br>($2.68 \times 10^{-7}$) | <0.01 | Negligible |
| Argon-41 (Air) | NSTX | 0.000207 ($7.66 \times 10^{6}$) | 0.0000025<br>($2.50 \times 10^{-8}$) | <0.01 | 0.0000048<br>($4.80 \times 10^{-8}$) |
| **Total** | | | **0.3100293**<br>**($3.10 \times 10^{-3}$)** | | **2.2563048**<br>**($2.26 \times 10^{-2}$)** |

Bq = Bequerel mSv = milli Sievert EDE = effective dose equivalent
HT = elemental tritium HTO = tritium oxide LEC = liquid effluent collection tanks
mrem = milli radiation equivalent man RWHF = Radioactive Waste Handling Facility-Compactor & vial crusher

Estimated dose equivalent at the nearest business is 0.07245 mrem ($7.25 \times 10^{-4}$ mSv) due to tritium air emissions from the D-site stack and RWHF, Ar-41 air emissions from the NSTX Test Cell (from neutron activation of air from NSTX operations), and direct/scattered neutron and gamma radiation from NSTX operations. Using COMPLY (computer code) Level 4 for airborne emissions, this dose is equivalent is 0.1 mrem/yr ($1.00 \times 10^{-3}$ mSv/yr), compared to the NESHAPS standard of 10 mrem/yr (0.1 mSv/yr).

Annual limit is 10 mrem/year; background is about 360 mrem/year.

Half life of tritium (HTO & HT) is 12.3 years.

Airborne doses assume maximum exposed individual is in continuous residence at the site boundary; waterborne doses assume that maximum exposed individual uses the ultimate destination of liquid discharges (Millstone River) as sole source of drinking water.

**Exhibit 5-2. Summary of 2003 Emissions and Doses from D Site Operations**

| Radionuclide & Pathway | Source | Source Term Curies (Bq) | EDE in mrem/yr (mSv/yr) at Site Boundary | Percent of Total | Collective EDE w/in 80 km in person-rem ( person-Sv) |
|---|---|---|---|---|---|
| Tritium (air) | D-site stack | HTO 34.329 ($1.27 \times 10^{12}$)<br>HT 1.789 ($6.62 \times 10^{10}$) | 0.0893000 ($8.93 \times 10^{-4}$) | 69.45 | 0.7295836 ($7.30 \times 10^{-3}$) |
| Tritium (air) | RWHF | 0.600 ($2.22 \times 10^{10}$) | 0.0380000 ($3.80 \times 10^{-4}$) | 29.55 | 0.0121200 ($1.21 \times 10^{-4}$) |
| Tritium (water) | LEC tank | 0.032 (HTO) ($1.18 \times 10^{9}$) | 0.0006360 ($6.36 \times 10^{-6}$) | 0.50 | 0.0008712 ($8.71 \times 10^{-6}$) |
| Tritium (water) | Surface Ground | 451 pCi/L (basin outfall)<br>2225 pCi/L (Monitoring Well (MW) 12S) | 0.0006460 ($6.46 \times 10^{-6}$) | 0.50 | 0.0008849 ($8.85 \times 10^{-6}$) |
| Direct/Scattered neutron & Gamma Radiation | NSTX | $3.4 \times 10^{15}$ DD neutrons + $6.8 \times 10^{13}$ DT neutrons | 0.0000040 ($4.00 \times 10^{-8}$) | <0.01 | Negligible |
| Argon-41 (Air) | NSTX | 0.0000806 ($2.98 \times 10^{6}$) | 0.0000010 ($1.00 \times 10^{-8}$) | <0.01 | 0.0000019 ($1.90 \times 10^{-8}$) |
| **Total** | | | **0.1285870 ($1.29 \times 10^{-3}$)** | | **0.7434616 ($7.43 \times 10^{-3}$)** |

Bq = Bequerel mSv = milli Sievert EDE = effective dose equivalent
HT = elemental tritium HTO = tritium oxide LEC = liquid effluent collection tanks
mrem = milli radiation equivalent man RWHF = Radioactive Waste Handling Facility-Compactor & vial crusher

NOTES:

Estimated dose equivalent at the nearest business is 0.0266 mrem ($2.66 \times 10^{-4}$ mSv) due to tritium air emissions from the D-site stack and RWHF, Ar-41 air emissions from the NSTX Test Cell (from neutron activation of air from NSTX operations), and direct/scattered neutron and gamma radiation from NSTX operations. Using COMPLY (computer code) Level 4 for airborne emissions, this dose is equivalent is 0.0466 mrem/yr ($4.66 \times 10^{-4}$ mSv/yr), compared to the NESHAPS standard of 10 mrem/yr (0.1 mSv/yr).

Annual limit is 10 mrem/year; background is about 360 mrem/year.

Half life of tritium (HTO & HT) is 12.3 years.

Airborne doses assume maximum exposed individual is in continuous residence at the site boundary; waterborne doses assume that maximum exposed individual uses the ultimate destination of liquid discharges (Millstone River) as sole source of drinking water.

Laboratory policy states that when occupational exposures have the potential to exceed 1,000 mrem per year (10 mSv/y), the PPPL Environment, Safety, and Health (ES&H) Executive Board must be requested to approve an exemption. This value (1,000 mrem per year limit) is 20 percent of the DOE legal limit for occupational exposure. In addition, the Laboratory applies the "ALARA" (As Low As Reasonably Achievable) policy to all its operations. This philosophy for control of occupational exposure means that environmental radiation levels for device operation are also very low. From all operational sources of radiation, the ALARA goal for maximum individual occupational exposure was less than 10 mrem per year (0.1 mSv/year) above natural background at PPPL.

### 5.1.1 Penetrating Radiation

The NSTX conducted experiments during 2002 and 2003 that generated neutron and gamma radiation. Experimental shots were conducted using neutral beam injection, which generated deuterium-deuterium (D-D) (2.5 MeV) neutrons. Approximately 2% of these shots are assumed to also generate deuterium-tritium (D-T) (14.1 MeV) neutrons. The total number of neutrons produced during NSTX experiments in 2002 was $2 \times 10^{16}$ D-D neutrons in addition to $5 \times 10^{14}$ D-T neutrons. The total number of neutrons produced during NSTX experiments in 2003 was $3 \times 10^{15}$ D-D neutrons in addition to $7 \times 10^{13}$ D-T neutrons (note that NSTX operations in 2003 were limited due to necessary repairs to magnetic field coil equipment). Gamma and x-ray radiation generated in the range of 0-10 MeV during these experiments contributed to the total penetrating radiation dose at the site boundary of $1 \times 10^{-21}$ mrem from D-D neutrons and $8.2 \times 10^{-21}$ mrem from D-T neutrons. [Lev04a].

### 5.1.2 Sanitary Sewage

Drainage from D site sumps in radiological areas is collected in the Liquid Effluent Collection (LEC) tanks; each of three tanks has a total capacity of 15,000 gallons. Prior to release of these tanks to the sanitary sewer system, *i.e.*, Stony Brook Regional Sewerage Authority (SBRSA), a sample is collected and analyzed for tritium concentration and gross beta. All samples for 2002 and 2003 showed effluent quantity and concentrations of radionuclides (tritium) to be within allowable limits established in New Jersey regulations (1 Ci/y for all radionuclides) (40 CFR 141.16 limit is 20,000 pCi/L) and DOE Order 5400.5 (2 x $10^6$pCi/liter for tritium).

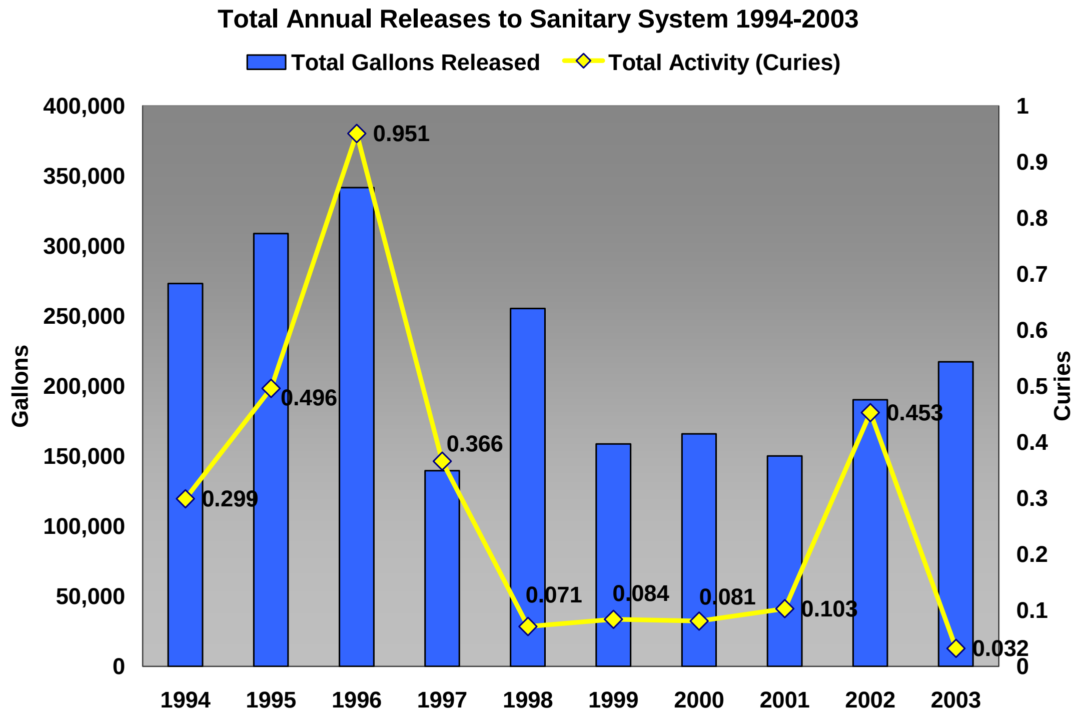
As shown in Exhibit 5-3, the 2002 total amount of tritium released to the sanitary sewer was 0.453 Curies, about forty-five percent of the allowable 1.0-Curie per year limit. In Appendix A Table 13, the gross beta activity is reported; the gross beta activity ranges from <194 to 6,080 pCi/L.

The 2003 total amount of tritium released to the sanitary sewer was 0.032 Curies, about three percent of the allowable 1.0-Curies per year limit. In Appendix A, Table 13, the gross beta activity is reported; the gross beta activity was less than the lower limit of detectability of <194 to <195 pCi/L [Lev04a].

**Exhibit 5-3. Total Annual Releases to Sanitary System from 1994 to 2003**

| Calendar Year | Total Gallons Released | Total Activity (Curies) |
|---|---|---|
| 1994 | 273,250 | 0.299 |
| 1995 | 308,930 | 0.496 |
| 1996 | 341,625 | 0.951 |
| 1997 | 139,650 | 0.366 |
| 1998 | 255,450 | 0.071 |
| 1999 | 158,760 | 0.084 |
| 2000 | 165,900 | 0.081 |
| 2001 | 150,150 | 0.103 |
| 2002 | 190,200 | 0.453 |
| 2003 | 217,320 | 0.032 |

**Exhibit 5-4**




### 5.1.3 Radioactive and Mixed Waste

In 2002 and 2003, low-level radioactive wastes were stored on-site prior to off-site disposal in the Radioactive Waste Handling Facility (RWHF) (Exhibit 5-5). Low-level radioactive shipments made in 2003 consisted of removed systems from TFTR and compacted solid waste, including personal protective clothing. No low-level radioactive mixed waste was generated in 2002 or 2003 [Pu04b].

**Exhibit 5-5. Total Low-Level Radioactive Waste 1997-2003**

| Year | Cubic feet ($ft^3$) | Total Activity in Curies (Bq) |
|---|---|---|
| **1997** | 1,997.7 | 31,903.0 |
| **1998** | 533.74 | 204.80 |
| **1999** | 1188 | 213.76 |
| **2000** | 4,235.7 | 50.0 |
| **2001** | 19,949.8 | 1,288.43 (47.58) |
| **2002** | 858,568 kgs | 4950.14 (192.44) |
| **2003** | 8,208 kgs | 0.03 (0.91) |

**Exhibit 5-6. Radioactive Waste Packaging (Duct Crushed and Warpped)**

#### 5.1.4 Airborne Emission - *Differential Atmospheric Tritium Samplers (DATS)*

PPPL uses the differential atmospheric tritium sampler (DATS) to measure elemental and oxide tritium at the D site stack and in the Radioactive Waste Handling Facility (RWHF)(Exhibit 5-7).

DATS are similarly used at eleven (11) environmental sampling stations: 4 located on D site facility boundary trailers (T1 to T4), 6 located at remote environmental air monitoring stations (R 1 to R6) (App. A, Tables 4-7). The baseline location was located in Roebling, N.J. (Burlington County). All of the aforementioned monitoring is performed continuously.

**Exhibit 5-7. Preparing the DATS**

Tritium (HTO and HT) was released and monitored at the D site stack (App. A, Table 3 and Exhibit 3-4). Projected dose equivalent at the nearest off-site business from airborne emissions of tritium was 0.1 mrem/year ($1.0 \times 10^{-3}$ mSv/year) in 2002 and 0.05 mrem/year ($5.0 \times 10^{-4}$ mSv/year) in 2003. Measurements at the D site facility boundary have measured concentrations in the range from 0.122 to 270 pCi/m$^3$ elemental tritium (HT) and from 0.122 to 118 pCi/m$^3$ oxide tritium (HTO) in 2002 and from 0.136 to 28.4 pCi/ m$^3$ elemental tritium (HT) and from 0.223 to 20.5 pCi/m$^3$ oxide tritium (HTO) in 2003 (Appendix A, Tables 4 & 5). Measurements from off-site monitoring stations are shown in Appendix A, Tables 6 & 7 "Air Tritium (HT)" and "Air Tritium (HTO)," respectively.

The EDE at the site boundary was calculated based on annual tritium totals as measured at the stack and RWHF (DATS air) and water samples at the LEC tanks and highest measure-mints from well and surface water during 2002 and 2003. The addition of the RWHF, which has no elevated stack, contributes more significantly to the EDE at the site boundary than to the EDE at the nearest business due to its close proximity to the site boundary (see Exhibit 4-3).

### 5.2 Release of Property Containing Residual Radioactive Material

Release of property containing residual radioactivity material is performed in accordance with PPPL ES&H Directives (ESHD) 5008, Section 10, Subpart L.

Such property cannot be released for unrestricted use unless it is demonstrated that contamination levels on accessible surfaces are less than the values in Appendix D of ES&HD 5008, Section 10, and that prior use does not suggest that contamination levels on inaccessible surfaces exceed Appendix D values. For tritium and tritiated compounds, the removable surface contamination value used for this purpose is 1,000 dpm/100 cm$^2$. No active or contaminated materials were free-released in 2002 or 2003. All materials were either reused in controlled environments or properly disposed.

### 5.3 Protection of Biota

The highest measured concentrations of tritium in surface and ground water in 2002 and 2003 was 2,225 pCi/L (Well MW-12S). This concentration is a very small fraction of the water biota concentration guide (BCG) (for HTO) of 3 x$10^8$ pCi/L for aquatic system evaluations, and the water BCG (for HTO) of 2 x $10^7$ pCi/L for terrestrial system evaluations, per Draft DOE Standard ENVR-001 ("A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota").

### 5.4 Unplanned Releases

There were no unplanned radiological releases in 2002 and 2003.

### 5.5 Environmental Radiological Monitoring

#### 5.5.1 Waterborne Radioactivity

*A. Surface Water*

Surface-water samples at nine locations (two on-site: DSN001, and E1; and seven off-site: B1, B2, C1, DSN003, M1, P1, and P2) have been analyzed for tritium (App. A, Table 8). Locations are indicated on Exhibits 4-3 (on-site) and 4-4 (off-site locations) (Ex. 5-9).

In April 2002, at on-site location DSN001, basin outfall tritium concentration was detected at 2,090 pCi/Liter, which was the highest in 2002 for surface water samples (App. A, Table 8). In September 2003, at on-site location, DSN001 basin outfall, the tritium concentration was detected at 451 pCi/L, which was the highest in 2003 for surface water samples.

Rain water samples were collected and analyzed and ranged from below detection) to 3,921 pCi/liter in 2002 and 1,126 pCi/liter in 2003 (App. A , Tables 10 & 11), which are lower than the six-year high of 61,660 pCi/liter. With the end of TFTR D&D project in September 2002, the decrease in rainwater tritium concentrations has mirrored the decreased tritium emissions measured at the D-site stack.

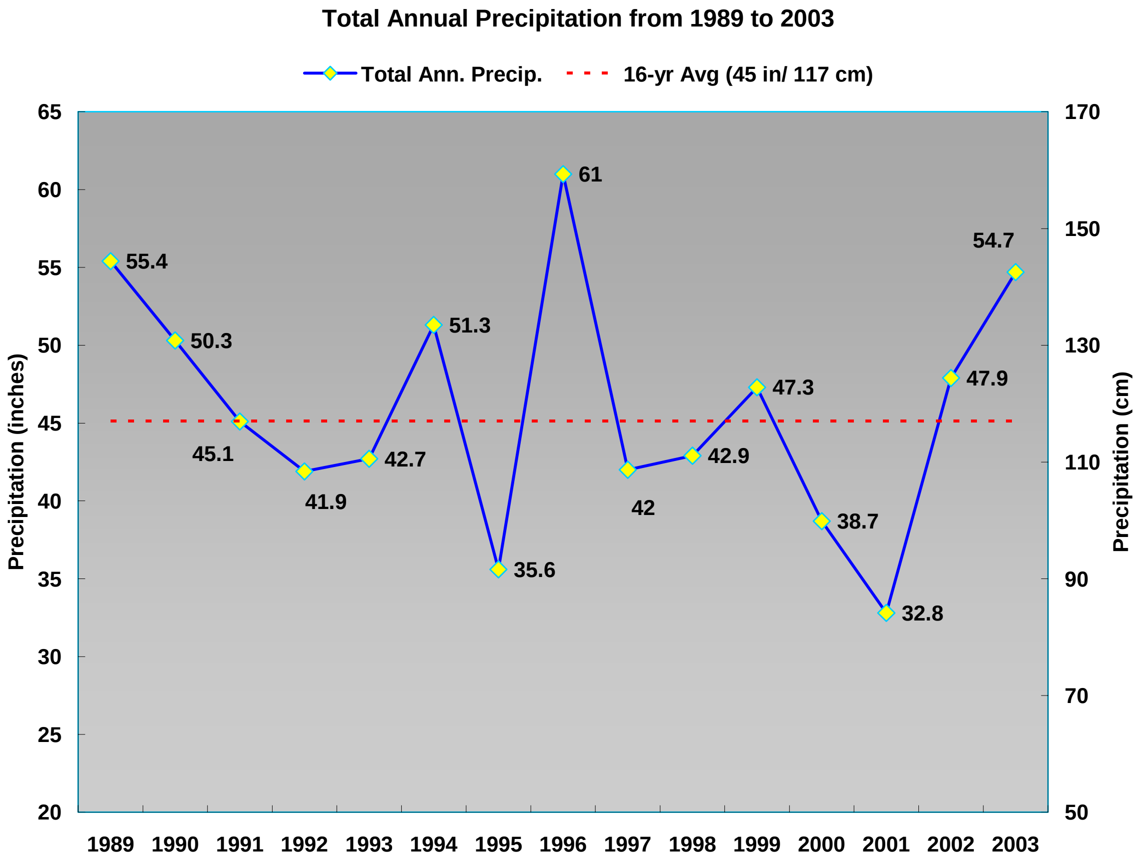
Based on this data and associated literature [Jo74, Mu77, Mu82, Mu90], it is believed that the observed increase in tritium concentrations in rain water is due to washout by precipitation of a portion of the tritium released from the D-site stack. Monitoring of tritium concentrations in rain water continues.

In April 1988, PPPL began precipitation measurements. On a weekly basis, on-site precipitation is measured by a rain gauge. Exhibit 5-8 shows the occurrence of dry and wet years compared to the 45-inch average (App. A, Table 2 for 2002 and 2003 weekly rainfall) [Ch03, Ch04]. While 2001 was the driest year since measurements began, the above-average rainfall in 2002 and 2003 ended the drought and water emergency in New Jersey.

*B. Ground Water*

In August 1995, PPPL began to monitor tritium levels in on-site ground water more intensely. This increase in the scope of ground-water monitoring was prompted by the slight increase in tritium levels in well TW-1 (Ex. 5-10). An investigation into the potential sources began in the fall of 1995. Leak tests and checks of lines and equipment in the area near TW-1 (north side of D-site) were performed; none were found to be leaking tritiated water into the ground water.

**Exhibit 5-8.**




Rainfall collected in 1988 for 10 months; est. >40 inches.

**Exhibit 5-9 Surface Water Monitoring**

**Exhibit 5-10. Ground Water Monitoring**

In 2002, the highest concentrations of tritium were found in well TW-8 (479 pCi/L,). In 2003, the highest concentration of tritium was found in well MW-12S (2,225 pCi/L). From PPPL's environmental monitoring data and the available scientific literature [Jo74, Mu77, Mu83, Mu90], the most likely source of the tritium detected in the on-site ground water samples is from the atmospheric venting of tritium from the D-site stack and the resulting "wash-out' during precipitation Ground water monitoring of the wells and the foundation sump (dewatering sump for D-site buildings) will continue.

*C. Drinking Water*

Potable water is supplied by the public utility, Elizabethtown Water Company. In April 1984, a sampling point at the input to PPPL was established (E1 location) to provide baseline data for water coming onto the site. Radiological analysis has included gamma spectroscopy and tritium-concentration determination. In 2002, tritium measurement of potable water was 27 pCi/liter. In 2003, tritium concentrations at this location ranged from 59 pCi/L to <189 pCi/liter).

### 5.5.2 Foodstuffs, Soil, and Vegetation

There were no foodstuffs, soil, or vegetation samples gathered for analysis in 2002 or 2003. In 1996, the Health Physics (HP) Manager reviewed the requirement for soil/biota sampling. At that time, a decision was made to discontinue the sampling program. Tritium was not detected in almost all samples and these data were not adding to the understanding of tritium transport in the environment. A heavier concentration was placed on water sampling and monitoring which produced more relevant results. ✵

Chapter 6

# ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

## 6.1 New Jersey Pollutant Discharge Elimination System (NJPDES) Program

### 6.1.1 Surface and Storm Water

To comply with permit requirements of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, NJ0023922, PPPL submitted to NJDEP monthly discharge monitoring reports (DMRs) for Discharge Serial Number (DSN)—DSN001 and DSN003 (App. A , Tables 22 & 23). During 2002, PPPL's discharges were within allowable limits for all testing parameters with the exception of one chlorine-produced oxidant concentration in August that exceeded the permit limit (0.016 mg/L). During 2003, the chemical oxygen demand (COD) limit of 50 mg/L was exceeded once in June and July and twice in November.

In 2002 and 2003, PPPL continued to monitor the total suspended solids concentration at DSN 003 and intake (at C1 -upstream of the D&R Canal pump house) quarterly. In 2002, new chlorine controllers were installed in the D&R Canal pump house and at the D-site cooling tower. A new chlorine storage tank was also installed in the D&R Canal pump house.

### 6.1.2 Chronic Toxicity Characterization Study

In 2002 and 2003, chronic toxicity testing for DSN001 effluent continued. In all chronic toxicity tests, *Pimephales promelas* (fathead minnow) was the only test species required [NJDEP95]. NJDEP chose the fathead minnow as the more sensitive species for the Chronic Toxicity Biomonitoring requirements.

As the result of the annual chronic toxicity test, the survival rate, as defined by the NJ Surface Water Quality Standards, was >100 percent (statistically possible) no observable effect concentration (NOEC) [PPPL02c & 03i]. The last unsuccessful test occurred in March 1995, the fathead minnows survived in the 50 percent dilution, *i.e.*, mortality was observed in the 100 percent effluent test (Ex. 6-1).

**Exhibit 6-1. Summary of Chronic Toxicity Testing (***One test result <100 NOEC failed))

| Test Freq. | Bi-month | Quarter | Semi-annual | Annual |
|---|---|---|---|---|
| 1994 | | 4* | | |
| 1995 | | 4* | | |
| 1996 | 3 | 2 | | |
| 1997 | | 4 | | |
| 1998 | | 3 | | |
| 1999 | | | 1 (Mar.) | 1(Oct.) |
| 2000 | | | | 1 (Dec.) |
| 2001 | | | | 1 (Nov.) |
| 2002 | | | | 1 (Sept.) |
| 2003 | | | | 1 (Oct.) |

### 6.1.3 Ground Water

Since 1989, PPPL has monitored ground-water quality in seven wells in compliance with the NJPDES ground-water discharge permit, NJ0086029; four of the seven wells are located on PPPL C and D sites, and three wells are located on A and B sites. The wells on A & B sites are not on DOE-leased property, but are on the adjacent James Forrestal Campus property. The two inflows to the on-site basin are included in the monitoring requirements.

The permit was issued effective April 1, 1989, and the expiration date was extended to December 31, 1996. In July 1994, DOE-PAO submitted to NJDEP the NJPDES permit renewal application. In May 2001, the renewal of the discharge to ground water permit was issued. The requirement to monitor ground water wells and at the detention basin inflows was removed. PPPL is required to continue monitoring ground water through the Remediation program [NJDEP01].

**A.** *NJPDES Ground Water Program in 2002 and 2003*

PPPL is no longer required to collect quarterly ground water samples as a condition of this permit. PPPL maintains compliance through its Operation and Maintenance Manual for the detention basin.

As discussed in Chapter 7, "Site Hydrology, Ground Water and Public Drinking Water Protection," the volatile organic compounds detected in the ground water monitoring wells adjacent to the basin are not believed to originate from the detention basin, but rather are the result of historical contamination in the Former Annex Building Area (FABA).

An estimated 35.3 and 62.8 million gallons of water were discharged from the detention basin in 2002 and 2003, respectively. Beginning in December 2000, flow from the basin was measured using an ultrasonic flow transducer; data are downloaded to a data spreadsheet from which total daily and daily average flows were calculated. The lined detention basin operates with a permanent oil boom, an oil detection .system that is capable of sending an alarm signal to Security and automatically closing the discharge valve, and a chain-link fence around the perimeter of the basin. The detention basin is operated in a flow-through mode

*B. Regional Ground Water Monitoring Program*

In 1993, a Memorandum of Understanding (MOU) was signed between Princeton University, the landowner of the James Forrestal Campus, and the NJ Department of Environmental Protection (NJDEP). For C and D sites, the Remedial Investigation is discussed in Section 3.2.3 and is fully documented in the *Remedial Investigation and Remedial Action Selection Report (RI & RASR)* approved by NJDEP in 2000 [PPPL00a]. The Remedial Action Work Plan (RAWP) was submitted by the DOE-PPPL in May 2000 and conditionally approved by NJDEP in June 2000 [PPPL00b].

In 2002 and 2003, ground water monitoring activities were continued in the area of potential environmental concern (APEC) near the location of the former PPPL Annex Building in the wooded area southwest of CAS/RESA. (Exhibits 4-3 7 6-2, and App. A, Tables 38-39) [Sh01, Sh03, Sh04].

**Exhibit 6-2. Ground Water Monitoring Equipment**

Volatile organic compounds (VOCs) probably from degreasing solvents were detected above both the NJ Ground Water Standards in 5 of the 12 wells/sumps sampled and in 2 wells in estimated concentrations lower than the ground water standard. The highest concentrations of tetrachloroethylene (PCE) were found in well MW-19S at 96.2 μg/L, which is lower than in 2000 (205 μg/L). The PCE concentration at D-site MG sump was 50.7 μg/L, which is lower than in 2000 (75.6 μg/L). The de-watering sumps located in the D-site MG and TFTR basements draw ground water radially from the shallow aquifer, controlling ground water flow and, thus, preventing off-site contaminant migration and slowly extracting contaminated ground water.

## 6.2 Non-Radiological Programs

The following sections briefly describe PPPL's environmental programs required by federal, state, or local agencies. These programs were developed to comply with regulations governing air, water, wastewater, soil, land use, and hazardous materials, as well as with DOE orders or programs.

### 6.2.1 Non-Radiological Emissions Monitoring Programs

*A. Airborne Effluents*

PPPL maintains New Jersey Department of Environmental Protection (NJDEP) air permits for its four boilers located on C site. The permit were modified in 2003 to include the burning of No.2 fuel oil in addition to No.4 fuel oil and natural gas. The boiler permits were part of NJDEP's inspection of the facility; the facility was determined to be in compliance of the air regulations and permit requirements (Exhibit 6-3).

Measurements of actual boiler emissions are not required. To optimize boiler efficiency and to reduce fuel cost in accordance with DOE Order 4330.2D, "In-House Energy Management," [DOE88] PPPL utilizes an outside contractor to tune all the boilers on an annual basis and provide a report for each boiler. The report includes the boiler efficiency, oxygen content, flue-gas temperature and carbon dioxide content of the stack gas for both oil (# 4) and natural gas fuels. The PPPL boiler operations Chief Engineer maintains records of this information [Kir03 & Kir04].

PPPL maintains the following equipment that requires air permits:

**Exhibit 6-3. Air-Permitted Equipment**

| Type of Air Permit | Location |
|---|---|
| Dust collectors | M&O woodworking shop<br>CAS metalworking area<br>Shop wood working area |
| Storage tanks vents | 25,000 gal. No. 2 & 4 oil<br>15,000 gal. No. 1 oil |
| Diesel generators | D-site generator<br>C-site generator |
| Utility boilers | Units 2,3,4, & 5 in M&OD |

*B. Drinking Water*

Potable water is supplied by the public utility, Elizabethtown Water Co. The PPPL used approximately 15.2 and 24 million gallons in 2002 and 2003 (Exhibits 6-4 and 6-5) [Kir03 and 04]. In 1994, a cross-connection was installed beneath the water tower to provide back-up potable water to the tower for the fire-protection system and other systems. In 2003, PPPL's shut-down of canal water (non-potable) for the elevated water tower project caused an increase in potable water usage for three months; this increase in the total of potable and a decrease in non-potable are seen in Exhibits 6-4, 6-5 and 6-6.

**Exhibit 6-4**
**PPPL's Potable and Non-Potable Water Use from 1995 to 2003**

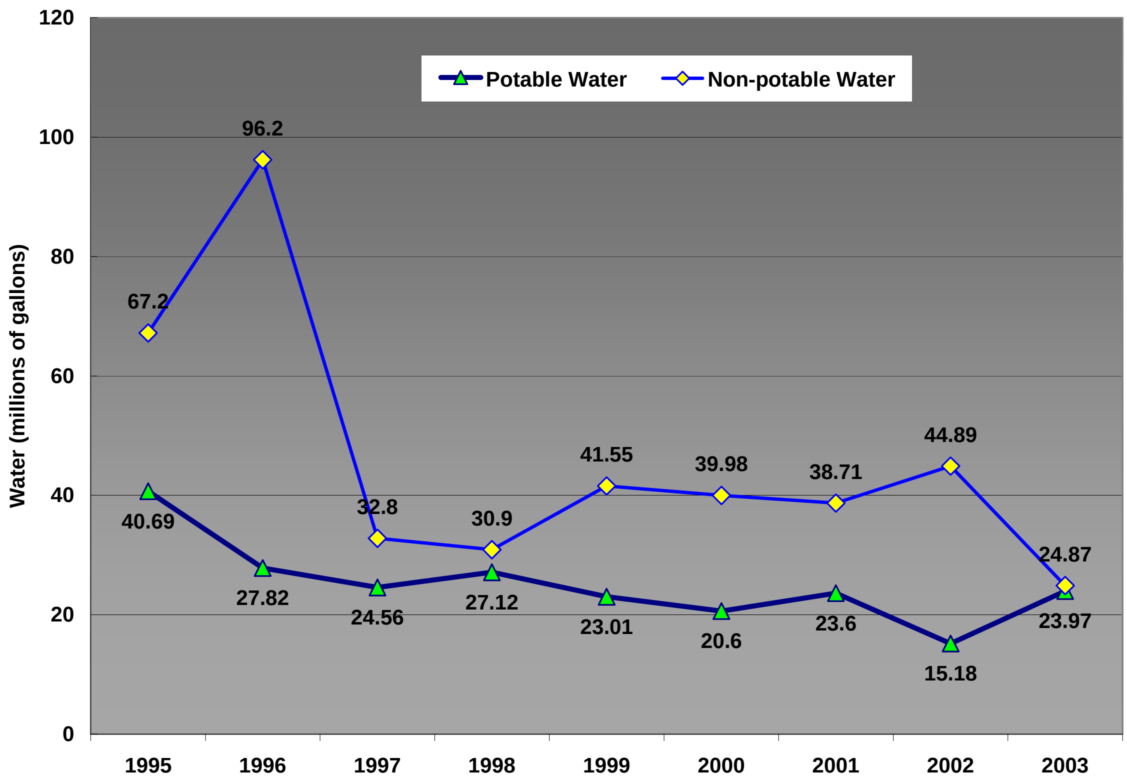



**Exhibit 6-5. PPPL Potable Water Use**

| CY | In million gallons |
|---|---|
| 1995 | 40.69 |
| 1996 | 27.82 |
| 1997 | 24.56 |
| 1998 | 27.12 |
| 1999 | 23.01 |
| 2000 | 20.6 |
| 2001 | 23.6 |
| 2002 | 15.18 |
| 2003 | 23.97 |

C. *Process (non-potable) Water*

In 1987, PPPL made a changeover from potable water to Delaware & Raritan (D&R) Canal non-potable water for the cooling-water systems. Non-potable water is pumped from the D&R Canal as authorized by a permit agreement with the New Jersey Water Supply Authority (Exhibits 6-4 and 6-6) [Kir04].

The present agreement gives PPPL the right to draw up to half a million gallons of water per day for process and fire-fighting purposes.

**Exhibit 6-6**
**PPPL Non-Potable Water Use**

| CY | In million gallons |
|---|---|
| 1995 | 67.2 |
| 1996 | 96.2 |
| 1997 | 32.8 |
| 1998 | 30.9 |
| 1999 | 41.55 |
| 2000 | 39.98 |
| 2001 | 38.71 |
| 2002 | 44.89 |
| 2003 | 24.87 |

Filtration to remove solids and the addition of chlorine and a corrosion inhibitor are the primary water treatment at the canal pump house. Discharge serial number DSN003, located at the canal pump house filter-backwash, is a separate discharge point in the NJPDES surface-water permit and is monitored monthly (App. A, Tables 27 & 36). A sampling point (C1) was established to provide baseline data for surface water that is pumped from the D&R Canal for non-potable uses. Appendix A Tables 21 & 30 summarizes results of water quality analysis at the canal.

*D. Surface Water*

Surface water is monitored for potential non-radioactive pollutants both on-site and at surface-water discharge pathways (upstream and downstream) off-site. Other sampling locations—Bee Brook (B1 & B2), Elizabethtown Water Co. (potable water supplier-E1), Delaware & Raritan Canal (C1), Millstone River (M1), and Plainsboro (P1 & P2) sampling points (App. A Tables 19-36)—are not required by regulation, but are a part of PPPL's environmental surveillance program.

*E. Sanitary Sewage*

Sanitary sewage is discharged to the Publicly-Owned Treatment Works (POTW) operated by South Brunswick Township, which is part of the Stony Brook Regional Sewerage Authority (SBRSA). During 1994, due to malfunctioning metering devices, PPPL, South Brunswick Sewerage Authority, who is part of SBRSA system, and the Township of Plainsboro agreed upon an estimated volume of sewage discharged. The estimated volume was based on historical data of approximate flow rates from PPPL. This volume was adjusted for the interconnections with Forrestal Campus A and B sites and a private business. For 2002 and 2003, PPPL estimates a total discharge of 8.40 million gallons of sanitary sewage to the South Brunswick sewerage treatment plant [Kir04**].**

In 1996, Stony Brook Regional Sewerage Authority (SBRSA) issued an Industrial Discharge License (22-96-NC) to PPPL and DOE-PSO. The license requires monthly measurement of radioactivity, flow, pH and temperature at the LEC tanks (designated compliance and sampling location) and monthly sampling for chemical oxygen demand (COD).

During 2002 and 2003, PPPL continued monthly radiological and non-radiological analyses to meet the license requirements (App. A. Table 13).

In May 2003, a SBRSA representative inspected PPPL's records and discharge location. PPPL split a sample for chemical oxygen demand analysis.

*F. Spill Prevention Control and*

*Counter-measure*

Spill Prevention Control and Counter-measure PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was revised in June 2003 by a Professional Engineer within the PPPL Materiel and Environmental Services Division [MESD] rather than an outside architect-engineering firm. This revised SPCC was reviewed internally by all the owners of equipment covered by the SPCC and Quality Assurance. The current SPCC is approved by both the Head of Materiel & Environmental Services and the Head ES&H and Infrastructure Support (PPPL03e).

The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan. Besides the 5-year major revision as required by the EPA, the PPPL ESD will complete a review every year and make any minor changes required to the SPCC.

*G. Herbicides and Fertilizers*

During 2002 and 2003, PPPL's Maintenance & Operations (M&O) Division managed the use of herbicides by outside contractors. These materials are applied in accordance with state and federal regulations. Chemicals are applied by certified applicators.

In addition to the fertilizer, the quantities applied during 2002 were as follows: herbicides - Dimension (98 gal.), Roundup (2 gal.), and Momentum (15.6 gal.) [Kin03]. In 2003, Roundup (15.4 gals) and Malathion (1.7 gals.) were used at PPPL [Kin04]. No herbicides or fertilizers are stored on site; therefore, no disposal of these types of regulated chemicals is required by PPPL.

*H. Polychlorinated Biphenyls (PCBs)*

At the end of 2002 and 2003, PPPL's inventory of equipment included 5 polychlorinated biphenyl (PCB)-regulated capacitors. 640 regulated-PCB capacitors were removed from PPPL in 1998. [Pu04].

*I. Hazardous Wastes*

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) was submitted to the NJDEP for 2001-2002. A description of Resource Conservation and Recovery Act (RCRA) compliance is found in Section 3.1.2 of this report.

### 6.2.2 Continuous Release Reporting

Under CERCLA's reporting requirements for the release of a listed hazardous substances in quantities equal to or greater than its reportable quantity, the National Response Center is notified and the facility is required to report annually to EPA. Because PPPL has not released any CERCLA-regulated hazardous substances, no "Continuous Release Reports" have been filed with EPA.

### 6.2.3 Environmental Occurrences

During CY2002 and 2003, two and four, respectively, unplanned releases of hazardous or petroleum substances occurred. In April and May 2002, PPPL reported to the NJDEP Hotline that PPPL released hydraulic oil from the L-wing elevator (~35 gallons) and D-site diesel generator (~2 quarts). The elevator hydraulic lift leaked sufficiently that it was taken out of service until repairs could be made; prior to repairs, the elevator shaft required clean-up of the hydraulic oil. A bio-based or vegetable-based oil replaced the petroleum-based hydraulic oil in the lift. The D-site diesel generator leaked hydraulic oil from a fuel line that spilled onto the concrete pad and adjacent gravel. PPPL cleanup the area and repaired the line.

In 2003, PPPL reported four releases to the NJDEP Hotline. Two involved lubricating oil – in February 2003, a heating, ventilation, and air conditioning unit (HVAC) line ruptured and released oil (~2 quarts) to the gravel and soil. In April 2003, the D-site diesel generator released lubricating oil (<2 gallons) onto the gravel and adjacent soil. The third release involved an employee's vehicle, which leaked gasoline (<2 gallons) onto the paved parking surface during a rain event in March 2003 causing the gasoline to runoff into a stormdrain. Lastly in September 2003, a subcontractor's backhoe ruptured a hydraulic line that released oil (~8 ounces) onto a grassed area. All of the above releases were cleaned up by PPPL personnel, and the contaminated gravel/soil was drummed and removed off-site by subcontractor waste removal company.

### 6.2.4 SARA Title III Reporting Requirements

NJDEP administers the Superfund Amendments and Reauthorization Act (SARA) Title III (also known as the Emergency Reporting and Community Right-to-Know Act) reporting for EPA Region II. The modified Tier I form includes SARA Title III and NJDEP-specific reporting requirements. PPPL submitted the SARA Title III Report to NJDEP in March 2002 and 2003 [PPPL03b & PPPL04]. No significant changes from the previous year were noted. The SARA Title III reports included information about eleven compounds used at PPPL as listed in Exhibit 3-16.

Though PPPL does not exceed threshold amounts for chemicals listed on the Toxic Release Inventory (TRI), PPPL completed the TRI cover page and laboratory exemptions report for 1996, and submitted these documents to DOE. Since PPPL did not exceed the threshold amounts, no TRI submittal was completed for 2002 or 2003. ✵

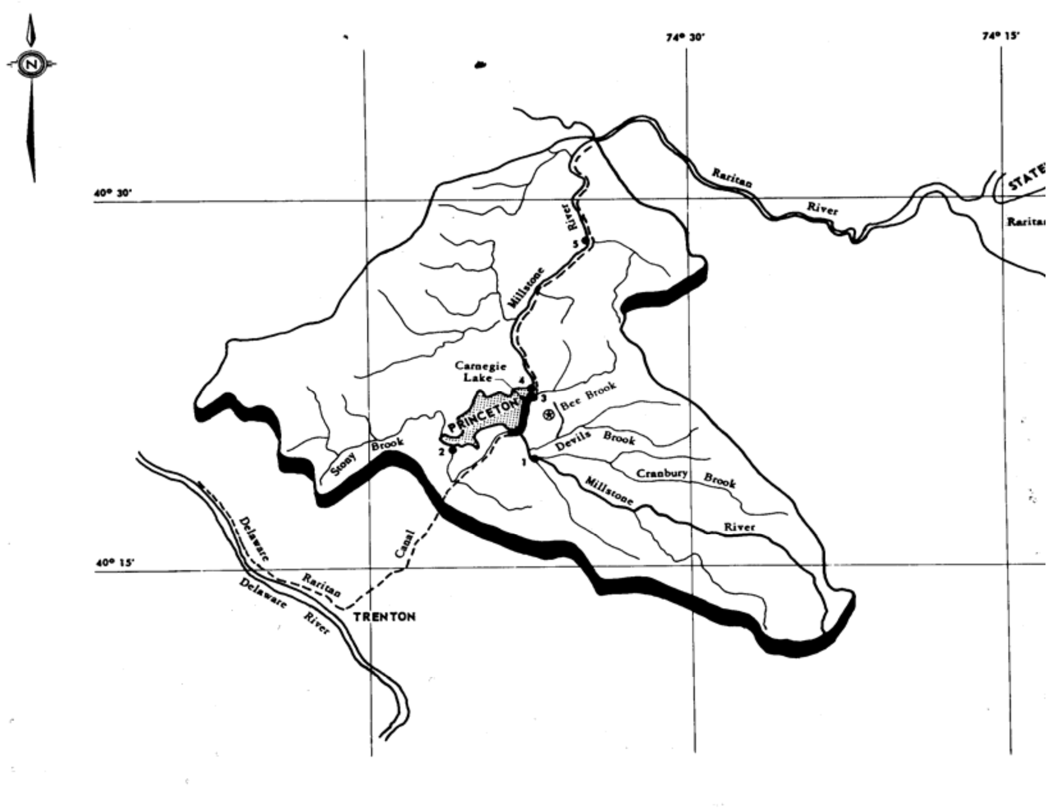
**Chapter 7**

## SITE HYDROLOGY, GROUND WATER, AND DRINKING WATER PROTECTION

PPPL is located within the Bee Brook Watershed. Bee Brook is a tributary to the Millstone River, which is part of the Raritan River Watershed (Exhibit 7-1). NJDEP has developed a watershed-based management program for prospective environmental planning and has divided the State of New Jersey into twenty watershed basins.

Locally, the Bee Brook Watershed encompasses approximately 700 acres within the Princeton Forrestal Center and James Forrestal Campus tracts. It begins at College Road East (approximately 1600 feet east of US Route 1), flows south in a wide flood plain, and then discharges into Devil's Brook at the entrance to Mill Pond [Sa80].

**Exhibit 7-1 Millstone River Watershed Basin**



PPPL is situated on the eastern edge of the Piedmont Physiographic Province, approximately one-half mile from the western edge of the Atlantic Coastal Plain Province. The site is underlain largely by gently dipping and faulted sedimentary rock of the Newark Basin. The Newark Basin is one of several rift basins that were filled with sedimentary material during the Triassic Period. At PPPL, bedrock is part of the Stockton Formation, which is reportedly more than 500 feet thick and consists of fractured red siltstone and sandstone [Lew87]. Regionally, the formation strikes approximately north 65 degrees east, and dips approximately 8 degrees to the northwest. The occurrence of limited amounts of clean sand near the surface indicates the presence of the Pennsauken Formation. This alluvial material was probably deposited during the Aftonian Interglacial period of the Pleistocene Ice Age.

Within 25 miles, there are a number of documented faults; the closest of which is the Hopewell fault located about 8 miles from the site. The Flemington Fault and Ramapo Faults are located within 20 miles. None of these faults are determined to be "active" by the U.S. Geological Survey. This area of the country (eastern central US) is not earthquake-prone, despite the occurrence of minor earthquakes that have caused little or no damage.

The Millstone River and its supporting tributaries geographically dominate the region. The well-watered soils of the area have provided a wealth of natural resources including good agricultural lands from prehistoric times to the present. Land use was characterized by several small early centers of historic settlement and dispersed farmland. It has now been developed into industrial parks, housing developments, apartment complexes and shopping centers [Gr 77].

The topography of the site is relatively flat and open with elevations ranging from 110 feet in the northwestern corner to 80 feet above mean sea level along the southern boundary. The low-lying topography of the Millstone River drainage reflects the glacial origins of the surface soils; sandy loams with varying percents of clay predominate.

Two soil series are recognized for the immediate environs of the site. Each reflects differences in drainage and subsurface water tables. Along the low-lying banks of stream tributaries, Bee Brook, the soils are classified Nixon-Nixon Variant and Fallsington Variant Association and Urban Land [Lew87].

This series is characterized by nearly level to gently sloping upland soils, deep, moderate to well drained, with a loamy subsoil and substratum. The yellowish-white sands contain patches of mottled coloring caused by prolonged wetness. On a regional scale, the water table fluctuates between 1.5 and 2.5 feet below the surface in wet periods and drops below 5 feet during drier months.

In the slightly higher elevations (above 70 feet), the sandy loams are better drained and belong to the Sassafras series. The extensive farmlands and nurseries in the area indicate this soil provides a good environment for agricultural purposes, both today and in the past.

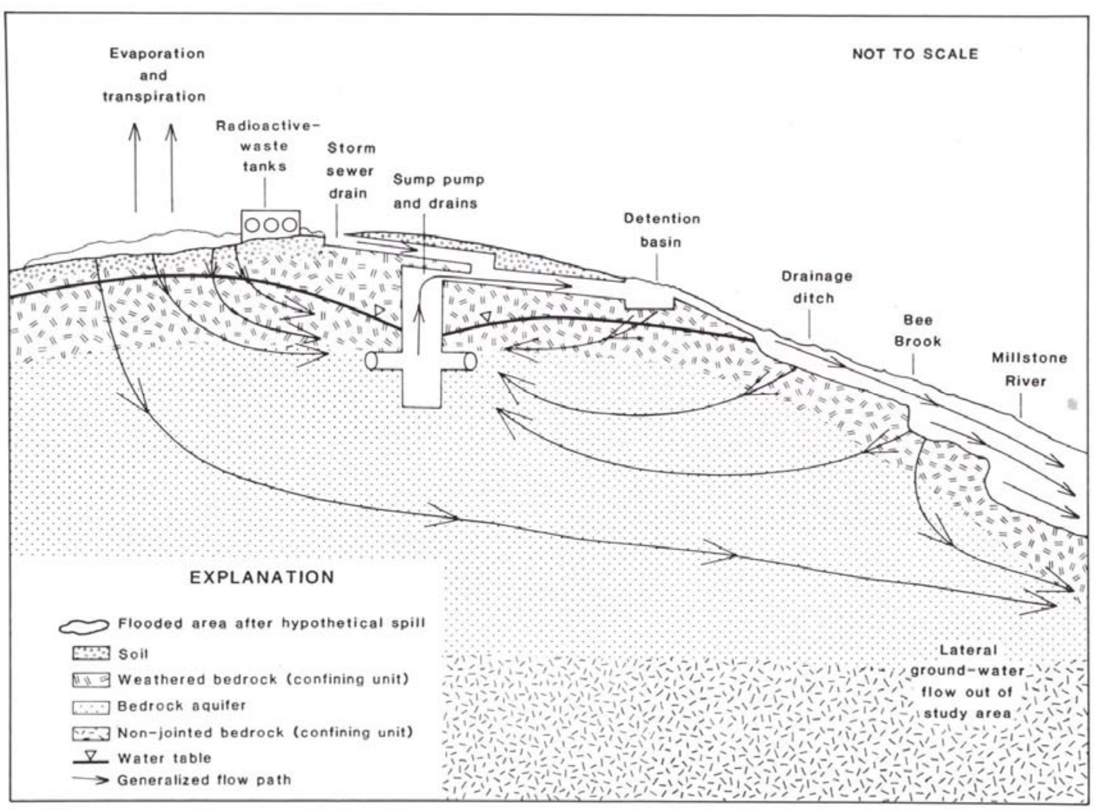
An upland forest type with dominant Oak forest characterizes vegetation of the site. Associated with the various oaks are Red Maple, Hickories, Sweetgums, Beech, Scarlet Oak, and Ash. Red, White, and Black Oaks are isolated in the lower poorly drained areas. Along the damp borders of Bee Brook, a bank of Sweetgum, Hickory, Beech, and Red Maple define the watercourse. The forest throughout most of the site has been removed either for farmland during the last century or recently for the construction of new facilities. Grass has replaced much of the open areas.

The under-story of the wooded areas is partially open with isolated patches of shrubs, vines, and saplings occurring mostly in the uplands area. The poorly drained areas have a low ground cover of ferns, grasses, and leaf litter.

All of PPPL's storm water runoff flows to Bee Brook, either directly *via* the detention basin (DSN001) or along the western swale to the wetlands south of the site. Approximately 45 % of the site's total area is covered by impervious surfaces - buildings, roadways and parking lots, and storage trailers.

PPPL's Stormwater Management Plan allows for a maximum impervious coverage of 60 % of the developable land, which excludes wetlands – 18 acres of the 88.5 acres (Exhibit 3-14) [PPPL 98].

**Exhibit 7-2. Generalized Potentiometric Surface of the Bedrock Aquifer at PPPL [Le87]**



Also, the 500-year flood plain elevation (85 ft above mean sea level) delineates the storm protection corridor, which is vital to the flood and water quality control program for PPPL as well as the Princeton Forrestal Center site. This "corridor" is preserved and protected from development by Princeton Forrestal Center in the Site Development Plan [PFC80].

The general direction of ground-water flow on the site is from the northwest of PPPL toward the southeast in the direction of Bee and Devil's Brooks. The operation of several building foundation drain sump pumps creates a local and shallow cone of depression radially toward the sumps (Exhibits 7-2 & 7-4).

Ground water is pumped from the sumps into the detention basin, which flows into Bee Brook. Bee Brook is hydraulically connected with ground water; during flooding stages, the brook recharges ground water and during low-flow periods, ground water discharges to the brook.

Under several regulatory programs administered by NJDEP, PPPL has performed ground water investigations to address potential impacts from former underground storage tanks (USTs), a formerly unlined detention basin, and in areas where spills occurred or may have occurred in the past. In all, PPPL has installed a total of 44 wells to monitor ground-water quality. Remedial Investigations and Remedial Alternative Assessment (RI/RAA) studies were conducted to delineate shallow ground water contamination and identify a suitable remedy as required by conditions of the Memorandum of Understanding (MOU) between Princeton University and NJDEP. A Remedial Action Work Plan was approved by NJDEP in 2000. Ground water monitoring continues as part of the selected remedy.

In September 2003, PPPL sealed 13 monitoring wells that were no longer needed for specific or site-wide monitoring programs. The wells were sealed by a New Jersey-licensed well driller using methods approved by NJDEP regulations. NJDEP approval was granted prior to the closure of these wells.

Ground-water monitoring results show that tetrachloroethylene, trichloroethylene (PCE, TCE), and their natural degradation products are present in a number of shallow and intermediate-depth wells on C site (Exhibit 7-5). These VOCs are commonly contained in solvents or metal degreasing agents.

By mid-1995, all USTs at PPPL were removed with the exception of one tank that was abandoned in-place with NJDEP's approval. PPPL replaced all USTs with above ground storage tanks. PPPL determined that the hazard of digging up one tank, buried next to a high-voltage electrical transformer yard, was too great a risk. The tank passed a tightness-test; soil borings around the tank showed no indications of any leakage from the tank or its associated piping. It was then emptied, cleaned, and filled with concrete in accordance with NJDEP regulations.

Foundation de-watering sumps located on D-site influence ground-water flow across the site. The sumps create a significant cone of depression drawing ground water toward them. Under natural conditions, ground-water flow is to the south-

southeast toward Bee Brook; it appears that ground water beneath the site (except in the northwestern corner) is drawn radially toward the D site sumps.

During Phase 1 and 2 of the Remedial Investigation, samples from wells and other ground water characterization activities lead to the identification of a new area of potential environmental concern (APEC) near the Former Annex Building Area (FABA). This finding expanded the site boundaries by 16.5 acres for a total of 88.5 acres. Characterization of soil and ground water in the former Annex Building area was conducted during 1997 and 1998 [HLA98].

Phase 3 activities were conducted to:

- Baseline Ecological Evaluation;
- Investigate soil and ground water quality at the Former Annex Building Area (FABA);
- Further assess PCE and other VOC concentrations and distribution in ground water.

In the Remedial Action Selection Report, PPPL proposed to NJDEP that no active ground water remediation beyond the capture and extraction performed by the building dewatering system should be implemented at the site. The natural attenuation processes in the subsurface augments building foundation-dewatering system. In a letter dated March 28, 2000, NJDEP approved the Remedial Investigation and Remedial Action Selection Reports [Sh99]. In response, PPPL prepared and submitted a Remedial Action Work Plan (RAWP) outlining continual operation of the ground water extraction system and a long-term monitoring program [Sh00]. The RAWP was submitted to NJDEP in May 2000 and is being implemented [HLA98, Sh00, Sh01, Sh03].

In January 2002 an Aquifer Classification Exception Area (CEA) Request was submitted to NJDEP. The CEA designation identifies specific areas where state-wide Ground Water Quality Standards are not met and will not be met for some time. CEAs are granted for a specific area and aquifer and for specific contaminants. The CEA for PPPL is shown on Figure 7-3 and only addresses specific VOCs in the shallow (<60 feet deep) aquifer. The CEA request was approved by NJDEP in August 2002.

In 2002 and 2003, RAWP activities accomplished the following:

1. Quarterly ground water monitoring was conducted through October 2003, at which time an annual sampling schedule was adopted upon approval by NJDEP;
2. Examination of analytical data and water level measurements indicates an inverse relationship between ground water level and VOC concentration;
3. Some natural attenuation (anaerobic biodegradation) occurs in the wetlands adjacent to CAS/RESA;
4. Contaminated ground water is captured by building sumps and is not migrating off-site.
5. VOCs in ground water do not pose a risk to site workers or the surrounding public.

Natural attenuation processes are active as evidenced by presence of degradation compounds in ground water down gradient of source. PCE is degraded into trichloroethylene (TCE) and cis-1,2-dichloroethlyene (c-1,2-DCE), and the presence of dissolved methane, reduced dissolved oxygen levels and negative redox values also provides definitive evidence of on-going biological degradation (See App. A, Tables 38-39) [Sh03, Sh04]

The second investigation began in August 1995, when the tritium concentration from well TW-1, located north of the TFTR stack, was found to be above the background or baseline concentration, 789 *versus* 150 pico Curies/Liter (pCi/L), respectively. As a result of this finding, PPPL began looking into the cause of the concentration increase. More wells and ground water sumps were sampled, underground utilities were tested for leaks, soil was tested, and roof drains were sampled. In addition, rainwater-sampling stations were established and sampled.

The results of this program were that no leaks were found emanating from underground utilities; soil results and utility testing inspections supported this finding. Drain samples from the liquid effluent collection tank roof showed that tritium concentrations were elevated as were soil samples next to drain spouts.

Based on site-specific studies and a review of the scientific literature, PPPL determined the most likely source of tritium detected in the ground water was atmospheric releases of tritium and the subsequent "wash out" and percolation of tritium into the subsurface. A number of published and un-published studies have described the effect of tritium releases and rain. Rain droplets act as a scrubber and wash tritiated water vapor (HTO) out of the plume from the stack [Mu90]. The water infiltrates into the ground, and eventually, some of the tritium reaches the ground water table and the monitoring wells.

During 2002 and 2003, the highest concentrations of tritium in the ground water were detected at well TW-5 in July 2003 (3,365 pCi/L). This is less than 20% of the USEPA Drinking Water standard of 20,000 pCi/L. Results of nearly eight years of tritium monitoring show a pattern of elevated ground water concentrations between three and six months after elevated tritium levels are detected in precipitation. The ground water results showed that the tritium concentrations fluctuate over time. PPPL believes that tritium concentrations in the atmosphere, amount of precipitation (rainfall), and time of year all have an effect on the concentration of tritium detected in the ground water. PPPL continues to monitor tritium concentrations in atmospheric releases, precipitation, ground water and surface water as part of its radiological environmental surveillance program. ✵

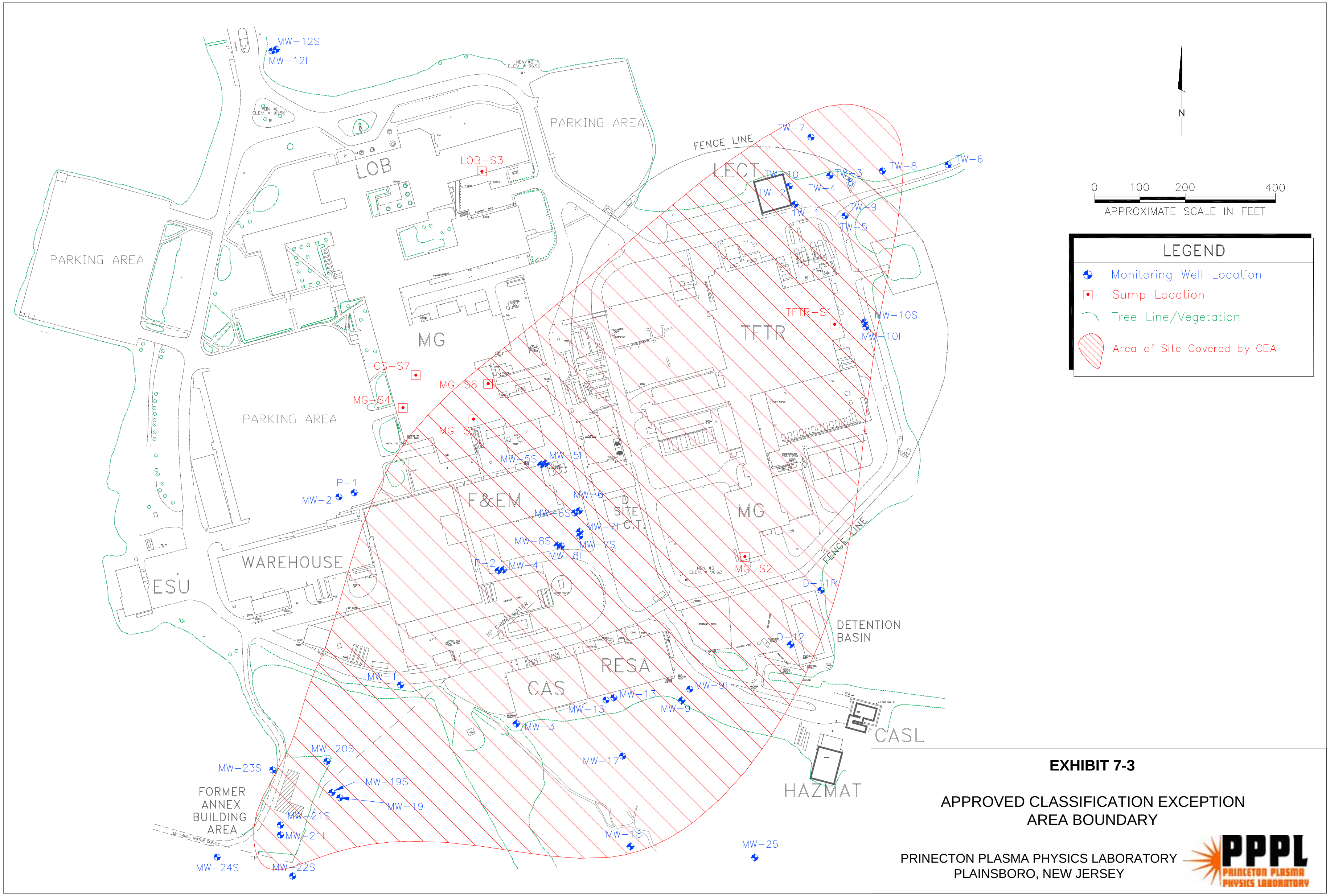



**EXHIBIT 7-3**

APPROVED CLASSIFICATION EXCEPTION AREA BOUNDARY

PRINCETON PLASMA PHYSICS LABORATORY
PLAINSBORO, NEW JERSEY

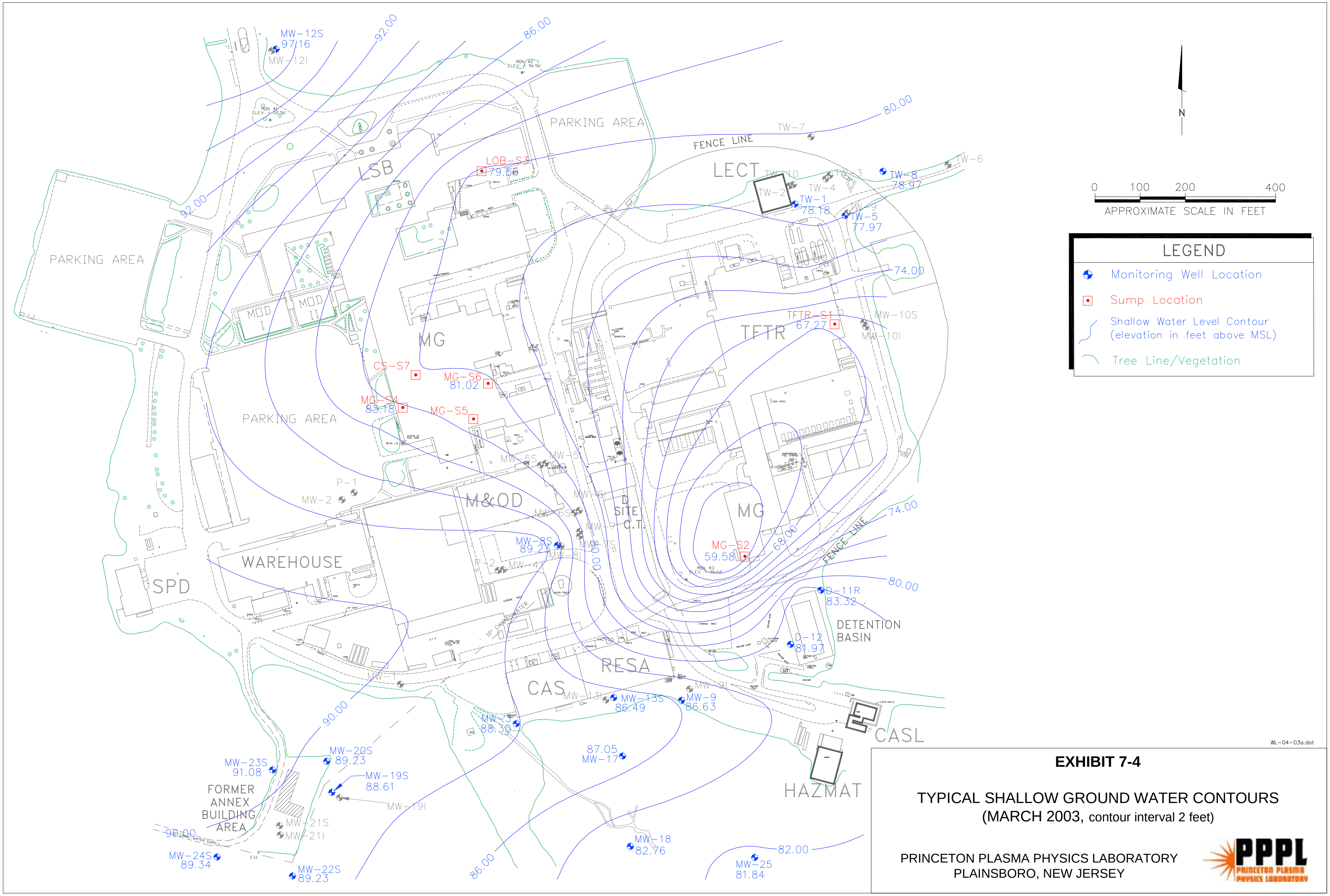



**EXHIBIT 7-4**

TYPICAL SHALLOW GROUND WATER CONTOURS
(MARCH 2003, contour interval 2 feet)

PRINCETON PLASMA PHYSICS LABORATORY
PLAINSBORO, NEW JERSEY

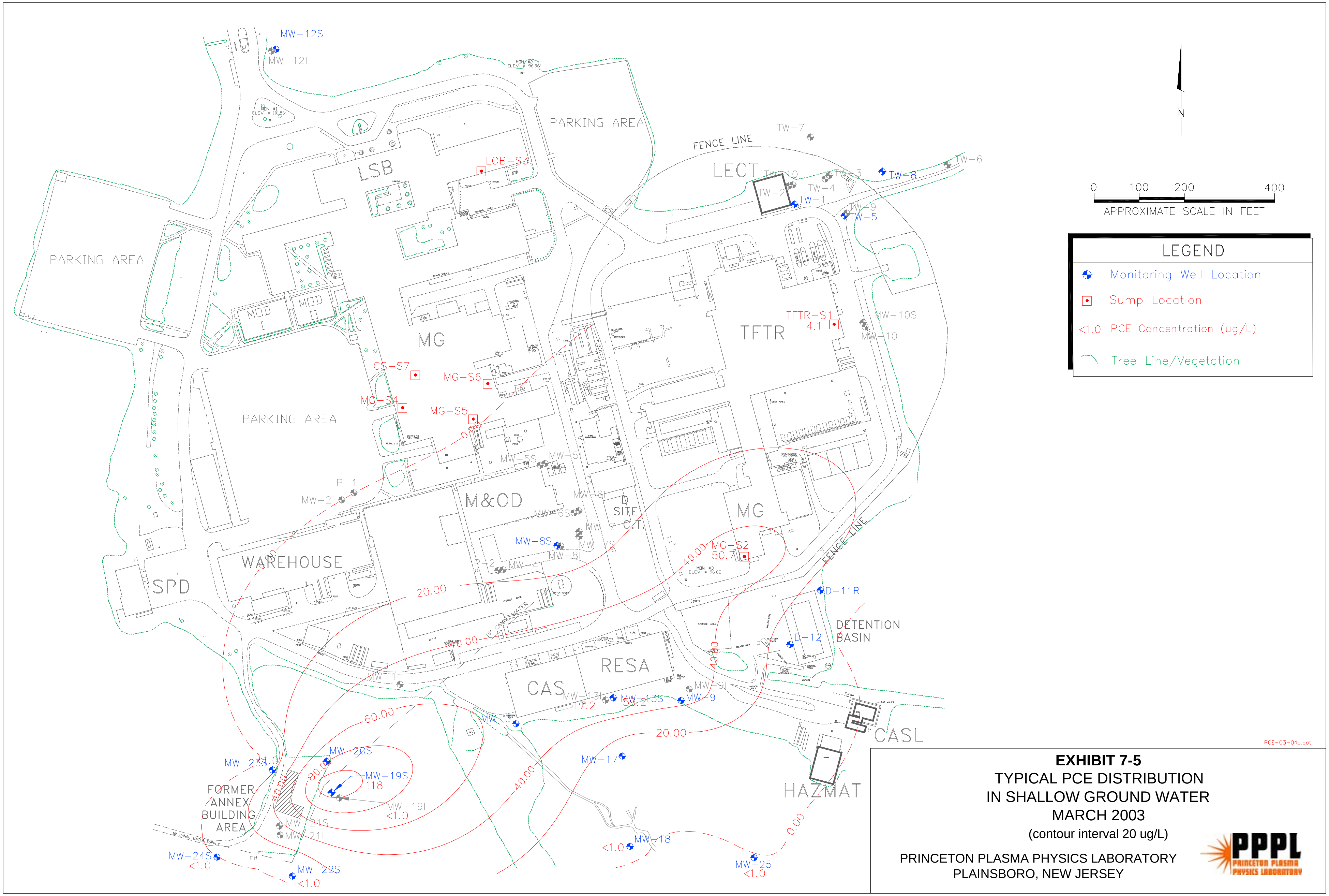



**EXHIBIT 7-5**
TYPICAL PCE DISTRIBUTION
IN SHALLOW GROUND WATER
MARCH 2003
(contour interval 20 ug/L)

PRINCETON PLASMA PHYSICS LABORATORY
PLAINSBORO, NEW JERSEY

Chapter
8

## QUALITY ASSURANCE

In 2002 and 2003, analyses of environmental samples for radioactivity and other parameters were conducted by PPPL's on-site analytical laboratory (Exhibits 8-1 and 8-2).

**Exhibit 8-1.**
**PPPL Technician analyzing Chemical Oxygen Demand samples at PEARL facility**

The PEARL procedures follow the DOE's Environmental Measurements Laboratory's *EML HASL-300 Manual* [Vo82], EPA's *Methods and Guidance for Analysis of Water* [EPA99] *and Standard Methods of Water and Wastewater Analysis* [SM92] that are nationally recognized standards. PPPL's approved procedures are documented on Health Physics web page. [PPPL00e].

To maintain its radiological certification, PPPL participates in the DOE Environmental Monitoring Laboratory (EML) program and New Jersey Department of Environmental Protection (NJDEP) Laboratory Certification program. For non-radiological parameters, PPPL participates in NJDEP Laboratory Certification program (NJ ID #12471).

A requirement of the certification program is to analyze within the acceptance range the quality control (QC) and proficiency test (PT) samples that are purchased from outside laboratory suppliers. These PT samples are provided as blind samples for analysis; the test results are submitted prior to the end of the study.

**Exhibit 8-2.**
**PPPL Technician analyzing samples for tritium at PEARL facility**

Results are supplied to PPPL and NJDEP to confirm a laboratories' ability to correctly analyze those parameters being tested [see App. A, Table 40]. In 2003, PEARL dropped its certification for Orthophosphate, Nitrate-nitrogen, and Turbidity as PPPL has no requirements to analyze for these parameters.

Beginning in 1984, PPPL participated in a NJDEP certification program initially through the USEPA Quality Assurance (QA) program. In March 1986, EPA/Las Vegas and NJDEP reviewed PPPL's procedures and inspected its facilities. The laboratory became certified for tritium analysis in urine (bioassays) and water. In 2001, USEPA turned the QA program over to the states; NJDEP chose a contractor laboratory, ERA, to supply the radiological proficiency tests. Results in Appendix A, Tables 40 & 41, show that PEARL's results were in the acceptable range.

In 2002 and 2003, PEARL performed EML semi-annual performance evaluation tests for radionuclides in water. PEARL results were close to EML's test results for tritium (though the results were not reported). Gamma spectroscopy instruments were operational in 2002 and 2003.

PPPL followed its internal procedures, EM-OP-31—"Surface Water Sampling Procedure," and EM-OP-38—"Ground Water Sampling Procedures." These procedures provide detailed descriptions of all NJPDES permit-required sampling and analytical methods for collection of samples, analyses of these samples, and quality assurance/quality control requirements. Chain-of-custody forms are required for all samples; holding times are closely checked to ensure that analyses are performed within established holding times and that the data is valid; trip blanks are required for all organic compound analyses.

Subcontractor laboratories used by PPPL are certified by NJDEP and participate in the state's QA program; the subcontractor laboratories must also follow their own internal quality assurance plans.

# Chapter 9

## ACKNOWLEDGMENTS

*ES&H and Infrastructure Support Department*:

- Jack Anderson - review and comments on this report
- Jim Graham - providing web site assistance
- Margaret Kevin-King - fertilizer, herbicide, and pesticide data and the recycling data
- Charlie Kircher - fuel consumption data and on-site water-utilization
- Jerry Levine - NEPA data, safety statistics, and dose calculations

*Materiel & Environmental Services Division*:

- John Bennevich – rainwater collection and supplying many photos
- Tom McGeachen -SPCC, Earth Day, and pollution prevention data
- Maria Pueyo - TSCA data, hazardous and radiological waste data
- Keith Rule – OSHA Inspection Summary
- Rob Sheneman - ground water data, review and comments on this report

*Drexel University Co-operative Students*:

- Jennifer Mkywawa – surface and ground water sampling and data table generation.

*Health Physics Branch*:

- George Ascione - radiological and calibration data
- Keith Case – meteorological data
- Carl Szathmary - in-house radiochemical and water analyses

*Quality Assurance Division*:

- Lynne Yager - OSHA Statistics

*Site Protection Division:*

- Bill Slavin - SARA Title III and Toxic Release Inventory information

*Information Services Division*:

Elle Starkman - Photos of NSTX, PBX-M, and Earth Day Poster
Patti Wieser – Earth Day articles

This work is supported by the U.S. Department of Energy Contract No. DE-AC02-76CHO3073.

Chapter

10

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Appendix
A

## TABLES

## Table 1. PPPL Radiological Design Objectives and Regulatory Limits[a]

| CONDITION | | PUBLIC | EXPOSURE[b] | OCCUPA-TIONAL | EXPOSURE |
|---|---|---|---|---|---|
| | | REGULATORY LIMIT | DESIGN OBJECTIVE | REGULATORY LIMIT | DESIGN OBJECTIVE |
| ROUTINE OPERATION<br><br>Dose equivalent to an individual from routine operations (rem per year, unless otherwise indicated) | NORMAL OPERATIONS | 0.1 Total, 0.01[c] Airborne, 0.004 Drinking Water | 0.01 Total | 5 | 1 |
| | ANTICIPATED EVENTS $(1 > P \geq 10^{-2})$ | 0.5 Total (including normal operation) | 0.05 per event | | |
| ACCIDENTS<br><br>Dose equivalent to an individual from an accidental release (rem per event) | UNLIKELY EVENTS $10^{-2} > P \geq 10^{-4}$ | 2.5 | 0.5 | (e) | (e) |
| | EXTREMELY UNLIKELY EVENTS $10^{-4} > P \geq 10^{-6}$ | 25 | 5[d] | (e) | (e) |
| | INCREDIBLE EVENTS $10^{-6} > P$ | NA | NA | NA | NA |

*P = Probability of occurrence in a year.*

(a) All operations must be planned to incorporate radiation safety guidelines, practices and procedures included in PPPL ESHD 5008, Section 10.

(b) Evaluated at PPPL site boundary.

(c) Compliance with this limit is to be determined by calculating the highest effective dose equivalent to any member of the public at any offsite point where there is a residence, school, business or office

(d) For design basis accidents (DBAs), i.e., postulated accidents or natural forces and resulting conditions for which the confinement structure, systems, components and equipment must meet their functional goals, the design objective is 0.5 rem.

(e) See PPPL ESHD-5008, Section 10, Chapter 10.1302 for emergency personnel exposure limits.

**Table 2. Annual Precipitation Data for 2002**

| START DATE | WEEK | INCH | INCH/MONTH | MONTH | ACCUMLATION |
|---|---|---|---|---|---|
| **1-Jan-02** | **1** | 0.000 | | | 0.000 |
| **7-Jan-02** | **2** | 1.525 | | | 1.525 |
| **14-Jan-02** | **3** | 0.400 | | | 1.925 |
| **21-Jan-02** | **4** | 0.475 | | | 2.400 |
| **28-Jan-02** | **5** | 0.550 | **2.9500** | **January** | 2.950 |
| **4-Feb-02** | **6** | 0.350 | | | 3.300 |
| **11-Feb-02** | **7** | 0.000 | | | 3.300 |
| **18-Feb-02** | **8** | 0.075 | | | 3.375 |
| **25-Feb-02** | **9** | 1.050 | **1.475** | **February** | 4.425 |
| **4-Mar-02** | **10** | 0.200 | | | 4.625 |
| **11-Mar-02** | **11** | 1.175 | | | 5.800 |
| **18-Mar-02** | **12** | 1.250 | | | 7.050 |
| **25-Mar-02** | **13** | 1.050 | **3.675** | **March** | 8.100 |
| **1-Apr-02** | **14** | 0. 000 | | | 8.100 |
| **8-Apr-02** | **15** | 0.200 | | | 8.300 |
| **15-Apr-02** | **16** | 0.300 | | | 8.600 |
| **22-Apr-02** | **17** | 2.250 | | | 10.850 |
| **29-Apr-02** | **18** | 1.150 | **3.9000** | **April** | 12.000 |
| **6-May-02** | **19** | 1.1000 | | | 13.100 |
| **13-May-02** | **20** | 2.075 | | | 15.175 |
| **20-May-02** | **21** | 0.075 | | | 15.250 |
| **27-May-02** | **22** | 0.250 | **3.500** | **May** | 15.500 |
| **3-Jun-02** | **23** | 1.950 | | | 17.450 |
| **10-Jun-02** | **24** | 1.990 | | | 19.440 |
| **17-Jun-02** | **25** | 0.175 | | | 19.615 |
| **24-Jun-02** | **26** | 0.700 | **4.815** | **June** | 20.315 |
| **1-Jul-02** | **27** | 0.000 | | | 20.315 |
| **8-Jul-02** | **28** | 0.050 | | | 20.365 |
| **15-Jul-02** | **29** | 1.650 | | | 22.015 |
| **22-Jul-02** | **30** | 0.000 | | | 22.015 |
| **29-Jul-02** | **31** | 1.100 | **2.800** | **July** | 23.115 |
| **5-Aug-02** | **32** | 1.250 | | | 24.365 |
| **12-Aug-02** | **33** | 0.000 | | | 24.365 |
| **19-Aug-02** | **34** | 0.900 | | | 25.265 |
| **26-Aug-02** | **35** | 3.800 | **5.950** | **August** | 29.065 |
| **2-Sep-02** | **36** | 0.000 | | | 29.065 |
| **9-Sep-02** | **37** | 0.700 | | | 29.765 |
| **16-Sep-02** | **38** | 0. 000 | | | 29.765 |
| **23-Sep-02** | **39** | 2.100 | | | 31.865 |
| **30-Sep-02** | **40** | 0.0750 | **2.875** | **September** | 31.940 |
| **7-Oct-02** | **41** | 3.400 | | | 35.340 |
| **14-Oct-02** | **42** | 0.700 | | | 36.040 |
| **21-Oct-02** | **43** | 1.450 | | | 37.490 |
| **28-Oct-02** | **44** | 0.475 | **6.025** | **October** | 37.965 |
| **4-Nov-02** | **45** | 0.800 | | | 38.765 |
| **11-Nov-02** | **46** | 2.750 | | | 41.515 |
| **18-Nov-02** | **47** | 0.550 | | | 42.065 |
| **25-Nov-02** | **48** | 0.350 | **4.450** | **November** | 42.415 |
| **2-Dec-02** | **49** | 0.505 | | | 42.920 |
| **9-Dec-02** | **50** | 1.850 | | | 44.770 |
| **16-Dec-02** | **51** | 0.650 | | | 45.420 |
| **23-Dec-02** | **52** | 1.250 | | | 46.670 |
| **30-Dec-02** | **53** | 1.250 | **5.505** | **December** | **47.920** |

**Table 3. Annual Precipitation Data for 2003**

| START DATE | WEEK | INCH | INCH/MONTH | MONTH | ACCUMLATION |
|---|---|---|---|---|---|
| **1-Jan-03** | **1** | 0.150 | | | 0.150 |
| **6-Jan-03** | **2** | 0.100 | | | 0.250 |
| **13-Jan-03** | **3** | 0.050 | | | 0.300 |
| **20-Jan-03** | **4** | 0.000 | | | 0.300 |
| **27-Jan-03** | **5** | 0.100 | **0.400** | **January** | 0.400 |
| **3-Feb-03** | **6** | 0.700 | | | 1.100 |
| **10-Feb-03** | **7** | 0.700 | | | 1.800 |
| **17-Feb-03** | **8** | 2.350 | | | 4.150 |
| **24-Feb-03** | **9** | 0.900 | **4.650** | **February** | 5.050 |
| **3-Mar-03** | **10** | 1.100 | | | 6.150 |
| **10-Mar-03** | **11** | 0.050 | | | 6.200 |
| **17-Mar-03** | **12** | 1.650 | | | 7.850 |
| **24-Mar-03** | **13** | 0.855 | | | 8.705 |
| **31-Mar-03** | **14** | 0. 000 | **3.655** | **March** | 8.705 |
| **8-Apr-03** | **15** | 1.900 | | | 10.605 |
| **14-Apr-03** | **16** | 0.000 | | | 10.605 |
| **21-Apr-03** | **17** | 0.350 | | | 10.955 |
| **28-Apr-03** | **18** | 0.450 | **2.700** | **April** | 11.405 |
| **5-May-03** | **19** | 0.450 | | | 11.855 |
| **12-May-03** | **20** | 0.600 | | | 12.455 |
| **19-May-03** | **21** | 3.250 | | | 15.705 |
| **26-May-03** | **22** | 3.150 | **7.450** | **May** | 18.855 |
| **2-Jun-03** | **23** | 0.000 | | | 18.855 |
| **9-Jun-03** | **24** | 1.650 | | | 20.505 |
| **16-Jun-03** | **25** | 2.300 | | | 22.805 |
| **23-Jun-03** | **26** | 0.000 | | | 22.805 |
| **30-Jun-03** | **27** | 0.150 | **4.100** | **June** | 22.955 |
| **7-Jul-03** | **28** | 0.000 | | | 22.955 |
| **14-Jul-03** | **29** | 2.100 | | | 25.055 |
| **21-Jul-03** | **30** | 1.700 | | | 26.755 |
| **28-Jul-03** | **31** | 0.450 | **4.250** | **July** | 27.205 |
| **4-Aug-03** | **32** | 4.150 | | | 31.355 |
| **11-Aug-03** | **33** | 0.250 | | | 31.605 |
| **18-Aug-03** | **34** | 0.000 | | | 31.605 |
| **25-Aug-03** | **35** | 0.900 | **5.300** | **August** | 32.505 |
| **1-Sep-03** | **36** | 0.750 | | | 33.255 |
| **8-Sep-03** | **37** | 1.750 | | | 35.005 |
| **15-Sep-03** | **38** | 1.750 | | | 36.755 |
| **23-Sep-03** | **39** | 1.800 | | | 38.555 |
| **29-Sep-03** | **40** | 0.000 | **6.050** | **September** | 38.555 |
| **6-Oct-03** | **41** | 0.000 | | | 38.555 |
| **13-Oct-03** | **42** | 1.500 | | | 40.055 |
| **20-Oct-03** | **43** | 1.950 | | | 42.005 |
| **27-Oct-03** | **44** | 1.300 | **4.750** | **October** | 43.305 |
| **3-Nov-03** | **45** | 1.775 | | | 45.080 |
| **10-Nov-03** | **46** | 0.400 | | | 45.480 |
| **17-Nov-03** | **47** | 2.350 | | | 47.830 |
| **24-Nov-03** | **48** | 0.850 | **5.375** | **November** | 48.680 |
| **1-Dec-03** | **49** | 0.600 | | | 49.280 |
| **8-Dec-03** | **50** | 3.450 | | | 52.730 |
| **15-Dec-03** | **51** | 0.4650 | | | 53.180 |
| **22-Dec-03** | **52** | 1.550 | | | 54.730 |
| **29-Dec-03** | **53** | 0.000 | **6.050** | **December** | **54.730** |

**Table 4. D–Site Tritium Stack Releases in Curies in 2002**

| Week Ending | HTO (Ci) | HT (Ci) | Weekly total (Ci) | Month | Annual Total (Ci) |
|---|---|---|---|---|---|
| Baseline 1/2/02 | 0 | 0 | 0 | 0 | **0** |
| 9-Jan-02 | 3.64 | 0.175 | 3.815 | | 3.815 |
| 16-Jan-02 | 4.45 | 0.152 | 4.602 | | 8.417 |
| 23-Jan-02 | 3.39 | 1.87 | 5.26 | | 13.677 |
| 30-Jan-02 | 7.56 | 0.191 | 7.751 | **January** | 21.428 |
| 6-Feb-02 | 4.53 | 0.26 | 4.79 | | 26.218 |
| 13-Feb-02 | 6.65 | 0.105 | 6.755 | | 32.973 |
| 20-Feb-02 | 1.76 | 0.065 | 1.825 | | 34.798 |
| 27-Feb-02 | 4.74 | 0.068 | 4.808 | **February** | 39.606 |
| 6-Mar-02 | 4.6 | 1.27 | 5.87 | | 45.476 |
| 13-Mar-02 | 2.38 | 0.15 | 2.53 | | 48.006 |
| 20-Mar-02 | 1.89 | 0.078 | 1.968 | | 49.974 |
| 27-Mar-02 | 1.9 | 0.069 | 1.969 | **March** | 51.943 |
| 3-Apr-02 | 1.1 | 3.29 | 4.39 | | 56.333 |
| 10-Apr-02 | 0.71 | 0.653 | 1.363 | | 57.696 |
| 17-Apr-02 | 1.005 | 0.021 | 1.026 | | 58.722 |
| 24-Apr-02 | 3.24 | 2.19 | 5.43 | | 64.152 |
| 1-May-02 | 0.872 | 0.026 | 0.898 | **April** | 65.05 |
| 8-May-02 | 1.5 | 0.203 | 1.703 | | 66.753 |
| 15-May-02 | 1.13 | 0.051 | 1.181 | | 67.934 |
| 22-May-02 | 0.846 | 0.045 | 0.891 | | 68.825 |
| 29-May-02 | 0.834 | 0.025 | 0.859 | **May** | 69.684 |
| 5-Jun-02 | 0.864 | 0.039 | 0.903 | | 70.588 |
| 12-Jun-02 | 0.932 | 0.045 | 0.977 | | 71.564 |
| 19-Jun-02 | 1.22 | 0.059 | 1.279 | | 72.843 |
| 26-Jun-02 | 0.943 | 0.002 | 0.945 | **June** | 73.788 |
| 3-Jul-02 | 0.439 | 0.034 | 0.473 | | 74.261 |
| 10-Jul-02 | 0.439 | 0.034 | 0.473 | | 74.734 |
| 17-Jul-02 | 0.423 | 0.028 | 0.451 | | 75.185 |
| 24-Jul-02 | 0.191 | 0.011 | 0.202 | | 75.388 |
| 31-Jul-02 | 0.008 | 0.001 | 0.009 | **July** | 75.396 |
| 7-Aug-02 | 0.069 | 0.019 | 0.088 | | 75.484 |
| 14-Aug-02 | 0.166 | 0.013 | 0.179 | | 75.663 |
| 21-Aug-02 | 0.011 | 0 | 0.011 | | 75.674 |
| 28-Aug-02 | 0.655 | 0.055 | 0.71 | **August** | 76.384 |
| 4-Sep-02 | 2.16 | 0.06 | 2.22 | | 78.604 |
| 11-Sep-02 | 1.16 | 0.059 | 1.219 | | 79.823 |
| 18-Sep-02 | 4.43 | 1.41 | 5.84 | | 85.663 |
| 25-Sep-02 | 1.36 | 0.067 | 1.427 | | 87.09 |
| 2-Oct-02 | 0.962 | 0.061 | 1.023 | **September** | 88.112 |
| 9-Oct-02 | 1.36 | 0.076 | 1.436 | | 89.548 |
| 16-Oct-02 | 1.62 | 0.056 | 1.676 | | 91.225 |
| 23-Oct-02 | 1.19 | 0.067 | 1.257 | | 92.482 |
| 30-Oct-02 | 1.04 | 0.036 | 1.076 | **October** | 93.558 |
| 6-Nov-02 | 0.904 | 0.056 | 0.96 | | 94.518 |
| 13-Nov-02 | 0.579 | 0.028 | 0.607 | | 95.125 |
| 20-Nov-02 | 8.21 | 0.284 | 8.494 | | 103.619 |
| 27-Nov-02 | 1.57 | 0.037 | 1.607 | **November** | 105.226 |
| 4-Dec-02 | 0.978 | 0.04 | 1.018 | | 106.244 |
| 11-Dec-02 | 0.964 | 0.031 | 0.995 | | 107.239 |
| 18-Dec-02 | 1.09 | 0.038 | 1.128 | | 108.367 |
| 27-Dec-02 | 1.13 | 0.035 | 1.165 | | 109.533 |
| 2-Jan-03 | 0.701 | 0.022 | 0.723 | **December** | 110.256 |
| | 96.495 | 13.76 | 110.256 | **Total 2002** | **110.256** |

## Table 5. D–Site Tritium Stack Releases in Curies in 2003

| Week Ending | HTO (Ci) | HT (Ci) | Weekly total (Ci) | Month | Annual Total (Ci) |
|---|---|---|---|---|---|
| Baseline 1/2/02 | 0 | 0 | 0 | 0 | 0 |
| 8-Jan-03 | 0.689 | 0.022 | 0.711 | | 0.711 |
| 15-Jan-03 | 1.32 | 0.056 | 1.376 | | 2.087 |
| 22-Jan-03 | 1.14 | 0.051 | 1.191 | | 3.277 |
| 29-Jan-03 | 0.937 | 0.055 | 0.992 | **January** | 4.269 |
| 5-Feb-03 | 0.825 | 0.033 | 0.858 | | 5.127 |
| 12-Feb-03 | 1.12 | 0.042 | 1.162 | | 6.289 |
| 19-Feb-03 | 0.636 | 0.051 | 0.687 | | 6.977 |
| 26-Feb-03 | 0.748 | 0.036 | 0.784 | **February** | 7.761 |
| 5-Mar-03 | 0.702 | 0.03 | 0.732 | | 8.493 |
| 12-Mar-03 | 0.755 | 0.04 | 0.795 | | 9.288 |
| 19-Mar-03 | 0.745 | 0.021 | 0.766 | | 10.054 |
| 26-Mar-03 | 0.727 | 0.137 | 0.864 | **March** | 10.918 |
| 2-Apr-03 | 0.921 | 0.055 | 0.976 | | 11.894 |
| 9-Apr-03 | 0.975 | 0.048 | 1.023 | | 12.917 |
| 16-Apr-03 | 0.891 | 0.019 | 0.91 | | 13.827 |
| 23-Apr-03 | 0.893 | 0.041 | 0.934 | | 14.761 |
| 30-Apr-03 | 0.889 | 0.009 | 0.898 | **April** | 15.659 |
| 7-May-03 | 1.17 | 0.055 | 1.225 | | 16.884 |
| 14-May-03 | 1.22 | 0.036 | 1.256 | | 18.14 |
| 21-May-03 | 1.07 | 0.035 | 1.105 | | 19.245 |
| 28-May-03 | 1.1 | 0.033 | 1.133 | **May** | 20.378 |
| 4-Jun-03 | 0.998 | 0.032 | 1.03 | | 21.408 |
| 11-Jun-03 | 1.13 | 0.028 | 1.158 | | 22.566 |
| 18-Jun-03 | 0.492 | 0.051 | 0.543 | | 23.109 |
| 25-Jun-03 | 0.62 | 0.017 | 0.637 | **June** | 23.746 |
| 2-Jul-03 | 0.617 | 0.029 | 0.646 | | 24.392 |
| 9-Jul-03 | 0.704 | 0.021 | 0.725 | | 25.117 |
| 16-Jul-03 | 0.674 | 0.03 | 0.704 | | 25.821 |
| 23-Jul-03 | 0.8 | 0.029 | 0.829 | | 26.65 |
| 29-Jul-03 | 0.85 | 0.03 | 0.88 | **July** | 27.53 |
| 6-Aug-03 | 0.78 | 0.024 | 0.804 | | 28.334 |
| 13-Aug-03 | 0.237 | 0.008 | 0.245 | | 28.579 |
| 20-Aug-03 | 0.265 | 0.006 | 0.271 | | 28.85 |
| 27-Aug-03 | 0.441 | 0.029 | 0.47 | **August** | 29.32 |
| 3-Sep-03 | 0.486 | 0.033 | 0.519 | | 29.839 |
| 10-Sep-03 | 0.366 | 0.026 | 0.392 | | 30.231 |
| 17-Sep-03 | 0.56 | 0.041 | 0.601 | | 30.832 |
| 24-Sep-03 | 0.563 | 0.058 | 0.621 | | 31.453 |
| 1-Oct-03 | 0.748 | 0.041 | 0.789 | **September** | 32.242 |
| 8-Oct-03 | 0.731 | 0.043 | 0.774 | | 33.016 |
| 15-Oct-03 | 0.768 | 0.028 | 0.796 | | 33.812 |
| 22-Oct-03 | 0.205 | 0.072 | 0.277 | | 34.089 |
| 29-Oct-03 | 0.031 | 0.001 | 0.032 | **October** | 34.121 |
| 5-Nov-03 | 0.266 | 0.037 | 0.303 | | 34.424 |
| 12-Nov-03 | 0.235 | 0.011 | 0.246 | | 34.67 |
| 19-Nov-03 | 0.183 | 0.049 | 0.232 | | 34.902 |
| 25-Nov-03 | 0.18 | 0.006 | 0.186 | **November** | 35.088 |
| 3-Dec-03 | 0.222 | 0.041 | 0.263 | | 35.351 |
| 10-Dec-03 | 0.22 | 0.009 | 0.229 | | 35.58 |
| 17-Dec-03 | 0.188 | 0.026 | 0.214 | | 35.794 |
| 23-Dec-03 | 0.133 | 0.005 | 0.138 | | 35.932 |
| 30-Dec-03 | 0.163 | 0.023 | 0.186 | **December** | 36.118 |
| | **34.329** | **1.789** | **36.118** | **Total 2003** | |

**Table 6. Ranges of Air Tritium Concentrations (in pCi/m3) Collected On-Site (T1-T4) and Off-Site (R1-R6 & BM1) in 2002**

| Station | **HTO** pCi/m3 | **HT** pCi/m3 |
|---|---|---|
| T1 | 0.419- 14.1 | 0.419 - 16.9 |
| T2 | 0.678 - 105 | 0.816 - 167 |
| T3 | 1.82 - 118 | 1.82 - 270 |
| T4 | 0.122 - 22.8 | 0.122 - 42.1 |
| R1 | 0.00172 - 3.30 | 0.0176 - 2.66 |
| R2 | 0.0638 - 7.37 | 0.0899 - 12.8 |
| R3 | 0.0554 - 6.67 | 0.0554- 8.05 |
| R4 | 0.0834 - 11.4 | 0.0834 - 33.5 |
| R5 | 0.0696- 14.3 | 0.0696 - 57.7 |
| R6 | 0.259 - 13.3 | 0.423 - 18.4 |
| BM1 | 0.3 - 3.03 | 0.3 - 7.97 |

**Table 7. Ranges of Air Tritium Concentrations (in pCi/m3) Collected On-Site (T1-T4) and Off-Site (R1-R6 & BM1) in 2003**

| Station | **HTO** pCi/m3 **(Ci)** | **HT** pCi/m3 |
|---|---|---|
| T1 | 0.435 -9.76 | 0.454 - 7.22 |
| T2 | 0.532 - 15.4 | 0.829 - 15.4 |
| T3 | 0.223 - 20.5 | 0.136 - 28.4 |
| T4 | 0.224 - 10.6 | 0.224 - 15.9 |
| R1 | 0.13 - 4.01 | 0.117 - 15.1 |
| R2 | 0.0348 - 3.4 | 0.0492 - 3.03 |
| R3 | 0.148 - 4.02 | 0.148 - 5.73 |
| R4 | 0.296 - 4.55 | 0.296 - 6.33 |
| R5 | 0.19 - 4.59 | 0.36 - 8.4 |
| R6 | 0.0824 - 5.1 | 0.0985 - 3.19 |
| BM1 | 0.166 - 1.4 | 0.305 - 1.77 |

## Table 8. Surface Water Tritium Concentrations for 2002 (in picoCuries/Liter)

| Sample Location | Bee Brook (B1) | Bee Brook (B2) | PPPL Basin (DSN001) |
|---|---|---|---|
| January | | | 110 |
| February | 279 | 270 | **877** |
| March | | | **225** |
| April | | | **2090** |
| May | **127** | **145** | **274** |
| June | | | |
| July | | | |
| August | | | |
| September | | | **336** |
| October | | | **291** |
| November | <155 | 33 | **354** |
| December | | | **232** |

| Sample Location | D&R Canal (C1) | D&R Canal (DSN003) | Potable Water (E1) |
|---|---|---|---|
| January | | <130 | |
| February | <343 | <343 | 27 |
| March | | 64 | |
| April | | 20 | |
| May | <81 | 14 | |
| June | | <203 | |
| July | | <131 | |
| August | | | |
| September | | | |
| October | | 42 | |
| November | <155 | 32 | |
| December | | <104 | |

| Sample Location | Millstone River (M1) | Cranbury Brook (P1) | Devil's Brook (P2) |
|---|---|---|---|
| January | | | |
| February | <343 | <343 | 14 |
| March | | | |
| April | | | |
| May | 40 | 36 | 35 |
| June | | | |
| July | | | |
| August | | **170** | **165** |
| September | | | |
| October | | | |
| November | 20 | <155 | 15 |
| December | | | |

**BOLD** indicates above the level of detection.

**Table 9. Surface Water Tritium Concentrations for 2003 (in picoCuries/Liter)**

| Sample Location | Bee Brook (B1) | Bee Brook (B2) | PPPL Basin (DSN001) |
|---|---|---|---|
| January | | | **305** |
| February | 54 | **151** | **237** |
| March | | | **248** |
| April | | | |
| May | 23 | 86 | 159 |
| June | | | **265** |
| July | | | **179** |
| August | 32 | 32 | **186** |
| September | | | **451** |
| October | | | 117 |
| November | 50 | **149** | **257** |
| December | | | |

| Sample Location | D&R Canal (C1) | D&R Canal (DSN003) | Potable Water (E1) |
|---|---|---|---|
| January | | 35 | |
| February | 25 | 62 | 59 |
| March | | <116 | |
| April | | <142 | |
| May | 13 | 49 | <183 |
| June | | 46 | |
| July | | <117 | |
| August | <189 | <222 | <189 |
| September | | <222 | |
| October | | | |
| November | 14 | | <131 |
| December | | | |

| Sample Location | Millstone River (M1) | Cranbury Brook (P1) | Devil's Brook (P2) |
|---|---|---|---|
| January | | | |
| February | 40 | 62 | 71 |
| March | | | |
| April | | | |
| May | <183 | <183 | <183 |
| June | | | |
| July | | | |
| August | <189 | <189 | <189 |
| September | | | |
| October | | | |
| November | <131 | 32 | <131 |
| December | | | |

**BOLD** indicates above the level of detection.

**Table10. Ground Water Tritium Concentrations for 2002 (in picoCuries/liter)**

| Well No. or Sump Location | Well TW-1 | Well TW-5 | Well TW-8 | Well MW-12S | Well D-12 | Air Shaft Sump | D-site MG Sump |
|---|---|---|---|---|---|---|---|
| January | **210** | **115** | **479** | | | **214** | |
| February | | | | | | 180 | |
| March | | | | | | **296** | |
| April | **297** | **321** | **105** | 167 | 40 | **311** | **229** |
| May | | | | | | **350** | **273** |
| June | | | | | | <203 | <203 |
| July | | | | | | | |
| August | | | | | | **152** | |
| September | | | | | | **277** | |
| October | | | | | | **352** | |
| November | **159** | **161** | **144** | **145** | 98 | **355** | |
| December | **146** | **177** | **133** | 71 | 67 | **263** | |

**BOLD** indicates highest concentrations above background levels.

**Table 11. Ground Water Tritium Concentrations for 2003 (in picoCuries/liter)**

| Well No. or Sump Location | Well TW-1 | Well TW-5 | Well TW-8 | Well MW-12S | Well D-12 | Air Shaft Sump | D-site MG Sump |
|---|---|---|---|---|---|---|---|
| January | | | | | | **401** | |
| February | | | | | | **176** | |
| March | | | | | | **214** | |
| April | **489** | **479** | **487** | 26 | <142 | | |
| May | | | **397** | <139 | **378** | **244** | |
| June | **501** | **439** | **435** | 9 | <117 | **402** | |
| July | **499** | **364** | **337** | 44 | 18 | **212** | |
| August | **500** | **414** | **392** | 36 | 54 | **226** | |
| September | **374** | 189 | 221 | <222 | <222 | **225** | |
| October | **824** | **478** | **851** | **2225** | **1050** | **196** | |
| November | **275** | 50 | **158** | <122 | <112 | | |
| December | **579** | **299** | **355** | 42 | <113 | 81 | |

**BOLD** indicates highest concentrations above background levels.

## Table 12. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 2002

| 250 feet from Stack | R1E (East) | R1W (West) | R1S (South) | R1N (North) | R1ND (Duplicate) |
|---|---|---|---|---|---|
| March 18 | **2291** | **1397** | **3024** | **1693** | **1490** |
| April 29 | **398** | **1129** | **3921** | **673** | **457** |
| May 22 | **1752** | **373** | **2071** | **308** | **311** |
| July 22 | **1222** | 102 | **677** | **402** | **401** |
| September 06 | **637** | **133** | **2306** | **125** | **128** |
| October 16 | **412** | **283** | **1155** | **109** | **129** |
| November 12 | **708** | **206** | **624** | 89 | 56 |

| 500 feet from Stack | R2E (East) | R2W (West) | R2S (South) | R2N (North) | R3N (Far field) |
|---|---|---|---|---|---|
| March 18 | **1369** | **1201** | **1590** | **1216** | **270** |
| April 29 | **229** | **212** | **212** | **519** | |
| May 22 | **120** | **319** | **758** | **239** | |
| July 22 | **240** | <131 | <131 | **302** | |
| September 06 | **304** | **238** | **1369** | 57 | |
| October 16 | **179** | **783** | **644** | **403** | |
| November 12 | 82 | **255** | **389** | | |

**BOLD** indicates highest concentrations above background levels.

## Table 13. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 2002

| | REAM 1 | REAM 2 | REAM 4 | REAM 5 | REAM 6 | RW Baseline |
|---|---|---|---|---|---|---|
| January 14 | | | | | 27 | |
| January 24 | **347** | **328** | | 40 | 56 | |
| March 14 | 101 | **168** | | | | |
| March 21 | | **225** | **152** | 24 | | |
| April 30 | 86 | 48 | 43 | 48 | **113** | |
| May 24 | | 202 | <203 | 45 | | |
| May 29 | | | | | 149 | |
| June 11 | <203 | | | | | |
| June 12 | | | | <203 | | |
| September 10 | 64 | | | 72 | | |
| October 07 | | | 81 | 35 | | |
| October 17 | 59 | <215 | <215 | <215 | 67 | |
| November 14 | 82 | 28 | | 72 | 153 | |

## Table 14. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 2003

| 250 feet from Stack | R1E (East) | R1W (West) | R1S (South) | R1N (North) | R1ND (Duplicate) |
|---|---|---|---|---|---|
| March 18 | **980** | 24 | **968** | 70 | 5 |
| May 01 | **334** | **470** | **379** | **203** | **103** |
| June 02 | **860** | **437** | **502** | **259** | **265** |
| June 23 | | **564** | **127** | **241** | **368** |
| July 22 | **1040** | **279** | **527** | **276** | **250** |
| August 12 | **485** | | **127** | **653** | **619** |
| September 18 | **896** | **649** | **644** | **505** | **545** |
| October 24 | 45 | **514** | **383** | 86 | **320** |
| November 07 | **1104** | | | | |
| November 10 | | 58 | **525** | **472** | **434** |
| December 11 | **539** | **228** | **596** | **241** | **345** |

| 500 feet from Stack | R2E (East) | R2W (West) | R2S (South) | R2N (North) | R3N (Far field) |
|---|---|---|---|---|---|
| March 18 | | **243** | **555** | 93 | **270** |
| May 01 | 68 | **310** | **378** | 23 | |
| June 02 | | **593** | **328** | **245** | |
| June 23 | **144** | **632** | **282** | 88 | |
| July 22 | **224** | **186** | | **220** | |
| August 12 | **96** | **93** | 83 | **711** | |
| September 18 | **1126** | **996** | **568** | **194** | |
| October 24 | **806** | 144 | **369** | **604** | |
| November 07 | **329** | | | **487** | |
| November 10 | | **261** | **209** | | |
| December 11 | **137** | 3 | **120** | **138** | |

**BOLD** indicates highest concentrations above background levels.

**Table 15. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 2003**

| | REAM 1 | REAM 2 | REAM 4 | REAM 5 | REAM 6 | RW Baseline |
|---|---|---|---|---|---|---|
| March 18 | | <116 | | <116 | | |
| April 16 | | | | 54 | <142 | |
| June 05 | | | | 81 | 55 | |
| June 09 | | 41 | | | | |
| June 16 | 54 | | | 40 | | |
| June 23 | | 26 | | 12 | 50 | |
| July 21 | | | | <117 | | |
| July 28 | | | | 59 | | |
| August 06 | | 34 | | <189 | <189 | |
| August 07 | 28 | | | | | |
| August 13 | | | | <222 | | |
| September 05 | | <222 | 36 | 18 | 45 | |
| September 24 | 23 | <148 | | <148 | | |
| October 28 | | | <131 | <148 | 9 | |

**Table 16. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 2003**

| Year | Tritium Range picoCuries/Liter | Precipitation In Inches | Difference from Middlesex County Avg. Precipitation of 46.5 inches/yr |
|---|---|---|---|
| 1985 | 40 to 160 | | |
| 1986 | 40 to 140 | | |
| 1987 | 26 to 144 | | |
| 1988 | 34 to 105 | | |
| 1989 | 7 to 90 | 55.4 | +8.8 |
| 1990 | 14 to 94 | 50.3 | +3.8 |
| 1991 | 10 to 154 | 45.1 | -1.5 |
| 1992 | 10 to 838 | 41.9 | -4.6 |
| 1993 | 25 to 145 | 42.7 | -3.8 |
| 1994 | 32 to 1,130 | 51.3 | +4.8 |
| 1995 | <19 to 2,561 | 35.6 | -10.9 |
| 1996 | <100 to 21,140 | 61.0 | +14.5 |
| 1997 | 131 to 61,660 | 42.0 | -4.5 |
| 1998 | <108 to 26,450 | 42.9 | -3.6 |
| 1999 | <58 to 7,817 | 47.3<br>(38.7 w/out Floyd) | +0.8<br>(-7.8) |
| 2000 | <31 to 3,617 | 38.7 | -7.8 |
| 2001 | 153 to 14,830 | 32.8 | -13.7 |
| 2002 | 24 to 3,921 | 47.9 | +1.4 |
| 2003 | 9 to 1,126 | 54.7 | +8.2 |

### Table 17. Liquid Effluent Collection Tank Release Data for 2002

| Sample Date | Gallons Released | COD (mg/l) | Tritium Sample LLD (pCi/L) | Tritium Sample Activity (pCi/L) | Total Tank Activity (Ci) | Annual Cumulative Activity (Ci) | Gross Beta Sample LLD (pCi/L) | Gross Beta Sample Activity (pCi/L) |
|---|---|---|---|---|---|---|---|---|
| 2/8/2002 | 12,750 | 65.4 | 226 | 83,900 | 0.00405 | 0.00405 | 195 | <195 |
| 3/1/2002 | 10,500 | 30.1 | 236 | 44,100 | 0.00175 | 0.00580 | 194 | <194 |
| 4/11/2002 | 12,150 | 22.8 | 227 | 58,000 | 0.00267 | 0.00847 | 194 | <194 |
| 5/9/2002 | 12,450 | 7.2 | 195 | 329,000 | 0.01550 | 0.02400 | 194 | 1,120 |
| 6/10/2002 | 12,750 | 20.6 | 216 | 195,000 | 0.00941 | 0.03340 | 195 | 472 |
| 6/26/2002 | 12,750 | 51.4 | 192 | 204,000 | 0.00985 | 0.04330 | 194 | 472 |
| 7/5/2002 | 12,750 | 68.8 | 195 | 144,000 | 0.00695 | 0.05020 | 195 | <195 |
| 7/22/2002 | 11,550 | 207.5 | 192 | 618,000 | 0.02700 | 0.07720 | 195 | 2,130 |
| 7/30/2002 | 10,800 | 63.8 | 211 | 1,540,000 | 0.06300 | 0.14000 | 194 | 6,080 |
| 8/5/2002 | 10,800 | 59.6 | 218 | 1,080,000 | 0.04400 | 0.18400 | 195 | 3,900 |
| 8/19/2002 | 12,150 | 52.4 | 185 | 1,280,000 | 0.05910 | 0.24300 | 195 | 2,300 |
| 8/26/2002 | 11,250 | 24.3 | 199 | 1,040,000 | 0.04440 | 0.28800 | 195 | 1,600 |
| 9/4/2002 | 12,300 | 35.0 | 195 | 1,460,000 | 0.06780 | 0.35600 | 194 | 5,080 |
| 9/19/2002 | 12,300 | 53.6 | 206 | 1,150,000 | 0.05370 | 0.40900 | 195 | 3,900 |
| 10/9/2002 | 12,750 | 63.9 | 209 | 650,000 | 0.03140 | 0.44100 | 194 | 1,240 |
| 10/28/2002 | 10,200 | 78.5 | 228 | 312,000 | 0.01200 | 0.45300 | 194 | 649 |
| Total Gallons | 190,200 | | | | | | | |

### Table 18. Liquid Effluent Collection Tank Release Data for 2003

| Sample Date | Gallons Released | COD (mg/l) | Tritium Sample LLD (pCi/L) | Tritium Sample Activity (pCi/L) | Total Tank Activity (Ci) | Annual Cumulative Activity (Ci) | Gross Beta Sample LLD (pCi/L) | Gross Beta Sample Activity (pCi/L) |
|---|---|---|---|---|---|---|---|---|
| 1/22/2003 | 11,250 | 57.5 | 185 | 104,000 | 0.004440 | 0.00444 | 194 | <194 |
| 3/21/2003 | 14,850 | 31.6 | 199 | 36,800 | 0.002070 | 0.00650 | 195 | <195 |
| 4/9/2003 | 3,000 | 21.8 | 190 | 48,400 | 0.000549 | 0.00705 | 194 | <194 |
| 5/13/2003 | 10,350 | 2,551.6 | 188 | 54,700 | 0.002140 | 0.00920 | 195 | <195 |
| 5/13/2003 | 12,000 | 6.5 | 183 | 64,200 | 0.002920 | 0.01210 | 194 | <194 |
| 6/30/2003 | 12,000 | 18.5 | 180 | 48,600 | 0.002210 | 0.01430 | 195 | <195 |
| 7/11/2003 | 12,000 | 69.3 | 187 | 36,100 | 0.001640 | 0.01600 | 195 | <195 |
| 7/24/2003 | 12,000 | 21.4 | 181 | 31,800 | 0.001440 | 0.01740 | 194 | <194 |
| 8/1/2003 | 12,000 | 14.8 | 180 | 32,300 | 0.001470 | 0.01890 | 194 | <194 |
| 8/12/2003 | 12,000 | 51.4 | 193 | 30,700 | 0.001390 | 0.02030 | 194 | <194 |
| 8/15/2003 | 12,000 | 52.6 | 182 | 29,900 | 0.001360 | 0.02160 | 194 | <194 |
| 8/21/2003 | 12,000 | 0.0 | 196 | 29,100 | 0.001320 | 0.02290 | 195 | <195 |
| 9/3/2003 | 12,000 | 18.8 | 191 | 18,400 | 0.000836 | 0.02380 | 195 | <195 |
| 9/9/2003 | 12,000 | 6.0 | 217 | 17,200 | 0.000783 | 0.02460 | 195 | <195 |
| 9/23/2003 | 12,000 | 3.5 | 205 | 14,000 | 0.000635 | 0.02520 | 195 | <195 |
| 10/16/2003 | 12,000 | 8.3 | 202 | 69,600 | 0.003160 | 0.02840 | 195 | <195 |
| 11/19/2003 | 12,000 | - | 178 | 53,000 | 0.002410 | 0.03080 | 195 | <195 |
| 11/21/2003 | 12,000 | 168.7 | 193 | 17,200 | 0.000781 | 0.03150 | 195 | <195 |
| 12/2/2003 | 9,870 | 28.6 | 199 | 7,030 | 0.000263 | 0.03180 | 195 | <195 |
| Total Gallons | 217,320 | | | | | | | |

### Table 19. Surface Water Analysis for Bee Brook, B1, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | <0.10 | | |
| Chemical Oxygen Demand, mg/L | <5.0 | 14.354 | <5.0 | 9.49 |
| Oxidation-Reduction Potential, mV | -28 | 76 | 11 | 53 |
| pH, standard units | 6.75 | 5.63 | 6.90 | 6.10 |
| Phosphorus, total, mg/L | 0.334 | <0.0500 | 0.199 | 0.096 |
| Temperature, °C | 2.90 | 13.6 | 18.8 | 7.7 |
| Total Suspended Solids, mg/L | 58.00 | 22.00 | 3.00 | 2.00 |
| Total Organic Carbon | | | 6.24 | |

*Location B1 = Bee Brook upsteam of PPPL basin discharge*
*See Exhibit 4-3 for location.*

### Table 20. Surface Water Analysis for Bee Brook, B2, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | <0.10 | | |
| Chemical Oxygen Demand, mg/L | <5.0 | 5.32 | 5.214 | 10.443 |
| Oxidation-Reduction Potential, mV | -28 | 50 | 76 | 44 |
| pH, standard units | 7.53 | 6.10 | 8.44 | 6.25 |
| Phosphorus, total, mg/L | 0.267 | 0.074 | 0.321 | 0.079 |
| Temperature, °C | 6.70 | 19.4 | 19.7 | 8.6 |
| Total Suspended Solids, mg/L | 5.00 | 3.00 | 8.00 | 3.00 |
| Total Organic Carbon | | | 3.32 | |

*Location B2 = Bee Brook downstream of PPPL basin discharge*

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### Table 21. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02 |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.150 | | |
| Chemical Oxygen Demand, mg/L | <5.00 | <5.00 | <5.00 | |
| Oxidation-Reduction Potential, mV | 29 | 29 | -9 | 7.0 |
| pH, standard units | 6.49 | 6.67 | 7.23 | 6.92 |
| Phosphorus, total, mg/L | 0.082 | 0.083 | 0.119 | 0.070<br>0.062 |
| Temperature, °C | 4.80 | 16.0 | 27.8 | 7.4 |
| Total Suspended Solids, mg/L | 5.00 | 4.00 | 3.00 | 2.00<br><2.00 |
| Total Organic Carbon | | | 3.69 | |
| Chlorine Produced Oxidants | | 0.23 | | |

*Location C1 = Delaware & Raritan Canal State Park at Mapleton Avenue, Plainsboro midway on pedestrian bridge*
*See Exhibit 4-3 for location.*

## Table 22. Surface Water Analysis for Millstone River, M1, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.360 | | |
| Chemical Oxygen Demand, mg/L | <5.00 | 27.766 | <5.00 | <5.00 |
| Oxidation-Reduction Potential, mV | 38 | | 15 | 32 |
| pH, standard units | 6.42 | 6.69 | 6.81 | 6.45 |
| Phosphorus, total, mg/L | 0.091 | 0.133 | 0.174 | 1.60 |
| Temperature, ° C | 4.80 | 28.1 | 23.9 | 8.30 |
| Total Suspended Solids, mg/L | 6.00 | 9.00 | 7.00 | 76.00 |
| Total Organic Carbon | | | 6.91 | |

*Location M1 = Millstone River at Delaware & Raritan Canal State Park at Mapleton Road, mid-span on bridge across Millstone River*
*See Exhibit 4-3 for location.*

## Table 23. Surface Water Analysis for Elizabethtown Water, E1, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | NS | | |
| Chemical Oxygen Demand, mg/L | 14.0 | | | <0.50 |
| Oxidation-Reduction Potential, mV | 25 | | -60 | 35 |
| pH, standard units | 6.89 | | 6.96 | 6.51 |
| Phosphorus, total, mg/L | <0.050 | | 0.195 | 0.192 |
| Total Suspended Solids, mg/L | <2.00 | | <2.00 | 3.00 |
| Total Organic Carbon | | | 2.55 | |

*Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth*
*NS = Not sampled*

## Table 24. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | <0.10 | | |
| Chemical Oxygen Demand, mg/L | <5.00 | <5.00 | <5.00 | 22.129 |
| Oxidation-Reduction Potential, mV | 67 | 26 | 63 | 53 |
| pH, standard units | 5.68 | 6.66 | 5.98 | 6.08 |
| Phosphorus, total, mg/L | 0.091 | 0.074 | 0.165 | 0.070 |
| Temperature | 4.6 | 17.7 | 25.8 | 7.8 |
| Total Suspended Solids, mg/L | 7.0 | 10.0 | 7.00 | 9.00 |
| Total Organic Carbon | | | 8.23 | |

*Location P1 = Cranbury Brook at George Davison Road, Plainsboro mid-span on bridge southbound*

## Table 25. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2002

| Sample Date | 2/6/02 | 5/3/02 | 8/7/02 | 11/6/02* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | <0.10 | | |
| Chemical Oxygen Demand, mg/L | <5.00 | 7.827 | <5.00 | 18.350 |
| Oxidation-Reduction Potential, mV | 80 | 44 | 73 | 64 |
| pH, standard units | 5.510 | 6.34 | 5.79 | 5.89 |
| Phosphorus, total, mg/L | <0.050 | <0.050 | 0.111 | <0.0500 |
| Temperature, ° C | 3.7 | 16.6 | 22.7 | 8.10 |
| Total Suspended Solids, mg/L | 2.0 | 3.0 | 9.0 | <2.00 |
| Total Organic Carbon | | | 7.82 | |

*Location P2 = Devil's Brook at Schalks Road overpass, adjacent to Amtrak railroad tracks*

## Table 26. DSN001 - Detention Basin Outfall 2002 Surface Water Analysis (NJPDES NJ0023922)

| Permit Limit | Units | Parameters | 1/3/02 | 2/6/02 | 3/6/02 | 4/4/02 | 5/3/02 | 6/10/02 |
|---|---|---|---|---|---|---|---|---|
| NA | mg/L | Ammonia-N | | | | | 0.0910 | |
| 50 mg/L | mg/L | Chemical Oxygen Demand | <5.00 | <5.00 | <5.00 | <5.00 | <5.00 | <5.00 |
| NL | mg/L | Chlorine Produced Oxidants | 0.18 | 0.21 | 0.16 | 0.22 | 0.23 | 0.11 |
| 100 | percent | Chronic Toxicity Test NOEC (% effluent)) *Pimephales promelas* | | | | | | |
| NA | mgd | Flow | 0.0518 | 0.0226 | 0.0713 | 0.0758 | 0.1321 | 0.1135 |
| NA | mV | Oxidation-Reduction Potential | -41 | -38 | -33 | -48 | 5 | -43 |
| 10 mg/L | mg/L | Petroleum Hydrocarbons | 0.78 | <0.500 | <0.500 | <0.500 | <0.500 | <0.500 |
| 6.0-9.0 | S.U. | pH | 7.85 | 7.81 | 7.71 | 7.96 | 6.94 | 8.20 |
| | mg/L | Phosphorus, Total | | 0.334 | | | 0.091 | |
| | µg/L | Tetrachloroethylene | | <0.700 | | | 0.74J | |
| 30 ◦C max. | ◦C | Temperature | 5.9 | 9.3 | 8.1 | 14.3 | 16.2 | 21.2 |
| NA | mg/L | Total Dissolved Solids | | | | | | |
| 50 mg/L | mg/L | Total Suspended Solids | <2.00 | <2.00 | <2.00 | <2.00 | 13.00 | 4.00 |

| Permit Limit | Units | Parameters | 7/10/02 | 8/7/02 | 9/4/02 | 10/8/02 | 11/6/02 | 12/4/02 |
|---|---|---|---|---|---|---|---|---|
| NA | mg/L | Ammonia-N | | | | | | |
| 50 mg/L | mg/L | Chemical Oxygen Demand | <5.00 | 36.9 | <5.00 | <5.00 | <5.00 | 11.0 |
| 0.016 | mg/L | Chlorine Produced Oxidants | <0.1 | 0.17<br>0.11 | <0.1 | <0.1 | <0.1 | <0.1 |
| 100 | perce nt | Chronic Toxicity Test NOEC (% effluent) *Pimephales promelas* | | | >100 | | | |
| NA | mgd | Flow | 0.0885 | 0.1320 | 0.1279 | 0.1390 | 0.1112 | 0.0944 |
| NL | mV | Oxidation-Reduction Potential | | -105 | | -55 | 78 | -42 |
| 10 mg/L | mg/L | Petroleum Hydrocarbons | <0.500 | <0.500<br><0.500 | <0.500 | <0.500 | 0.84 | 0.91 |
| 6.0-9.0 | S.U. | pH | 8.39 | 8.95 | 8.11 | 8.03 | 7.34 | 7.78 |
| | mg/L | Phosphorus, Total | | 0.241<br>0.262 | | | 0.105 | |
| | µg/L | Tetrachloroethylene | | <0.600<br><0.600 | | | <0.600 | |
| 30 ◦C max. | ◦C | Temperature | 24.2 | 21.6 | 23.5 | 16.4 | 11.4 | 5.9 |
| NA | mg/L | Total Organic Carbon | | 3.27<br>4.47 | | | 1.7 | |
| 50 mg/L | mg/L | Total Suspended Solids | 8.00 | 6.00<br>7.00 | 7. 00 | 8.00 | 5.00 | <2 .0 |

*Blank indicates no measurement*
*NA = not applicable*
*NL = no limit*
** Low flow due to 1) new flow meter installed that measures fulltime, and 2) little precipitation fell in December 2000.*

### Table 27. D&R Canal Pump House - DSN003 2002 Monthly Surface Water Analysis (NJPDES NJ0023922)

| Permit Monthly Avg. | Limit Daily Max. | Units | Parameters | 1/3/02 | 2/6/02 | 3/6/02 | 4/4/02 | 5/3/02 | 6/10/02 |
|---|---|---|---|---|---|---|---|---|---|
| NA | NA | mg/L | Ammonia-N | | | | | 0.160 | |
| NA | NA | mg/L | Chemical Oxygen Demand | | <5.00 | | | <5.00 | |
| NL | NL | mg/L | Chlorine Produced Oxidants | 0.11 | 0.14 | 0.17 | 0.27 | 0.26<br>0.16 | <0.1 |
| NL | NL | mV | Oxidation-Reduction Potential | 3 | 18 | 9 | 26 | 45 | 31 |
| 10 mg/L | 15 mg/L | mg/L | Petroleum Hydrocarbons | <0.500 | 3.10 | <0.500 | <0.500 | <0.500 | <0.500 |
| NA | 6.0-9.0 | S.U. | pH | 7.01 | 6.71 | 6.88 | 6.53 | 6.33 | 6.51 |
| NA | | mg/L | Phosphorus, Total | | 0.317 | | | 0.125 | |
| NA | NA | °C | Temperature | 1.70 | 3.80 | 7.20 | 14.4 | 16.4 | 26.6 |
| NA | NA | mg/L | Total Organic Carbon | | | | | | |
| 20 mg/L | 60 mg/L | mg/L | Total Suspended Solids | | 23.0 | | | 4.00 | |

| Permit Monthly Avg. | Limit Daily Max. | Units | Parameters | 7/15/02 | 8/7/02 | 9/4/02 | 10/8/02 | 11/6/02 | 12/4/02 |
|---|---|---|---|---|---|---|---|---|---|
| NA | NA | mg/L | Ammonia-N | | | | | | |
| NA | NA | mg/L | Chemical Oxygen Demand | | <5.00 | | | <5.00 | |
| NL | NL | mg/L | Chlorine Produced Oxidants | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| NL | NL | mV | Oxidation-Reduction Potential | | -6 | 9 | | 13<br>14 | 27 |
| 10 mg/L | 15 mg/L | mg/L | Petroleum Hydrocarbons | 0.510 | <0.500 | 0.690 | <0.500 | 1.60 | <0.5 |
| NA | 6.0-9.0 | S.U. | pH | 7.02 | 7.18 | 6.85 | 7.05 | 6.77 | 6.64 |
| NA | NA | mg/L | Phosphorus, Total | | 0.132 | | | 0.062 | |
| NA | NA | °C | Temperature | 27.1 | 28.2 | 23.7 | 18.7 | 6.8 | 0.3 |
| NA | NA | mg/L | Total Organic Carbon | | 3.90 | | | | |
| NL | NL | mg/L | Total Suspended Solids | | 5.00 | | | 2.00 | |

*Flow = 250 gallons per minute X 2 minutes per cycle X 10 cycles per day = 5,000 gallons per day*
** Permit changed from monthly to quarterly monitoring and no limit for Total suspended solids*
*Blank indicates no measurement*
*NA = not applicable*
*NL = no limit*

## Table 28. Surface Water Analysis for Bee Brook, B1, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/8/03 | 11/7/03<br>11/24/03* | 12/11/03 |
|---|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.240 | | <0.010 | |
| Biochemical Oxygen Demand, 5-day total, mg/L | | | <2.60 | <3.10 | |
| Chemical Oxygen Demand, mg/L | <5.0 | 32.819 | 25.031 | 65.649<br>32.418 | 35.3<br>46 |
| Oxidation-Reduction Potential, mV | 35 | 53 | 29 | 68 | |
| pH, standard units | 6.38 | 6.14 | 6.54 | 5.88 | |
| Phosphorus, total, mg/L | <0.050 | 0.054 | 0.085 | 0.116 | |
| Temperature, °C | -0.6 | 14.4 | 21.1 | 14.6 | |
| Total Dissolved Solids, mg/L | | | | 120 | |
| Total Suspended Solids, mg/L | <2.00 | 8.00 | 3.00 | 4.00 | |
| Total Organic Carbon, mg/L | | | | 32.3 | 10.6, 13 |

*Location B1 = Bee Brook upsteam of PPPL basin discharge*
*See Exhibit 4-3 for location.*

## Table 29. Surface Water Analysis for Bee Brook, B2, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/8/03 | 11/7/03/<br>11/24/03* | 12/11/03 |
|---|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.230 | | <0.100 | |
| Biochemical Oxygen Demand, 5-day total, mg/L | | | | <3.10 | |
| Chemical Oxygen Demand, mg/L | <5.0 | 85.959 | 18.363 | 79.801<br>32.731 | 38.4<br>31 |
| Oxidation-Reduction Potential, mV | -1 | 29 | 7 | 42 | |
| pH, standard units | 7.06 | 6.57 | 6.954 | 6.31 | |
| Phosphorus, total, mg/L | <0.050 | <0.050 | 0.085 | 0.074 | |
| Temperature, °C | 2.8 | 15.1 | 21.2 | 15.0 | |
| Total Dissolved Solids, mg/L | | | | 157 | |
| Total Suspended Solids, mg/L | 4.00 | 9.00 | 6.00 | 6.00 | |
| Total Organic Carbon, mg/L | | | | 22.2 | 10.3, 11 |

*Location B2 = Bee Brook downstream of PPPL basin discharge*

## Table30. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2003

| Sample Date | 2/6/03 | 5/8/03<br>5/20/03 | 8/7/03<br>8/11/03 | 8/27/03 | 11/7/03 |
|---|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | <0.100 | | | <0.100 |
| BOD-5-Day, total, mg/L | | | | | <3.10 |
| Chemical Oxygen Demand, mg/L | <5.00 | <5.00 | <5.00 | | 35.498 |
| Oxidation-Reduction Potential, mV | 17 | 26<br>25, 12 | 20<br>35 | 12 | 7.0 |
| pH, standard units | 6.74 | 6.62<br>6.98, 6.99 | 6.77<br>6.61 | 6.85 | 6.92 |
| Phosphorus, total, mg/L | <0.050 | <0.050 | 0.076<br>0.119 | | 0.099 |
| Temperature, °C | 0.4 | 16.0<br>17.8 | 24.9<br>25 | 26.30 | 16.6 |
| Total Dissolved Solids, mg/L | | | | | 123 |
| Total Suspended Solids, mg/L | <2.00 | 5.00<br>7.00 | 9.00<br>10.0 | 6.00 | 10.8 |
| Total Organic Carbon, mg/L | | | | 3.28 | 10.9 |
| Chlorine Produced Oxidants | | | <0.1 | | |

*Location C1 = Delaware & Raritan Canal State Park at Mapleton Avenue, Plainsboro midway on pedestrian bridge*
*See Exhibit 4-3 for location.*

### Table 31. Surface Water Analysis for Millstone River, M1, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/7/03 | 11/7/03* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.420 | | <0.100 |
| BOD 5-day total, mg/L | | | | <3.10 |
| Chemical Oxygen Demand, mg/L | <5.00 | <5.00 | 69.156 | 29.905 |
| Oxidation-Reduction Potential, mV | 52 | 44 | 46 | 48 |
| pH, standard units | 6.04 | 6.36 | 6.32 | 6.20 |
| Phosphorus, total, mg/L | 0.0641 | 0.071 | 0.118 | 0.132 |
| Temperature, °C | 1.9 | 167 | 24.2 | 15.6 |
| Total Dissolved Solids, mg/L | | | | 114 |
| Total Suspended Solids, mg/L | 7.00 | 9.00 | 75.00 | 12.00 |
| Total Organic Carbon, mg/L | | | | 15.0 |

*Location M1 = Millstone River at Delaware & Raritan Canal State Park at Mapleton Road, mid-span on bridge across Millstone River See Exhibit 4-3 for location.*

### Table 32. Surface Water Analysis for Elizabethtown Water, E1, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/8/03 | 11/7/03* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.200 | | <0.100 |
| BOD- 5-day total, mg/L | | | | <3.10 |
| Chemical Oxygen Demand, mg/L | <5.00.0 | <5.00 | <5.00 | 12.013 |
| Oxidation-Reduction Potential, mV | 52 | 36 | -3 | 3 |
| pH, standard units | 6.22 | 6.39 | 7.07 | 7.01 |
| Phosphorus, total, mg/L | 0.080 | 0.113 | 0.076 | 0.149 |
| Total Dissolved Solids, mg/L, mg/L | | | | 240 |
| Total Suspended Solids, mg/L | <2.00 | <2.00 | <2.00 | <2.00 |
| Total Organic Carbon, mg/L | | | | 2.24 |

*Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth*

### Table 33. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/7/03 | 11/7/03* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.250 | | <0.100 |
| BOD 5-day total, mg/L | | | | <3.10 |
| Chemical Oxygen Demand, mg/L | <5.00 | <5.00 | 19.949 | 18.170 |
| Oxidation-Reduction Potential, mV | 1 | 38 | 60 | 72 |
| pH, standard units | 6.30 | 5.90 | 6.06 | 5.81 |
| Phosphorus, total, mg/L | <0.050 | 0.054 | 0.052 | 0.140 |
| Temperature | 1.3 | 18.5 | 24.2 | 15.4 |
| Total Dissolved Solids, mg/L | | | | 111 |
| Total Suspended Solids, mg/L | 11.00 | 15.0 | 5.00 | 14.5 |
| Total Organic Carbon, mg/L | | | | 9.00 |

*Location P1 = Cranbury Brook at George Davison Road, Plainsboro mid-span on bridge southbound*

### Table 34. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2003

| Sample Date | 2/6/03 | 5/8/03 | 8/7/03 | 11/7/03* |
|---|---|---|---|---|
| Ammonia nitrogen as N, mg/L | | 0.150 | | <0.100 |
| BOD-5 day, total, mg/L | | | | <3.10 |
| Chemical Oxygen Demand, mg/L | 10.892 | <5.00 | 55.552 | 43.493 |
| Oxidation-Reduction Potential, mV | 74 | 67 | 74 | 74 |
| pH, standard units | 5.61 | 5.90 | 5.83 | 5.71 |
| Phosphorus, total, mg/L | <0.050 | <0.050 | 0.101 | <0.0500 |
| Temperature, °C | 1.3 | 16.1 | 22.0 | 14.4 |
| Total Dissolved Solids, mg/L | | | | 108 |
| Total Suspended Solids, mg/L | 7.00 | 4.00 | 12.0 | 7.00 |
| Total Organic Carbon, mg/L | | | | 22.8 |

*Location P2 = Devil's Brook at Schalks Road overpass, adjacent to Amtrak railroad tracks*
*BOD-5-day, total is Biochemical Oxygen Demand, 5-day test*

**Table 35. Table 22. DSN001 - Detention Basin Outfall 2003 Surface Water Analysis (NJPDES NJ0023922)**

| Permit Limit | Units | Parameters | 1/7/03 | 2/6/03 | 3/5/03 | 4/2/03 | 5/8/03 | 6/6/03 |
|---|---|---|---|---|---|---|---|---|
| NL | mV | Oxidation-Reduction Potential | 35 | -29 | 25<br>19 | -7<br>-6 | 2 | |
| NA | mg/L | Ammonia-N | | | | | 0.240 | |
| NA | mg/L | BOD-5-day, total | | | | | | |
| 50 mg/L | mg/L | Chemical Oxygen Demand | <5.00 | <5.00 | <5.00 | <5.00 | <5.00 | 126.611<br>32.036 |
| 0.016 | mg/L | Chlorine Produced Oxidants | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| >100 | percent | Chronic Toxicity Test NOEC (% effluent)) *Pimephales promelas* | | | | | | |
| NA | mgd | Flow Monthly Avg. | 0.077 | 0.099 | 0.188 | 0.146 | 0.151 | 0.345 |
| 10 mg/L | mg/L | Petroleum Hydrocarbons | <0.500 | <0.500 | 0.650 | 1.20 | <0.500 | 1.40 |
| 6.0-9.0 | S.U. | pH | 7.24 | 7.60 | 6.56 | 7.18 | 7.04 | 6.88 |
| | mg/L | Phosphorus, Total | | 0.0560 | | | 0.088 | |
| | μg/L | Tetrachloroethylene | | 1.16 | | | <0.800 | |
| 30 ◦C max. | ◦C | Temperature | 9.0 | 6.9 | 10.55 | 14.5 | 17.3 | 16.9 |
| NA | mg/L | Total Dissolved Solids | | | | | | |
| 50 mg/L | mg/L | Total Suspended Solids | <2.00 | 3.00 | 21.00 | 3.00 | 12.0 | 3.00 |

| Permit Limit | Units | Parameters | 7/1/03 | 8/1/03<br>8/27/03 | 9/4/03 | 10/6/03 | 11/7/03 | 12/11/03 |
|---|---|---|---|---|---|---|---|---|
| NL | mV | Oxidation-Reduction Potential | -33 | -61,-61<br>-55, -56 | -29, -29 | -31 | 2 | 35 |
| NA | mg/L | Ammonia-N | | | | | <0.100 | |
| NA | mg/L | BOD-5-day, total | | | | | <2.30 | |
| 50 mg/L | mg/L | Chemical Oxygen Demand | <10,15.04<br>73.308<br><21.130 | 14.242 | <5.00 | 6.061 | 118.33<br>48.63<br>58.421<br>15.752 | 37.893 |
| 0.016 | mg/L | Chlorine Produced Oxidants | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| >100 | perce nt | Chronic Toxicity Test NOEC (% effluent) *Pimephales promelas* | | | | >100 | | |
| NA | mgd | Flow Monthly Avg. | 0.192 | 0.201 | 0.161 | 0.148 | 0.153 | 0.205 |
| 10 mg/L | mg/L | Petroleum Hydrocarbons | 0.570 | <0.500 | <0.500 | <0.500 | <0.500 | 0.76 |
| 6.0-9.0 | S.U. | pH | 7.61 | 8.16<br>8.36 | 7.57 | 7.58 | 7.02 | 6.39<br>6.42 |
| | mg/L | Phosphorus, Total | | 0.06 | | | 0.058 | |
| | μg/L | Tetrachloroethylene | | 0.4 | | | 0.58J | |
| 30 ◦C max. | ◦C | Temperature | 19.8 | 21.7<br>21.9 | 21.7 | 19.2 | 17.3 | 13.2 |
| NA | mg/L | Total Organic Carbon | | 2.34 | | | 2.26 | 5.09<br>6 |
| | mg/L | Total Dissolved Solids | | | | | 234 | |
| 50 mg/L | mg/L | Total Suspended Solids | <2.00 | 3.00 | 8 00 | 2.00 | 3.20 | 24.0<br>24.0 |

*Blank indicates no measurement*
*NA = not applicable*
*NL = no limit*
** Average concentration for Nov. 2003 COD 11/7 (118.33); 11/11 (48.63); 11/19 (58.421); 11/20 (15.75.2); and 11/21 (22.002) (mg/L).*
*J = Present yet below the method detection limit.*

**Table 36. DSN003 D&R Canal Pump House - 2003 Monthly Surface Water Analysis (NJPDES NJ0023922)**

| Permit Monthly Avg. | Limit Daily Max. | Units | Parameters | 1/3/03 | 2/6/03 | 3/5/03 | 4/2/03 | 5/20/03 | 6/6/03 |
|---|---|---|---|---|---|---|---|---|---|
| NL | mV | | Oxidation-Reduction Potential | 35 | 13 | 43 | 30<br>30 | 25<br>12 | 42 |
| NA | NA | mg/L | Ammonia-N | | | | | <0.100 | |
| NA | NA | mg/L | Biochemical Oxygen Demand | | | | | | |
| NA | NA | mg/L | Chemical Oxygen Demand | | <5.00 | | | <5.00 | |
| 0.016 | NL | mg/L | Chlorine Produced Oxidants | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 10 mg/L | 15 mg/L | mg/L | Petroleum Hydrocarbons | <0.500 | 3.10 | 0.590 | 0.890 | <0.500 | <0.500 |
| NA | 6.0-9.0 | S.U. | pH | 6.40 | 6.82 | 6.12 | 6.45<br>6.53 | 6.91 | 6.33 |
| NA | | mg/L | Phosphorus, total | | <0.050 | | | 0.071 | |
| NA | NA | °C | Temperature | 2.1 | 0.2 | | 12.1 | 16.4 | 18.0 |
| NA | NA | mg/L | Total Dissolved Solids | | | | | | |
| 20 mg/L | 60 mg/L | mg/L | Total Suspended Solids | | <2.00 | | | 6.00 | |

| Permit Monthly Avg. | Limit Daily Max. | Units | Parameters | 7/7/03 | 8/11/03<br>8/27/03 | 9/4/03 | 10/03 | 11/03 | 12/23/03 |
|---|---|---|---|---|---|---|---|---|---|
| NL | | mV | Oxidation-Reduction Potential | -2 | -10, -19<br>-3, -3 | -5, -5 | | | 20 |
| NA | NA | mg/L | Ammonia-N | | | | | | |
| NA | NA | mg/L | Biochemical Oxygen Demand | | | | | | |
| NA | NA | mg/L | Chemical Oxygen Demand | | <5.00 | | | | <10 |
| 0.016 | NL | mg/L | Chlorine-Produced Oxidants | <0.1 | <0.1<br><0.1 | <0.1 | NODI | NODI | <0.1 |
| 10 mg/L | 15 mg/L | mg/L | Petroleum Hydrocarbons | <0.500 | <0.500<br><0.500 | <0.500 | NODI | NODI | <0.500 |
| NA | 6.0-9.0 | S.U. | pH | 7.00 | 7.34<br>7.14 | 7.15 | NODI | NODI | 6.50<br>6.84 |
| NA | NA | mg/L | Phosphorus, total | | 0.932 | | | | |
| NA | NA | °C | Temperature | 21.4 | 21.4<br>24.9 | 21.7 | NODI | NODI | 3.8 |
| NA | NA | mg/L | Total organic carbon | | 3.41 | | | | 4.82 |
| NL | NL | mg/L | Total Suspended Solids | | 17.0<br>8.00 | | | | |

*Flow = 250 gallons per minute X 2 minutes per cycle X 10 cycles per day = 5,000 gallons per day*
** Permit changed from monthly to quarterly monitoring and no limit for Total suspended solids*
*Blank indicates no measurement*
*NA = not applicable*
*NL = no limit*
*NODI = No discharge*

**Table 37. Summary of Ground Water Sampling Results – 2002**
**Target Chlorinated volatile Organic Compounds**

| Location | Date | PCE (ug/L) | TCE (ug/L) | c-1,2-DCE (ug/L) | 1,1-DCE (ug/L) | 1,1,1-TCA (ug/L) |
|---|---|---|---|---|---|---|
| **NJ GWQS** | | **1.0** | **1.0** | **70.0** | **2.0** | **30.0** |
| | | | | | | |
| **MW-13I** | 4/25/2002 | 34.1 | < 0.8 | < 1.0 | < 0.8 | 1.82 J |
| | 7/29/2002 | 38.2 | 0.52 J | < 0.6 | 0.76 J | 2.96 J |
| | 11/21/2002 | 23.7 | < 0.4 | < 0.4 | < 0.4 | 1.58 J |
| | | | | | | |
| **MW-13S** | 4/24/2002 | 50.9 | 1.41 J | < 0.8 | < 0.8 | 1.75 J |
| | 7/29/2002 | 51.4 | 1.57 J | 4.5 NJ | <0.4 | 1.72 J |
| | 11/21/2002 | 36.4 | 1.72 J | 6.32 NJ | < 0.4 | 0.95 J |
| | | | | | | |
| **MW-18** | 4/24/2002 | < 0.7 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 7/30/2002 | 0.62 J | 0.5 J | < 0.8 | < 0.8 | < 0.8 |
| | 11/21/2002 | 0.76 J | 0.59 J | < 0.6 | < 0.7 | < 0.5 |
| | | | | | | |
| **MW-19I** | 4/25/2002 | < 0.7 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 7/30/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 11/20/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | | | | | | |
| **MW-19S** | 4/25/2002 | 151 | 8.64 J | 41.1 | < 1.6 | < 1.6 |
| | 7/30/2002 | 135 | 9.75 | 27.8 | < 0.8 | < 0.8 |
| | 11/20/2002 | 214 | 12.8 | 61.2 | < 0.7 | 0.55 J |
| | | | | | | |
| **MW-22S** | 4/25/2002 | < 0.7 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 7/30/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | 0.68 J |
| | 11/20/2002 | < 0.6 | 0.25 | < 0.6 | < 0.7 | 0.84 J |
| | | | | | | |
| **MW-23S** | 4/25/2002 | < 0.7 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 7/30/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 11/20/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | | | | | | |
| **MW-24S** | 4/25/2002 | < 0.6 | <0.5 | <0.5 | < 0.4 | < 0.7 |
| | 7/30/2002 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 11/20/2002 | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 0.7 |
| | | | | | | |
| **MW-25** | 4/24/2002 | 0.86 J | <0.5 | 3.86 NJ | < 0.7 | <0.8 |
| | 7/30/2002 | 0.62 J | <0.5 | 3.37 NJ | < 0.8 | < 0.8 |
| | 11/21/2002 | 0.90 J | < 0.6 | 4.21 | < 0.6 | < 0.7 |
| | | | | | | |
| **D-Site MG Building Sump** | 4/24/2002 | 84.3 | 6.19 | 3.23 NJ | 2.19 J | 1.53 J |
| | 7/29/2002 | 88.6 | 6.31 | 3.61 NJ | 2.01 J | 1.36 J |
| | 11/21/2002 | 75.8 | 5.39 | 5.24 NJ | 1.80 J | 1.45 J |
| | | | | | | |
| **D-site Air Shaft Building Sump** | 4/25/2002 | 2.17 J | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 7/29/2002 | 2.88 J | < 0.8 | < 0.8 | < 0.8 | < 0.8 |
| | 11/21/2002 | 3.23 J | <0.4 | <0.4 | <0.4 | <0.4 |

Notes:
"J" indicates a value that is greater than the MDL but lower than the lowest standard.
"N" indicates presumptive evidence of a compound.
PCE – Tetrachloroethene TCE – Trichloroethene

c-1,2-DCE – cis-1,2-Dichlorothene 1,1-DCE – 1,1-Dichloroethene 1,1,1-TCA – 1,1,1-Trichloroethane

**Table 38. Summary of Ground Water Sampling Results – 2003**
**Target Chlorinated Volatile Organic Compounds**

| Location | Date | PCE (ug/L) | TCE (ug/L) | c-1,2-DCE (ug/L) | 1,1-DCE (ug/L) | 1,1,1-TCA (ug/L) |
|---|---|---|---|---|---|---|
| **NJ GWQS** | | **1.0** | **1.0** | **70.0** | **2.0** | **30.0** |
| **MW-13I** | 3/26/2003 | 16 | 1.41 | < 0.8 | < 0.6 | 1.16 |
| | 6/17/2003 | 13.7 | < 0.8 | < 0.6 | < 0.6 | 0.89 J |
| | 10/20/2003 | 38.7 | 3.42 | 3.04 NJ | <1.2 | 2.9 |
| **MW-13S** | 3/26/2003 | 64.2 | 2.19 | 4.47 NJ | 1.03 | 1.97 |
| | 6/17/2003 | 80.1 | 6.85 | 5.59 NJ | 0.85 J | 2.15 |
| | 10/20/2003 | 75.5 | 315 | 10.4 NJ | <1.2 | 1.68 |
| **MW-18** | 3/26/2003 | 0.82 J | < 0.8 | < 0.8 | < 0.6 | < 0.7 |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/20/2003 | 0.74 J | 0.54 J | < 0.7 | < 1.2 | < 0.7 |
| **MW-19I** | 3/25/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 | < 0.4 | < 0.3 | < 1.0 | < 1.2 | < 0.9 |
| **MW-19S** | 3/25/2003 | 125 | 6.6 | 18.3 NJ | < 0.6 | < 0.7 |
| | 6/17/2003 | 188 | 10.6 | 31.2 NJ | < 0.6 | < 0.7 |
| | 10/21/2003 | 229 | 14.9 | 52.5 | < 6.0 | < 4.5 |
| **MW-22S** | 3/25/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | 0.91 J |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 | < 0.4 | < 0.3 | < 1.0 | < 1.2 | < 0.9 |
| **MW-23S** | 3/25/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.8 | < 0.6 | < 0.7 |
| | 10/21/2003 | < 0.4 | < 0.3 | < 1.0 | < 1.2 | < 0.9 |
| **MW-24S** | 3/25/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 12:00 AM | < 0.4 | < 0.3 | < 1.0 | < 1.2 | < 0.9 |
| **MW-25** | 3/25/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 6/17/2003 | < 0.8 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 | 0.9 J | 0.5 J | 5.31 NJ | 0.6 J | < 0.7 |
| **D-Site MG Building Sump** | 3/25/2003 | 49.2 | 3.09 | < 0.7 | 1.33 | < 0.7 |
| | 6/18/2003 | 35.4 | 2.07 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 | 77.5 | 5.76 | 3.81 NJ | 1.52 | 0.93 J |
| **D-site Air Shaft Building Sump** | 3/25/2003 | 4.59 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 6/18/2003 | 5.19 | < 0.8 | < 0.7 | < 0.6 | < 0.7 |
| | 10/21/2003 | < 0.3 | 2.73 | < 0.7 | < 1.2 | < 0.9 |

**Table 39. Quality Assurance Data for Radiological and Non-Radiological Samples for 2002**

| Laboratory, Program, and Parameter | Reported Value | Actual Value | Acceptance Range |
|---|---|---|---|
| *PPPL DOE-EML Tritium in water* (Bequerel/Liter)) | | | |
| QAP-56 (0203) | 275.600 | 283.700 | Not reported |
| QAP-57 (0209) | 225.110 | 227.300 | Not reported |
| *ERA (picoCuries/Liter)* | | | |
| RAD-49 | 15,300 | 17,400 | 14,400-20,400 |
| RAD-51 | 9350 | 10200 | 8440-12000 |
| *PPPL Test Results- WP0102* | | | |
| Total residual chlorine (mg/L ) | 3.845 | 4.46 | 3.69-5.23 |
| pH (S.U.) | 9.12 | 9.04 | 8.77-9.31 |
| Chemical oxygen demand (mg/L ) | 104.594 | 105 | 78.2-123 |
| Specific conductance (µmhos/cm) | 786 | 843 | 773-913 |
| *WP0202* | | | |
| Chemical oxygen demand (mg/L ) | 155.15 | 173 | 133-197 |
| Specific conductance (µmhos/cm) | 905.5 | 910 | 834-986 |
| pH (S.U.) | 5.62 | 5.62 | 5.50-5.74 |
| Total residual chlorine (mg/L ) | 3.875 | 3.88 | 3.20-4.56 |
| Turbidity NTU | 9.25 | 6.80 | 5.50-8.50 |
| WPJune 2002 | | | |
| Chlorine residual (mg/L ) | 2.315 | 2.21 | 1.7-2.5 |
| pH (S.U.) | 7.39 | 7.41 | 7.21-7.61 |
| Chemical oxygen demand (mg/L ) | 126.373 | 122 | 92-141 |
| Specific conductance (µmhos/cm) | 453 | 464 | 426-500 |
| Nitrate-+Nitrogen as N | 11.899 | 8.08 | 6.38-9.62 |
| Turbidity NTU | 3.123 | 1.25 | 0.857-1.48 |

**Table 40. Quality Assurance Data for Radiological and Non-Radiological Samples for 2003**

| Laboratory, Program, and Parameter | Reported Value | Actual Value | Acceptance Range |
|---|---|---|---|
| *PPPL DOE-EML Tritium in water* (Bequerel/Liter)) | | | |
| QAP-58 (0303) | 384370 | 390.00 | Not reported |
| QAP-57 (0209) | 225.110 | 227.300 | Not reported |
| *ERA (picoCuries/Liter)* | | | |
| RAD-53 | 1150 | 1250 | 678-1820 |
| *PPPL Test Results- WP 3006 June 2003* | | | |
| Total residual chlorine (mg/L ) | 2.053 | 2.27 | 1.77-2.59 |
| pH (S.U.) | 9.54 | 9.6 | 9.3-9.89 |
| Chemical oxygen demand (mg/L ) | 139.79 | 156 | 120-178 |
| Specific conductance (µmhos/cm) | 407 | 351 | 319-371 |
| Turbidity NTU | 7.50 | 1.66 | 1.33-1.99 |
| Nitrate-+Nitrite as N | 10.45 | 16.9 | 13.4-20.14 |
| Orthophosphate as P | 2.72 | 3.86 | 3.29-4.466 |
| *WP 3012 0 December 2003* | | | |
| Specific conductance (µmhos/cm) | 578.0 | 586 | 513-617 |

Appendix

# B

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