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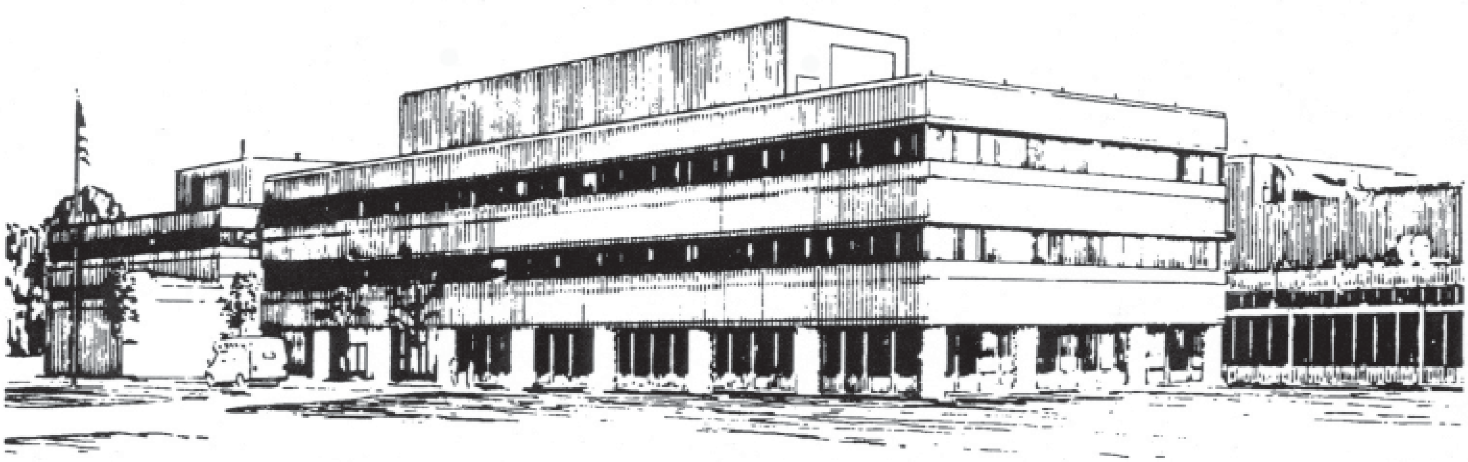
Princeton Plasma Physics Laboratory Annual Site Environmental Report for Calendar Year 2000

by

Virginia L. Finley

April 2002



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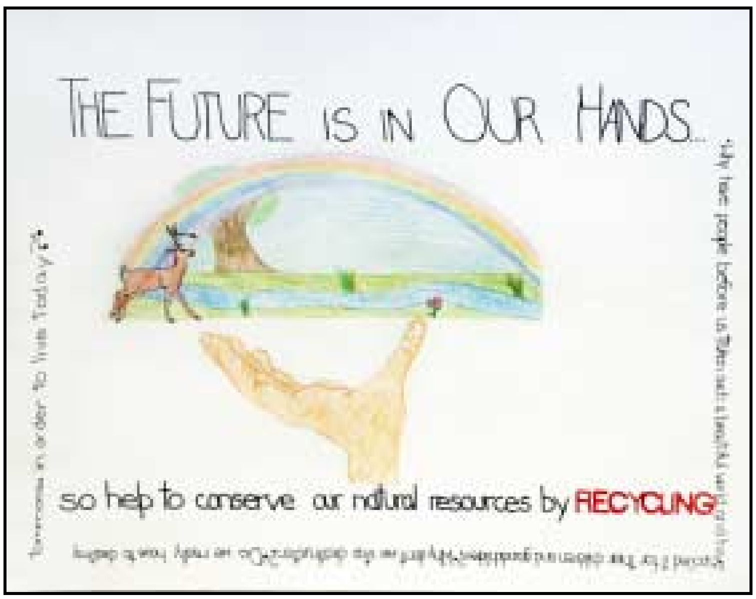
ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2000



POSTER BY A SIXTH GRADE STUDENT FOR PPPL EARTH DAY 2000 CELEBRATION

Princeton Plasma Physics Laboratory
P.O. Box 451
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For the U.s. Department of Energy
Under Contract DE-AC02-76-CHO-3073

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Princeton Plasma Physics Laboratory

Annual Site Environmental Report

For Calendar Year 2000– Abstract

The results of the 2000 environmental surveillance and monitoring program for the Princeton Plasma Physics Laboratory (PPPL) are presented and discussed. The purpose of this report is to provide the U.S. Department of Energy and the pollutants (if any) that are added to the environment as a result of PPPL's operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 2000.

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951. The long-range goal of the U.S. Magnetic Fusion Energy Research Program is to create innovations to make fusion power a practical reality – an alternative energy source. The Year 2000 marked the second year of National Spherical Torus Experiment (NSTX) operations and Tokamak Fusion Test Reactor (TFTR) dismantlement and deconstruction activities. A collaboration among fourteen national laboratories, universities, and research institutions, the NSTX is a major element in the US Fusion Energy Sciences Program. It has been designed to test the physics principles of spherical torus (ST) plasmas. The ST concept could play an important role in the development of smaller, more economical fusion reactors. With its completion within budget and ahead of its target schedule, NSTX first plasma occurred on February 12, 1999.

In 2000, 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 waste water monitoring. Ground water investigations continued under a voluntary agreement with the New Jersey Department of Environmental Protection. PPPL monitored for the presence of non-radiological contaminants, mainly volatile organic compounds (components of degreasing solvents). Monitoring revealed the presence of low levels of volatile organic compounds in an area adjacent to PPPL. Also, PPPL's radiological monitoring program characterized the ambient, background levels of tritium in the environment and from the D-site stack; the data are presented in this report.

Virginia L. Finley, author

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

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List of Acronyms

AEA	Atomic Energy Act of 1954
AGT	above ground tank
ALARA	as low as reasonably achievable
APEC	area of potential environmental concern
ARD	America Recycles Day (November 15th annually)
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, ethylbenzene, 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 (atPPPL)
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 pordcued 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-PAO	Department of Energy - Princeton Area 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
EM-30	Waste Management - DOE
EM-40	Environmental Restoration - DOE
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
ER/WM	Environmental Restoration/Waste Management (PPPL)
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

List of Acronyms

GBq	giga Becquerel or 10^9Bq
GCUA	Gloucester County Utility Authority
GP	General Permit (Wetlands)
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
ISO14000	International Standards Organization 14000 (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	Materiel Control &
MCHD	Middlesex County Health Department
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
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
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
POTWs	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
χ/Q	atmospheric dilution factor (NOAA)
μg/L	micrograms per liter
μSv	microSievert

List of Exhibits Contained in the Text

NOTE: Data tables are located in Appendix A beginning on page 68.

Princeton Plasma Physics Laboratory (PPPL)

Certification of Monitoring Data for

Annual Site Environmental Report for 2000

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 – QC, Inc. and Reliance Laboratory. To the best of our knowledge, these data, as contained in the "Annual Site Environmental Report for 2000," are documented and certified to be correct.

Signed:

____

Virginia L. Finley,
Head, Environmental Compliance
Environmental Restoration
& Waste Management Division

____

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

Approved:

____

Scott B. Larson
Head, Environmental Restoration &
Waste Management Division

____

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

EARTH DAY 2000 POSTER CONTEST WINNERS

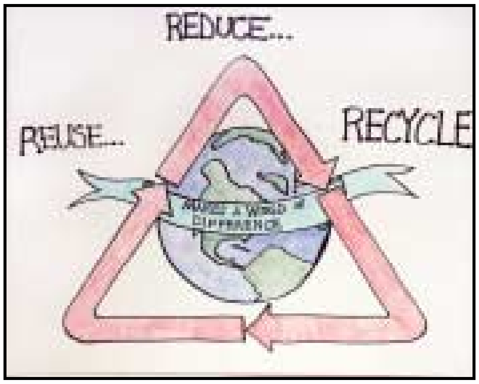
As I was preparing this Annual Report, I began to think of my audience. To whom is this document intended to reach, to inform, and to guide in the understanding of fusion energy's impact on our lives – the safety of the public and the health of the environment? The answer came to me simply – it's future generations. Judging by these wonderfully visual, informative, and creative posters representing more than 600 children's posters, they've already received the message!

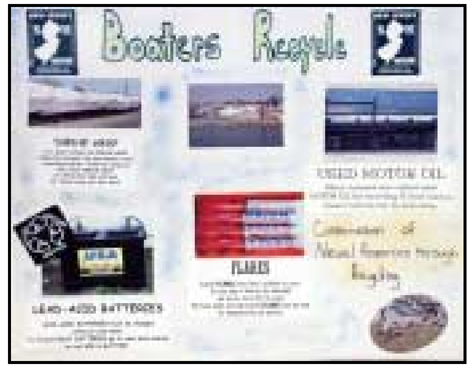
THANK YOU

2000 Participating Schools

Carl Getz Middle School, Jackson NJ, 2nd year
Chesterfield Elementary, Bordentown NJ, 1st year
Christopher Columbus School, Trenton NJ, 1st year
Corpus Christi School, Willingboro NJ, 3rd year
Grace N. Rogers School, East Windsor Reg. NJ, 3rd year
Martin Luther King Middle School, Trenton NJ, 1st year
Parkway Elementary, Trenton NJ, 1st year
Toll Gate Grammar School, Pennington NJ, 4th year
Timberlane Middle School, Hopewell NJ, 3rd year
Terrill Middle School, Scotch Plains NJ, 2nd year

EARTH DAY 2000 POSTER CONTEST WINNERS





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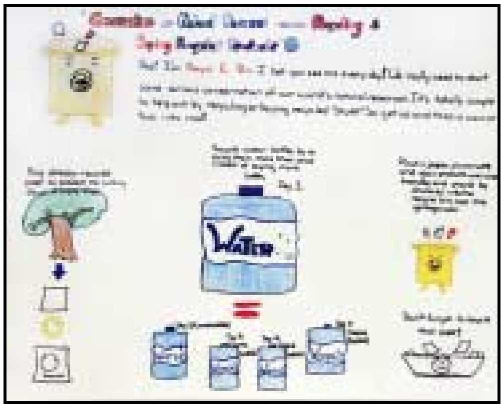
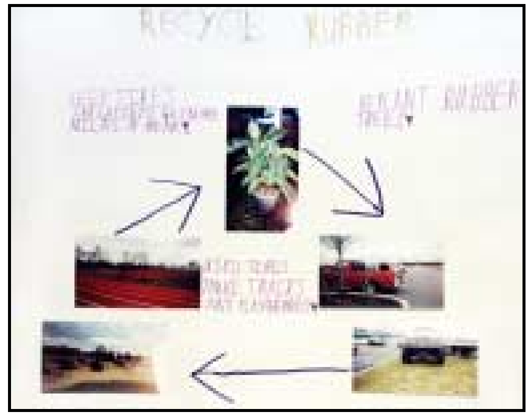
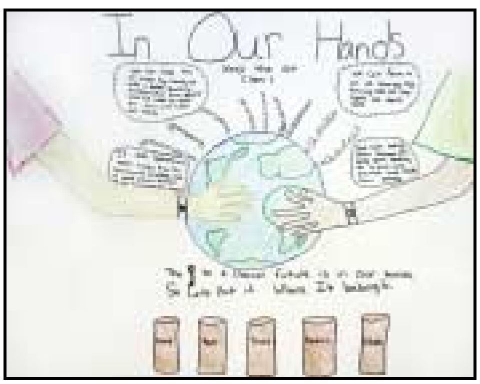
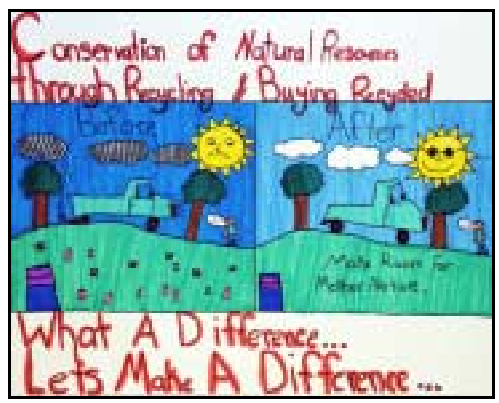
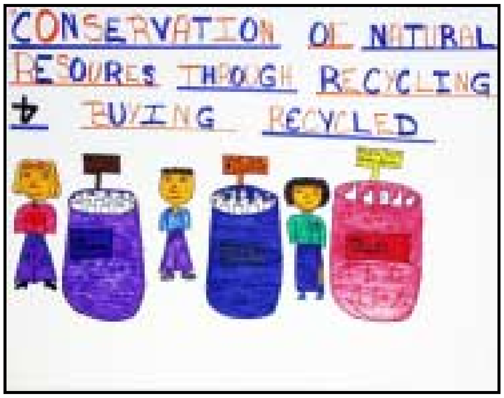


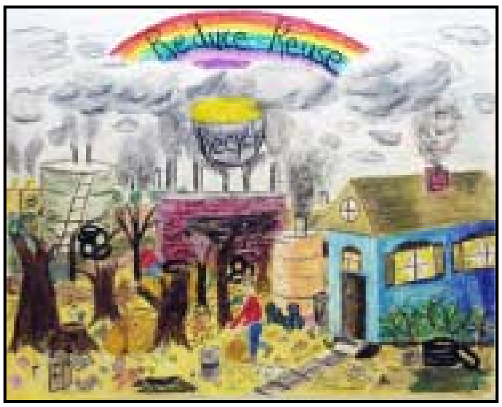






EARTH DAY 2000 POSTER CONTEST WINNERS





Chapter
1

Princeton Plasma Physics Laboratory

Annual Site Environmental Report for Calendar Year 2000

Executive Summary

This report presents the results of environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Year 2000. 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 2000. 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 a release of neutrons and energy. Unlike the sun, PPPL's fusion reactions are magnetically confined within a vessel or reactor. 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 Year 2000 marked the second year of the National Spherical Torus Experiment (NSTX) operations and the second 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 three-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 2000, TFTR deconstruction and dismantlement (D&D) project was well in-progress; diagnostic equipment, electrical power cables, ductwork, and other ancillary equipment were removed from around the tokamak. As seen in the photograph on this page, the umbrella structure and upper magnetic poloidal-field coils were lifted off the top of TFTR in November 2000. Workers using a 110-ton capacity overhead bridge crane lifted the 92-ton structure off the tokamak and lowered it successfully onto the floor.

The Tokamak Fusion Test Reactor Umbrella Lift

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

In 2000, 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 2000 were as follows:

1. Total maximum off-site dose from all sources—airborne and liquid releases—was 0.21 mrem/year.

2. Dose at the nearest business due to airborne releases was 0.098 mrem/year.
3. The collective effective dose equivalent for the population living within 80 kilometers was 1.57 person-rem.

The total maximum off-site dose is 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 2000 Pollution Prevention and Community Outreach Programs included:

1. Infrastructure modification (roof replacements and building automation system) yielding an estimated $20K annually in energy savings.
2. Community Outreach through an Open House, which was attended by over 2000 visitors in June, the annual Earth Day poster contests for Grades 4-6 held in mid-April, and America Recycle Day (ARD) on November 15, 2000, hosting environmental-friendly vendors and regulatory agencies.
3. Monitoring usage of recycled material *versus* non-recycled material.
4. Reducing hazardous waste disposal by 56**%** and solid waste by 55**%** through actively seeking recyclers for these waste materials.

PPPL's non-radiological environmental monitoring program demonstrates compliance with all applicable environmental requirements. The program includes monthly surface water monitoring, annual chronic toxicity testing, quarterly ground-water sampling, and twice-annual samples from the detention basin inflows.

In 2000, PPPL concluded a remedial investigation and remedial alternative assessment (RI/RAA) for C-and D-sites of the James Forrestal Campus. This is land leased to the Department of Energy (DOE) by Princeton University. Since 1989, ground-water data has revealed volatile organic compound (VOC) contamination (most likely from solvents) at low levels in three locations. PPPL's remedial action work plan has monitoring and reporting of quarterly sampling of selected wells.

Through its Integrated Safety Management (ISM) program, PPPL emphasizes environment, safety, and health (ES&H) in accordance with DOE requirements at the facility. 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. 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 assists 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.

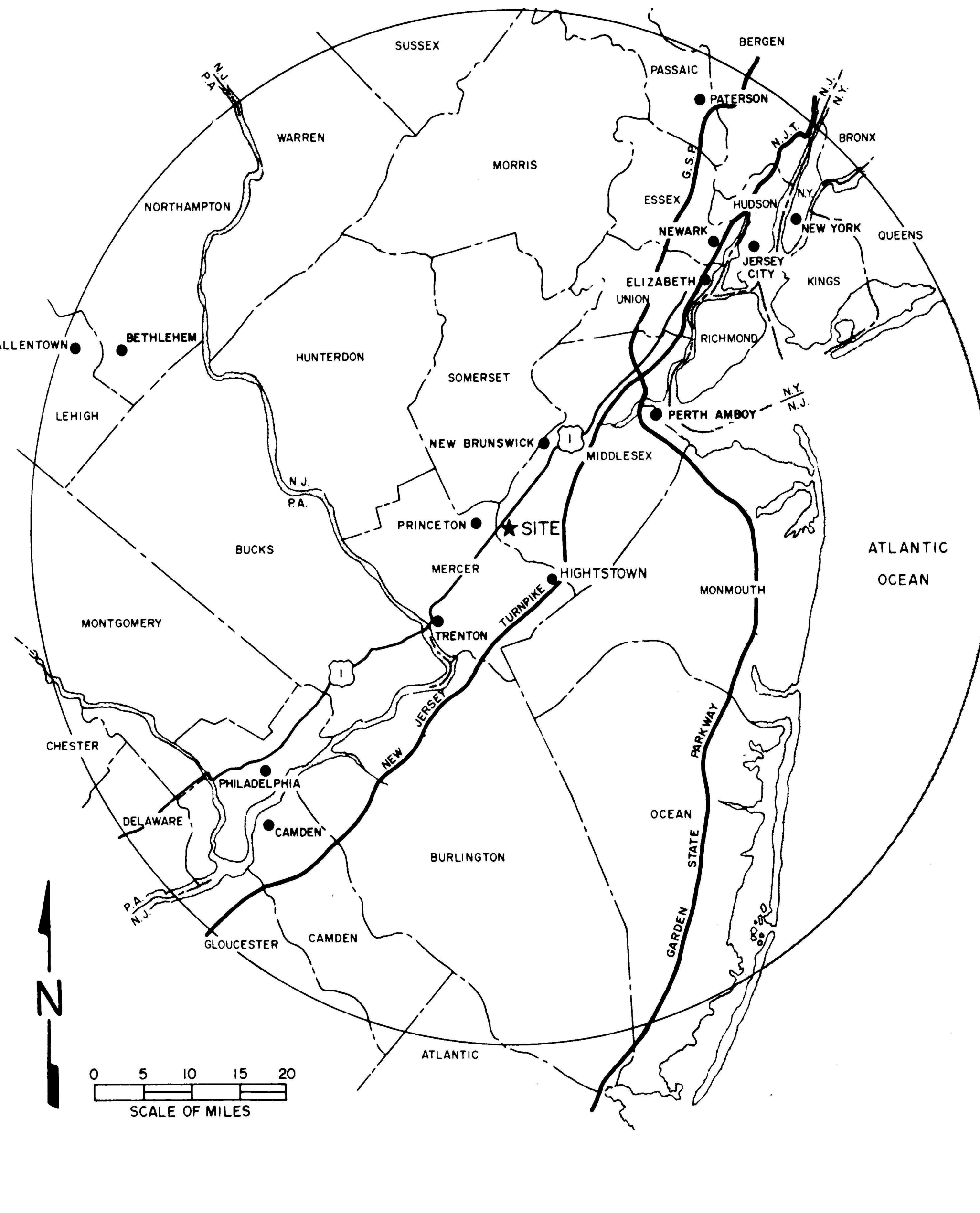
2.2 Site Location

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), which includes 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).

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



Undisturbed areas surround the site: upland forest, wetlands, open grassy areas, cultivated fields, and a minor stream (Bee Brook), which flows along its eastern boundary. In an aerial photo (Exhibit 2-3), the general layout of the facilities at the C- and D-sites of Forrestal Campus is viewed; the specific location of TFTR and NSTX is at D-site (on the left side of photo).

Exhibit 2-2. PPPL James Forrestal Campus

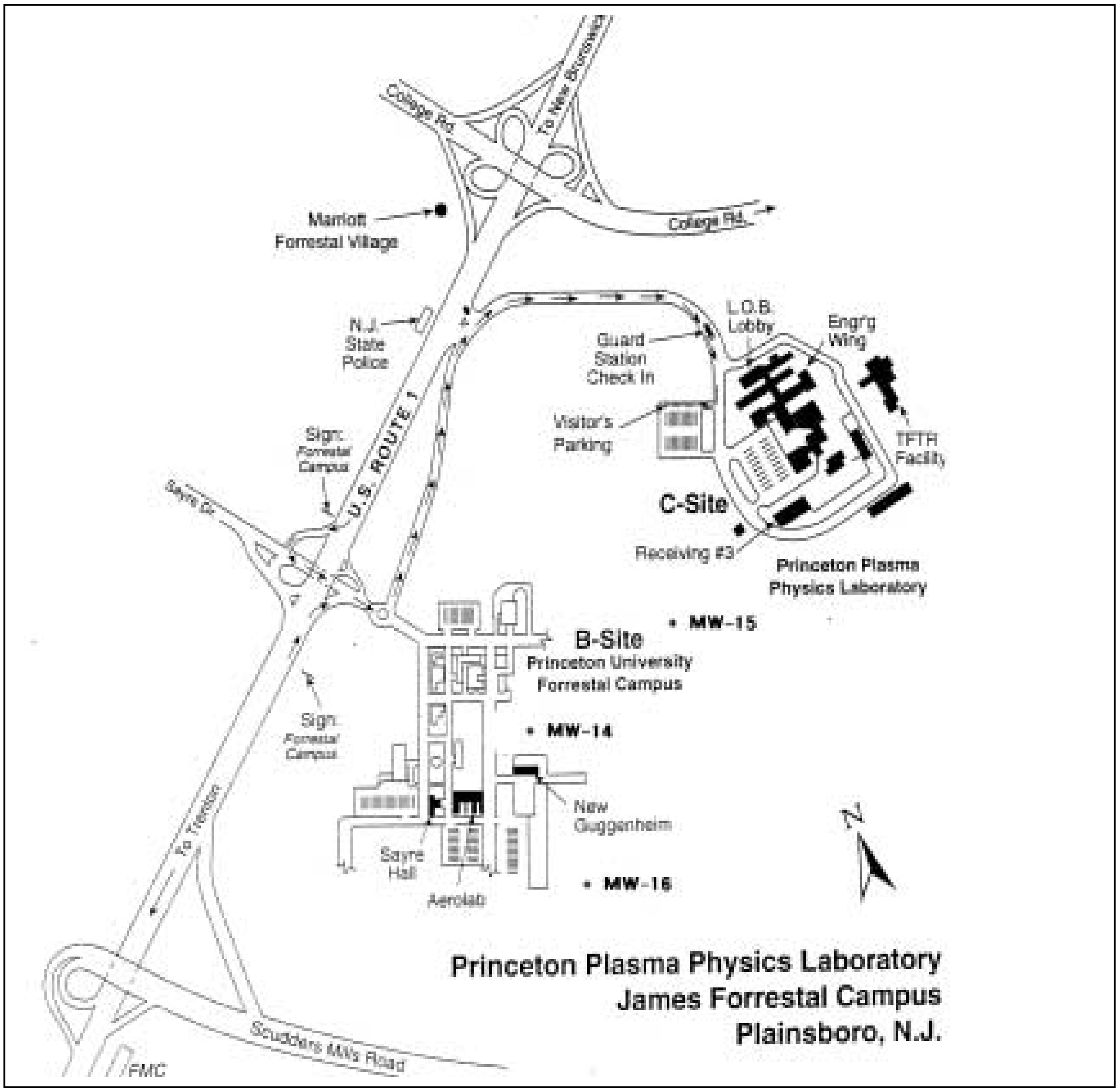


Exhibit 2-3. Aerial View of PPPL

D-site is fully surrounded with a barbed -wire, chain-linked fence for securing controlled access. 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; the extreme temperatures 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 occur about once every 15 years [PSAR78]. In 2000, the annual rainfall, 38.7 inches (98.3 cm), was well below the average rainfall for central New Jersey; this below-average level was primarily due to a relatively dry winter (January and February) and an extremely dry October when less than 1 inch (2.5 cm) of precipitation was recorded (Appendix A, Table 2).

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].

Exhibit 2-4. Current Drive Experiment – Updgrade (CDX-U) and Principal Investigators

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. Though TFTR has not operated since April 1997, dismantling activities have been underway since October 1999 and result in releases to the stack. When TFTR is fully dismantled, the area will be vacant, availing the Test Cell for a new device. Many of the TFTR support systems are being 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).

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.

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

2000 COMPLIANCE SUMMARY

3.1 Environmental Restoration and Waste Management

Princeton Plasma Physics Laboratory's (PPPL) goal is 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 orders are discussed in this chapter.

Resulting from the February 1998 multi-media inspection, US Environmental Protection Agency (EPA) Region II issued PPPL two notices of violations (NOVs) – one for Resource Conservation and Recovery Act (RCRA) and one for Spill Control and Countermeasure Plan (SPCC) programs [EPA98]. The first NOV for RCRA training of satellite accumulation area managers was rescinded on grounds that the regulations did not apply.

The second NOV was issued for deficiencies in the SPCC Plan and for the lack of secondary containment at 1) the C site MG basement mineral oil tanks, 2) the vehicle refueling island, and 3) the 138 kV switchyard [EPA98]. The SPCC Plan was readily amended rendering PPPL in compliance. The installation of containment in the deficient areas was completed in 1999 for the C site MG basement tanks; the refueling island containment project was scheduled for completion in 2001. During the inspection, PPPL was in compliance with the following federal environmental regulations:

- Clean Air Act (CAA) including National Emissions Standards for Hazardous Air Pollutants (NESHAPs)
- Clean Water Act (CWA) including National Pollutant Discharge Elimination system (NPDES)
- RCRA including Underground Storage Tanks (USTs)
- Emergency Preparedness and Community Right-to-Know Act (EPCRA)
- Toxic Substances Control Act (TSCA) including poly-chlorinated biphenyls (PCBs)
- Safe Drinking Water Act (SDWA) including underground injection control (UIC)
- Superfund Act Reauthorization Act (SARA)

Department of Energy-Princeton Area Office (DOE-PAO) annually performs a review of one aspect of PPPL's Environmental Permitting Program. [DOE-PAO]. The conclusion of this review was that 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 and/or applications developed; and the procedure for Environmental Permits completed and posted on ERWM's web page.

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

During 2000, 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 2000, PPPL shipped off site approximately 3.14 tons (2.85 metric tons) metric tons) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 70.8 tons (64.23 MT) to recycling facilities [Pu01].

PPPL is also in compliance with the requirements of the RCRA-mandated Underground Storage Tank (UST) Program. Since 1995, PPPL has taken 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.

In 2000, PPPL's non-hazardous, solid waste hauler removed 107.73 tons (97.73 metric tons, MT) of solid wastes to a sanitary landfill. PPPL generated 212.01 tons (192.33 MT) of non-recyclable construction waste primarily from demolition of modular buildings (Exhibits 3-3, 3-4, and 3–5) [Kin01a]. The Laboratory has implemented and maintains an aggressive recycling program (Exhibit 3-2).

Exhibit 3-1. Hazardous Waste Quantity Comparisons 1997-2000

	1997	1998	1999	2000
Tons	7.8	81.98	63.11	82.74
Metric tons	7.08	74.37	57.25	75.06
Largest Qty.	**Hazardous Waste**			
1	RCRA-regulated, flammable liquids	Oil-contaminated soil (recycled)	Lead (recycled)	Lead (recycled)
2	Batteries containing acid (hazardous under RCRA),	Electronic and computer scrap (recycled)	Electronic and computer scrap (recycled)	RCRA –regulated Misc. lab waste, solvents
3	Potassium permanganate/ sodium hydroxide from REML/PEARL	Mercury from ignitrons (switches) & fluorescent lamps (recycled)	(CFC) R-11, R-500, & R-502 (recycled)	Batteries containing acid (hazardous under RCRA - recycled)

MT = metric tons = 2,204.6 lbs.

Exhibit 3-2. 2000 Waste Reduction

Landfill versus Recycled, Reused or Source Reduction

Type	Source	Amount	Fate
TSCA Waste	Asbestos*	45.93MT	***Landfill***
	PCBs	0.02MT	***Landfill***
	Ballasts incl. Ballasts (PCBs)	2.63 MT	**Recycled**
Hazardous Waste	Oil and oily debris	0.33MT	***Landfill***
	Misc. lab wastes, solvents	7.65MT	***Landfill***
	Batteries (includes lead acid batteries in emergency lighting	2.85 MT	**Recycled**
	Refrigerants (CFC) R-11, R-500, & R-502	0 MT	**Recycled**
	Electronic and computer scrap	1.16 MT	**Recycled**
	Fluorescent lamps (contain mercury)	2.74 MT	**Recycled**
	Lead	60.33 MT	**Recycled**
	Mercury	0.00 MT	**Recycled**
	Recycled / Total Hazardous Waste (Recycled+Landfill)	**56.38%**	
Municipal Solid Waste (MSW)	Front end trash	97.73 MT	***Landfill***
	Construction waste	192.33 MT	***Landfill***
	Concrete	104 MT	**Recycled**
	Paper (mixed)	18 MT	**Recycled**
	Cardboard	34.21 MT	**Recycled**
	Aluminum & glass (bottles & cans)	11.09 MT	**Recycled**
	Wood	9.74 MT	**Recycled**
	Metals – aluminum & stainless steel	42.98 MT	**Recycled**
	Metals copper & wiring	16.57 MT	**Recycled**
	Metals - iron	91.71 MT	**Reused**
	Computer/electronic scrap	25.77 MT	**Recycled**
	Office supplies	0.15 MT	**Recycled**
	NB Systems & equipment for NSTX	14 MT	**Reused**
	Recycled + Reused / Total MSW (Recycled + Reused+ Landfill)	**55.94%**	**368.22 MT/656.28 MT * 100**

*In 2000 405 cubic yards of asbestos waste were disposed in a secure landfill [Pu01b].
PPPL Pollution Prevention Accomplishments may be viewed on line @ www.doep2.org/wastemin/Accompl.HSP

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)."

Exhibit 3-3. Modular Building I (MOD I)

Exhibit 3-4. Demolition of MOD I –materials for recycling and landfilling

Exhibit 3-5. Completed removal of MODs I and II

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 will keep PPPL in compliance with the applicable Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions. DOE will provide the state and EPA with annual updates and will keep 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)

Seventy-seven PPPL activities received NEPA reviews in 2000, with all of these determined to be categorical exclusions (CX) according to the NEPA regulations and guidelines of the Council on Environmental Quality (CEQ) and DOE, or covered in a previously approved environmental assessment (EA). No EAs or Environmental Impact Statements (EISs) were completed or in progress during 2000 [Lev01b].

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 capacitors were removed from the total inventory of 645 capacitors. At the end of 2000, only 5 PCB capacitors that met the regulation criteria remained at PPPL [Pu01].

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 was used on the PPPL site in 2000 [Kin01b].

Herbicides: Surflan (7 qts.)
Dimension (7 gallons)
Roundup (19 gallons)
Dissolve (5.6 pounds)
Dissolve- liquid (6 gals.)

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. [VNH98]. 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) do not apply.

3.2 Radiation Protection

3.2.1 DOE Order DOE 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 [PPPL99c]; 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 on TFTR are contained in the TFTR Technical Safety Requirements document (OPR-R-23) [PPPL93]. These criteria are shown in Appendix A, Table 1.

The emphasis of the radiation monitoring program was placed on exposure pathways appropriate to fusion energy projects at PPPL. These pathways include external exposure from direct penetrating radiation.

Exhibit 3-6. 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. Six major critical pathways are considered as appropriate (see Exhibit 3-6).

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 3-7).

The 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 3-7. 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) 2 – Delaware & Raritan Canal (DSN003) 3 – Off-site (Bee, Cranbury, Devils Brooks, Millstone River)	1 – Monthly 2 – Monthly 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) 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 2 –D-site sumps (Air shaft and MG basement)	1 –Quarterly 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 Gamma spectroscopy
Air	A1, A2, & A3	TFTR Test Cell	Continuously	Activated air (Gross b) HT and HTO
Air	A1, A2, & A3	Tritium Vault	Continuously	HT and HTO
Air	A1, A2, & A3	D-site Stack (HVAC)	Continuously	Activated air (Gross b), HT and HTO, Particulates
Direct & Air (on-site)		4 air monitoring trailers on D-site facility boundary	Continuously	g, n, HT and HTO, Activated air (Gross b)
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 implementing two 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 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 generated at PPPL. This plan includes transportation and subsequent burial at DOE's Hanford Burial Site in the state of Washington.

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 its 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 will be 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 2000. 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.

Exhibit 3-8. 2000 Fuel Use at PPPL

Fuel type [NJDEP Limit]	1998	1999	2000
No. 4 oil (gal.) [227,370 gal.]	13,470	21,358	42,155
Natural gas (million cf) [88.6 million cf]	28.9	36.94	38.26

At PPPL, NO_x are 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 (Exhibit 3-8) 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. [NJDEP96 and Kir01a].

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 TFTR 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. PPPL is pursuing replacement of older equipment (air conditioners, chiller units) with non-Class I and II refrigerants.

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, and the remaining inventory of SF_6 was removed from these systems and stored for use with NSTX.

3.3.2 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

PPPL has an in-stack sampler within the D-site (TFTR) stack to monitor tritium releases. The monitor has been independently verified as meeting NESHAPs radionuclide emission monitoring requirements. In August 1993, PPPL received EPA's concurrence on this determination. In 2000, the levels of tritium released during TFTR safe-shutdown operations were measured: 58.320 curies of tritiated water (HTO) and 18.073 curies of elemental tritium (HT) (Exhibits 3-9 and 3-10 and App. A, Table 3) [Lev01a].

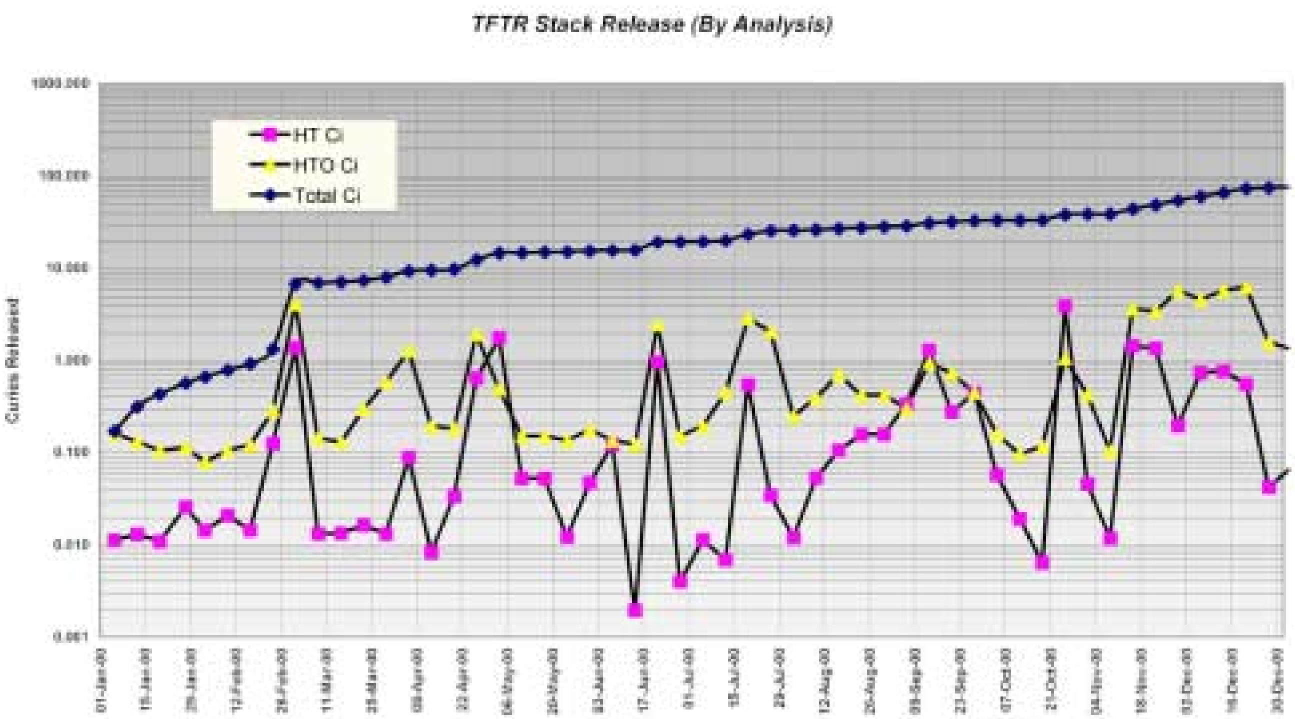
Exhibit 3-9. Total Air Releases from D-Site (formerly TFTR) Stack from 1994 to 2000

Calendar Year	HTO (Curies)	HT (Curies)	Total Curies (HTO + HT)	Activities
1994	4.30	9.28	13.58	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

Annual Limit is 500 Curies

.

Exhibit 3-10. For 2000



In Appendix A, see Table 3, "D-Site Stack Tritium Releases in Curies in 2000."

Monthly sampling continued at DSN003 – a filter backwash discharge located at the Delaware and Raritan Canal pump house. Changes in monitoring included total suspended solids (TSS) on a quarterly frequency at the discharge and intake (D&R Canal water) without a limit for TSS and monthly monitoring for chlorine-produced oxidants (CPO) (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. Semi-annual study results were submitted for December 2000 test. PPPL's discharge water and the control tests were the same – no mortality to the test specimens.

As required in the NJPDES ground water permit, NJ0086029, seven ground water monitoring wells were sampled quarterly in 2000 (App. A Tables 24-26 & 28 and Exhibits 2-2 & 4-3). Exhibit 4-5 presents the required parameters, wells, frequency, and permit standard. Under May 5, 1997-adopted NJPDES regulations, NJDEP extended expiration dates for all permits until a new ground-water discharge permit could be issued.

Monitoring conducted under the Environmental Restoration program is discussed in Chapters 6.0 and 7.0.

Exhibit 4-5. NJPDES NJ0086029 Ground Water Discharge Standards and Monitoring Requirements for Ground Water Monitoring Wells

Parameters	Standards	Feb.	May	Aug.	Nov.
Ammonia-Nitrogen	0.5 mg/L		X	X	X
Base/Neutral Extractable	See Note below			X	
Chlorides	250 mg/L			X	X
Chromium (hexavalent) & Compounds - (D-12, MW-14, MW-15, MW-16)	0.05 mg/L			X	X
Lead and Compounds	0.05 mg/L			X	X
pH- field determined	Standard Units	X	X	X	X
Petroleum Hydrocarbons				X	
Phenols	0.3 mg/L			X	X
Specific Conductance - field determined	μmho/cm	X	X	X	X
Sulfate	250 mg/L	X	X	X	X
Total Dissolved Solids TDS	500 mg/L	X	X	X	X
Total Organic Carbon TOC				X	
Total Organic Halogen TOX				X	
Total Volatile Organic VOC D-11,D-12,TW-3	See Note below		X	X	
Tritium - (D-11, D-12, TW-3)				X	

Elevation of top of casing, depth to water table from top of casing and ground level reported every quarter. All monitoring wells D-11, D-12, MW-14, MW-15, MW-16, TW-2, and TW-3 are sampled except where so noted. Note: 40 CFR Part 136-Methods 624 and 625 shall be used to identify and monitor for the volatile organic compounds and base/neutral toxic pollutants as identified in Appendix B of the NJPDES Regulations (NJAC 7:14A-1 *et seq.*).

2. Chlorine monitoring was increased from quarterly to monthly. Additionally, an elimination plan for chlorine produced oxidants (CPO) from the discharges was to be provided to NJDEP each year, as progress reports.
3. Total suspended solid(TSS) analytical frequency was reduced at the D&R Canal pump house from monthly to quarterly and without a permit limit of 20 mg/L maximum concentration.

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).

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 Table 18).

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 new 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. In order to maintain an uncontaminated potable water supply, other cross-connection equipment is tested annually. These inspection reports are submitted to the NJDEP annually.

3.5 <u>Other Environmental Statutes</u>

3.5.1 Endangered Species Act (ESA)

In 2000 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 2000, 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 Executive Orders (EO)

3.6.1 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.

3.6.2 Executive Orders (EO) 11988, "Floodplain Management"

In 2000, 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 3-13).

The 88.5-acre parcel that PPPL occupies is included in Princeton Forrestal Center's (PFC) Storm Water Management Plan-Phase I. 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.

3.6.3 Executive Orders (EO) 11990, "Protection of Wetlands"

In 2000, 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 3-13).

3.6.4 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 2000. This inventory reports the quantities of chemicals listed in the CERCLA regulations (Exhibit 3-12).

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 forms

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 3-12. 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

TRI – Toxic Release Inventory

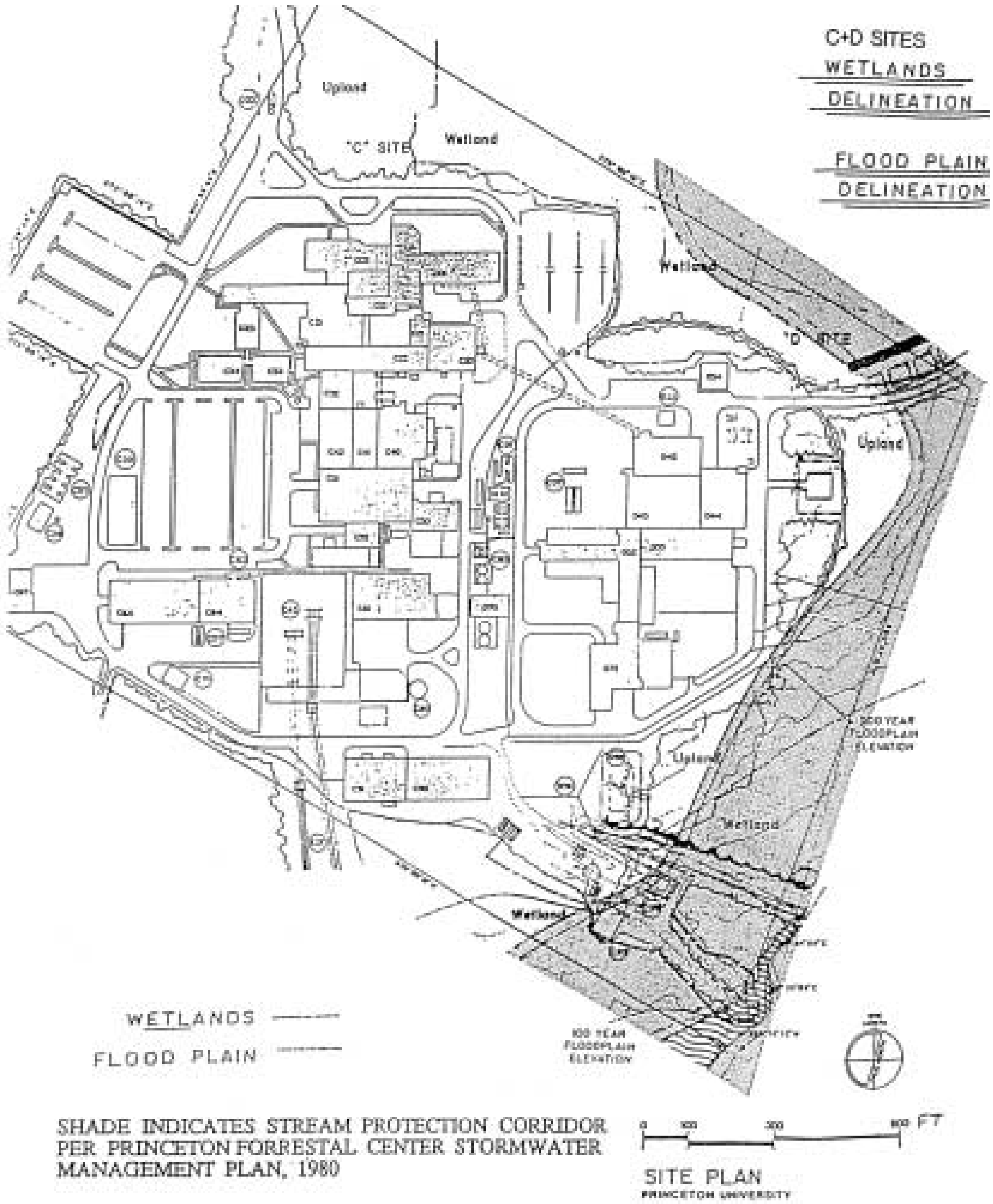


Exhibit 3-13 PPPL Site Map – Floodplain and Wetland Boundaries

Exhibit 3-14 lists hazardous compounds at PPPL reported under SARA Title III for 2000 [PPPL01a]. These chemicals are found in 40 CFR Part 372, Subpart D, which lists names and chemical abstract system numbers for toxic chemicals.

Exhibit 3-14. 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

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.

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 [PPPL01a].

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 2000 (not required).

3.7 Other Major Issues and Actions

3.7.1 Air Quality

Through PPPL's Waste Minimization and Pollution Prevention program, PPPL replaced over 100,000 square feet of roofing, increasing the thermal resistance. Based on the electrical energy savings, PPPL estimates an annual reduction in air pollutants: 465,000 pounds carbon dioxide (CO_2 - a greenhouse gas), 2.4 pounds sulfur dioxide (SO_2), 29.4 pounds particulates, and 42.58 pounds total organic compounds for a total of 210 metric tons [McG01a].

3.7.2 Surface Water Quality

Under NJPDES requirements, PPPL needs to eliminate from its discharges (basin outfall designate serial number, DSN001, and D&R Canal pump house outfall, DSN003) chlorine-produced oxidants (CPO). CPO is created by the reaction of chlorine combining with organic material in the water. Chlorine is added to prevent biofouling in water pipes and cooling tower equipment. CPO is generally harmful to biota in the receiving streams.

PPPL purchased a chlorine controller with plans to install a new metering system in the D&R Canal water system in 2001. A similar system is planned at the D-site cooling tower. By reducing/ limiting the amount of chlorine added to these systems, PPPL intends to protect its water systems/equipment while protecting the environment.

3.7.3 Ground Water Quality

Under New Jersey's State program for NJPDES ground water discharges, PPPL's permit (NJ0086029) expired on December 31, 1994. A renewal application was prepared and included a report on ground-water quality based on quarterly ground water samples collected from December 1989 through February 1994 [Fi94]. Since 1995, PPPL continues to quarterly monitor seven ground water wells in compliance with the conditions of the expired permit.

The NJDEP proposed that PPPL prepare a Ground Water Protection Plan (GWPP), in which data and recommendations are presented on the basis for reducing sample locations, sampling frequency, and number of parameters. In 2000, PPPL submitted a GWPP for NJDEP's review and approval [PPPL00b].

In 1993, NJDEP signed a Memorandum of Understanding (MOU) with Princeton University to investigate A and B sites; PPPL and DOE-PAO were to investigate C and D sites. 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.

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.

3.7.4 Pollution Prevention Activities

In 2000, PPPL continued its efforts to pursue waste minimization and pollution prevention opportunities during the dismantlement of two modular office buildings. With the demolition of the two connected modular structures, PPPL recycled 104 metric tons of building debris while sending 192 metric tons to landfills.

Metal recycling was also increased; the metals include iron, steel (stainless), copper, and aluminum, which resulted from interior renovations and exterior alterations. Lead shielding blocks were recycled from TFTR.

3.7.5 Outreach – 4th Annual Earth Day, Open House and America Recycles Day

In April 2000, the fourth annual Earth Day Celebration at PPPL involved ten local area middle schools and children of PPPL staff in a poster contest: "Conservation of Natural Resources through Recycling and Buying Recycled." Over 200 students, teachers, parents, and PPPL staff attended the celebration that included presentation of contest awards, a briefing on the National Spherical Torus Experiment by the Program Director, and a student presentation by "Earth Neighbors Club" on efforts to landscape school grounds with low-water usage plants (xeriscaping)and recycling of 600 pounds of paper weekly.

In June 2000, PPPL invited the public to visit the facility and participate in Open House tours, demonstrations, and other activities. Over 2000 visitors enjoyed a beautiful day, making the Open House a popular and well-received outreach program.

For America Recycles Day (ARD - November 15th of each year), PPPL hosted a forum that brought together representatives from EPA, NJDEP, commercial recyclers, and PPPL staff. The purpose of ARD is to promote awareness and action to "Reduce, Reuse, Recycle, and Buy Recycled," at PPPL and at home. The Laboratory Director presented "Green Machine" awards to staff members who demonstrated their commitment to the ARD principles through their actions at PPPL [McG01b].

3.7.6 Safety

PPPL's 2000 performance with respect to worker safety was as follows:

Recordable injury case rate:
3.72 per 200,000 hours worked
Lost Work Day case rate:
0.51 per 200,000 hours worked
Lost Workday rate:
0.85 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)

3.8 Continous Release Reporting

In 2000, PPPL had no continuous releases to report.

3.9 Unplanned Releases

In December 2000, PPPL reported to NJDEP that less than 1 gallon of No. 4 fuel oil spilled on gravel adjacent to an above ground storage tank. During refilling operations, an oil line was opened, a dipstick was inserted and the cap was removed. When oil was pumped into the tank, it splashed out of the open line, spilling into the tank's secondary containment and down the side of the tank onto the concrete base and gravel. Refilling operations stopped and the cap was replaced. Cleanup of the oil included cleaning the exterior of the tank and removal of the soiled gravel.

The operations procedure was revised and operators were re-trained on the revised procedure to ensure that the dipstick is removed and the system checked prior to filling the tank.

3.10 Current Issues and Actions

3.10.1 Stony Brook Regional Sewerage Authority (SBRSA)

In August 1999, PPPL sampled the liquid effluent collection (LEC) tank #3 for pH, temperature, chemical oxygen demand (COD), and tritium (HTO). These results were sent to Stony Brook Regional Sewerage Authority as part of the monthly monitoring report as required by the discharge license. COD was monitored annually. The COD concentration limits are 1,000 mg/L monthly average and 1,500 mg/L daily maximum. The August 1999 COD concentration was 1,200 mg/L; as only one tank sample was analyzed for COD, the monthly average limit (1,000 mg/L) was exceeded. Investigation into the cause/source of the high COD concentration was not conclusive; the exact source remained unidentified.

In April 2000, SBRSA issued a notice of violation (NOV) for the COD exceedance and required COD testing for six consecutive samples with results below the limit. In April 2000, PPPL and DOE-PAO submitted the renewal application for the Industrial Discharge License.

SBRSA issued the renewed license in August 2000, with monthly COD monitoring. Despite COD analyses for all LEC tank samples prior to release, high COD concentrations were detected in June 2000. Tanker trucks removed the LEC tank wastewater for treatment at Gloucester County Utility Authority (GCUA). A strict examination of each wastewater system and control to prevent high COD wastes from entering the LEC tanks were instituted by PPPL. Again in December 2000, LEC tank wastewater was removed for treatment at GCUA due to high COD concentrations. PPPL continues to investigate the source of COD.

3.10.2 Environmental Management Systems

The benefits of Environmental Management Systems (EMS) and the associated International Standard Organization (ISO) 14000 system are being reviewed by PPPL. There is no formal EMS program at present, while many of the elements of an EMS are presently instituted in plans, policies, and procedures at PPPL.

3.11 Summary of Environmental Permits

The following table (Exhibit 3-15) presents the different regulatory requirements/permits with which PPPL must comply. It is not solely a list of environmental permits, but rather the 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 3.0 and 6.0, "Environmental Non-Radiological Program Information." ✳

Exhibit 3-15. 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 7:27-8 – Air Pollution Control – Permits and Certificates	4 Boiler stacks; 2 Storage tank vents; 3 Dust collectors; 2 Diesel generators.	Fuel use reported in ASER; 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) formerly Radiological Environmental Monitoring Laboratory (REML)	Annual application; semi-annual performance testing; results reported in ASER
Land Use - Wetlands	NJAC 7:7A – Freshwater Wetlands Protection Act Rules	Delineated wetlands – LOI; 26 kV tower maintenance, well installations	Status reported in bi-monthly updates; Also, reported in ASER
Meteorology	DOE Order 430.1A - Life Cycle Asset Management	Meteorological tower – 3 levels (10, 30, and 60 meters) 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 4 mrem/year annual dose. 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; 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 40 CFR 110 – Discharge of Oil 40 CFR 112 – Oil Pollution Prevention	PPPL designated minor facility – no DPCC or DCR required; Spill Prevention, Control, and Countermeasure Plan (SPCC) required	SPCC Plan required; Inspections, records, procedures

Exhibit 3-15. Environmental Requirements (cont.)

Media	Regulatory Citation	Requirement/Permit	Data Reported
TSCA	40 CFR 761- Polychlorinated Biphenyls (PCBs)	Label, inspect, records of polychlorinated biphenyls (PCBs) in capacitors	Inventory; Disposal records; Also reported in ASER
Waste - Hazardous	40 CFR 260 –279 – Resource Conservation and Recovery Act (RCRA) NJAC 7:26-8 – Hazardous Waste Regulations	On-site 90 –day temporary storage; EPA ID #. NJ1960011152 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: Tritium 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 Gross beta	2 million picoCuries/Liter per discharge
	Stony Brook Regional Sewerage Authority Industrial Discharge License (22-96-NC)	LEC tank sampled for: Tritium & Gross beta pH, temperature, Chemical oxygen demand (COD) Quantity released	Monthly Discharge Report – Self Reporting Form to SBRSA 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*.; Also reported in ASER
Water - Ground	NJAC 7:14A – The New Jersey Pollutant Discharge Elimination System (NJPDES)	Quarterly ground water monitoring of seven wells; May & Aug. sampling two inflows	Quarterly reports to NJDEP; Also, reported in ASER
	NJAC 7:19 – Water Supply Allocation Permits	Two former production wells - quantities pumped not to exceed 100,000 gpd	Annual report to NJDEP
	NJAC 7:26E – Technical Requirements for Site Remediation	Investigation - ground water monitoring, soil assessment, soil removal	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, & County Health Officer
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; semi-annual chronic toxicity test	Monthly discharge monitoring reports to NJDEP; annual chronic toxicity test report to NJDEP; Also, reported in ASER

Chapter 4

ENVIRONMENTAL PROGRAM INFORMATION

4.1 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 established baselines prior to TFTR operations. Exhibit 4-1 lists the air stations that were monitored for radiological parameters in 2000.

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

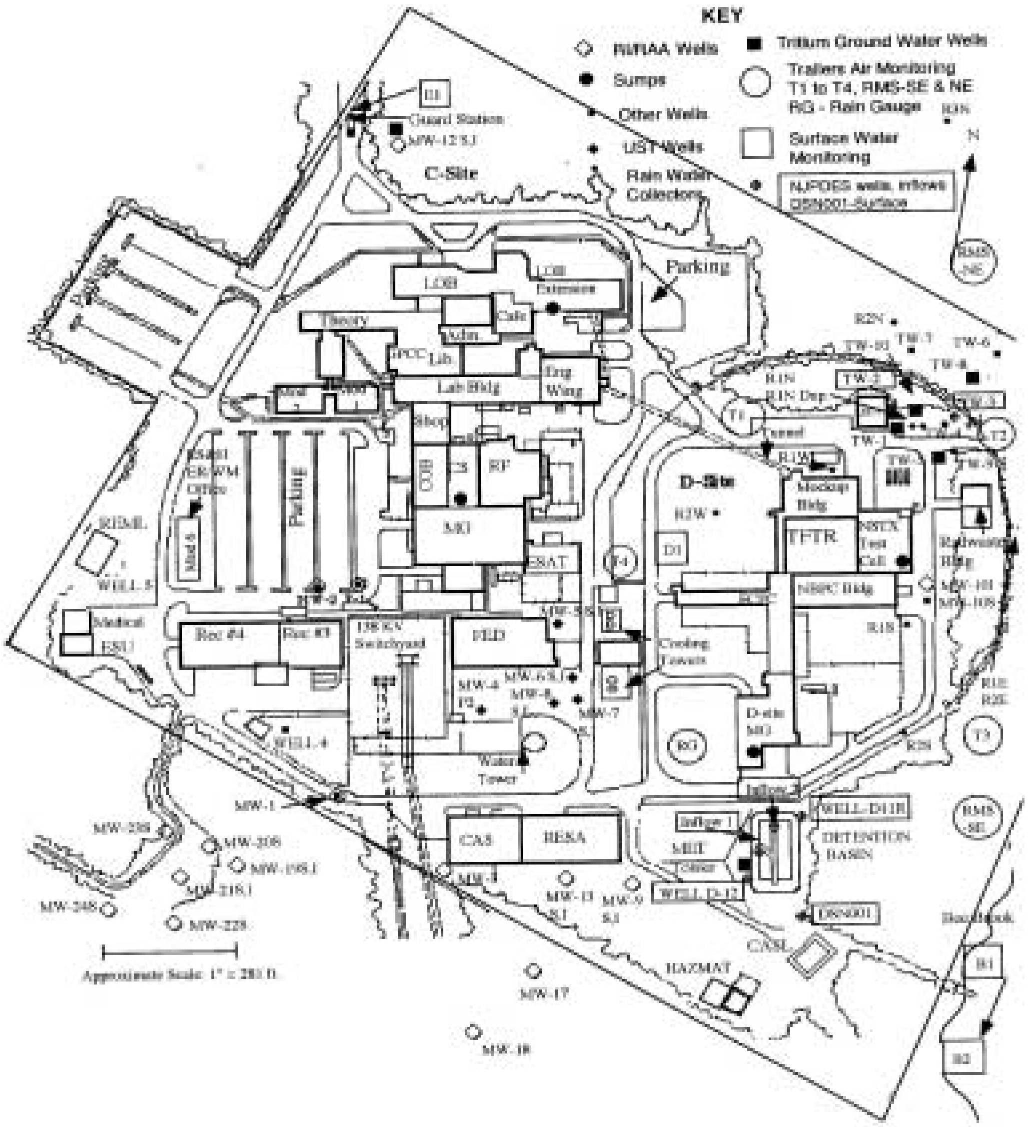
Exhibit 4-1. Radiological Air Monitoring Stations

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	8 Neutron detectors and gamma ionization detectors and passive tritium monitors at *T 1-4*:	4-3
Radiological monitoring system (RMS) at property line stations	2 Neutron detectors and gamma ionization detectors at Northeast (*RMS-NE*) and Southeast (*RMS-SE*)	4-3

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

Station #	Location/Exhibit #	Description
B1	Off-site / 4-4	Bee Brook Upstream of discharge from detention basin
B2	Off-site / 4-4	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 TFTR & NSTX
LECT 1,2,or 3	On-site /4-3	Liquid effluent collection tanks north of TFTR & NSTX
R Series R1S to R3N	On-site /4-3	8-Rain water monitoring locations for North, South, East, & West @ 250 & 500 ft. from stack
Rainwater R1-R6	On-site /4-3	Rain water monitoring locations (5 co-located with air DATS)

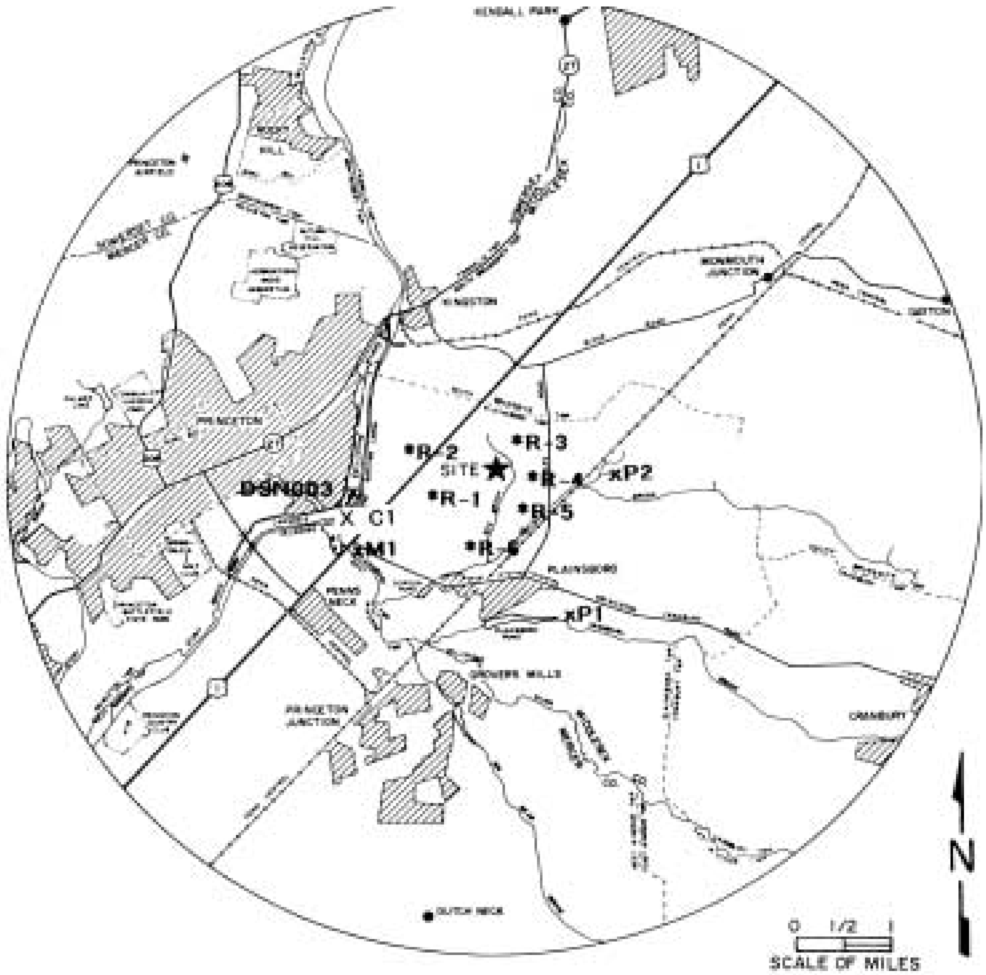
Exhibit 4-3. PPPL Site Map On-site Monitoring Locations



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 16 million people live within 50 miles radius (80 km) of the site and approximately 212,000 within 10 miles (16 km) of PPPL.

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 0.045 mrem (0.45 µSv) for 2000 (see Exhibit 3-7). Detailed person-rem

Exhibit 4-4. Off-site Monitoring Locations



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.

4.2 Summary of Non-Radiological Monitoring Program

During 2000, PPPL operated under New Jersey Pollutant Discharge Elimination System (NJPDES) surface water permit, number NJ0023922, effective on March 1, 1994 and renewed effective June 1, 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 (Old and new permit conditions):

- Temperature
- pH
- Petroleum hydrocarbon (TPH)
- Total suspended solids (TSS)
- Chemical oxygen demand (COD)
- Chlorine-produced oxidants (CPO)
- Flow

Quarterly, as revised under the new permit:

- Total phosphate (Tot. P)
- Tetrachloroethylene (PCE)

Semi-Annual/Annual:

- Chronic Toxicity Testing

Monthly sampling continued at DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house. Changes in monitoring included total suspended solids (TSS) on a quarterly frequency at the discharge and intake (D&R Canal water) without a limit for TSS and monthly monitoring for chlorine-produced oxidants (CPO) (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. Semi-annual study results were submitted for December 2000 test. PPPL's discharge water and the control tests were the same – no mortality to the test specimens.

As required in the NJPDES ground water permit, NJ0086029, seven ground water monitoring wells were sampled quarterly in 2000 (App. A Tables 24-26 & 28 and Exhibits 2-2 & 4-3). Exhibit 4-5 presents the required parameters, wells, frequency, and permit standard. Under May 5, 1997-adopted NJPDES regulations, NJDEP extended expiration dates for all permits until a new ground-water discharge permit could be issued.

Monitoring conducted under the Environmental Restoration program is discussed in Chapters 6.0 and 7.0.

Exhibit 4-5. NJPDES NJ0086029 Ground Water Discharge Standards and Monitoring Requirements for Ground Water Monitoring Wells

Parameters	Standards	Feb.	May	Aug.	Nov.
Ammonia-Nitrogen	0.5 mg/L		X	X	X
Base/Neutral Extractable	See Note below			X	
Chlorides	250 mg/L			X	X
Chromium (hexavalent) & Compounds - (D-12, MW-14, MW-15, MW-16)	0.05 mg/L			X	X
Lead and Compounds	0.05 mg/L			X	X
pH- field determined	Standard Units	X	X	X	X
Petroleum Hydrocarbons				X	
Phenols	0.3 mg/L			X	X
Specific Conductance - field determined	µmho/cm	X	X	X	X
Sulfate	250 mg/L	X	X	X	X
Total Dissolved Solids TDS	500 mg/L	X	X	X	X
Total Organic Carbon TOC				X	
Total Organic Halogen TOX				X	
Total Volatile Organic VOC D-11,D-12,TW-3	See Note below		X	X	
Tritium - (D-11, D-12, TW-3)				X	

Elevation of top of casing, depth to water table from top of casing and ground level reported every quarter.
All monitoring wells D-11, D-12, MW-14, MW-15, MW-16, TW-2, and TW-3 are sampled except where so noted.
Note: 40 CFR Part 136-Methods 624 and 625 shall be used to identify and monitor for the volatile organic compounds and base/neutral toxic pollutants as identified in Appendix B of the NJPDES Regulations (NJAC 7:14A-1 *et seq.*).

4.3 Environmental Requirements

Environmental requirements, for which DOE and PPPL are held accountable, are listed in Exhibit 3-12 and are discussed in Chapters 3.0, "Environmental Compliance Summary" and 6.0, "Environmental Non-Radiological Program Information," of this report.

4.4 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements or Environmental Assessments were prepared in 2000.

4.5 Summary of Significant Environmental Activities at PPPL

4.5.1 Regulatory Inspections/Audits

In July 2000, an NJDEP Enforcement Inspector conducted the annual inspection of the Discharge to Surface Water Permit (NJPDES NJ0023922 [NJDEP98b). 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 exceedances of any permit limits during 2000.

4.5.2 Tritium in the Environment

In August 1995, when the tritium concentration (in water) was found to be above background or baseline in well TW-1, a more extensive monitoring program for environmental tritium began. More wells and ground water sumps were sampled, underground utilities were tested for leaks; soil was tested; roof drains were evaluated. Ten on-site and six off-site rainwater-stations were located and sampled at least monthly as precipitation allowed.

The investigation found no leaks emanating from underground utilities; soil results supported this finding. Drain samples from the liquid effluent collection (LEC) tank roof as well as soil samples next to drain spouts showed that tritium concentrations were elevated. Periodic samples of rain, surface, and ground water continue.

Exhibit 4-6. 2000 Highest Tritium Concentrations in Environmental Samples

Media	Location	Highest HTO	Week Ending	Stack Data (Date)
Air	T1 (NW D-site)	238.66 pCi/m^3	Oct. 16	0.117 Ci HTO (Oct. 18)
	R1 (W of PPPL)	189.43 pCi/m^3	Feb. 7	0.106 Ci HTO (Feb. 9)
	T3 (S D site)	228.61 pCi/ m^3	Jun 27	0.152 (Jun 28)
	D-site Stack	6.25Curies	Dec. 20	6.25 Curies
Well	TW-2	1,027pCi/L	May 4	(May 10) 0.151 Ci HTO
	TW-3	878pCi/L		
	D-12	1,104pCi/L		
	D-11R	941pCi/L		
Rain water	R1S	3,617pCi/L	Nov. 28	(Nov. 29) 5.74 Ci HTO
	R1W	1,910pCi/L		
	R2W	1,559pCi/L		
Surface water	DSN001	730pCi/L	May 23	(May 24) 0.135 Ci HTO

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

4.5.3 TFTR Deconstruction and Decontamination Project (D&D)

The dismantlement and removal TFTR presented a unique and challenging task for PPPL. The first challenge is the size of the vacuum vessel – 100 cubic meters; the second challenge is the total tritium content that remains in the vessel in excess of 7,000 Curies (dose rates approach 50 mrem/hr). Plasma arc cutting is the current baseline technology for the dismantlement of fission reactors. In 2000, PPPL chose an innovative diamond-wire cutting technology following a series of successful trials.

In preparation for the cutting of the vacuum vessel, PPPL spent the majority of 2000 removing structures from around the vacuum vessel. These activities included removal of carbon tiles that lined the vessel interior from the cut-line zones, the upper poloidal-field coils (PF - large copper magnets) and umbrella structure (a single lift of 92 tons), and vacuum pumping ducts and neutral beam lines. Despite the size and magnitude of the removal of systems and equipment, the D&D project is on-schedule to be completed by the end of Fiscal Year 2002 (September 30, 2002) [Pe01].

4.5.4 Pollution Prevention-P[2]

In 2000, PPPL accomplished the activities described in the following paragraphs [McG02b]. The waste recycling program continued with PPPL's solid waste stream reduction of 115,102 pounds of recycled paper and cardboard, and 24,449 pounds of aluminum cans, plastic and glass bottles [Exhibit 3-2].

Exhibit 4-7. TFTR Photographed on March 6, 1989

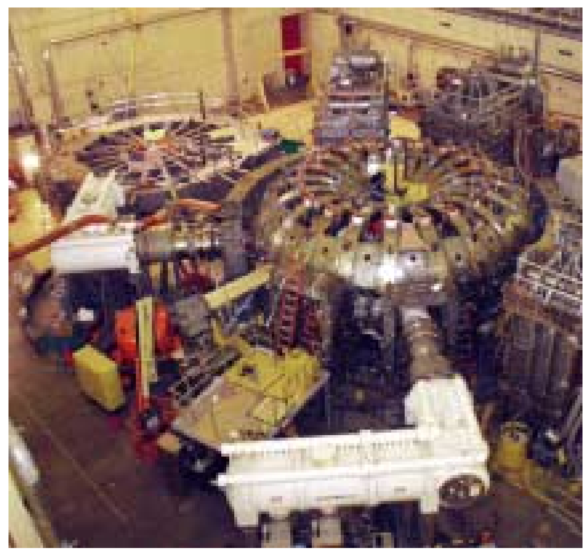


Exhibit 4-8. TFTR Photographed on November 15, 2000

These accomplishments are attributable to improvements in the sanitary waste evaluation process [Kin01a, McG01b].

In the three years, 1998-2000, PPPL's hazardous waste disposal (landfill) to recycled material ratio see-sawed from 37.5% to 94% and back down again to 56% respectively. For the same period, the municipal solid waste (MSW) ratio followed a similar trend going from 47.4% to 70.5 % and down again to 56%. PPPL endeavors to increase both ratios as well as instituting a "buy recycled-content products" through its Procurement Office.

Other PPPL P^2 activities included:

- Recycled 2,500 fluorescent light ballasts
- Sale of 133,004 lbs. lead to a recycler

In 2000, PPPL demolished two modular structures. From these modules, 192.33 metric tons (MT) of building debris was sent to a landfill and 104 MT of concrete and 42.26 MT of steel were recycled. For this particular project, the ratio of recycled/reused (146.26 MT) to the total amount of material removed (338.59 MT) was 43.19%. This ratio is less than the annual ratio of the recycled/reused *versus* total quantity of MSW (55.94% - Exhibit 3-2).

PPPL participated in several energy savings programs. These programs included replacement of the old fluorescent bulbs with newer, more-energy efficient lighting, roof replacement, expansion of the building automation system, installation of efficient air handlers for the air-conditioning and heating units, and installation of controllers on large motor generators.

In 2000, the National Spherical Torus Experiment (NSTX) reused systems and equipment removed from TFTR. The equipment included neutral beam (NB) systems, vacuum pumps, NB duct seals, bellows and eleven Diagnostic Systems for a reported cost savings/avoidance of an estimated $2.9 million.

4.5.5 Environmental Training and College Interns

In 2000, 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 4-9. Drexel Intern Collecting Data

In 2000, 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 2000, the release 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 is summarized in Exhibit 5-1 below. The calculated EDE at the site boundary is one-quarter of one mrem, far below the annual limit of 10 mrem per year [Lev01a].

Exhibit 5-1. Summary of 2000 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 58.320(2.16x 10^{12}) HT 18.073(0.669 x 10^{12})	0.1521000	71.28	1.5431386
Tritium (air)	RWHF	0.17855 (6.61 x 10^{9}) 0.76285 (Est. 2.82 x 10^{10})	0.0590000	27.65	0.0190163
Tritium (water)	LEC tank	0.0842 (HTO) (3.12 x 10^{9})	0.0016840	0.79	0.0023068
Tritium (water)	Surface Ground	216 pCi/L (Bee Brook) 1104 pCi/L (Well D-12)	0.0005960	0.28	0.0008164
Direct/Scattered neutron & Gamma Radiation	NSTX	2X10^{15} DD neutrons + 4X10^{13} DT neutrons	0.0000023	<0.01	Negligible
Argon-41 (Air)	NSTX	0.0000474 (1.75 x 10^{6})	0.0000006	<0.01	0.0000011
Total			**0.2133829 (2.13 x 10^{-3})**		**1.5652792 (1.57 x 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

NOTES:

Estimated dose equivalent at the nearest business is 0.04519 mrem 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, this dose is equivalent is 0.098 mrem/yr (9.8 x 10^{-7} 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 design objective for 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 2000 that generated neutron and gamma radiation. Approximately 2,000 experimental shots were conducted using neutral beam injection, which generate a maximum of 1×10^{12} deuterium-deuterium (D-D) (2.5 MeV) neutrons/shot. Approximately 2% of these shots also generate deuterium-tritium (D-T) (14.1 MeV) neutrons. The total number of neutrons produced during NSTX experiments in 2000 was 2×10^{15} D-D neutrons in addition to 4×10^{13} D-T neutrons. 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 1×10^{-21} mrem from D-D neutrons and 8.2×10^{-21} mrem from D-T neutrons. [Lev01a].

5.1.2 Sanitary Sewage

Drainage from D site sumps 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 2000 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 (2×10^6 pCi/liter for tritium).

As shown in Exhibit 5-2, the 2000 total amount of tritium released to the sanitary sewer was 0.0809 Curies, about eight 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 885 pCi/L.

Exhibit 5-2. Total Annual Releases to Sanitary System from 1994 to 2000

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	0.0809

5.1.3 Radioactive and Mixed Waste

In 2000, low-level radioactive wastes were stored on-site prior to off-site disposal, either in the Radioactive Waste Handling Facility (RWHF) or within a controlled area of TFTR. Low-level radioactive shipments made in 2000 consisted of removed systems from TFTR and compacted solid waste, including personal protective clothing. No low-level radioactive mixed waste was generated in 2000 [Pu01b].

Exhibit 5-3. Securing B-25 boxes for shipment.

Exhibit 5-4. Total Low-Level Radioactive Waste 1997-2000

Year	Cubic feet (ft^3)	Total Activity in Curies
1997	1,997.7	31,903.0
1998	533.74	204.80
1999	1188	213.76
2000	4,235.7	50.0

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

PPPL uses the differential atmospheric tritium sampler (DATS) to measure elemental (HT as shown in Exhibit 5-6) and oxide (HTO) tritium at the D site stack and in the Radioactive Waste Handling Facility (RWHF). The peaks in Exhibit 5-6 correlate generally with elevated D-site stack releases.

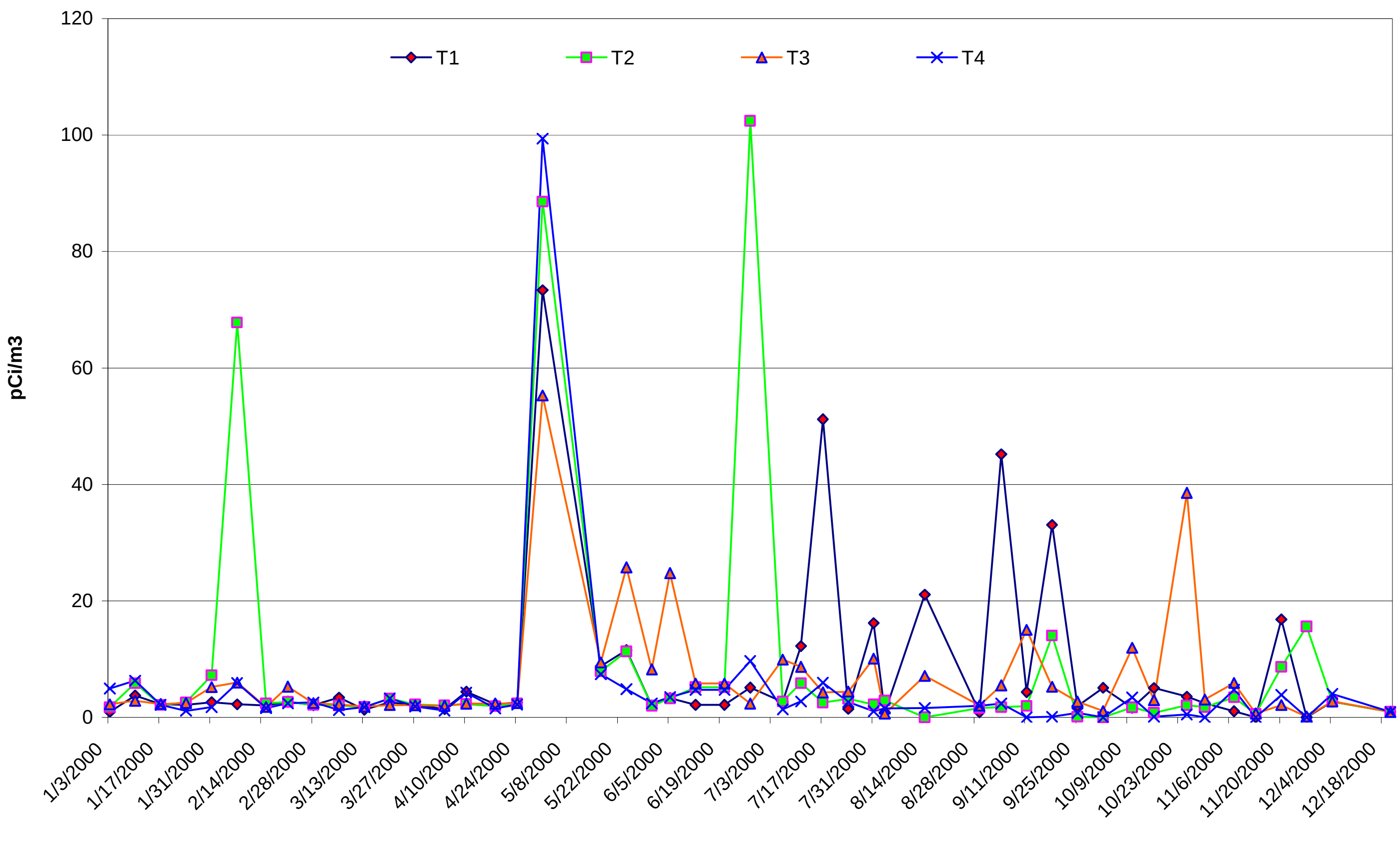
DATS are similarly used at eleven (11) environmental sampling stations: 4 located on D site facility boundary trailers (T1 to T4), 6 located at remote environmental air monitoring stations (R 1 to R6) (App. A, Tables 4-7). The baseline location was moved to Roebling, N.J. (Burlington County) from Hopewell,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

Exhibit 5-5. Health Physics surveying

Tritium (HTO and HT) was released and monitored at the D site stack (App. A, Table 3 and Exhibit 3-7). Projected dose equivalent at the nearest off-site business from airborne emissions of tritium was 0.098 mrem/year (9.8×10^{-7} μSv/year). Measurements at the D site facility boundary have measured concentrations in the range from 0.09 to 102.43 pCi/m^3 elemental tritium (HT) and from 0.34 to 238.66 pCi/m^3 oxide tritium (HTO) (App. 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.

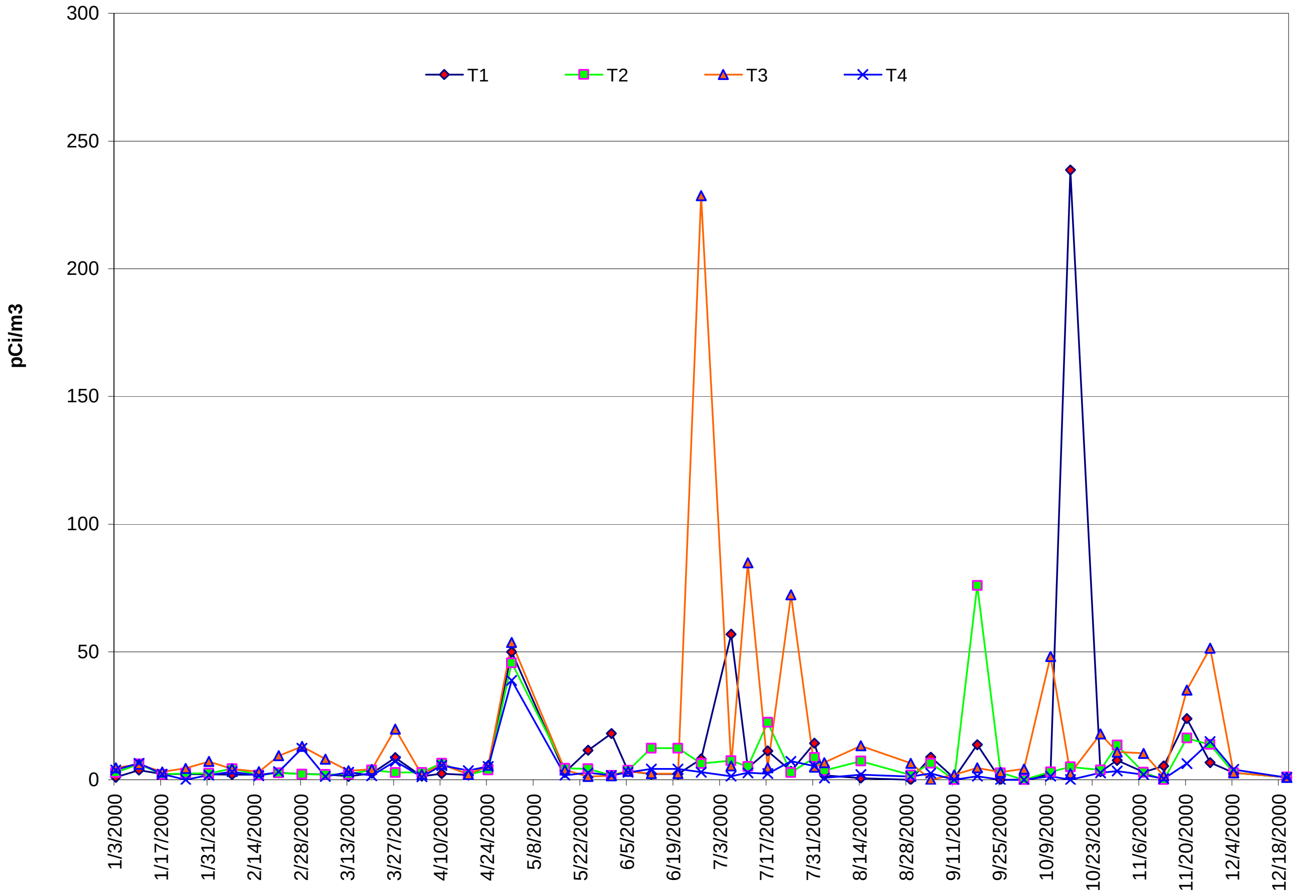
The EDE at the site boundary was calculated based on annual tritium totals as measured at the stack and RWHF (DATS air) and water samples at the LEC tanks and highest measurements from a well and surface water during 2000. The addition of the RWHF, which has no elevated stack, contributes more significantly to the EDE at the site boundary than to the EDE at the nearest business.

Exhibit 5-6 Airborne Emissions (HT) at On-site Monitors (T1 to T4)



In Appendix A, see Table 4, "Air Tritium (HT) Concentrations Collected On-Site in 2000."

Exhibit 5-7 Airborne Emissions (HTO) at On-site Monitors (T1-T4)



In Appendix A, see Table 5, "Air Tritium (HTO) Concentrations Collected On-Site in 2000."

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, Subsection.

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.
10.1101.

5.3 Protection of Biota

The highest measured concentrations of tritium in surface and ground water in 2000 was 1,104 pCi/L (Well D-12). This concentration is a very small fraction of the water biota concentration guide (BCG) (for HTO) of 3 x10^8 pCi/L for aquatic system evaluations, and the water BCG (for HTO) of 2 x 10^7 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 releases in 2000.

5.5 Environmental Radiological Monitoring

5.3.1 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).

In late May 2000, at on-site location DSN001, basin outfall, tritium was detected at 728 pCi/Liter, which was the highest in 2000 for surface water samples (App. A, Table 8).

Exhibit 5-8 Total Rainfall in Inches (centimeters) 1988-2000

Dry < 40 in		Average 40-50 in		Wet > 50 in	
1988*		1991	45 (114)	1989	55 (140)
1995	35.6 (90)	1992	42 (107)	1990	50.3 (128)
2000	38.7 (98.3)	1993	42.7 (108)	1994	51 (130)
		1997	41.99 (107)	1996	61 (155)
		1998	42.96 (109)		
		1999**	47.27 (120)		

*Rainfall collected for 10 months; est. >40 inches.
**1999 without Hurricane Floyd 38.72 inches (98).

Rain water samples collected and analyzed in 2000 ranged from below detection (<31) to 3,617 pCi/liter (App. A , Tables 10 & 11), which are lower than the three-year high of 61,660 pCi/liter (App. A, Table 12). In the weeks prior to collecting the highest-level rain water sample (3,617 pCi/L), elevated HTO levels from D-site stack were detected during the month of November 2000 (3.418 to 5.740 Curies). Though these levels are elevated the highest release of tritium was detected from December 13 to 20 (6.250 Curies HTO) this release occurred during the D&D activities in TFTR Test Cell. The total annual quantity of tritium (HTO + HT) was measured to be 76.393 Curies.

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 TFTR stack. Monitoring of tritium concentrations in rain water continues.

In April 1988, PPPL began precipitation. Monitoring program to record on-site precipitation on a weekly basis. Exhibit 5-8 shows the occurrence of dry, average, and wet years (App. A, Table 2 for 2000 weekly rainfall) [Ch01].

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. 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.

In 2000, ten on-site wells -, TW-8, MW-12S, MW-14, MW-16, D-11R and D-12 on C site, and TW-1, TW-2, TW-3, and TW-5, on D site - were sampled. Water from two foundation sumps (located in the TFTR Air Shaft room and D-site MG basement) were also sampled and analyzed for tritium. Since the presence of tritium at D site and the onset of D-T operations, ground water results were slightly elevated in TW-1 and TW-5.

In 2000, the highest concentrations of tritium were found in wells TW-2 and TW-3 (1,027 and 878 pCi/L, respectively) not in wells TW-1 or TW-5, though they are in the same proxomate area. Wells D-11R and D-12 also showed elevated tritium concentrations (941 and 1,104 pCi/L, respectively) and are not located in the same area as the TW wells. D-11R and D-12 are located south of D-site, next to the detention basin. Rain water results for the locations nearest to the basin (R2S and R1S) show elevated tritium concentrations in the 1,000 pCi/L range (App. A, Table 10).

HTO concentrations ranged (pCi/Liter):

TW-1 536 to 707
TW-2 140 to 1,027
TW-3 135 to 878
TW-5 491 to 694
D-11R <93 to 941
D-12 <106 to 1,104

See App. A, Table 9 .

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 into 2001.

C. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. 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 2000, tritium measurements of potable water ranged below the level of detection (<92pCi/L to <452 pCi/liter App. A , Table 8).

5.3.2 Foodstuffs and Soil and Vegetation

There were no foodstuffs, soil, or vegetation samples gathered for analysis in 2000. 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 the water sampling and monitoring which produced more relevant results.

The capability to perform soil/biota analysis has been retained and is now performed using oxidation, when necessary.

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 2000, PPPL's discharges were within allowable limits for all testing parameters.

The last exceedance at DSN001 was reported in November 1993 for total suspended solids (73 mg/L *vs*. 50 mg/L—the permit limit). The last exceedance at DSN003 occurred in January 1999, when the total suspended solids (TSS) concentration was measured at 24 mg/L at DSN003 exceeding the monthly average limit of 20 mg/L. Once each year for three previous years 1997-1999, TSS concentrations were exceeded at DSN003, which is the discharge for the filter back wash at the Delaware & Raritan (D&R) Canal pump house. PPPL attributed the TSS concentration above the 20 mg/L limit to the quality of the D&R Canal water.

In 2000, due to a change in the NJPDES permit, total suspended solids were required to be sampled quarterly at both the discharge outfall and intake (upstream of the D&R Canal pump house). The TSS limit was also removed.

In May 2000, the first of three annual progress reports was submitted to NJDEP. [PPPL00a} The NJPDES permit required the preparation of a progress report on the reduction of chlorine from PPPL's cooling water. PPPL reported that new chlorine controller equipment was being considered for the D&R Canal water as well as for the D-site cooling tower; blowdown from the tower is discharged to the detention basin (DSN001). Monthly analysis for chlorine-produced oxidants (CPO) or total residual chlorine (TRC) are conducted at both outfalls.

6.1.2 Chronic Toxicity Characterization Study

In 2000, 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) [PPPL01d]. 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 (Exhibit 6-1).

Exhibit 6-1. Summary of Chronic Toxicity Testing

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.)

*One test result <100 NOEC (failed test).

6.1.3 Ground Water

Since 1989, PPPL has monitored groundwater 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-PG submitted to NJDEP the NJPDES permit renewal application. Included in that application was the "Ground Water Quality Report for the NJPDES Permit Renewal Application Permit No. NJ0086029," which summarized data from 1989 to 1994 [Fi94]. PPPL is preparing Ground Water Protection Plan (GWPP), which will replace the standard NJPDES permit [PPPL01b].

A. NJPDES Quarterly Ground Water Monitoring Program in 2000

In this section, the NJPDES Quarterly Ground Water Monitoring Program is discussed in three parts: A and B site wells (MW-14, MW-15, and MW-16); C and D site wells (D-11, D-12, TW-2, and TW-3); and the detention basin Inflows 1 and 2.

Three A and B site wells-MW-14, MW-15, and MW-16-were sampled quarterly (App. A, Table 24). All results from the August 1999 sampling showed concentrations below permit standards for base/neutral compounds.

The C and D site wells-D-11R, D-12, TW-2, and TW-3-were sampled quarterly in 2000, (App. A, Tables 25 & 26). Tetrachloroethene (PCE) was detected (May and August samples); these PCE results were above the Ground Water Quality Standards (GWQS) (Exhibit 6-2). Also, detected above the GWQS was trichloroethene (TCE) in well D-12. 1,1-Dichloroethene was detected in concentrations well below the GWQS (70 µg/) in well D-12 (App. A, Table 28).

As discussed in Chapter 7, "Site Hydrology, Ground Water and Public Drinking Water Protection," the volatile organic compounds detected in these wells are not believed to originate from the detention basin.

Exhibit 6-2. Volatile Organics in Ground Water

Volatile Organics in µg/L	D-11R		D-12		TW-3		*GWQS*
	May	**Aug.**	**May**	**Aug.**	**May**	**Aug.**	
Tetrachloroethene (PCE)	4.52	4.83	3.26	4.36	2.53	5.04	*0.4*
Trichloroethene (TCE)	<0.3	<0.8	1.87	1.75	<0.6	<0.8	*1.0*
1,1-dichloroethane	<0.5	<0.7	1.82 T	1.18T	<0.5	<0.7	*70*

Detention basin inflows or influents are monitored twice each year, in May and August (App. A Tables 21 & 28), pursuant to PPPL NJPDES ground water discharge permit, NJ0086029.
VOCs were detected at Inflows 1 and 2 in concentrations above the GWQS for tetrachloroethene in May 2000(1.39 and 1.64, respectively µg/L), bromo-dichloromethane (0.37 and 0.45 µg/L) and chloroform (1.36 and 1.12 µg/L *vs.*GWQS 6 µg/L). In August 2000, at Inflow 1 no tetrachloroethene was detected; bromodichloromethane and chloroform were detected at 1.23 and 4.98 µg/L, respectively. At Inflow 2, no volatile organic compounds were detected.

Located on the north side of the detention basin, Inflow 2 receives ground water from the D-site basement sump pumps and storm water from the transformer yard sumps. Located on the west side of the detention basin, Inflow 1 receives water from the C site Motor Generator (MG), Lyman Spitzer Building (LSB), and C Stellarator (CS) basement sumps, C and D site cooling tower and boiler blow down, and non-contact heat exchanger cooling water, as well as storm water.

Based on 12 months of flow data, an estimated 99 million gallons of water were discharged from the detention basin in 2000. The lined detention basin operates with a permanent oil boom, oil sensors that are capable of sending an alarm signal to Security, an outfall exit valve mechanism, and a chain-link fence around the perimeter of the basin. Presently, 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). The Remedial Investigation and Remedial Alternative Assessment (RI/RAA) were required in this MOU. For C and D sites, the Remedial Investigation is discussed in Section 3.2.3 and is fully documented in the Phase 3 Remedial Investigation Report prepared by Harding Lawson Associates and submitted to NJDEP in 1998 [HLA98], and subsequent reports submitted by PPPL in 1999 and 2000 [Sh99 and Sh2000].

Exhibit 6-3. Ground Water Sampling

In 2000, 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. (Exhibit 4-3 and App. A, Table 27) [Sh99]. VOCs (probably from degreasers/solvents) were detected above both the NJ Ground Water Standards and the method detection limit (MDL) in 5 of the 13 wells/sumps sampled and in 3 wells in estimated concentrations lower than the ground water standard. The highest concentrations of tetrachloroethylene (PCE) were found in well MW-19S at 205 μg/L, which is higher than in 1999 (111 μg/L). The PCE concentration at D-site MG sump was 75.6 μg/L, which is lower than in 1999 (114 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.

6.2 Non-Radiological Programs

The following sections briefly describe PPPL's environmental programs required by federal, state, or local agencies. The 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 certificate numbers 061295 through 061299 were issued as 90-day temporary certificates; however, in 1997, NJDEP stopped issuing the temporary certificates. 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.

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," [DOE88a] 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 a record of this information [Kir00].

PPPL maintains the following equipment that require air permits:

Exhibit 6-4. Air-Permitted Equipment

Type of Air Permit	Location
Dust collectors	M&O woodworking shop CAS metalworking area Shop wood working area
Storage tanks vents	25,000 gal. No. 4 oil 15,000 gal. No. 1 oil
Diesel generators	D-site generator 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 20.6 million gallons in 2000 (Exhibit 6-5) [Kir00]. In 1994, a cross-connection was installed beneath the water tower to provide potable water to the tower for the fire-protection system and other systems.

Exhibit 6-5. PPPL Potable Water Use

CY	In million gallons
2000	20.6
1999	23.01
1998	27.12
1997	24.56
1996	27.82
1995	40.69

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 (Exhibit 6-6). 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
2000	39.98
1999	41.55
1998	30.9
1997	32.8
1996	96.2
1995	67.2

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, Table 23). A sampling point (C1) was established to provide baseline data for process water coming on-site. Appendix A Table 16 indicates 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 14-20)—are not required by regulation, but are a part of PPPL's environmental monitoring 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 2000, PPPL estimates a total discharge of 6.00 million gallons of sanitary sewage to the South Brunswick sewerage treatment plant [Kir01b**]**.

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

During 2000, PPPL continued monthly radiological and non-radiological analyses to meet the license requirements (App. A. Table 13). Beginning in August 1999, the COD concentration (1,200 mg/L) was found to exceed the monthly average of 1,000 mg/L. SBRSA issued PPPL a Notice of Violation (NOV) for this COD exceedance. PPPL investigated the potential source for the excess COD; no definitive cause was found.

In June and December 2000, the liquid effluent collection (LEC) tanks contained high COD concentrations (>1,000 mg/L the release maximum). An approximate 31,000 gallons of waste water was removed for treatment at a licensed facility, Gloucester County Utilities Authority (GCUA) Treatment Facility.

F. Spill Prevention Control and Counter-measure

PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was revised in 1998 [VNH98]. The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan.

G. Herbicides and Fertilizers

During 2000, 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 2000 were as follows: herbicides - Surflan (7 qts.), Dimension (7 gal.), Roundup (19gal.), and Dissolve (5.63 pounds)) [Kin01b]. 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 2000, PPPL's inventory of equipment included 5 polychlorinated biphenyls (PCBs)-regulated capacitors. 640 regulated-PCB capacitors were removed from PPPL in 1998. Disposal records are listed in the Biennial Hazardous Waste Generators Report [Pu01a].

I. Hazardous Wastes

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) was submitted to the NJDEP for 1999-2000. 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

One reportable release to the environment was reported to the New Jersey Department of Environmental Protection (NJDEP) Hotline. In December 2000, during a routine No.4 fuel oil delivery, oil overflowed from a vent that should have been secured; it spilled on the exterior of the tank, into its secondary containment, and onto gravel adjacent to the tank. The soiled gravel was removed and properly disposed. The majority of the clean-up involved the exterior and interior of the secondary containment on the tank proper. Less than a gallon of oil was spilled; under New Jersey Spill Regulations, there is no *de minimus* amount for petroleum or other hazardous substances that may be spilled onto the ground or into waterways without making the proper notifications to NJDEP.

The procedure for tank refueling was modified to reflect changes to prevent a re-occurrence of this kind of spill. Operators were trained on the revised procedures and refueling operations are being closely monitored by PPPL.

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 2000 [PPPL01a]. 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 3-11.

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 2000.

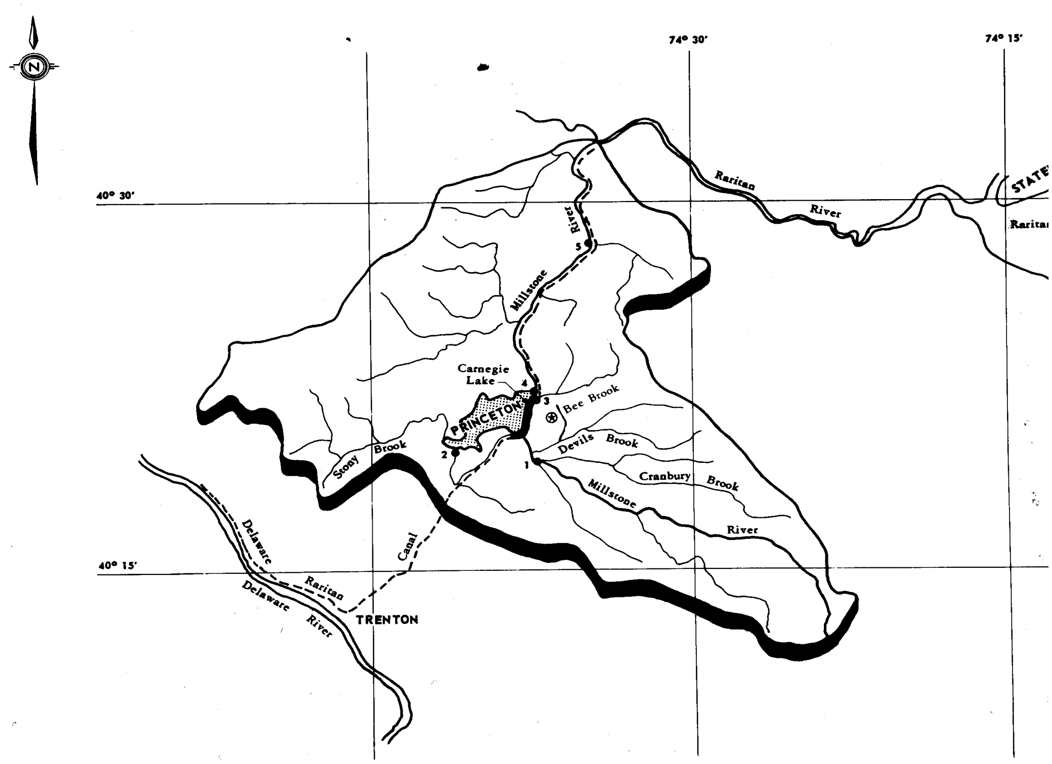
Chapter 7

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 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]. 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. 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.

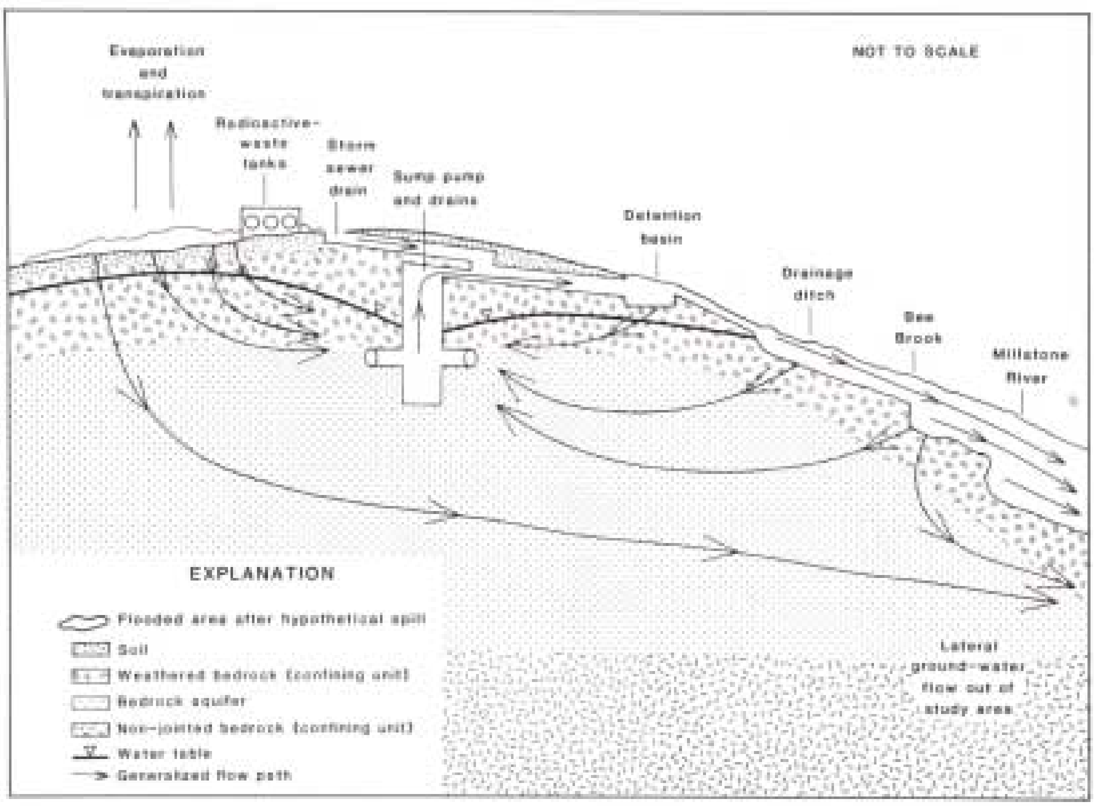
In the slightly higher elevations (above 70 feet), the sandy loams are better drained and belong to the Sassafras series. The extensive farmlands and nurseries in the area indicate this soil provides a good environment for agricultural purposes, both today and in the past.

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 understory 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.

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



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 3-9) [PPPL 98]. 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.

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 sump pumps creates a local and shallow cone of depression radially toward the sumps (Exhibit 8-1 and 8-2).

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.

PPPL's "Ground water Protection Management Plan" (GPMP) is a requirement of DOE Order 5400.1, "General Environmental Protection Program." The GPMP is a written plan that PPPL uses as a management tool to ensure protection of ground water. The GPMP was implemented in conjunction with two ground water investigations; an investigation of volatile organic compounds (VOCs), and an investigation regarding tritium.

As required by NJDEP, PPPL 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 at PPPL are ongoing as required by conditions of the Memorandum of Understanding (MOU).

Generally, all parameters measured meet the New Jersey Ground Water Quality Standards. Ground-water monitoring results showed that tetrachloroethylene, trichloroethylene (PCE, TCE), and their natural degradation products are present in a number of shallow and intermediate-depth wells on C site (Exhibits 7-3 and 7-5). These VOCs are commonly contained in solvents or metal degreasing agents. In two wells, low levels of petroleum hydrocarbons were also detected. The source of the petroleum hydrocarbons is believed to have originated from former underground storage tanks that have been removed.

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 largely influence the ground-water gradient. The sumps create a significant cone of depression drawing ground water toward them (Exhibit 7-4). Under natural conditions, ground-water flow is to the south-southeast toward Bee Brook; it appears that all ground water (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:

- Fulfill Baseline Ecological Evaluation (NJAC 7:26E) requirements;
- 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;

Evaluate potential for natural attenuation.

Based on the investigation results, PPPL continued hydraulic control *via* the foundation de-watering by the D-site sumps (located in TFTR and MG basements) as the remediation action for PCE and TCE. Natural attenuation (natural reduction of these VOCs) was proposed for those areas beyond the influence of the sumps as evidenced that off-site migration is not present [HLA98].

In 2000, Phase 4 of this investigation accomplished the following actions:

1. No VOCs detected in soil of 2 additional borings in the FABA area;
2. Low levels of VOCs, including degradation products detected in ground water screening samples in wetland monitoring wells, southeast of CAS/RESA;
3. Measured ground water levels and assessed the flow direction in the FABA and CAS/RESA areas flows toward building dewatering system.
4. Contaminated ground water is captured by building sumps and is not migrating off-site.
5. Shallow ground water at and near PPPL is not used for either potable water or non-potable purposes.
6. 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.

Exhibit 7-5. Six-Year Maximum Monitoring Results 1995-2000

Volatile Organic Compound	Inflow 1	Inflow 2	DSN 001	Well D-12
Tetrachloro-ethylene	4.43	2.19	1.96	10.6
Trichloro-ethylene	<1.0	<1.0	<1.0	5.43
c-1,2Dichloro-ethlyene	<1.0	<1.0	<1.0	3.4

Notes: 1995-2000 data are used for 6-year maximum.
NJ Ground water quality standard:
PCE & TCE - 1.0 µg/L;
cis-1,2-Dichloroethylene - 10 µg/L.
Sampling locations shown in Exhibit 4-3

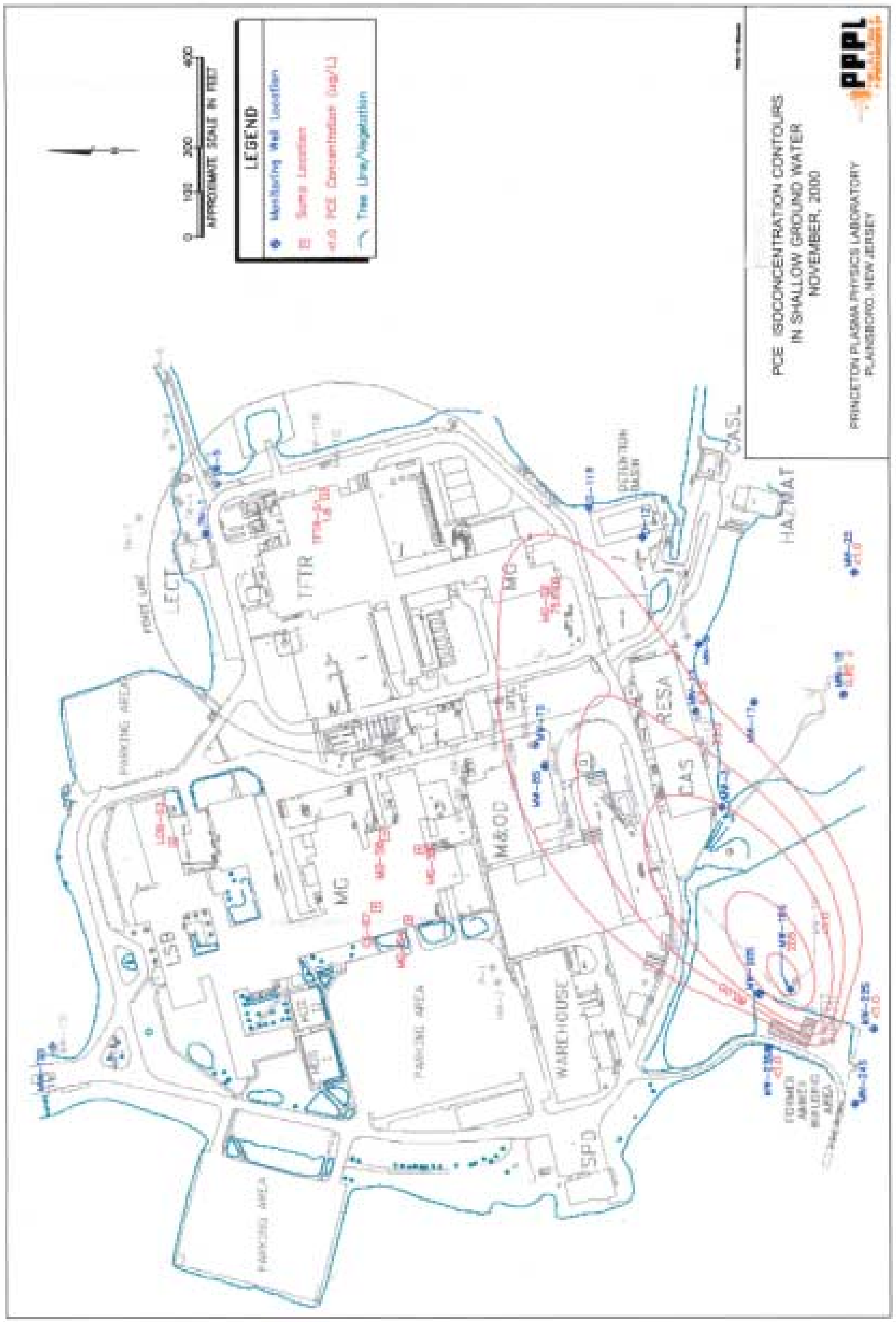


Exhibit 7.3 PCE Distribution in Ground Water – November 2000

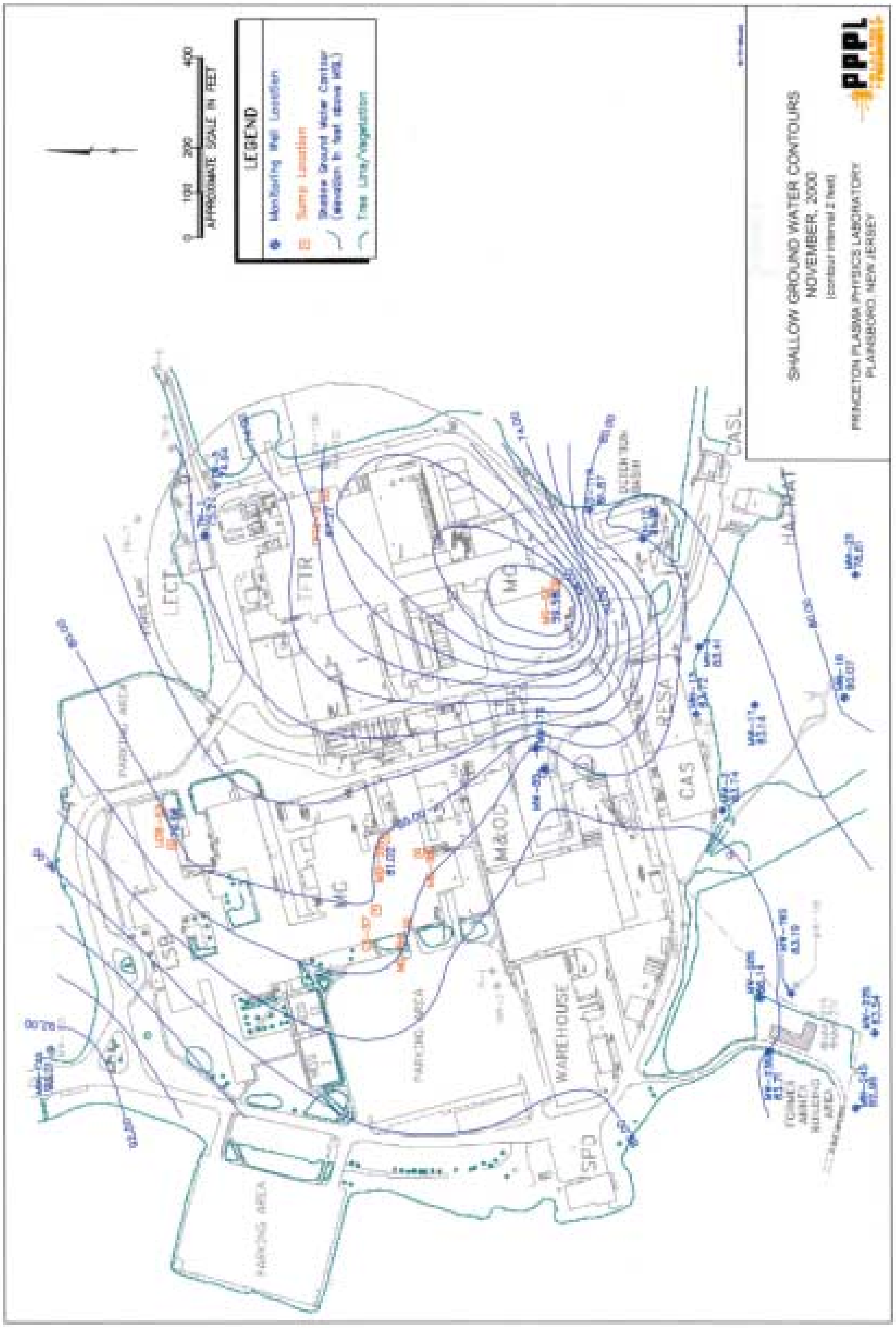


Exhibit 7-4. Shallow Ground Water Contours – November 2000

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 be the method of choice. 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.

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 picoCuries/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 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. Rain water samples showed elevated levels of tritium during December 1999 (7,817 pCi/L at station R2 South) when atmospheric releases were elevated (Exhibit 4-6). A number of documents 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.

The highest concentrations of tritium in the ground water occurred in May 2000: 1,104 pCi/L at D-12, 1,027 pCi/L at TW-2, 941 pCi/L at D-11R and 878 pCi/L at TW-3 (compared to the Drinking Water standard of 20,000 pCi/L). 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.

Chapter 8

QUALITY ASSURANCE

In 2000, analyses of environmental samples for radioactivity and other parameters were conducted by PPPL's on-site analytical laboratory. In December 2000, the laboratory's name changed from the REML - Radiological Environmental Monitoring Laboratory to PEARL - Princeton Environmental, Analytical, and Radiological Laboratory when the laboratory moved to its new facility (Exhibit 8-1).

Exhibit 8-1. PPPL Technician analyzing water 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. [PPPL00f].

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. Results are supplied to PPPL and NJDEP to confirm a laboratories' ability to correctly analyze those parameters being tested [see App. A, Table 29].

Beginning in 1984, PPPL participated in a NJDEP certification program initially through the EPA 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 2000, PEARL performed EML semi-annual performance evaluation tests for radionuclides in water. PEARL passed EML's tests for tritium (App. A, Table 29). Gamma spectroscopy instruments were not used in 2000, because of time constraints involved with moving the equipment to its new location. A regulatory inspection of PEARL is anticipated in 2001 because of the laboratory's relocation and its request for certification to conduct analyses for chemical oxygen demand (COD) in water.

In 2000, 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 [QC96].

In June 2000, PEARL purchased Chemical oxygen demand (COD) instrumentation and prepared procedures for COD analysis. For the liquid effluent collection tanks (LECT) samples, the turn-around time is critical during the summer when the tanks quickly fill (largely due to high humidity that is removed for the air). Therefore, release to Stony Brook Regional Authority (SBRSA) needs to be prompt in order to maintain safe operations on D-site. ✵

Chapter
9

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Chapter

10

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Appendix A

TABLES

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

CONDITION		PUBLIC	EXPOSURE[b]	OCCUPATIONAL	EXPOSURE
		REGULATORY LIMIT	DESIGN OBJECTIVE	REGULATORY LIMIT	DESIGN OBJECTIVE
ROUTINE OPERATION 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 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.

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[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 2000

START DATE	WEEK	INCH	INCH/MONTH	MONTH	ACCUMLATION
3-Jan-00	**1**	1.20			1.20
10-Jan-00	**2**	0.05			1.25
17-Jan-00	**3**	0.00			1.25
24-Jan-00	**4**	0.80			2.05
31-Jan-00	**5**	0.10	**2.15**	**January**	2.15
7-Feb-00	**6**	0.55			2.70
14-Feb-00	**7**	1.25			3.95
21-Feb-00	**8**	0.20			4.15
28-Feb-00	**9**	0.05	**2.10**	**February**	4.20
6-Mar-00	**10**	1.35			5.55
13-Mar-00	**11**	1.40			6.95
20-Mar-00	**12**	0.10			7.05
27-Mar-00	**13**	1.05	**3.90**	**March**	8.10
3-Apr-00	**14**	0.45			8.55
10-Apr-00	**15**	1.25			9.80
17-Apr-00	**16**	1.20			11.00
24-Apr-00	**17**	0.00	**2.90**	**April**	11.00
1-May-00	**18**	0.10			11.10
8-May-00	**19**	0.90			12.00
15-May-00	**20**	1.75			13.75
22-May-00	**21**	1.05			14.80
29-May-00	**22**	0.14	**3.94**	**May**	14.94
5-Jun-00	**23**	1.20			16.14
12-Jun-00	**24**	1.33			17.46
19-Jun-00	**25**	0.50			17.96
26-Jun-00	**26**	0.25	**3.28**	**June**	18.21
3-Jul-00	**27**	0.30			18.51
10-Jul-00	**28**	0.98			19.49
17-Jul-00	**29**	0.45			19.94
24-Jul-00	**30**	2.65			22.59
31-Jul-00	**31**	1.78	**6.15**	**July**	24.36
7-Aug-00	**32**	0.95			25.31
14-Aug-00	**33**	1.00			26.31
21-Aug-00	**34**	0.03			26.34
28-Aug-00	**35**	0.45	**2.43**	**August**	26.79
4-Sep-00	**36**	0.45			27.24
11-Sep-00	**37**	1.50			28.74
18-Sep-00	**38**	1.18			29.92
25-Sep-00	**39**	1.25	**4.38**	**September**	31.17
2-Oct-00	**40**	0.48			31.64
9-Oct-00	**41**	0.00			31.64
16-Oct-00	**42**	0.30			31.94
23-Oct-00	**43**	0.00	**0.78**	**October**	31.94
30-Oct-00	**44**	0.00			31.94
6-Nov-00	**45**	1.00			32.94
13-Nov-00	**46**	0.40			33.34
20-Nov-00	**47**	1.75			35.09
27-Nov-00	**48**	0.20	**3.35**	**November**	35.29
4-Dec-00	**49**	0.00			35.29
11-Dec-00	**50**	3.05			38.34
18-Dec-00	**51**	0.05			38.39
25-Dec-00	**52**	0.30	**3.40**	**December**	38.69

Table 3. D–Site Tritium Stack Releases in Curies in 2000

Week Ending	HTO (Ci)	HT (Ci)	Weekly total (Ci)	Month	Annual Total (Ci)
5-Jan-00	0.16	0.011	0.171		**0.171**
12-Jan-00	0.131	0.013	0.144		**0.315**
19-Jan-00	0.105	0.011	0.116		**0.431**
27-Jan-00	0.114	0.026	0.14	**January**	**0.571**
2-Feb-00	0.079	0.014	0.093		**0.664**
9-Feb-00	0.106	0.021	0.127		**0.791**
16-Feb-00	0.121	0.014	0.135		**0.926**
23-Feb-00	0.285	0.126	0.411	**February**	**1.337**
1-Mar-00	4.096	1.371	5.467		**6.804**
8-Mar-00	0.143	0.013	0.156		**6.961**
15-Mar-00	0.13	0.013	0.143		**7.104**
22-Mar-00	0.296	0.016	0.312		**7.416**
29-Mar-00	0.59	0.013	0.603	**March**	**8.019**
5-Apr-00	1.27	0.089	1.359		**9.377**
12-Apr-00	0.193	0.008	0.201		**9.579**
19-Apr-00	0.183	0.034	0.217		**9.795**
26-Apr-00	1.93	0.644	2.574	**April**	**12.369**
3-May-00	0.492	1.768	2.26		**14.629**
10-May-00	0.151	0.053	0.204		**14.833**
17-May-00	0.151	0.053	0.204		**15.036**
24-May-00	0.135	0.012	0.147		**15.184**
31-May-00	0.178	0.047	0.225	**May**	**15.408**
7-Jun-00	0.135	0.123	0.258		**15.667**
14-Jun-00	0.122	0.002	0.124		**15.791**
21-Jun-00	2.46	0.955	3.415		**19.206**
28-Jun-00	0.152	0.004	0.156	**June**	**19.362**
5-Jul-00	0.194	0.011	0.205		**19.567**
12-Jul-00	0.454	0.007	0.461		**20.028**
19-Jul-00	2.86	0.548	3.408		**23.436**
26-Jul-00	2.06	0.034	2.094	**July**	**25.53**
2-Aug-00	0.248	0.012	0.26		**25.79**
9-Aug-00	0.396	0.053	0.449		**26.239**
16-Aug-00	0.703	0.106	0.809		**27.048**
23-Aug-00	0.422	0.157	0.579		**27.627**
30-Aug-00	0.422	0.157	0.579	**August**	**28.206**
6-Sep-00	0.302	0.341	0.643		**28.849**
13-Sep-00	0.942	1.29	2.232		**31.081**
20-Sep-00	0.722	0.276	0.998		**32.079**
27-Sep-00	0.448	0.445	0.893	**September**	**32.972**
4-Oct-00	0.159	0.057	0.216		**33.188**
11-Oct-00	0.096	0.019	0.115		**33.303**
18-Oct-00	0.117	0.006	0.123		**33.426**
25-Oct-00	1.05	3.89	4.94	**October**	**38.366**
1-Nov-00	0.428	0.046	0.474		**38.84**
8-Nov-00	0.106	0.012	0.118		**38.958**
15-Nov-00	3.63	1.44	5.07		**44.028**
22-Nov-00	3.418	1.346	4.764		**48.792**
29-Nov-00	5.74	0.196	5.936	**November**	**54.728**
6-Dec-00	4.59	0.737	5.327		**60.055**
13-Dec-00	5.76	0.77	6.53		**66.585**
20-Dec-00	6.25	0.552	6.802		**73.387**
27-Dec-00	1.57	0.042	1.612		**74.999**
3-Jan-01	1.325	0.069	1.394	**December**	**76.393**
	58.320	18.073		**Total 2000**	**76.393**

Table 4. Air Tritium (HT) Concentrations (in picoCuries/meter^3) Collected On-Site in 2000

Week Ending	T1	T2	T3	T4
3-Jan-00	0.93	1.71	2.21	4.93
10-Jan-00	3.73	5.85	2.83	6.29
17-Jan-00	2.26	2.08	2.24	2.13
24-Jan-00	2.13	2.55	2.46	1.09
31-Jan-00	2.60	7.19	5.19	1.72
7-Feb-00	2.21	67.78	5.96	5.87
15-Feb-00	2.01	2.39	1.78	1.55
21-Feb-00	2.69	2.62	5.26	2.38
28-Feb-00	2.04	2.14	2.43	2.56
6-Mar-00	3.36	2.00	2.20	1.25
13-Mar-00	1.33	1.78	1.86	1.71
20-Mar-00	2.56	3.22	2.10	3.27
27-Mar-00	2.11	2.20	2.05	1.86
4-Apr-00	1.38	2.03	1.96	1.15
10-Apr-00	4.38	2.25	2.35	4.22
18-Apr-00	2.28	1.90	2.35	1.54
24-Apr-00	2.49	2.37	2.44	2.16
1-May-00	73.37	88.56	55.30	99.39
17-May-00	8.77	7.88	9.41	7.39
24-May-00	11.51	11.31	25.77	4.83
31-May-00	2.02	1.99	8.22	2.39
5-Jun-00	3.31	3.21	24.77	3.45
12-Jun-00	2.12	5.16	5.81	4.67
20-Jun-00	2.12	5.16	5.81	4.67
27-Jun-00	5.11	102.43	2.36	9.65
6-Jul-00	2.65	2.73	9.93	1.36
11-Jul-00	12.21	5.82	8.67	2.70
17-Jul-00	51.17	2.51	4.28	5.93
24-Jul-00	1.42	3.15	4.38	2.61
31-Jul-00	16.18	2.16	10.09	1.04
3-Aug-00	0.83	2.88	0.60	1.54
14-Aug-00	21.05	0.00	7.13	1.61
29-Aug-00	0.87	1.55	2.02	1.97
4-Sep-00	45.16	1.74	5.46	2.33
11-Sep-00	4.31	1.95	15.00	0.00
18-Sep-00	33.03	14.01	5.22	0.08
25-Sep-00	1.94	0.09	2.69	0.72
2-Oct-00	5.06	0.00	1.06	0.00
10-Oct-00	1.64	1.70	11.95	3.40
16-Oct-00	5.03	0.78	2.96	0.10
25-Oct-00	3.53	2.04	38.54	0.48
30-Oct-00	2.40	1.71	3.06	0.00
7-Nov-00	1.02	3.42	5.86	4.74
13-Nov-00	0.00	0.56	0.66	0.00
20-Nov-00	16.81	8.64	2.10	3.83
27-Nov-00	0.00	15.59	0.11	0.00
4-Dec-00	2.68	2.68	2.70	3.99
20-Dec-00	0.95	0.95	0.92	0.90

Table 5. Air Tritium (HTO) Concentrations (in picoCuries/meter^3) Collected On-Site in 2000

Week Ending	T1	T2	T3	T4
3-Jan-00	0.93	2.75	4.69	3.85
10-Jan-00	3.69	6.16	5.97	6.44
17-Jan-00	2.26	2.08	3.06	2.13
24-Jan-00	2.13	2.55	4.40	-0.02
31-Jan-00	2.08	2.52	7.10	1.81
7-Feb-00	2.03	4.28	4.25	3.13
15-Feb-00	2.01	1.82	3.12	1.55
21-Feb-00	2.69	2.62	9.37	3.14
28-Feb-00	2.15	2.14	12.95	12.26
6-Mar-00	2.06	2.00	8.07	1.25
13-Mar-00	1.33	2.12	3.48	2.95
20-Mar-00	2.47	3.69	4.06	1.53
27-Mar-00	8.67	2.80	19.78	7.14
4-Apr-00	1.38	2.74	1.96	1.15
10-Apr-00	2.37	6.39	5.99	5.55
18-Apr-00	1.83	1.90	2.09	3.56
24-Apr-00	5.50	3.82	5.66	5.16
1-May-00	49.98	45.76	53.72	38.83
17-May-00	2.76	4.41	3.79	1.71
24-May-00	11.51	4.22	1.24	2.65
31-May-00	18.06	1.67	1.58	1.64
5-Jun-00	3.31	3.65	3.30	2.88
12-Jun-00	2.12	12.32	2.32	4.12
20-Jun-00	2.12	12.32	2.32	4.12
27-Jun-00	8.14	6.36	228.61	2.98
6-Jul-00	56.92	7.46	5.46	1.36
11-Jul-00	4.58	5.13	84.85	2.70
17-Jul-00	11.25	22.37	4.67	2.30
24-Jul-00	3.28	2.76	72.35	7.20
31-Jul-00	14.27	8.69	4.83	5.31
3-Aug-00	1.61	3.53	6.62	0.67
14-Aug-00	0.62	7.23	13.23	1.98
29-Aug-00	0.00	1.84	6.38	1.23
4-Sep-00	8.85	6.43	0.00	2.49
11-Sep-00	0.52	0.00	1.86	0.00
18-Sep-00	13.65	76.01	4.59	1.41
25-Sep-00	0.00	2.66	2.96	0.00
2-Oct-00	0.00	0.00	4.18	0.00
10-Oct-00	2.28	3.04	48.29	1.36
16-Oct-00	238.66	5.02	2.43	0.00
25-Oct-00	3.09	3.81	17.89	2.66
30-Oct-00	7.52	13.51	10.81	3.36
7-Nov-00	2.94	2.86	10.30	2.01
13-Nov-00	5.35	0.00	1.50	0.34
20-Nov-00	23.90	16.30	35.11	6.28
27-Nov-00	6.70	13.75	51.49	14.85
4-Dec-00	2.68	2.68	2.70	3.99
20-Dec-00	0.95	0.95	0.92	0.90

Table 6. Air Tritium (HT) Concentrations (in picoCuries/meter³) Collected Off-site in 2000

Week Ending	R1	R2	R3	R4	R5	R6	BM1
3-Jan-00	1.42	1.28	1.61	10.44	6.81	4.39	N/A
10-Jan-00	1.95	2.21	1.99	169.53	5.00	3.67	
17-Jan-00	2.21	1.53	2.83	5.56	1.49	1.39	337.09
24-Jan-00	113.61	2.43	1.68	151.22	2.25	4.43	
31-Jan-00	10.42	6.14	2.75	11.92	3.13	3.67	
7-Feb-00	184.07	0.83	8.28	8.35	9.74	7.34	
15-Feb-00	1.43	1.89	1.36	20.15	1.91	1.96	
21-Feb-00	3.03	1.71	2.31	24.06	5.28	1.75	
28-Feb-00	2.00	1.99	2.02	17.45	2.11	2.25	
6-Mar-00	3.55	2.05	2.02	68.72	1.33	1.42	12.65
13-Mar-00	7.03	3.46	1.67	10.52	1.83	1.88	1.79
20-Mar-00	11.11	2.84	2.05	103.62	1.86	2.29	13.79
27-Mar-00	6.72	1.87	2.63	2.05	1.57	2.05	5.90
4-Apr-00	1.33	1.31	1.27	115.73	1.27	1.25	2.60
10-Apr-00	4.41	2.97	4.80	11.33	3.24	4.53	
18-Apr-00	1.88	1.82	1.76	105.76	1.76	1.93	43.32
24-Apr-00	1.86	2.83	2.81	9.85	1.92	2.65	2.60
1-May-00	129.88	58.85	79.77	178.97	82.38	55.37	
17-May-00	5.91	0.78	0.52	2.40	0.02	1.10	10.70
24-May-00	8.82	4.07	2.12	8.26	11.15	36.19	
31-May-00	1.88	1.37	2.66	1.99	2.04	1.93	4.03
5-Jun-00	2.16	2.05	12.38	5.79	3.08	3.26	76.09
12-Jun-00	4.01	1.94	7.86	3.44	2.87	2.31	14.46
20-Jun-00	4.01	1.94	7.86	3.44	2.87	2.31	14.46
27-Jun-00	2.99	4.69	6.61	2.45	3.60	1.83	13.00
6-Jul-00	3.32	1.86	22.24	2.29	1.83	3.00	3.73
11-Jul-00	3.00	2.80	14.66	2.63	3.10	3.04	3.69
17-Jul-00	1.87	2.93	1.68	2.37	2.52	2.70	4.79
24-Jul-00	16.56	4.95	0.00	1.67	3.57	1.58	2.11
31-Jul-00	1.29	2.81	21.63	1.35	4.55	2.20	4.11
3-Aug-00	2.53	0.00	4.46	1.60	1.34	0.33	107.25
14-Aug-00	2.29	2.64	9.12	1.85	0.81	2.57	2.61
29-Aug-00	1.49	0.27	0.00	0.68	0.05	1.20	0.49
4-Sep-00	1.97	0.00	0.00	0.00	0.30	1.86	0.00
11-Sep-00	0.37	0.31	0.00	0.00	0.00	0.00	0.00
18-Sep-00	3.00	1.91	3.42	0.00	1.14	19.63	1.31
25-Sep-00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
2-Oct-00	0.00	0.00	0.00	0.00	0.40	0.00	0.00
10-Oct-00	1.25	0.74	2.82	0.42	1.26	0.00	0.20
16-Oct-00	0.97	0.00	3.22	0.00	0.65	2.70	10.06
25-Oct-00	0.74	10.86	0.04	1.94	1.01	1.29	0.00
30-Oct-00	0.00	0.62	5.86	0.00	1.14	1.18	2.62
13-Nov-00	0.42	0.00	0.53	0.00	0.61	1.48	1.22
20-Nov-00	0.97	2.71	4.26	0.57	0.00	0.00	0.00
27-Nov-00	0.00	0.87	0.00	1.33	0.00	0.69	0.00
4-Dec-00	2.54	2.29	2.47	2.29	2.04	2.44	0.00
20-Dec-00	0.97	0.96	0.62	0.97	1.12	1.11	0.00

Table 7. Air Tritium (HTO) Concentration (in picoCuries/meter^3) Collected Off-Site in 2000

Week Ending	R1	R2	R3	R4	R5	R6	BM1
3-Jan-00	1.23	0.93	0.97	2.03	0.89	1.97	N/A
10-Jan-00	1.92	1.95	1.79	2.08	1.95	2.38	
17-Jan-00	2.21	1.53	2.83	2.05	1.49	1.39	0.14
24-Jan-00	2.11	2.29	1.68	2.19	2.25	2.48	
31-Jan-00	1.81	2.02	2.17	2.78	2.04	2.30	
7-Feb-00	189.43	4.90	4.50	4.20	2.27	3.03	
15-Feb-00	1.43	1.89	1.36	1.92	1.91	1.96	
21-Feb-00	2.41	1.71	2.31	33.78	2.53	1.75	
28-Feb-00	2.00	1.99	2.02	2.53	2.13	1.35	
6-Mar-00	2.17	2.05	2.02	6.27	1.33	1.42	24.67
13-Mar-00	1.11	1.29	1.67	4.88	2.72	1.88	15.30
20-Mar-00	1.84	1.78	2.65	3.76	1.86	1.85	19.74
27-Mar-00	2.13	1.87	2.02	5.27	1.51	2.05	49.67
4-Apr-00	1.33	1.31	1.27	1.34	1.27	1.25	9.97
10-Apr-00	2.08	2.55	2.06	3.38	3.85	2.37	
18-Apr-00	1.88	2.82	1.76	1.64	1.76	1.93	1.89
24-Apr-00	1.86	2.83	2.81	1.84	1.84	2.65	2.60
1-May-00	53.87	63.11	47.76	41.08	45.53	44.34	90.82
17-May-00	2.07	0.68	0.70	0.68	1.04	0.72	4.67
24-May-00	2.04	1.57	5.84	5.41	5.34	10.03	
31-May-00	2.04	1.37	1.98	1.99	2.38	1.92	8.16
5-Jun-00	2.16	2.05	2.21	2.15	3.80	3.26	2.13
12-Jun-00	2.32	1.94	1.92	2.47	2.40	2.31	2.03
20-Jun-00	2.32	1.94	1.92	2.47	2.40	2.31	2.03
27-Jun-00	2.47	3.01	3.12	2.45	5.67	1.83	29.53
6-Jul-00	1.61	2.91	1.94	1.60	3.35	1.34	2.22
11-Jul-00	2.69	3.67	3.00	2.63	4.38	3.04	2.07
17-Jul-00	1.87	2.93	1.68	2.37	2.52	3.45	4.79
24-Jul-00	0.29	0.42	0.55	3.99	2.27	2.98	0.08
31-Jul-00	8.03	4.13	2.13	6.29	5.71	4.77	5.19
3-Aug-00	1.24	0.00	2.18	0.56	0.00	0.00	0.00
14-Aug-00	0.00	2.02	1.99	3.99	0.00	3.51	2.06
29-Aug-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Sep-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Sep-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18-Sep-00	1.94	0.00	3.83	0.27	2.81	4.99	0.00
25-Sep-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-Oct-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-Oct-00	0.00	1.88	0.00	0.00	0.00	1.61	0.57
16-Oct-00	0.73	0.76	0.00	0.00	0.00	1.02	0.00
25-Oct-00	0.14	1.77	0.87	2.16	1.67	1.11	1.20
30-Oct-00	1.19	3.28	0.68	2.18	0.32	0.00	0.72
7-Nov-00	0.47	2.55	1.17	1.69	0.97	1.35	0.48
13-Nov-00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
20-Nov-00	3.25	4.57	0.21	3.81	0.00	0.75	0.00
27-Nov-00	0.41	0.00	0.00	2.90	0.00	0.29	0.00
4-Dec-00	2.54	2.29	2.47	2.29	2.04	2.44	0.00
20-Dec-00	0.97	0.96	0.62	0.97	1.12	1.11	0.00

Table 8. Surface Water Tritium Concentrations for 2000
(in picoCuries/Liter)

Sample Location	Bee Brook (B1)	Bee Brook (B2)	PPPL Basin (DSN001)
January			**188.3**
	95.95	**142.8**	**142.3**
February			**189.6**
March			**191.4**
			157.7
April			**157.7**
	162.2	**216.2**	**197.7**
May			**310.8**
			729.7
June			**288.3**
July			**166.7**
August	<177.4	<177.4	**157.7**
September			**157.7**
October			**193.7**
November	<452.4	<452.4	<452.4
December			

Sample Location	D&R Canal (C1)	D&R Canal (DSN003)	Potable Water (E1)
January			
February	**111.7**	<153.6	<91.66
March		<107.6	
April		<153.7	
	<112	<112	<120.4
May	**229.7**	**288.3**	
June		**189.2**	
July		<126.1	
August	<177.4	<177.4	<177.4
September		<119.5	
October			
November	<452.4	<452.4	<452.4
December			

Sample Location	Millstone River (M1)	Cranbury Brook (P1)	Devil's Brook (P2)
January			
February	<91.66		<91.66
March			
April			
May	**126.1**		**211.7**
June			
July			
August	<177.4	<177.4	<177.4
September			
October			
November	<452.4	<452.4	<452.4
December			

BOLD indicates above the level of detection.

Table 9. Ground Water Tritium Concentrations for 2000 (in picoCuries/liter)

Well No. or Sump Location	Well TW-1	Well TW-2	Well TW-3	Well TW-5	Well TW-8	Well MW-12S
January						
February	633	366	244	553		
March	707			694	635	<115.6
April						
May		**1,027**	878			
June						
July	536			536	581	<115.6
August	563	140	135	491	351	<119
September						
October						
November						
December						

Well No.	Well MW-14	Well MW-16	Well D-12	Well D-11R	TFTR Sump	D-site MG Sump
January					210	192
February	<93	<93	137	<96	209	163
March			112		278 283	314 271
April					230	234
May	464	500	**1,104**	**941**	**806**	**775**
June					351	311
July			<115.6		275	266
August	<105.8	<124.3	<105.8 <119	<105.8	207	189
September					356	185
October						
November	<115	<115				
December					140	126

BOLD indicates elevated concentrations above background levels.

Table 10. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 2000

250 feet from Stack	R1E (East)	R1W (West)	R1S (South)	R1N (North)	R1ND (Duplicate)
January 11	196	478	466	<133	<136
February 1					
February 14	449		362	<123	<123
February 21					
March 14	197	<163	399	<163	<163
March 28	<111	<111	<116	<111	<111
April 10					
April 24	374	635		766	955
May 25		135		140	117
June 12					
June26		180		126	<124
July 25	401	270	1451	351	315
July 31	-	-	-	-	-
August 7	<136-	<136	<136	<136	<136
September 6	428	<110	360	162	<110
September 26	<278	<278	<278	<278	<278
October 2					
November 28	509	**1,910**	**3617**	671	671

500 feet from Stack	R2E (East)	R2W (West)	R2S (South)	R2N (North)	R3N (Far field)
January 11	258	272	179	<136	
February 1					
February 14	191	226	<123	<130	<130
February 21	230				
March 14	<163	<163	198	<163	<163
March 28	<111	220	<111	<111	<111
April 10					
April 24	149	523	446	604	119
May 25	-<116	176	<116-	<116-	<116-
June 12					
June 26	221	257	**1,541**		<124
July 25	207	<110	**1, 189**	531	451
July 31					
August 7	<136	<136	<136	<136	<136
September 6	212	167	419	113	<110
September 26	<278	<169	<169	<169	<169
October 2					
November 28	712	**1,559**	275	324	297

BOLD indicates elevated concentrations above background levels.

Table 11. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 2000

	REAM 1	REAM 2	REAM 4	REAM 5	REAM 6	RW Baseline
January 11		<75	<75	<75	<75	<114
February 1				106	193	
February 14		<130	214	169		
February 21				<130		
March 14	<556		<108	<108		129
March 28			<56	<56		<56
April 10			<106	<106	<106	<106
April 24			<106	<106		<106
May 25			171	198	230	
June 12				275	162	
June 26		135		230	<126	
July 25	<31	<314	<221	<221	<31	
July 31			<31	<31		
August 7		117	207	131	<104	
September 6		<106		<106		
September 26	<615	<278	<278	<278	<278	
October 2		<615	<615	<615	<615	
November 28		<615	<615	<615	<615	

Table 12. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 2000

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	+0.8
		(38.7 w/out Floyd)	(-7.8)
2000	<31 to 3,617	38.7	-7.8

Table 13. Liquid Effluent Collection Tank Release Data for 2000

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)
3/7	11,250		325	84,451	0.003596	0.003596	194	2.95
4/21	10,500	186	295	16,700	0.000665	0.00426	194	58.9
6/13	7,950	152	210	40,400	0.00121	0.00548	194	59.0
6/22	7,350	264	258	196,000	0.00545	0.0109	194	531
6/28	13,500	92.5	248	167,000	0.00851	0.0194	195	473
7/7	9,000	62.2	242	93,500	0.00319	0.0226	195	236
7/20	10,500	71.3	238	213,000	0.00848	0.0311	195	709
8/1	12,900	144	266	131,000	0.00642	0.0375	194	353
8/8	12,900	44.4	255	85,100	0.00416	0.0417	195	<195
8/14	12,750	37.0	267	84,200	0.00406	0.0457	194	295
8/29	13,050	33.8	611	266,000	0.0132	0.0589	195	414
9/5 tank 2	6,300	<60	232	74,700	0.00178	0.0607	195	<195
9/5 tank 3	12,900	61	227	78,300	0.00382	0.0645	195	<195
9/21	12,750	42.9	260	248,000	0.0120	0.0765	195	885
10/26	12,300	28.6	238	96,100	0.00447	0.0809	195	414
Total gallons	165,900							

Table 14. Surface Water Analysis for Bee Brook, B1, in 2000

Sample Date	2/3/00	5/3/00	8/2/00	11/3/00
Ammonia-N, mg/L		<0.100		
Biochemical Oxygen Demand, 5-day total, mg/L		<2.30		
Chemical Oxygen Demand, mg/L	7.50	10.5	48.8	46.5
Petroleum hydrocarbons, mg/L		<0.500		<0.50
pH, standard units	5.75	6.92		
Phosphorus, total, mg/L	<0.0500	0.0680	0.0990	0.14
Temperature, °C	<0.500	12.2		
Total Dissolved Solids, mg/L		274.		
Total Suspended Solids, mg/L	4.00	8.00	20.0	4.0
Total Organic Carbon			15.4	14.1

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

Table 15. Surface Water Analysis for Bee Brook, B2, in 2000

Sample Date	2/3/00	5/3/00	8/2/00	11/3/00
Ammonia-N, mg/L		<0.100		
Biochemical Oxygen Demand, 5-day total, mg/L		<2.30		
Chemical Oxygen Demand, mg/L	8.50	5.00	41.4	<20
Petroleum hydrocarbons, mg/L		<0.500		<0.50
pH, standard units	7.32	7.59		
Phosphorus, total, mg/L	8.50	<0.0500	0.0990	0.22
Temperature, ° C	4.10	14.7		
Total Dissolved Solids, mg/L		2250		
Total Suspended Solids, mg/L	7.00	11.0	13.0	
Total Organic Carbon			11.6	2.1

Location B2 = Bee Brook downstream of PPPL basin discharge

Table 16. Surface Water Analysis for Delaware & Raritan Canal, C1, in 2000

Sample Date	2/10/00	5/3/00	8/2/00	8/2/00 (dup)	11/3/00
Ammonia-N, mg/L		<0.100			
Biochemical Oxygen Demand, 5-day total, mg/L		<2.30			
Chemical Oxygen Demand, mg/L	8.00	7.00		<10.0	<20
Petroleum hydrocarbons, mg/L	<0.500	<0.500			<0.50
pH, standard units	6.32		<0.500	7.03	
Phosphorus, total, mg/L	0.0720	<0.0500		<0.0500	<0.10
Temperature, ° C	2.40				
Total Dissolved Solids, mg/L		406.			
Total Suspended Solids, mg/L	2.00	2.00	3.00	2.00	4.0
Total Organic Carbon			6.45	4.81	2.2

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

Table 17. Surface Water Analysis for Millstone River, M1, in 2000

Sample Date	2/10/00	5/2/00	8/2/00	11/3/00
Ammonia-N, mg/L		0.440		
Biochemical Oxygen Demand, 5-day total, mg/L		<2.90		
Chemical Oxygen Demand, mg/L	7.50	10.0	34.1	<20
Petroleum hydrocarbons, mg/L		<0.500		<0.50
pH, standard units	5.73	6.65		
Phosphorus, total, mg/L	0.0920	0.0560	0.0820	<0.10
Temperature, ° C	4.70	17.6		
Total Dissolved Solids, mg/L		158.		<4.0
Total Suspended Solids, mg/L	3.00	10.0	16.0	
Total Organic Carbon			13.8	3.0

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 18. Surface Water Analysis for Elizabethtown Water, E1, in 2000

Sample Date	2/10/00	5/3/00	8/2/00	8/3/00	11/3/00
Ammonia-N, mg/L		0.110			
Biochemical Oxygen Demand, 5-day total, mg/L		<2.30			
Chemical Oxygen Demand, mg/L	<5.00	<5.00	44.4	<10.0	<20
Petroleum hydrocarbons, mg/L		<0.500			<0.50
pH, standard units	6.29	6.69		6.84	
Phosphorus, total, mg/L	0.144	0.0680	0.0660	0.0500	0.13
Total Dissolved Solids, mg/L		622.			
Total Suspended Solids, mg/L	<2.00	<2.00	5.00	<2.00	<4.0

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

Table 19. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 2000

Sample Date	2/10/00	5/3/00	8/3/00	11/3/00
Chemical Oxygen Demand, mg/L				<20
Petroleum hydrocarbons, mg/L				<0.50
pH, standard units			6.36	
Phosphorus, total, mg/L			0.0570	<0.10
Total Suspended Solids, mg/L			4.00	4.0
Total Organic Carbon			6.71	2.5

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

Table 20. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 2000

Sample Date	2/7/00	5/2/00	8/2/00	11/3/00
Ammonia-N, mg/L		<0.100		
Biochemical Oxygen Demand, 5-day total, mg/L		<2.90		
Chemical Oxygen Demand, mg/L	8.50	14.0	44.4	<20
Petroleum hydrocarbons, mg/L		<0.500		<0.50
pH, standard units	5.61			
Phosphorus, total, mg/L	0.0500	<0.0500	0.0660	<0.10
Temperature, °C	4.20			
Total Dissolved Solids, mg/L		98.0		
Total Suspended Solids, mg/L	3.00	2.00	5.00	<4.0
Total Organic Carbon			15.1	6.2

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

Table 21. Detention Basin Influents Analysis (NJPDES NJ0086029) in 2000

Location Sample Date	Inflow 1 5/2/00	Inflow 2 5/2/00	Inflow 1 8/2/00	Inflow 2 8/2/100
Ammonia-N, mg/L	0.120		<0.0500	<0.0500
Biochemical Oxygen Demand, 5-day total, mg/L	<2.20	<2.20	2.10	2.80
Chemical Oxygen Demand, mg/L	5.50	<5.00	<10.0	<10.0
Chromium, mg/L			<0.00500	<0.00500
Petroleum hydrocarbons, mg/L	<0.500		<0.500	<0.500
pH, standard units	7.48			
Phenolics, as phenol, mg/L	<0.00500		0.00600	0.00600
Settleable solids, mg/L	<0.200		<0.200	<0.200
Temperature, °C	18.7	16.0		
Total Dissolved Solids, mg/L	200.			190.
Total Organic Carbon				1.53

Inflow 1 = Detention basin influent located on western side of basin and Inflow 2 = Detention basin influent located on northern side of basin

Table 22. DSN001 - Detention Basin Outfall 2000 Surface Water Analysis (NJPDES NJ0023922)

Permit Limit	Units	Parameters	1/6/00	2/2/00	3/7/00	4/5/00	5/3/00	6/5/00
NA	mg/L	Ammonia-N					<0.100	
NA	mg/L	Biochemical Oxygen Demand, 5-day total					<2.20	
50 mg/L	mg/L	Chemical Oxygen Demand	7.50	<5.00	<5.00	7.50	7.00	6.0
NL	mg/L	Chlorine Produced Oxidants as chlorine, free	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
NA	mg/L	Chromium, total		<0.010				
100	percent	Chronic Toxicity Test NOEC (% effluent)) *Pimephales promelas*						
NA	gpm	Flow	263.8	173.5	123.6	131.1	188.4	162.7
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	7.43	8.04	8.97	7.05	7.50	7.92
NA	mg/L	Phenolics, as phenol					<0.005	
	mg/L	Phosphorus, Total					0.148	
	µg/L	Tetrachloroethylene					1.33 T	
30 ◦C max.	◦C	Temperature	10.8	7.70	17.5	13.1	18.6	20.4
NA	mg/L	Total Dissolved Solids		190			200	
50 mg/L	mg/L	Total Suspended Solids	5.00	5.00	<2.00	7.00	4.00	3.00

Permit Limit	Units	Parameters	7/5/00	8/2/00	9/7/00	10/6/00	11/2/00	12/7/00
NA	mg/L	Ammonia-N						
NA	mg/L	Biochemical Oxygen Demand, 5-day total						
50 mg/L	mg/L	Chemical Oxygen Demand	28.0	<10.0	<10.00	<20.0	<20.00	<20.0
NL	mg/L	Chlorine Produced Oxidants as chlorine, free	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	mg/L	Chromium, total					<0.005	
100	percent	Chronic Toxicity Test NOEC (% effluent) *Pimephales promelas*						>100
NA	gpm	Flow	275.6	344.6	203.4	108	271.8	60.7*
10 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	7.67	8.14	8.38	7.42	8.21	8.24
NA	mg/L	Phenolics, as phenol					0.008	
	mg/L	Phosphorus, Total		0.0990			0.23	
	µg/L	Tetrachloroethylene		1.09 T			<0.91	
30 ◦C max.	◦C	Temperature	23.2	23.5	18.8	19.7	15.6	7.05
NA	mg/L	Total Organic Carbon					1.7	
50 mg/L	mg/L	Total Suspended Solids	<2.00	10.00	<2.00	<4.00	<4.00	<4.0

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 23. D&R Canal Pump House - DSN003 2000 Monthly Surface Water Analysis (NJPDES NJ0023922)

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	1/6/00	2/2/00	3/7/00	4/5/00	5/3/00	6/5/00
NA	NA	mg/L	Ammonia-N					<0.100	
NA	NA	mg/L	Biochemical Oxygen Demand					<2.30	
NA	NA	mg/L	Chemical Oxygen Demand	<5.00	<5.00			8.50	
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1				<0.1	<0.1
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
NA	6.0-9.0	S.U.	pH	6.63	6.36	6.74	6.55	7.23	6.73
NA		mg/L	Phosphorus, total					<0.0500	
NA	NA	°C	Temperature	5.90	0.5	7.80	12.9	16.2	21.4
NA	NA	mg/L	Total Dissolved Solids					206	
20 mg/L	60 mg/L	mg/L	Total Suspended Solids	<2.00	<2.00			8.00	*

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	7/5/00	8/3/00	9/7/00	10/6/00	11/3/00	12/7/00
NA	NA	mg/L	Ammonia-N						
NA	NA	mg/L	Biochemical Oxygen Demand						
NA	NA	mg/L	Chemical Oxygen Demand		<10.0			<20.00	
NL	NL	mg/L	Chlorine Produced Oxidants	0.24	0.14	<0.1	0.34	<0.1	<0.1
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	<0.500	0.52	<0.500	<0.500	<0.5
NA	6.0-9.0	S.U.	pH	6.93	6.83	7.86	6.66	7.11	8.16
NA	NA	mg/L	Phosphorus, total		0.0660			<0.10	
NA	NA	° C	Temperature	26.5	25.3	21.8	18.6	11.6	0.2
NA	NA	mg/L	Total organic carbon		4.90			3.7	
NL	NL	mg/L	Total Suspended Solids		<2.00			26	

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 24. Ground Water Analysis for Wells MW-14, MW-15, and MW-16 for 2000

Well No. **Date**	**MW-14** **2/9/00**	**MW-14** **5/4/00**	**MW-14** **8/9/00**	**MW-14** **11/7/00**	**NJPDES Permit Standard**
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.10	*0.5*
Chloride, mg/L			5.40	<20	*250*
Chromium,dissolved, hexavalent,mg/L			<0.0100	<0.050	*0.05*
Conductivity, µmhos/cm^2	86.60	57.00		134	
Lead, dissolved, mg/L			<0.00500	<0.003	*0.05*
Nitrate-Nitrogen, mg/L			2.00	2.1	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	5.56	5.32			
Phenolics as phenol, mg/L			0.00600	<0.050	*0.3*
Sulfate, mg/L	16.2	16.7	15.6	<20	*250*
Total Dissolved Solids, mg/L	174.	236.	110.	87.0	*500*
Total Organic Carbon, mg/L			1.34		
Total Organic Halides, mg/L			0.0165		
Tritium, pCi/L	<93	464	<106	<115	

Well No. **Date**	**MW-16** **2/9/00**	**MW-16** **5/1/00**	**MW-16** **8/9/00**	**MW-16** **11/7/00**	***NJPDES Permit Standard***
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.10	*0.5*
Chloride, mg/L			6.20	<20	*250*
Chromium, dissolved, hexavalent, mg/L			<0.0100	<0.050	*0.05*
Conductivity, µmhos/cm^2	483.0	388.0	491.0	674	
Lead, total, mg/L			<0.00500	<0.003	*0.05*
Nitrate-Nitrogen, mg/L			<0.500	0.33	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	6.99	6.05	5.12		
Phenolics as phenol, mg/L			0.00900	0.075	*0.3*
Sulfate, mg/L	81.2	56.2	41.3	<20	*250*
Total Dissolved Solids, mg/L	394.	1250	322.	390	*500*
Total Organic Carbon, mg/L			4.32		
Total Organic Halides, mg/L			0.0357		
Tritium, pCi/L	<93	500	<124	<115	

Blank indicates no measurement.

Table 25. Ground Water Analysis for Wells D-11R and D-12 for 2000

Well No. Date	D-11R 2/9/00	D-11R 5/4/00	D-11R 8/9/00	D-11R 11/7/00	*NJPDES Permit Standard*
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.10	*0.5*
Chloride, mg/L			16.4	<20	*250*
Chromium, dissolved hexavalent,mg/L			<0.0100	<0.050	*0.05*
Conductivity, µmhos/cm^2	301.0	313.0	327	318	
Lead, total, mg/L			<0.00500	<0.0030	*0.05*
Nitrate-Nitrogen, mg/L			<0.500	<0.11	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	7.51	7.18	6.54	6.44	
Phenolics as phenol, mg/L			0.00700	<0.050	*0.3*
Sulfate, mg/L	11.1	10.3	11.5	<20	*250*
Total Dissolved Solids, mg/L	188.	216.	224	162	*500*
Total Organic Carbon, mg/L			5.62		
Total Organic Halides, mg/L			0.0103		
Tritium, pCi/L	<96	941	<106		

Well No. Date	D-12 2/9/00	D-12 5/4/00	D-12 8/9/00	D-12 duplicate MW-15	D-12 11/7/00	*NJPDES Permit Standard*
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	0.10	*0.5*
Chloride, mg/L			18.9	19.1	<20	*250*
Chromium, dissolved hexavalent,mg/L			<0.0100	<0.0100	<0.050	*0.05*
Conductivity, µmhos/cm^2	257.0	253.0	220	220	190	
Lead, total, mg/L			<0.00500	<0.00500	<0.003	*0.05*
Nitrate-Nitrogen, mg/L			<0.500	<0.500	<0.11	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500	<0.500		
pH, units	6.86	7.06	5.14	5.14	5.82	
Phenolics as phenol, mg/L			0.0100	<0.00500	<0.050	*0.3*
Sulfate, mg/L	32.9	28.3	32.6	32.6		*250*
Total Dissolved Solids, mg/L	148.	746.	150	98	124	*500*
Total Organic Carbon, mg/L			3.30	3.83		
Total Organic Halides, mg/L			0.0566	0.0334		
Tritium, pCi/L	137	1,104	<106	<119		

Blank indicates no measurement.

Table 26. Ground Water Analysis for Wells TW-2 and TW-3 for 2000

Well No. Date	TW-2 2/9/00	TW-2 5/5/99	TW-2 8/9/00	TW-2 11/08/00	*NJPDES Permit Standards*
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.10	*0.5*
Chloride, mg/L			16.7	<20	*250*
Conductivity, µmhos/cm²	361.0	357.0		378	
Lead, total, mg/L			<0.00500	<0.0030	*0.05*
Nitrate-Nitrogen, mg/L			<0.500	0.11	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	7.53	7.70	8.43		
Phenolics as phenol, mg/L			0.00800	<0.050	*0.3*
Sulfate, mg/L	22.6	98.8	17.2	<20	*250*
Total Dissolved Solids, mg/L	248.	178.	190.	205	*500*
Total Organic Carbon, mg/L			1.94		
Total Organic Halides, mg/L			<0.01		
Tritium, pCi/L	366	1,027	140		

Well No. Date	TW-3 2/9/00	TW-3 5/4/00	TW-3 8/9/00	TW-3 Duplic. (MW-15)	TW-3 11/7/00	*NJPDES Permit Standard*
Ammonia-Nitrogen, mg/L		<0.100	<0.100			*0.5*
Chloride, mg/L			17.7	20.7	20.6	*250*
Chromium, dissolved hexavalent,mg/L			<0.0100	<0.050	<0.050	*0.05*
Conductivity, µhos/cm²	428.0	366.0	385	379	373	
Lead, dissolved, mg/L						*0.05*
Nitrate-Nitrogen, mg/L			<0.500	<0.11	<0.11	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500			
pH, units	8.20	8.04	7.79	7.22	7.22	
Phenolics as phenol, mg/L			0.0150	<0.050	<0.050	*0.3*
Sulfate, mg/L	22.0	19.0	21.3	23.4	23.5	*250*
Total Dissolved Solids, mg/L	226.	1580	204.	198	197	*500*
Total Organic Carbon, mg/L			<1.00			
Total Organic Halides, mg/L			<0.01			
Tritium, pCi/L	244	878	135			

Blank indicates no measurement.

Table 27. Summary of Ground Water Sampling Results – June 2000
Target Volatile Organic Compounds (µg/L)

Well No.	MW-13S	MW-13I	MW-18	MW-19S	MW-19I	NJ GW Standard
Tetrachloroethylene	73.6 J	41.3	0.52 T	93.1	<0.4	1
Trichloroethylene	1.50 T	<1.1	<1.1	3.43	<1.1	1
c-1,2-Dichloroethylene	3.49 T	2.71 T	<0.4	17.6	<0.4	70
1,1,1-Trichloroethane	<0.6	3.82 T	<0.6	<0.6	<0.6	30
1,1-Dichloroethylene	0.980 T	1.28 T	<0.5	<0.5	<0.5	2
Chloroform	1.0T	1.54 T	<0.6	<0.6	<0.6	6
Carbon tetrachloride	2.63 T	<0.6	<0.6	<0.6	<0.6	2
Tentatively Identified Compounds						
1,1,2-trichloro-trifluoroethane	<1.0	<1.0	5.38 NT	8.27 NT	15.6 NT	--

Well No.	MW-22S	MW-23S	MW-24S	MW-25	MW-26*	NJ GW Standard
Tetrachloroethylene	<0.4	<0.4	<0.4	<0.4	73.5	1
Trichloroethylene	<1.1	<1.1	<1.1	<1.1	1.63 T	1
c-1,2-Dichloroethylene	<0.4	<0.4	<0.4	3.63 T	3.51 T	70
1,1,1-Trichloroethane	<0.6	<0.6	<0.6	<0.6	2.78 T	30
1,1-Dichloroethylene	<0.5	<0.5	<0.5	<0.5	1.02 T	2
Chloroform	0.75 T	<0.6	<06	<06	1 T	6
Carbon tetrchloride	<0.6	<0.6	<0.6	<0.6	<0.6	2
Tentatively Identified Compounds						
1,1,2-trichloro-trifluoroethane	5.95 NT	5.26	<1.0	<1.0	<1.0	

Well No.	D-DSN001	MG-D Site Sump	TFTR Sump	TB 6/26/00		NJ GW Standard
Tetrachloroethylene	1.08 T	41.6	2.54 T	<0.4		1
Trichloroethylene	<1.1	3.24 T	<1.1	<1.1		1
c-1,2-Dichloroethylene	<0.4	2.60 T	<0.4	<0.4		70
1,1,1-Trichloroethane	<0.6	0.810 T	<0.6	<0.6		30
1,1-Dichloroethylene	<0.5	1.47 T	<0.5	<0.5		2
Chloroform	2.52 T	<0.6	5.17	<06		6
Carbon tetrchloride	<0.6	<0.6	<0.6	<0.6		2
Bromodichloromethane	<0.7	<0.7	0.880 T	<0.7		1
Methylene chloride	<0.6	<0.6	<0.6	3.54 T		2
Acetone	4.33 T	<5.0	<5.0	<5.0		700
Tentatively Identified Compounds						
1,1,2-trichloro-trifluoroethane	24.3 NT	<1.0	8.01 NT	<1.0		

N – Indicated presumptive evidence of the compound's presence
T- Estimated, concentration listed is below detection limit.
TB – Trip Blank

** MW-26 is duplicate sample from well MW-13S.*

Ground water quality standards as published in N.J.A.C. 7:9-6.9.

-- Compound-specific Ground Water Quality Standard not published.

Table 28. Summary of Ground Water Sampling Results – November 2000
Target Volatile Organic Compounds (µg/L)

Well No.	MW-13S	MW-13I	MW-18	MW-19S	MW-19I	NJ GW Standard
Tetrachloroethylene	67.3	33.0	0.82 T	205	<1.0	1
Trichloroethylene	2.0	<1.0	<1.0	8.00	<1.0	1
c-1,2-Dichloroethylene	5.2	1.7 T	<5.0	35.9	<5.0	70
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	30
1,1-Dichloroethylene	<2.0	<2.0	<2.0	<2.0	<2.0	2
Chloroform	<5.0	0.79 T	<5.0	<5.0	<5.0	6

Well No.	MW-22S	MW-23S	MW-24S	MW-25	MW-26*	NJ GW Standard
Tetrachloroethylene	<1.0	<1.0	NS	<1.0	212	1
Trichloroethylene	<1.0	<1.0	NS	<1.0	8.8	1
c-1,2-Dichloroethylene	<5.0	<5.0	NS	5.0	36.3	70
1,1,1-Trichloroethane	<5.0	<5.0	NS	<5.0	<5.0	30
1,1-Dichloroethylene	<2.0	<2.0	NS	<2.0	<2.0	2
Chloroform	<5.0	2.3 T	NS	<5.0	<5.0	6

Well No.	DSN001	MG-D Site Sump	TFTR Sump	TB 6/26/00		NJ GW Standard
Tetrachloroethylene	0.87 T	75.6	1.8	<1.0		1
Trichloroethylene	<1.0	4.8	<1.0	<1.0		1
c-1,2-Dichloroethylene	<5.0	3.2 T	<5.0	<5.0		70
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	<5.0		30
1,1-Dichloroethylene	<2.0	<2.0	<2.0	<2.0		2
Chloroform	1.5 T	<5.0	4.9 T	<5.0		6
Acetone	5.5	<5.0	<5.0	<5.0		700

NS – No sample collected, due to water level too low in well.

N – Indicated presumptive evidence of the compound's presence
T- Estimated, concentration listed is below detection limit.
TB – Trip Blank

** MW-26 is duplicate sample from well MW-19S.*

Ground water quality standards as published in N.J.A.C. 7:9-6.9.

-- Compound-specific Ground Water Quality Standard not published.

Table 29. Volatile Organics Analytical Results from Wells, D-11R, D-12 and TW-3, Detention Basin Inflows 1 and 2— May and August 2000 (in µg/L)

Well No. May 2000	D-11R	D-12	TW-3	Inflow 1	Inflow 2	Trip Blank	NJ GW Standard
1,1-Dichloroethane	<0.5	1.82 T	<0.5	<0.5	<0.5	<0.5	*70*
Chloroform	<0.8	<0.8	<0.8	1.36 T	1.12 T	<0.8	*6*
1,1,1-Trichloroethane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	*30*
Trichloroethylene	<0.3	1.87 T	<0.3	<0.3	<0.3	<0.3	*1*
Bromodichloromethane	<0.2	<0.2	<0.2	0.37 T	0.45 T	<0.2	*1*
Tetrachloroethylene	4.52 T	3.26 T	2.53 T	1.39 T	1.64 T	<0.4	*0.4*
Bromoform	<0.3	<0.3	<0.3	<0.3	0.28 T	<0.3	*4*
Toluene	<0.2	<0.2	<0.2	<0.2	0.57 T	<0.2	*1,000*

Well No. August 2000	D-11R	D-12	TW-3	Inflow 1	Inflow 2	Trip Blank	NJ GW Standard
1,1-Dichloroethane	<0.5	1.18T	<0.5	<0.5	<0.5	<0.5	*70*
Chloroform	<0.8	<0.8	<0.8	4.98 T	2.74 T	<0.8	*6*
1,1,1-Trichloroethane	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	*30*
Trichloroethlyene	<0.3	1.75 T	<0.3	<0.3	<0.3	<0.3	*1*
Bromodichloromethane	<0.2	<0.2	<0.2	1.23 T	0.67 T	<0.2	*1*
Tetrachloroethylene	4.83 T	4.36 T	5.04	<0.4	1.55 T	<0.4	*1*

T- Estimated, concentration listed is below detection limit.

Table 30. Quality Assurance Data for Radiological and Non-Radiological Samples for 2000

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
PPPL DOE-EML Tritium in water (Bequerel/Liter))			
QAP-2003	78.96	79.4	Pass
QAP-2009	98.3	91.3	Pass
ERA (picoCuries/Liter)			
March 2000 RAD-20	20,400	23,800	Pass
August 2000 RAD-26	6,770	8,320	Fail
PPPL Test Results-SPEXCertiPrep P0300			
Total residual chlorine (mg/L)	0.667	0.680	Pass
pH	8.02	8.00	Pass
Nitrate-nitrogen	13.3	15.0	Pass
Ortho-phosphate	3.14	4.00	Fail

Appendix

B

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