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PPPL-3557

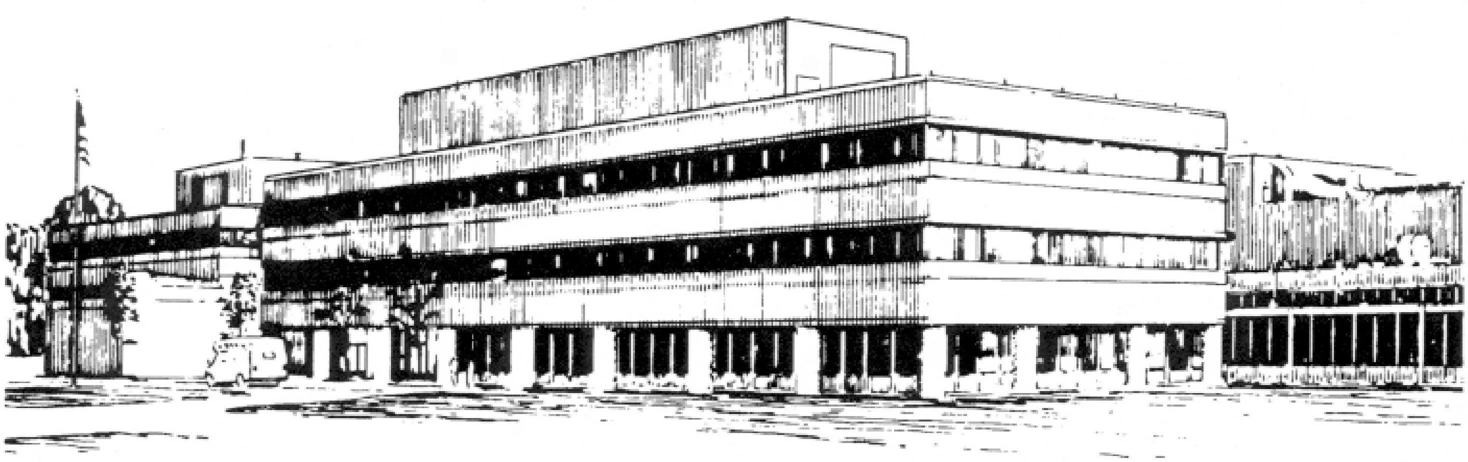
Princeton Plasma Physics Laboratory Annual Site Environmental Report for Calendar Year 1999

by

Virginia Finley

April 2001

PRINCETON PLASMA PHYSICS LABORATORY



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PRINCETON UNIVERSITY, PRINCETON, NEW JERSEY

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ANNUAL SITE ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1999

Princeton Plasma Physics Laboratory

P.O. Box 451

Princeton, New Jersey 08543

Prepared by: Virginia L. Finley

Under Contract DE-AC02-76-CHO-3073

Princeton Plasma Physics Laboratory (PPPL)
Certification of Monitoring Data for
Annual Site Environmental Report for 1999

Contained in the following report are data for radioactivity in the environment collected and analyzed by Princeton Plasma Physics Laboratory's Radiological Environmental Monitoring Laboratory (REML). The REML is located on-site and is certified for analyzing radiological parameters through the New Jersey Department of Environmental Protection's Laboratory Certification Program, Certification Number 12471. Non-radiological surface and ground water and soil 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 1999," are documented and certified to be correct.

Signed:

____
Virginia L. Finley,
Head, Environmental Compliance
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Princeton Plasma Physics Laboratory

Annual Site Environmental Report

For Calendar Year 1999–Abstract

The results of the 1999 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 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's operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 1999.

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. 1999 marked the first 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.

The 1999 performance of the Princeton Plasma Physics Laboratory was rated "outstanding" by the U.S. Department of Energy in the Laboratory Appraisal report issued early in 2000. The report cited the Laboratory's consistently excellent scientific and technological achievements, its successful management practices, and included high marks in a host of other areas including environmental management, employee health and safety, human resources administration, science education, and communications.

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

Virginia L. Finley, author

(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 TFTR stack; the data are presented in this report.

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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
B1, B2	Bee Brook 1 (upstream of DSN001) and 2 (downstream of DSN001) (surface water stations)
BCG	biota concentration guide
BPX	Burning Plasma Experiment (proposed at PPPL)
Bq	Becquerel
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C	C site of James Forrestal Campus, part of PPPL site named for C Stellarator
°C	Degrees Celsius
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
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cf	cubic feet
CFCs	chlorofluorocarbons
CFR	Code of Federal Regulations
Ci	Curie (3.7 ^{E10} Becquerel)
cm	centimeter
COD	chemical oxygen demand
CS	C site stellarator (PPPL)
CWA	Clean Water Act
CY	calendar year
D	deuterium
D&D	decontamination and decommissioning
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-PG	Department of Energy - Princeton Group
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 Systems
EO	Executive Order
EOHSI	Environmental and Occupational Health Sciences Institute
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
ESHD	Environment Safety & Health Directives
ES&H	Environment, Safety, and Health
ESU	Emergency Services Unit (PPPL)
°F	Degrees Fahrenheit
FCPC	Field Coil Power Conversion Building
FFCA	Federal Facility Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act

List of Acronyms

FONSI	Finding of No Significant Impact
FSAR	Final Safety Analysis Report
FSCD	Freehold Soil Conservation District (Middlesex and Monmouth Counties)
g	gram
GBq	giga Becquerel or 10^9Bq
GP	General Permit (Wetlands)
GPMP	Groundwater Protection and Monitoring Program
GWPP	Ground Water Protection Plan
GW	ground water
H-3	tritium
HAPs	Hazardous Air Pollutants
HAZWOPER	Hazardous Waste Operations – Health & Safety Training for Site Investigation Personnel
HMSF	Hazardous Material Storage Facility
HQ	Headquarters
HT	tritium (elemental)
HTO	tritiated water or tritium oxide
HVAC	heating, ventilation, and air-conditioning
ICRF	Ion Cyclotron Radio Frequency
IC_{25}	inhibition concentration 25 percent (Chronic biomonitoring test result)
ISM	Integrated Safety Management
ISO	International Standards Organization (14000 series – Environmental Management Systems)
JET	Joint European Torus (UK)
JFC	James Forrestal Campus
km	kilometer
kV	kilovolt (thousand volts)
LEC	liquid effluent collection (tanks)
LEPC	Local Emergency Planning Committee
LSB	Lyman Spitzer Building (Formerly Laboratory Office Building)
LOI	Letter of Interpretation (Wetlands)
LLW	Low level waste (radiological waste)
m	meter
M1	Millstone River (surface water station)
MC&A	Material Control & Accountability (Plan – PPPL)
MCHD	Middlesex County Health Department
MeV	million electron volts
MG	Motor Generator (Building)
mg/L	milligram per liter
M&O	Maintenance & Operations Division (PPPL)
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
MSW	Municipal Solid Waste
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
NG	Natural gas
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 (Chronic biomonitoring test result)
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission

List of Acronyms

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)
PBX-M	Princeton Beta Experiment - Modification
PCBs	polychlorinated biphenyls
PCE	perchloroethylene, tetrachloroethene, or tetrachloroethylene
pCi/L	picoCuries per liter
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
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	Radioactive Waste Handling Facility (PPPL)
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
SF_6	sulfur hexafluoride
SPCC	Spill Prevention Control and Countermeasure
STP	Site Treatment Plan for the Federal Facility Compliance Act (PPPL Proposed Plan)
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
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.***

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Chapter 1

Princeton Plasma Physics Laboratory

Annual Site Environmental Report for Calendar Year 1999

Executive Summary

This report presents the results of environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Year 1999. 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, added to the environment as a result of PPPL operations. The report also summarizes environmental initiatives, assessments, and programs that were undertaken in 1999. The objective of the Annual Site Environmental Report is to document that PPPL's environmental protection programs protect the public health and the environment.

The Princeton Plasma Physics Laboratory has engaged in fusion energy research since 1951. The reaction occurring in our sun, as within other stars, is fusion. In a fusion reaction, the nuclei of hydrogen atoms in a plasma state fuse or join to form helium atoms thereby releasing neutrons and energy. Unlike the sun, PPPL's reaction is 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 an alternative energy source.

1999 marked the first year of National Spherical Torus Experiment (NSTX) operations and the first year of the Tokamak Fusion Test Reactor (TFTR) dismantlement.

After fifteen years of operation (1982-1997), PPPL put the TFTR device in a safe, shut-down mode. Milestones of the TFTR program included achieving a world power record - approximately 10.7 million watts of controlled fusion power - during the deuterium-tritium plasma experiments. The deuterium-tritium (D-T) phase of experiments used forms of hydrogen with different numbers of neutrons to create the fusion reaction. The amount of the energy produced - 10.7 megawatts (millions of watts) - is sufficient power for 3,000 houses, though that power level was generated for a brief moment.

More than 700 D-T experiments were conducted, which generated approximately 5.6 x 10^{20} neutrons and 1.6 gigajoules of fusion energy**.** These achievements represent major steps forward toward the reality of a commercial fusion reactor in the twenty-first century.

From groundbreaking in May 1998 to first plasma on February 12, 1999, the new National Spherical Torus Experiment (NSTX) was completed within budget and ahead of its target schedule. The NSTX is housed in the former TFTR Hot Cell of D-site, which significantly contributed to the cost savings. This device represents a major effort toward a smaller and more economical fusion reactor or volumetric neutron source.

The NSTX program is a national collaboration; the following institutions (in addition to PPPL) 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

The 1999 performance of the Princeton Plasma Physics Laboratory was rated "outstanding" by the U.S. Department of Energy in the Laboratory Appraisal report issued early in 2000 [DOE00]. The report cited the Laboratory's consistently excellent scientific and technological achievements, its successful management practices, and included high marks in a host of other areas including environmental management, employee health and safety, radiation protection, human resources administration, science education, and communications.

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

In 1999, PPPL's radiological monitoring program measured on-site and off-site tritium in air. Capable of detecting small changes in the ambient levels of tritium in the air, highly sensitive monitors are located at four on-site and six off-site stations within 1 km of TFTR. Operation of an in-stack monitor located at PPPL is a requirement of the National Emission Standard for Hazardous Air Pollutants (NESHAPs) regulations with limits set by the U.S. Environmental Protection Agency. 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 1999 were as follows:

> Total maximum off-site dose from all sources—airborne and liquid releases—was 0.26 mrem / year.
>
> Dose at the nearest business due to airborne releases was 0.05 mrem / year.

These doses are the lowest in the last six years since D_T experiments began and are a small fraction of the 10 mrem / year

PPPL objective and the 100-mrem / year DOE limit.

PPPL's 1999 Pollution Prevention Program included:

1. Dismantlement of the Princeton Large Torus (PTL) with 209 tons of metal reclaimed and recycled.
2. Community Outreach through Earth Day poster contests for Grades 4-6 and America Recycle Day on November 15 hosting environmental-friendly vendors and regulatory agencies.
3. Monitoring amounts of recycled material *versus* non-recycled material.
4. Reducing hazardous waste disposal by 94% and solid waste by 71% through pro-actively seeking recyclers for these materials.

PPPL's non-radiological environmental monitoring program demonstrates compliance with 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 1999, PPPL continued its remedial investigation and remedial alternative assessment for C and D sites of the James Forrestal Campus, which are land leased to the Department of Energy (DOE) by Princeton University. Since 1989, ground-water data has revealed volatile organic compound contamination (most likely from solvents) at low levels in three locations. In February 1993, Princeton University signed a voluntary agreement, or Memorandum of Understanding (MOU), with the New Jersey Department of Environmental Protection. PPPL's environmental restoration program included ground-water sampling, soil sampling, and soil removal from two locations that exceeded the New Jersey Soil Cleanup Standards. This activity has progressed to an approved remedy with quarterly monitoring of selected wells.

Through its Integrated Safety Management (ISM) program, PPPL continues to emphasize environment, safety, and health (ES&H) in accordance with DOE requirements at the facility. The expectations are that the Laboratory will continue to excel 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 employs state-of-the-art monitoring and best management practices, and is an institution that serves other research facilities and the nation with valuable information gathered from its fusion 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 is a Collaborative National Center for plasma and fusion science. Its primary mission is to develop the scientific understanding and the key innovations leading to an attractive fusion energy source [PPPL98a]. Associated missions include conducting world-class research along the broad frontier of plasma science and providing the highest quality of scientific education.

At PPPL, the National Spherical Torus Experiment (NSTX) is a collaboration 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 assisted 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.

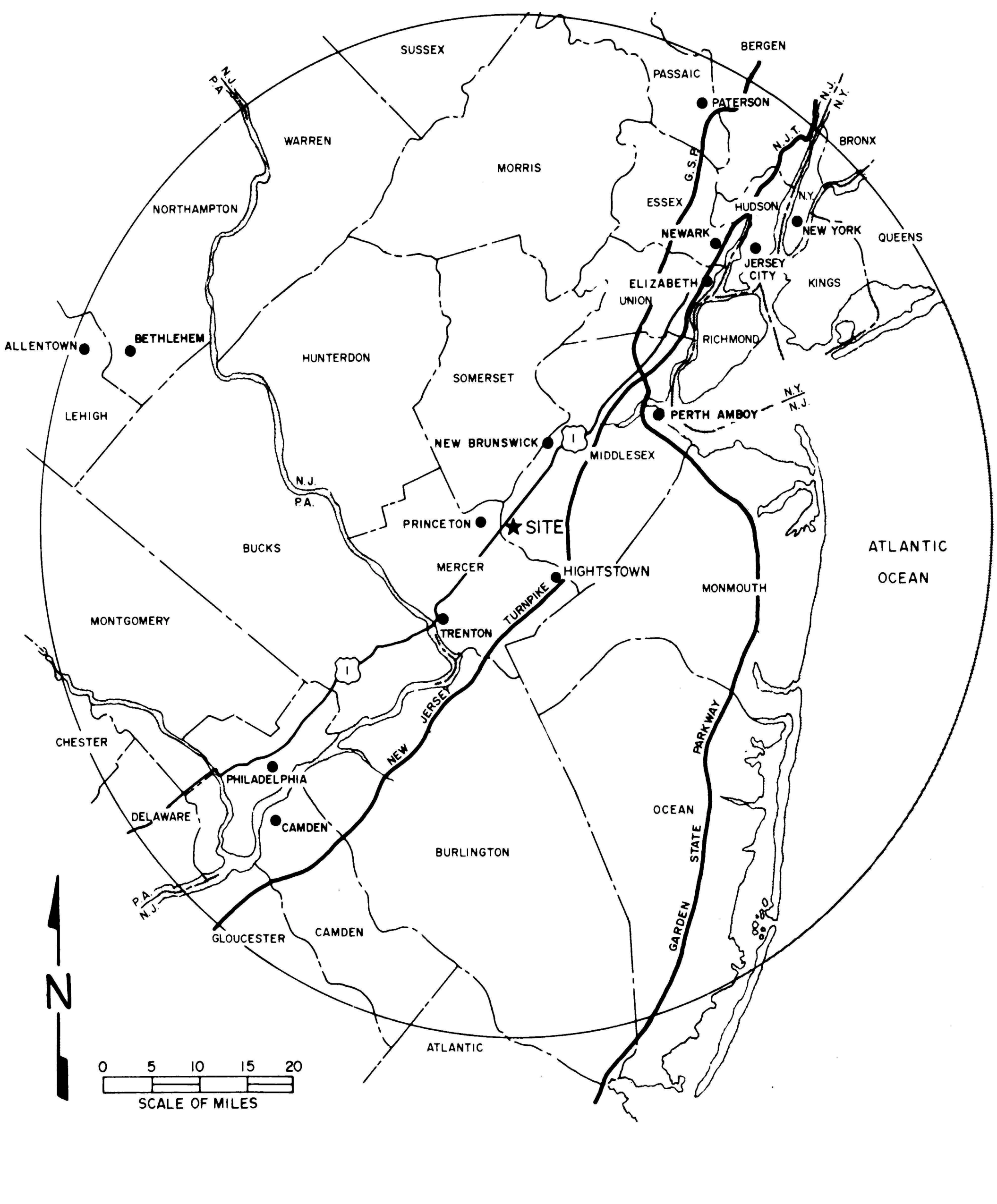
2.2 Site Location

The Princeton Plasma Physics Laboratory site is in the center of a highly urbanized region extending from Boston, Massachusetts, to Washington, D.C., and beyond. The closest urban centers are New Brunswick, 14 miles to the northeast, and Trenton, 12 miles to the southwest. Major metropolitan areas, including New York City, Philadelphia, and Newark, are within 50 miles of the site (Exhibit 2-1).

The site is located in Plainsboro Township (Middlesex County-central New Jersey) with the municipalities of Princeton, Kingston, West Windsor, and Cranbury in the immediate vicinity. The Princeton area continues to experience a substantial increase in new business moving into the Route 1 corridor near the site. Also, the main campus of Princeton University, located primarily 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; 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-currently being dismantled) and is now home of the National Spherical Torus Experiment (NSTX) (Exhibit 2-2).

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



The site is surrounded by undisturbed areas with upland forest, wetlands, open grassy areas and cultivated fields on the west, 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

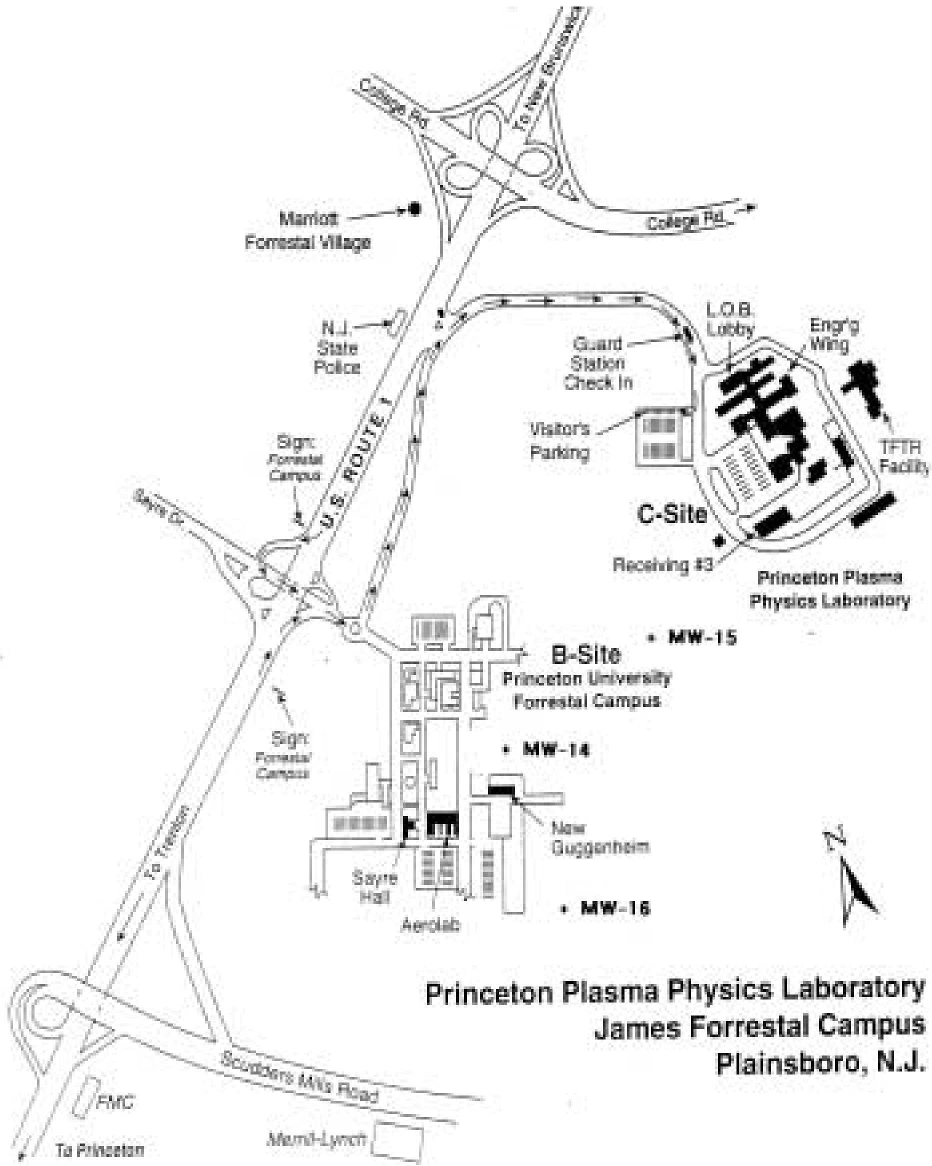


Exhibit 2-3. Aerial View of PPPL (Looking Southeast)

The D site is fully surrounded with a chain-linked fence for controlled access. As an unfenced site with access controls for security purposes, PPPL openly operates C site, allowing the public access for educational purposes. This free access to C site warranted a thorough evaluation of on-site discharges, as well as the potential for off-site releases of radioactive and non-radioactive effluents. To maintain free access to C site, PPPL instituted an extensive monitoring program that was expanded over 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) occurring once every five years. Approximately half the year, or 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 evenly distributed throughout the year. Droughts occur about once every 15 years [PSAR78]. In August 1999, the Governor of New Jersey issued a drought emergency based on the water levels of reservoirs and water supplies. Typically, the average rainfall in July is 4.8 inches; in 1999, less than one-tenth of an inch fell during that month. The previous three months were also below average, though not to the same extreme. The drought emergency was lifted about seven weeks later due to thunderstorms in August (6.7 inches total for the month) and to Hurricane Floyd, which provided the area with more than eight (8) inches of rain over a two-day period (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. The site apparently 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 nearer the Millstone River, which are within a mile of the site [Gr77].

Exhibit 2-4. NSTX Test Cell in 1999.

2.4 Primary Operations and Activities

The fusion experiments in devices in operation in 1999, *i.e.*, NSTX, MRX, or CDX-U, currently in operation at PPPL, did 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, underway since October 1999, result in releases to the stack. When TFTR is fully dismantled, the area will be available for a new device. Many of the 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, the NSTX device (Exhibit 2-4) has exceeded its target milestones.

2.5 Relevant Demographic Information

A demographic study or population study of the surrounding 50 kilometers was completed in 1987 as part of the Environmental Assessment for the proposed Burning Plasma Experiment (BPX) [Be87a]. Other information gathered and updated from previous BPX or TFTR studies include socioeconomic information [Be87b] and an ecological survey [En87].

Chapter 3

1999 COMPLIANCE SUMMARY

3.1 Environmental Compliance

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 those actions that enhance its compliance efforts and fully documents how it is meeting the requirements. The compliance status of each applicable federal and state environmental statute or regulation, and executive order are discussed in this chapter.

In February 1998, the US Environmental Protection Agency (EPA) Region II conducted a four-day, comprehensive multi-media inspection of PPPL. Included in the inspection were 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)
- Resource Conservation and Recovery Act (RCRA) including Underground Storage Tanks (USTs)
- Emergency Preparedness and Community Right-to-Know Act (EPCRA)
- Toxic Substances Control Act (TSCA) including polychlorinated biphenyls (PCBs)
- Safe Drinking Water Act (SDWA) including underground injection control (UIC)
- Spill Control and Countermeasure Plan (SPCC)
- Superfund Act Reauthorization Act (SARA)

The results of this intensive inspection determined that PPPL complies with the statute requirements with two exceptions (one of which was subsequently rescinded). EPA issued two notices of violations (NOVs) – one for RCRA and one for SPCC programs [EPA98]. PPPL received the first NOV for the lack of RCRA training provided to satellite accumulation area managers; PPPL and DOE-PG contested this NOV on grounds that the regulations were not applicable; EPA agreed and rescinded the NOV.

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 Plans were readily amended rendering PPPL in compliance. The installation of containment in the deficient areas was completed for the C site MG basement tanks; the refueling island containment project is being scheduled. Drainage of the third area, 138-kV switchyard, was routed into the switchyard catch basins that allow for stormwater percolation.

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

PPPL is not involved nor has been involved with CERCLA-mandated cleanup actions. Resulting from the 1991 DOE-HQ Tiger Team assessment, 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 by the results of the inventory.

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 1999, PPPL shipped off site approximately 3.85 tons (3.49 metric tons) of waste to facilities permitted to treat, store, or dispose of hazardous wastes and 59.26 tons (53.8 metric tons) to recycling facilities [El00].

PPPL is also in compliance with the requirements of the RCRA-mandated Underground Storage Tank 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]. Pending NJDEP's Final acceptance of the RI/RAA, the tank closure file remains open.

In 1999, PPPL's non-hazardous, solid waste hauler removed 82 metric tons of solid wastes to a sanitary landfill. Also, PPPL generated 58.33 metric tons of construction waste that was not recyclable [Kin00a]. The Laboratory has implemented and maintains an aggressive recycling program (Exhibit 3-2).

Exhibit 3-1. Hazardous Waste Quantity Comparisons 1997-1999

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

MT = metric tons = 2,204.6 lbs.

Exhibit 3-2. 1999 Waste Reduction

Landfill versus Recycled, Reused or Source Reduction

Type	Source	Amount	Fate
TSCA Waste	Asbestos*	18.14 MT	***Landfill***
	PCBs	0.47 MT	***Landfill***
	Ballasts incl. Ballasts (PCBs)	0.96 MT	**Recycled**
Hazardous Waste	Oil and oily debris	1.44 MT	***Landfill***
	Misc. lab wastes, solvents	2.05 MT	***Landfill***
	Batteries (includes lead acid batteries in emergency lighting	1.91 MT	**Recycled**
	(CFC) R-11, R-500, & R-502	3.26 MT	**Recycled**
	Electronic and computer scrap	12.95 MT	**Recycled**
	Fluorescent lamps	0.70 MT	**Recycled**
	Lead	34.24 MT	**Recycled**
	Mercury	0.70 MT	**Recycled**
	Recycled / Total Hazardous Waste (Landfill + Recycled)	**93.9 %**	
Municipal Solid Waste (MSW)	Front end trash	82.09 MT	***Landfill***
	Construction waste	58.33 MT	***Landfill***
	Paper	17.23 MT	**Recycled**
	Cardboard	30.86 MT	**Recycled**
	Aluminum & glass	10.78 MT	**Recycled**
	Wood	8.31 MT	**Recycled**
	Concrete	11.55 MT	**Recycled**
	Scrap metals	29.63 MT	**Recycled**
	PLT Metals (Copper & Stainless)	209 MT	**Recycled**
	PLT Insulation	3 MT	**Recycled**
	D&D Diamond wire cutting metals (Stainless & inconel)	15 MT	**Reused**
	Office supplies	0.11 MT	**Recycled**
	Recycled & Reused / Total MSW (Landfill + Recycled & Reused)	**70.5 %**	

*In 1999, 160 cubic yards of asbestos waste were disposed in a secure landfill [El00].

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, waste containing both hazardous and radioactive components. Based on the possibility of the site generating mixed waste, which could require treatment on site, PPPL was identified on the list of DOE sites that would be included in the FFCA process [PPPL95]. In 1995, PPPL prepared its proposed “Site Treatment Plan (STP) for Princeton Plasma Physics Laboratory (PPPL).”

PPPL 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 USEPA 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. However, DOE will provide the state and USEPA with annual updates and will keep the regulators apprised of the status 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-one (71) PPPL activities received NEPA reviews in 1999, with all of these determined to be Categorical Exclusions 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 were in progress in 1999 [Lev00].

3.1.5 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].

The Plan through its monitoring program, provides assurance that the release of radioactive material at or beyond PPPL's site boundary will be within regulatory limits, and PPPL's policy limits of "as low as reasonably achievable" (ALARA). The order pertains to permissible dose equivalents and concentration guides and gives guidance on maintaining exposures to ALARA.

When 10 CFR 835 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.

Exhibit 3-3. 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

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.

Following the end of TFTR D-T experiments, internal exposure from radionuclides, such as tritium (H-3) 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 3-3).

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 3-4).

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 public good.

Exhibit 3-4. 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 – H-3 (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)	H-3 (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	H-3 (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	H-3 (HTO), Gross b
Air	A1, A2, & A3	TFTR Test Cell Tritium Vault D-site Stack (HVAC)	Continuously	H-3 (HT and HTO)
Direct & Air (on-site)		4 air monitoring trailers on D-site facility boundary	Continuously	g, n, H-3 (HT and HTO),
Direct & Air (off-site)		6 locations off-site with 1 km radius	Continuously	H-3 (HT and HTO)

H-3 = tritium HT = elemental tritium HTO = tritiated water
Gross b = Gross beta g = gamma n = neutron

3.1.6 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 for transportation and subsequent burial at the Hanford Burial Site.

3.1.7 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 plan, "Nuclear Materials Control and Accountability (MC&A) Plan" describes the elements of PPPL system for control and accountability of nuclear materials in PPPL's custody [PPPL98d]. PPPL management assures that all 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.

3.1.8 Clean Air Act (CAA)

PPPL complied with the requirements of the CAA in 1999. Under Title I, "Nonattainment Provisions, "PPPL is located in a severe 17-ozone nonattainment 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 and 10 tons per year of volatile organic compounds (VOCs). Formed during the burning of fossil fuels in boilers, generators, vehicle engines, *etc*., nitrogen oxides (NO_x) and VOCs are precursors to ozone formation.

At PPPL, nitrogen oxides (NO_x) are the one class of regulated air contaminant that has the potential to exceed thresholds limits. In order to meet this limit, PPPL requested that NJDEP allow PPPL a total fuel use limit for all four boilers. NJDEP granted that request and imposed a maximum annual fuel (oil and natural gas) use limitation for the C site boilers rather than the individual boiler fuel use limit (Exhibit 3-5). PPPL continues to operate successfully within the stated limitations. [NJDEP96 and Kir00a].

Exhibit 3-5. 1998-1999 Fuel Use at PPPL

Fuel type	NJDEP Limit	PPPL 1998 Use	PPPL 1999 Use
No. 4 oil (gal.)	227,370	13,470	21,358
Natural gas (cf)	88.6 million	28.9 million	36.943 million

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 before disposal of equipment. PPPL employs trained and certified technicians to service and repair equipment containing ozone-depleting substances and to operate the Laboratory's four refrigerant recovery units. PPPL is pursuing replacement of older equipment (air conditioners, chiller units) with non-Class I and II refrigerants.

In order to track gases that contribute to global warming, NJDEP requested that PPPL determine the amount of sulfur hexafluoride (SF_6) released annually from TFTR. During TFTR operations, SF_6 was used in high-voltage electrical equipment - modulator regulators, ICRF, and NB high voltage and ion source enclosures. 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. 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.

3.1.9 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

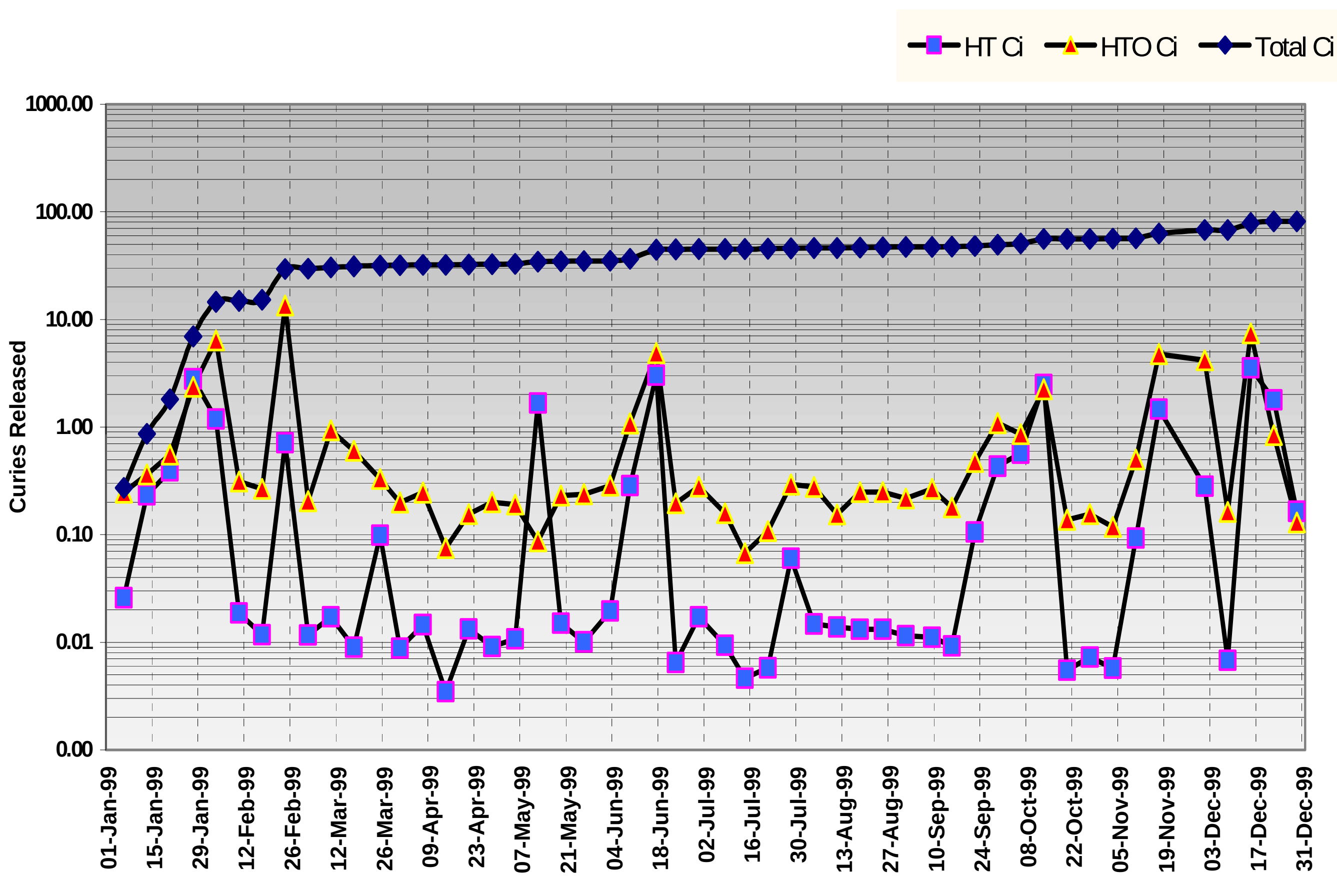
PPPL has an in-stack sampler within the D-site (TFTR) stack to monitor tritium releases. The monitor has been independently verified as meeting National Emission Standard for Hazardous Air Pollutants (NESHAPs) radionuclide emission monitoring requirements. In August 1993, PPPL received USEPA's concurrence on this determination. In 1999, the levels of tritium released during TFTR safe-shutdown operations were measured: 59.712 curies of tritiated water or HTO and 21.779 curies of elemental tritium or HT (Exhibits 3-6 and 3-7 and App. A, Table 3) [As00].

Exhibit 3-6. Total Air Release of Tritium from D-Site (formerly TFTR) Stack 1994 to 1999

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

*December 1994 only (when D-T operations began).
Annual Limit is 500 Curies

Exhibit 3-7. 1999 TFTR Stack Release (by Analysis)



In Appendix A, see Table 3, "D-Site Stack Tritium Releases in Curies in 1999."

Exhibit 3-8. Dose from PPPL Operations from 1994 to 1999

Calendar Year	Estimated Dose Equivalent (mrem) at Site boundary	Estimated Dose Equivalent (mrem) at Nearest Business
1994	0.30	0.01
1995	0.31	0.01
1996	0.43	0.11
1997	0.51	0.12
1998	0.68	0.08
1999	0.26	0.05

Annual Limit is 10 mrem/year.

In 1999, the effective dose equivalent (EDE) to a person at the business nearest PPPL, due to radionuclide air emissions, was 0.05 mrem (0.5 µSv), which is significantly lower than the NESHAPs standard of 10 mrem/yr (Exhibit 3-8). During their most recent inspection of PPPL facilities in March 1998, representatives from USEPA Region II indicated that PPPL complied with NESHAPs requirements [Lev00].

3.1.10 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." 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 tanks used for vehicle refueling and equipment oil storage tanks contain petroleum products that are regulated under this regulation.

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 the regulations including notification of discharges and discharge confirmation reporting requirements. PPPL is considered a minor facility and therefore, the Discharge Prevention Control and Containment Plan and Discharge Cleanup Plans do not apply.

3.1.11 Clean Water Act (CWA)

PPPL complies with the requirements of the CWA. An assessment of ground water has been undertaken as part of an effort that followed identification of leaking underground storage tanks (USTs) containing heating oil and vehicle fuel. Quarterly ground water monitoring for petroleum hydrocarbons and volatile organic compounds was conducted until September 1997 (see Section 6.1.3). The data collected for 24 quarters (6 years) were consistent: trace or no petroleum hydrocarbons were detected and the tanks were not the source of any low levels of volatile organic compounds. Following discussions with NJDEP, PPPL concluded that quarterly ground water monitoring should not continue.

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported four (4) releases: two were air-related and two were soil-related– none impacted a waterway) These releases are described in Section 3.4.

3.1.12 National Pollutant Discharge Elimination System (NPDES)

In 1999, PPPL operated under the requirements of New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit (NJ0023922). The NJDEP issued the renewed surface water permit on April 29, 1999, with an effective date of June 1, 1999 [NJDEP99].

In 1999, the monitoring locations in the permit are the detention basin outfall (DSN001), and the filter backwash discharge (DSN003) at the Delaware & Raritan Canal pump house. These two locations are designated as monthly sampling points. One exceedance of the permit conditions occurred at DSN003 monitoring location in January 1999.

This exceedance was for a total suspended solids (TSS) concentration of 24 mg/L (limit is 20 mg/L), which was identical to the previous permit exceedance (June 1998) of 22 mg/L at DSN003. The TSS concentration (24 mg/L *versus* the limit of 20 mg/L) was likely due to high solids in the D&R Canal at the time the sample was collected and not due to PPPL operation of the pump house. The NJDEP agreed with this finding and did not include a TSS limit for DSN003.

The renewed surface water permit required a number of changes to PPPL's surface water monitoring program; the most significant were:

1) Chronic Toxicity Testing frequency was reduced from semi-annual to annual.
2) Chlorine monitoring was increased from quarterly to monthly. Additionally, a plan to eliminate chlorine produced oxidants (CPO) from the discharges must be provided to NJDEP each year, as progress reports; and
3) Total suspended solid 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).

3.1.13 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).

In the event of a fire or other emergency situation, PPPL can switch from Delaware & Raritan Canal water (non-potable) to potable water for its non-contact water supply. During 1999, when the D&R Canal supply line was being re-routed across Forrestal Campus property, potable water was used for make-up water to the cooling towers and other water systems.

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.

3.1.14 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 1999, only 5 PCB capacitors, which met the regulation criteria, remained at PPPL [Pu00].

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

NJDEP-certified subcontractors, who meet all the requirements of FIFRA, performed the application of herbicides, pesticides, and fertilizers. PPPL Maintenance & Operations Division (M&O) monitors this subcontract. In 1999, 1000 pounds of fertilizers were applied. The following list of herbicides and one insecticide were used on the PPPL site in 1999 [Kin00b].

Herbicide:	Surflan (2 gallons)
	Dimension (5 gallons)
	Roundup (10 gallons)
	Dissolve (20 pounds)
Insecticide:	Dursban (10 quarts)

3.1.16 Endangered Species Act (ESA)

In 1999, 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].

3.1.17. Migratory Bird Treaty Act

In 1999, 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.

3.1.18 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].

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

In 1999, 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 (MSL), respectively [NJDEP84] (Exhibit 3-9.).

The 88.5-acre parcel that PPPL occupies is included in Princeton Forrestal Center's (PFC) stormwater management plan-Phase I. The 88.5-acre parcel is part of the Bee Brook watershed and therefore includes PPPL in the PFC stormwater 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 Stormwater 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 compilation of activities already in practice at PPPL.

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

In 1999, 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.

A General Permit (GP 1) was applied for and approved by the NJ Department of Environmental Protection. PPPL required a GP 1 for vegetation cutting and equipment maintenance of the 26 kV box-frame tower.

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, which is valid until January 2004 (Exhibit 3-9).

3.1.21 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.

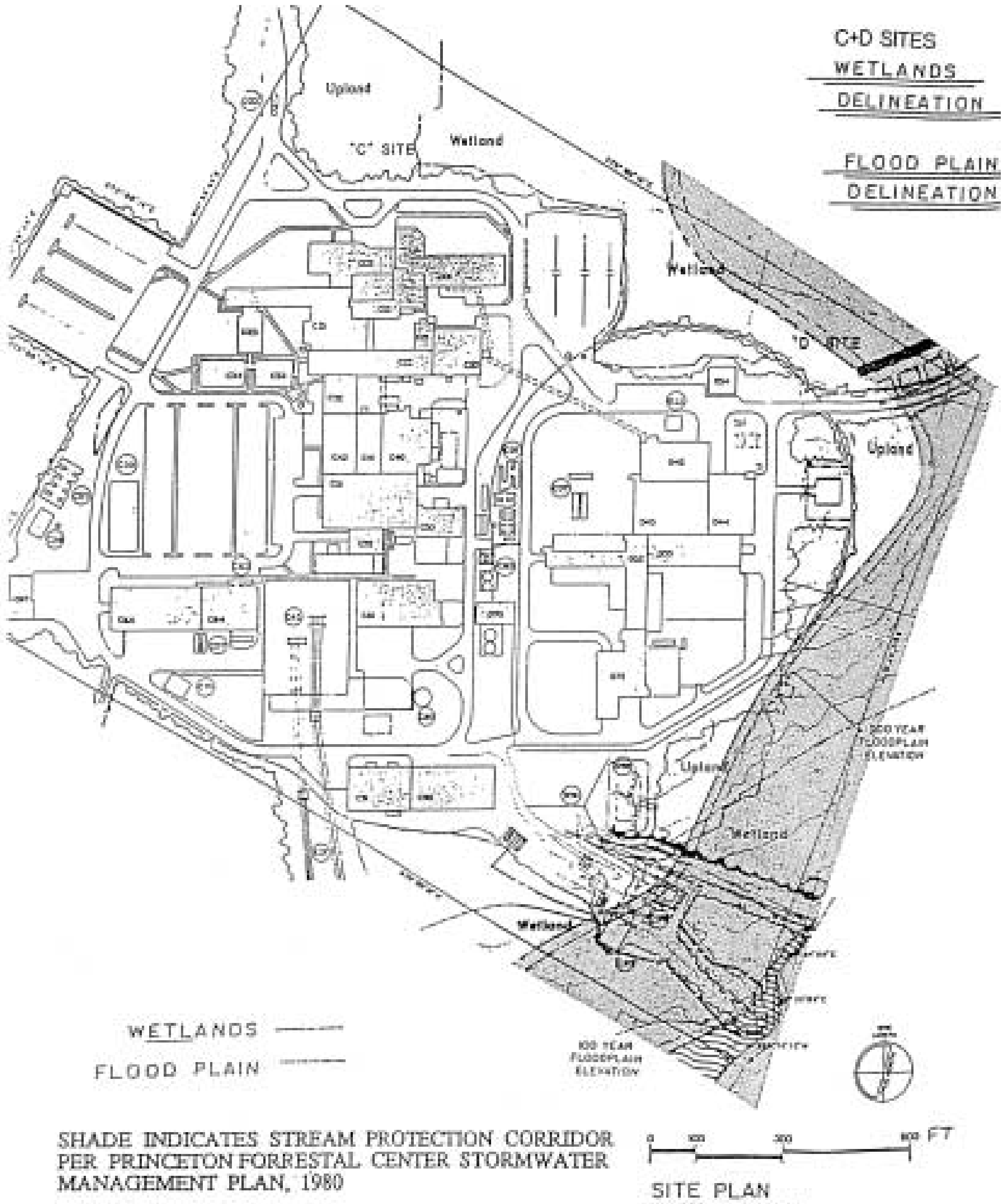


Exhibit 3-9 PPPL Site Map – Floodplain and Wetland Boundaries

Under the reporting requirements of EO 12856 and SARA Title III, PPPL complied with the following:

Exhibit 3-10. Summary of PPPL EPCRA Reporting Requirements

Required (✓):

✓ EPCRA 302-303: Planning Notification

EPCRA 304: EHS Release Notification

✓ EPCRA 311-312: MSDS/ Chemical Inventory

EPCRA 313: TRI Inventory

In 1999**,** PPPL submitted an annual chemical inventory in compliance with SARA Title III (EPCRA Section 312). This inventory reports the quantities of chemicals listed in the CERCLA regulations.

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) Completed SARA Tier I forms listing each hazardous substance stored by users above a certain threshold planning quantity (typically 10,000 pounds, but lower for certain compounds).

Exhibit 3-11 lists hazardous compounds at PPPL reported under SARA Title III for 1999 [PPPL00a].

Of the twelve, six compounds are in their gaseous form and are therefore classified as sudden release of pressure hazards; three gaseous compounds are also classified as acute health hazards: carbon dioxide, chlorodifluoromethane, and dichlorodifluoromethane (CFC-12).

Exhibit 3-11. Hazard Class of Chemicals at PPPL

Compound	Category
Carbon dioxide	Sudden release of pressure & Reactive
Chlorodifluoro-methane(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
Trichlorotrifluoro-ethane (CFC 113)	Reactive

There are seven liquid compounds; 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 planning agencies 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 [PPPL00a].

Because PPPL's use of chemicals listed on the Toxic Release Inventory (TRI) is below threshold amounts, PPPL is technically 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 1999 (not required).

3.1.22 Safety

PPPL's 1999 performance with respect to worker safety was as follows:

Recordable injury case rate:
3.04 per 200,000 hours worked
Lost Work Day case rate:
1.14 per 200,000 hours worked
Lost Workday rate:
29.3 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)

3.2 Other Major Environmental Issues and Actions

3.2.1 Air Quality

Through PPPL's Waste Minimization and Pollution Prevention program, PPPL converted four air-handling units on the largest office building (Lyman Spitzer Building) to direct digital control. Based on the electrical energy savings, PPPL estimates the following annual reductions in air pollutants: 500,000 pounds carbon dioxide (CO_2), 3,700 pounds sulfur dioxide (SO_2), and 2,000 pounds nitrogen oxides (NO_x) for a total of 230 metric tons.

In 1999, PPPL expanded the building automation system (BAS) to control lighting circuits. PPPL estimates that 61 metric tons of air emissions will be reduced annually: 133,000 pounds carbon dioxide (CO_2), 1,000 pounds sulfur dioxide (SO_2), and 500 pounds nitrogen oxides (NO_x).

By tracking the fuel consumption of the four utility boilers during 1999, PPPL calculates the amount of nitrogen oxides generated. The actual NO_x emissions from PPPL permitted sources based on actual fuel consumption and operating hours during 1999 was 2.35 tons (2.12 metric tons) for the entire year versus the 25 ton potential to emit [McG00a].

PPPL sold 7,177 pounds of refrigerants, R-11, R-500, and R-502 to a certified CFC reclaimer. This sale results in a reduction to the PPPL ODS Class I and II inventory.

3.2.2 Surface Water Quality

In July 1999, the NJDEP conducted its annual NJPDES inspection of the facility including record maintenance. The inspector rated PPPL "conditionally acceptable," based on deficiencies occurring in 1998 and 1999. Two minor non-compliances were reported both for total suspended solids (TSS) exceedances at DSN003 (Delaware & Raritan Canal pump house discharge). The TSS limit (24 mg/L and 22mg/L *versus* the limit of 20 mg/L) was exceeded, likely due to high solids in the D&R Canal at the time the sample was collected and not due to PPPL operation of the pump house. NJDEP agreed with this finding and the renewed NJPDES permit does not include a limit for TSS.

Under NJPDES requirements, PPPL needs to eliminate from its discharges (DSN001 and DSN003) chlorine-produced oxidants (CPO). CPO is created by the reaction of chlorine combining with organic materials in the water. Chlorine is added to prevent biofouling in water pipes and cooling tower equipment. CPO has been found to be generally harmful to biota in the receiving streams.

PPPL plans to install a new metering system in the D&R Canal water system and 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.

3.2.3 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 monitor quarterly 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 as 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-PG were to investigate C and D sites. The following actions have occurred at C and D sites:

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 IV RI report and Remedial Action Selection Report were submitted in October. Ground water monitoring continued.

3.2.4 Integrated Safety Management

In June 1999, U.S. Department of Energy – Chicago Operations Office, conducted a verification of PPPL's Integrated Safety Management System (ISMS) [DOE99a].

The DOE Team found that the Integrated Safety Management System at PPPL is consistent with DOE policy, requirements, and guidance in a manner that applies controls and precautions tailored appropriately to the hazards of the projects and work being performed. ISM at PPPL is implemented at all levels within the organization [PPPL99b].

Two opportunities for improvement were identified by the DOE team. The first area was related to down-sizing actions taken in 1997; ES&H areas that had been impacted by limited staffing were Quality Control inspection and Industrial Hygiene. The second identified the need for procedures to mirror practices more closely in some areas, particularly, responsibility for categorizing low-hazard projects.

3.2.5 Outreach – Earth Day and America Recycles Day

In April 1999, the third annual Earth Day Celebration at PPPL involved ten local area middle schools and children of PPPL staff in a poster contest: "Your Energy in the 21st Century." Over 300 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 an interactive demonstration by the Franklin Institute of Science Museum (Philadelphia, PA).

For America Recycles Day (ARD - November 15th of each year), PPPL hosted a forum that brought together representatives from US 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 [McG00b].

3.3 Continous Release Reporting

In 1999, PPPL had no continuous releases to report.

3.4 Unplanned Releases

In May 1999, PPPL submitted a report to NJDEP detailing the occurrence of a chlorofluorocarbon-12 (R-12) release from Chiller A on D-site [Fi99a]. About 1,400 pounds of R-500 (a mixture of R-12 and R-152A) was released to the atmosphere due to a leak of an estimated 5 pounds per day from the system. Once the loss of refrigerant R-500 was found, the chiller was checked for leaks and the system thoroughly inspected. The room monitors had not alarmed and were found to be out-of-calibration. A leaking valve was repaired, the monitors re-calibrated, and the system was maintained and placed back into operation once it was deemed tight.

The second reportable unplanned release was reported to NJDEP in June 1999 [Fi99b]. A newly installed fast-fill cascade system for natural gas (NG) refueling (for vehicles powered by NG) leaked. About 250 cubic feet of NG leaked from six faulty "O" rings. These six rings were replaced by the contractor who installed the tanks; the system was successfully pressure checked with nitrogen for tightness before being filled with NG and made operational.

The third incident that required reporting to NJDEP Hotline was the discharge on the ground of latex paint and residual gasoline (from fire-fighting extinguisher class) [Fi99c]. Both were located at or near the Emergency Services Unit building (ESU). In June 1999, these discharges were identified; the paint (exterior painting of ESU Building) was cleaned up and removed; the residual gasoline release was investigated by soil sampling, which revealed no contamination. Training was given to the ESU staff, and the procedure for fire extinguisher training was revised.

The fourth report to NJDEP Hotline was the discovery of insecticide containers on a roadway on C-site [Fi99d]. One container was intact, one was empty, and a third was leaking on the gravel roadway. The insecticide, DursbanPro®,was used by PPPL's landscape contractor. The spill was removed, and the contractor was instructed to secure all items in their vehicles prior to traveling around the site.

3.5 Current Issues and Actions

3.5.1 Stony Brook Regional Sewerage Authority

In August 1999, PPPL sampled the liquid effluent collection (LEC) tank #3 for pH, temperature, chemical oxygen demand (COD), and tritium (HTO). These results are sent to SBRSA as part of the monthly monitoring report as required by the discharge license. COD was an annual parameter measured at the LEC tanks. The COD concentration limits are 1,000 mg/L monthly average and 1,500 mg/L daily maximum. The COD concentration was 1,200 mg/L; as there was only one tank sample 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 was not identified.

Subsequent to August 1999, COD is analyzed for all LEC tank samples prior to allowing releases to SBRSA. A strict examination of each wastewater system and controls to prevent high COD wastes from entering the LEC tanks were instituted by PPPL.

3.5.2 Environmental Management Systems

Environmental Management Systems (EMS) and ISO 14000 requirements are being reviewed by PPPL. Many of the elements of an EMS are presently instituted in plans, policies, and procedures implemented at PPPL. There is no formal EMS program at present.

3.6 Summary of Environmental Permits

The following table (Exhibit 3-12) presents the different regulatory requirements/permits with which PPPL must comply. It is not solely a list of environmental permits, but rather the list 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 3-12. 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
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	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
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 3-12. 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 tanks (LECT) 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	LECT - Tritium Gross beta	2 million picoCuries/Liter per discharge
	Stony Brook Regional Sewerage Authority Industrial Discharge License (22-967-NC)	LECT 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

Monitoring for sources of potential radiological exposures is extensive. Begun in 1981, real-time prompt gamma and/or neutron environmental monitoring on the D site established baselines prior to the start-up of operations. Exhibit 4-1 lists the air stations that were monitored for radiological parameters in 1999.

Water samples are collected at the same locations for both non-radiological and radiological, HTO, analysis (Exhibit 4-2).

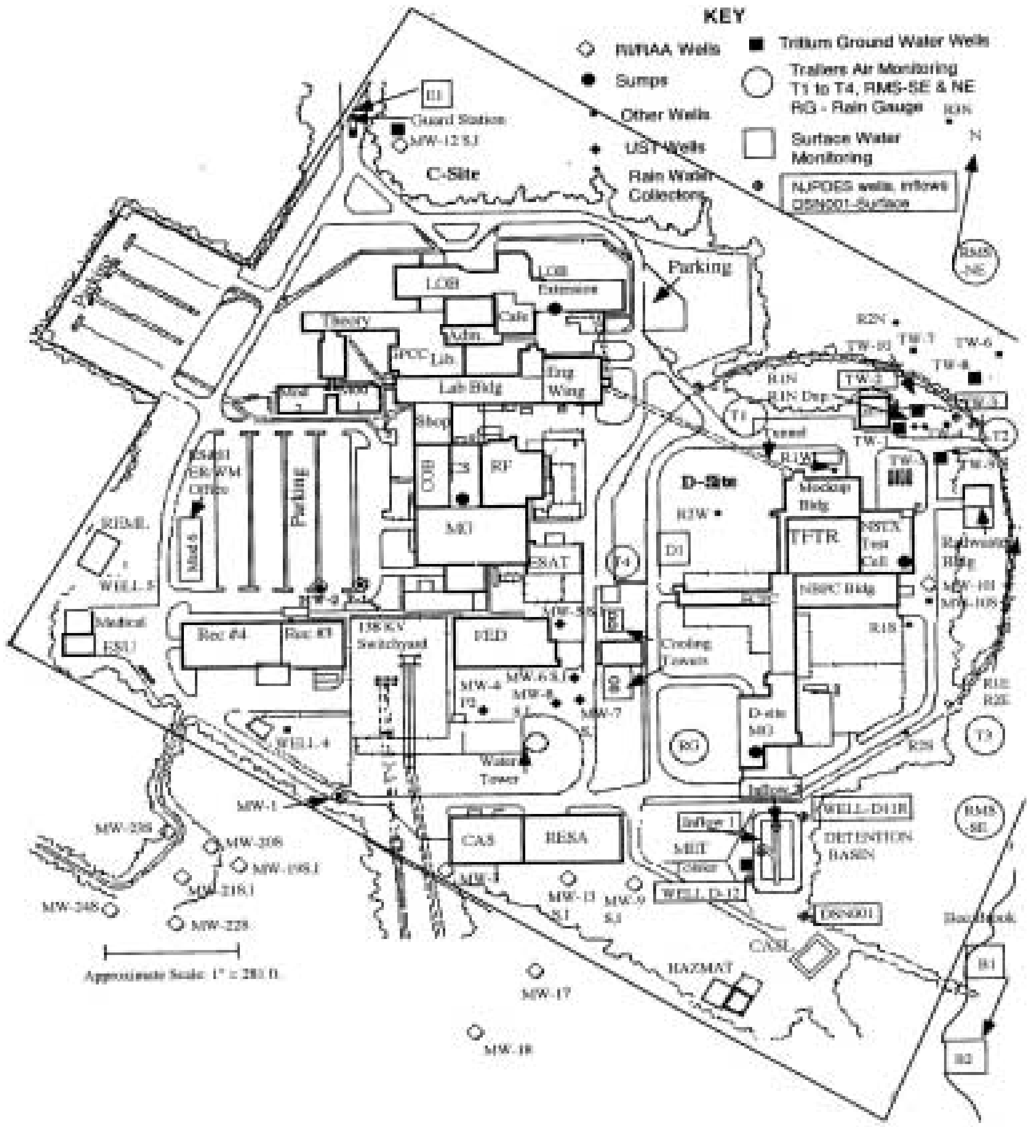
Exhibit 4-1. Radiological Air Monitoring Stations

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

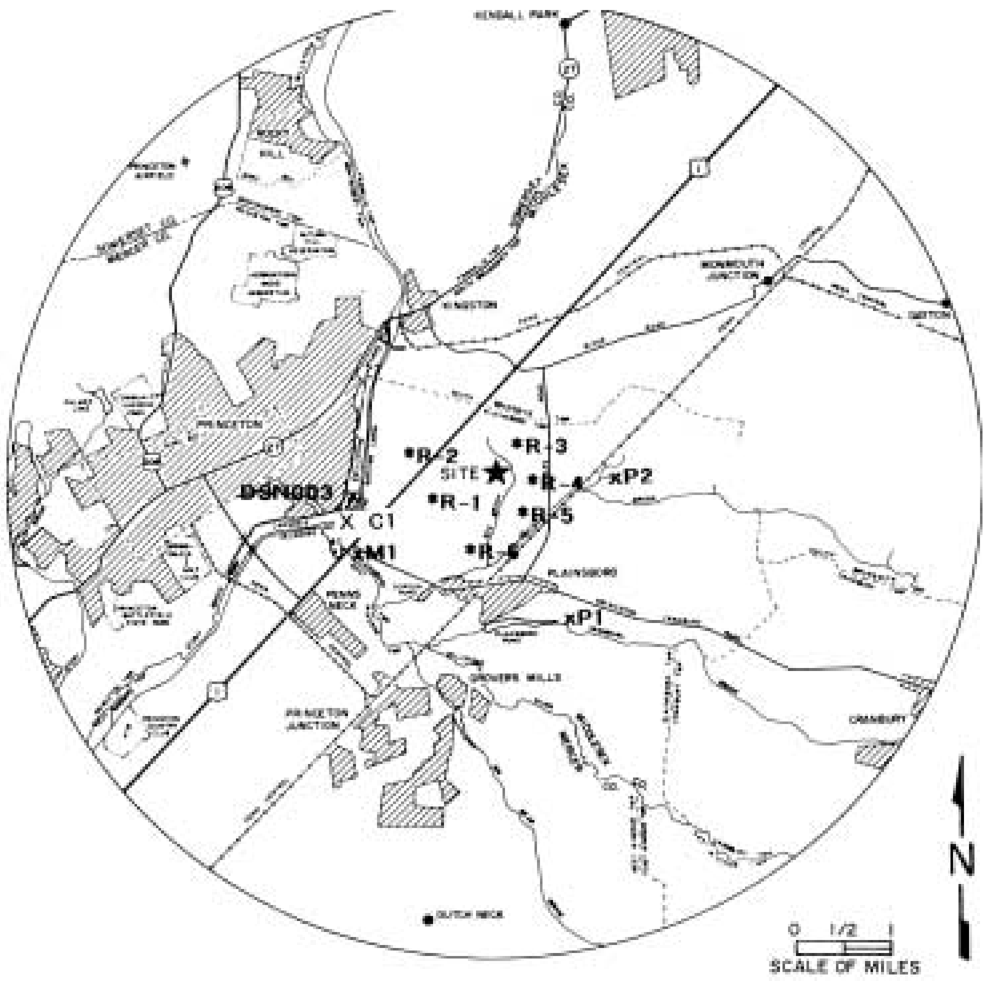
Exhibit 4-3. PPPL Site Map On-site Monitoring Locations



As previously mentioned, 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 80 km radius (50 miles) of the site and approximately 212,000 within 16 km (10 miles) 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 0.05 mrem (0.5 µSv) for 1999 (see Exhibit 3-7). The collective effective dose equivalent (CEDE) from all sources (excluding natural background) to the population within 50 miles (80 km) of PPPL was 2.79 person-rem (0.027 person-Sv) in 1999.

Exhibit 4-4. Off-site Monitoring Locations



4.2 Summary of Non-Radiological Monitoring Program

During 1999, PPPL operated under a NJPDES surface water permit, number NJ0023922, which became effective on March 1, 1994 and also under the renewed NJPDES permit 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 on a quarterly frequency at the discharge and intake (D&R Canal water) without a limit for TSS and monthly monitoring for CPO (Exhibit 4-4).

As a requirement of the surface water permit, a chronic toxicity characterization study was conducted to test the DSN001 effluent with the fathead minnow (*Pimephales promelas*) as the test organism. Semi-annual study results were submitted for March 1999 and October 1999 tests.

As required in the NJPDES ground water permit, NJ0086029, seven ground water monitoring wells were sampled quarterly in 1999 (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.

Remedial Investigation and Remedial Alternative Assessment (RI/RAA) program monitoring is discussed in Chapters 6.0 and 8.0.

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	
Chloride	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	500 mg/L	X	X	X	X
Total Organic Carbon				X	
Total Organic Halogen				X	
Total Volatile Organic 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 1999.

4.5 Summary of Significant Environmental Activities at PPPL

4.5.1 Regulatory Inspections/Audits

In July 1999, 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 a "conditionally acceptable" rating based on two minor total suspended solids concentration exceedances at outfall DSN003 in June 1998 and January 1999. NJDEP noted that as of the new permit (effective June 1, 1999) TSS at DSN003 no longer had a permit limit. PPPL continues to monitor TSS on a quarterly frequency as well as the intake water from the Delaware & Raritan Canal.

4.5.2 Tritium in the Environment

In August 1995, when the tritium concentration (in water) was found to be above back-ground 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 LECT roof as well as soil samples next to drain spouts showed that tritium concentrations were elevated.

Exhibit 4-6. 1999 Highest Tritium Concentrations in Environmental Samples

Media	Location	Highest HTO	Week Ending	Stack Data
Air	T1 (NW D-site)	274.649 pCi/m^3	Feb. 1	Feb. 3 (6.41 Ci HTO)
	R1 (W of PPPL)	17.088 pCi/m^3	Dec. 21	Dec. 15 (7.429 Ci HTO)
	T4 (W D site)	190.75 pCi/ m^3	Dec. 21	
	D-site Stack	13.481Curies	Feb. 24	
Well	TW-8	1,041 pCi/L	January	
	TW-1	982 pCi/L		
	TW-5	964 pCi/L		
Rain water	R2S	7,817 pCi/L	Dec. 15	Dec. 15 (7.429 Ci HTO)
	R2W	5,714 pCi/L		
	R1S	5,264 pCi/L		
Surface water	DSN001	592 pCi/L	Oct. 7	Oct. 13 (2.25 Ci HTO)

In January 1999, the highest concentration of tritium in the ground water was 982 pCi/L at TW-1 and 964 pCi/L at TW-5, well below the Safe Drinking Water Act tritium limit of 20,000 pCi/L. Ground water tritium concentrations at TW-1 and TW-5 declined throughout 1999 to about 500 pCi/L at the end of the year. Monitoring of ground water (wells and sumps), precipitation, and the D-site stack will continue.

Also, in December 1999, the highest tritium concentrations in rainwater occurred (5,000 to 7,000 pCi/L), which relates to the highest tritium air releases detected (7.429 Ci HTO during December 1999) (App. A, Tables 3 & 10-11). Numerous scientific studies have documented the effects of atmospheric tritium releases and the subsequent "washout" in precipitation. Rain droplets act as a scrubber and wash tritiated water vapor (HTO) out of the plume from the stack [Mu90]. Water infiltrates into the ground, and eventually, some of the tritium reaches the ground water table and monitoring wells.

4.5.3 Pollution Prevention-P^2

In 1999, PPPL accomplished the activities described in the following paragraphs [McG00b]. The hazardous waste recycling program continued with PPPL's solid waste stream reduced by the recycling of 106,000 pounds of paper and cardboard, and 23,800 pounds of aluminum cans, plastic and glass bottles [Exhibit 3-2]. These accomplishments are attributable to improvements in the sanitary waste evaluation process [Kin00a, McG00b].

From 1998 to 1999, PPPL improved its hazardous waste disposal (landfill) *versus* recycled ratio from 37.5 % to 94 %, respectively; through active recycling efforts, municipal solid waste ratio improved from 47.4% to 70.5 %. PPPL also instituted a "buy recycled-content products" through its Procurement Office.

Other PPPL P^2 activities included:

- New parts cleaners eliminated >600 spray cans of solvents
- Recycled 800 fluorescent light ballasts
- Sale of 75,500 lbs. lead to a recycler
- Sale of 7,200 lbs. CFCs to reclaimer
- Recycled 4,400 lbs. old computer monitors

The Princeton Large Torus (PLT) device, which was no longer operational, was disassembled and removed from C-site in 1999. During that process, PPPL reclaimed and sent to a metals recycler the following:

- 110 tons of copper
- 99 tons of stainless steel
- 3 tons of insulation compound

In 1999, the National Spherical Torus Experiment (NSTX) reused systems and equipment in its construction. NSTX re-used the TFTR neutral beam, vacuum pumps, ion cyclotron radio frequency (ICRF), and poloidal magnetic field systems, and concrete modular shielding wall equipment.

4.5.4 TFTR Diamond Wire Cutting Demonstration [Ru00]

The dismantlement and removal of TFTR presented a unique and challenging task. First challenge is the size of the vacuum vessel – 100 cubic meters; second challenge is the total tritium content that remains in the vessel is 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. PPPL chose to explore the use of diamond wire cutting technology.

During July 1999, PPPL conducted the diamond wire cutting demonstration on-site. It was a collaboration between PPPL and the DOE Decommissioning & Dismantlement (D&D) Focus Area team at Federal Energy Technology Center (Morgantown, West Virginia). In the RESA building, mock-up segments of the TFTR vacuum vessel were filled with 1) low-density, foamed concrete, 2) mortar, and 3) Perma-Fill foam (aqueous based) (Exhibits 4-7 & 8). Water was used as the primary coolant for the cutting. Liquid nitrogen cooling was also tested successfully.

Based on PPPL's demonstration, the diamond-wire cutting technology was superior to the baseline technology for both cost and safety factors. The combination of fillers will reduce personnel radiation exposure through shielding, remote operation, and radionuclide stabilization. Both low-density concrete and mortar proved to be acceptable fillers and provided a number of benefits for health and safety and technical performance.

4.5.5 Environmental Training and College Interns

In 1999, 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) provided these training courses.

In 1999, PPPL and Drexel University (Philadelphia, PA) continued its successful co-operative internship program at the Laboratory. Those selected students with computer, physics, engineering, or environmental studies majors 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 providing them guidance and instruction.

Exhibit 4-9. Drexel University Co-op Student collects water samples

Exhibit 4-7. Technician inspecting apparatus.

Before actual testing could began, technician inspected set-up. The TFTR surrogate rests in a cradle within a specially prepared enclosure. A specified blend of concrete fill was set inside of the steel mock-up of the vacuum vessel

Exhibit 4-8. Checking the diamond wire.

Each wire is 75 feet loop, 0.25 inch thick. At 0.75-inch intervals, synthetic diamonds stud the wire similar to knuckles. Technician is inspecting the diamonds for wear. Protective clothing worn by technician simulates true operating requirements.

Chapter 5

ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

5.1 Radiological Emissions and Doses

Exhibit 5-1 below summarizes the release of tritium in air and water. The total effective dose equivalent (EDE) at the site boundary and the population within 80 kilometers are the sum of the contributions from those releases. The calculated EDE at the site boundary is one-quarter of one mrem, far below the annual limit of 10 mrem per year [Lev00].

Exhibit 5-1. Summary of 1999 Emissions and Doses from D Site Operations

Radionuclide & Pathway	Source	Source Term Curies (Bq)	EDE in mrem/yr (mSv) at Site Boundary	Percent of Total	Collective EDE within 80 km in person-rem (person-Sv)
Tritium (air)	D-site stack	HTO 59.712 (2.209 x 10^{12}) HT 21.779(0.806 x 10^{12})	0.155800	60.4	2.640308
Tritium (air)	RWHF	HTO 0.037 (Compactor & vial crusher) HTO 1.665 (Calc. est. based on measurements)	0.100000	38.8	0.055145
Tritium (water)	LECT	0.084 (HTO) (3.108 x 10^9)	0.001680	0.6	0.002301
Tritium (water (measured))	Surface Ground	117 pCi/L (Bee Brook) 1041 pCi/L (Well TW-8)	0.000394	0.2	0.000540
Total		**HTO 61.414** **HT 21.779**	**0.257874** **(0.00257874)**		**2.698294** **(0.026983)**

Bq = Bequerel
HT = elemental tritium
LECT = liquid effluent collection tanks
mSv = milli Sievert
EDE = effective dose equivalent
HTO = tritium oxide
mrem = milli radiation equivalent man
RWHF = Radioactive Waste Handling Facility

NOTES:

Estimated dose equivalent at the nearest business is 0.04832 mrem due to tritium air emissions from the D-site stack and RWHF, using site-specific information. Using CAP 88-PC, this dose is equivalent is 0.0563 mrem (5.63 x 10^{-4} mSv), 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 DOE 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 TFTR conducted high power Deuterium-Tritium operations from December 1993 to April 1997, after which TFTR went into a safe shut down mode. These operations were a potential source of neutron and gamma/x-ray exposure. When TFTR last operated in 1997, D-D (2.5 MeV) and D-T (14.0 MeV) neutrons and gamma/x-rays were produced in the range of 0 to 10 MeV [Ja98].

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 1999 showed effluent quantity and concentrations of radionuclides (tritium) to be within allowable limits established in New Jersey regulations (1 Ci/y for all radionuclides) and DOE Order 5400.5 (2 x 10^6 pCi/liter for tritium).

As shown in Exhibit 5-2, the 1999 total amount of tritium released to the sanitary sewer was 0.084 Curies, about nine 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 20 to 1,630 pCi/L (high result correlates with higher air emissions in December 1999).

Exhibit 5-2. Total Annual Releases to Sanitary System from 1994 to 1999

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

5.1.3 Radioactive and Mixed Waste

In 1999, low-level radioactive wastes were stored on-site prior to off-site disposal, either in the Radioactive Waste Handling Facility or within a controlled area of TFTR. Low-level radioactive shipments made in 1999 consisted of removed systems from TFTR and compacted solid waste, including personal protective clothing. No low-level radioactive mixed waste was generated in 1999 [El00].

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

Exhibit 5-4. Total Low-Level Radioactive Waste 1997-1999

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

5.1.4 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 10.1101. 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.

5.1.5 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.

Exhibit 5-5. Health Physics survey

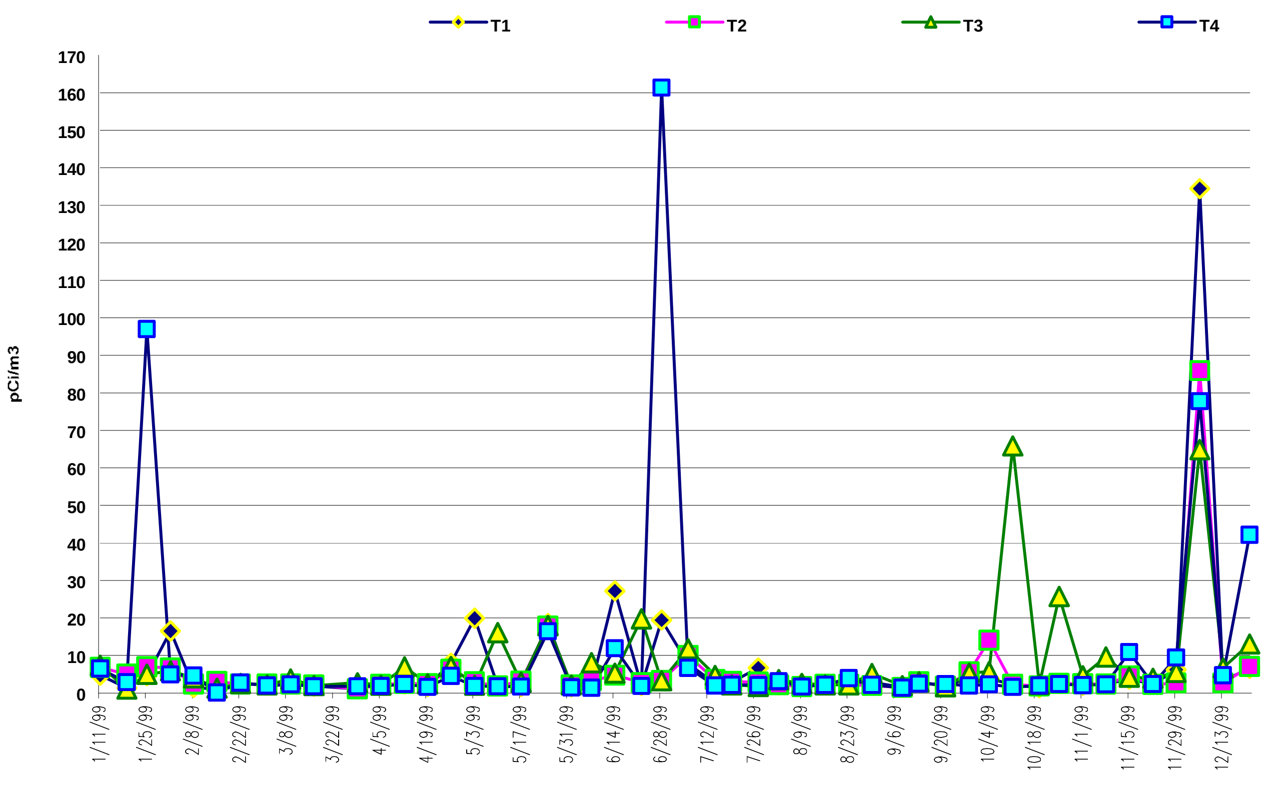
DATS are similarly used at eleven (11) environmental sampling stations: 4 located on D site facility boundary trailers (T1 to T4), 6 located at remote environmental air monitoring stations (R 1 to R6) (App. A, Tables 4-7). The baseline location was moved to Roebling, N.J. (Burlington County). All of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

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 0.05 mrem (0.5 µSv). Measurements at the D site facility boundary have measured concentrations in the range from 0.138

to 134.408 pCi / m³ elemental tritium (HT) and from 0.958 to 274.649 pCi / m³ 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.

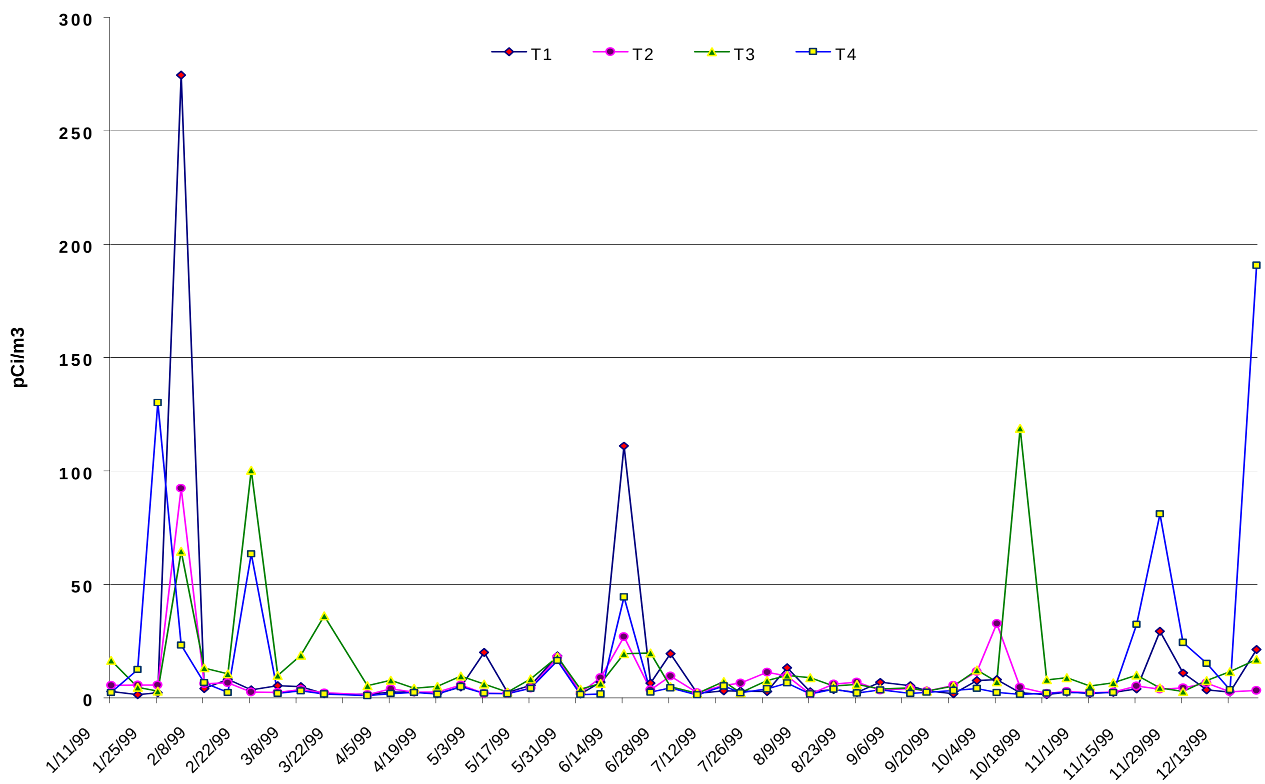
The EDE at the site boundary was calculated based on annual tritium totals as measured at the stack and RWHF (DATS air) and water samples at the LECT and highest measurements from a well and surface water during 1999. The addition of the RWHF, which has no elevated stack, contributes more significantly 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 1999."

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 1999."

5.1.5 Protection of Biota

The highest measured concentrations of tritium in surface and ground water in 1999 was 1,041 pCi/L. This concentration is a very small fraction of the water biota concentration guide (BCG) (for H-3) of 3 x10^8 pCi/L for aquatic system evaluations, and the water BCG for H-3) 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").

5.2 <u>Unplanned Releases</u>

There were no unplanned releases in 1999.

5.3 <u>Environmental Monitoring</u>

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 October 1999, at on-site location DSN001, basin outfall, tritium was detected at 348 pCi/Liter, which was the highest in 1999 for surface water samples (App. A, Table 8). As an explanation for this data, the highest HTO concentration in surface water correlates with the highest tritium concentration measured at Station T3 (118.831 pCi/m^3, App. A ,Table 5), located closest to DSN001. In October 1999, the second highest HTO concentration in rainfall was detected at R1S (close to DSN001).

Exhibit 5.8 - Total Rainfall in Inches (centimeters) 1988-1999

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)
		1993	42.7 (108)	1994	51 (130)
		1997	41.99 (107)	1996	61 (155)
		1998	42.96 (109)		
		1999**	47.27 (120)		

*Rainfall was not collected for a full 12 months in 1988; estimate for 1988 is >40 inches.
**1999 without Hurricane Floyd 38.72 inches (98).

Rain water samples collected and analyzed in 1999 ranged from below detection (<23) to 7,817 pCi/liter (App. A , Tables 10 & 11), which are lower than the previous two years' range of <108 to 61,660 pCi/liter (App. A, Table 12). In the week prior to collecting the highest-level rainwater sample (7,817 pCi/L), D-site stack released the highest amount of HTO in 1999 (7.429 Curies); this release occurred during D&D activities in the TFTR Test Cell.

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 rainwater continues.

In April 1988, PPPL initiated the recording of precipitation. Exhibit 5-8 shows the occurrence of dry, average, and wet years (App. A, Table 2 for 1999 weekly rainfall) [Ch00].

B. Ground Water

Beginning in August 1995, more frequent ground-water monitoring and sampling of different wells began. This increase in 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 1999, eleven on-site wells - TW-7, TW-8, MW-12S, MW-17, MW-18, D-11R and D-12 on C site, and TW-1, TW-2, TW-3, and TW-5, on D site - were sampled. Ground water results were slightly elevated in TW-1 and TW-5 in 1999 (App. A, Table 9).

HTO concentrations ranged (pCi/Liter):

TW-1 511 to 982
TW-5 507 to 964
TW-8 486 to 1,041

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 the TFTR and Motor Generator buildings) will continue.

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 1999, tritium measurements of potable water ranged below the level of detection (<25pCi/L to <376 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 1999. In 1996, the HP Manager reviewed the requirement for soil/biota sampling. At that time, a decision was made to discontinue the sampling program based on continued lack of findings, which would indicate contamination from PPPL. Continused monitoring of soil/biota sampling was therefore determined to contribute "no value added." A heavier concentrated effort was, however, 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 1999, PPPL was within allowable limits for all testing parameters at DSN001. The last exceedance at DSN001 was reported in November 1993 for total suspended solids (73 mg/L *vs.* 50 mg/L—the permit limit).

In January 1999, total suspended solids (TSS-24 mg/L) sample at DSN003 exceeded the monthly average limit of 20 mg/L. In the previous two years, 1997 (27 mg/L)-1998 (22 mg/L), the same parameter, TSS, exceeded the permit limit at DSN003 (filter back wash for the pumps at the Delaware & Raritan Canal). PPPL attributed the TSS concentration above the 20 mg/L limit to the water quality (solids) of the source water (Delaware & Raritan Canal- D&R).

Effective June 1, 1999, the renewed NJPDES surface water permit required a number of changes to PPPL's surface water monitoring program; the most significant were:

1) Chronic Toxicity Testing frequency was reduced from semi-annual to annual;
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; and
3) Total suspended solid 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. Quarterly samples of D&R Canal water are also tested for TSS.

6.1.2 Chronic Toxicity Characterization Study

In 1999, 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.

For two tests in 1999, the survival rate, as defined by the NJ Surface Water

Quality Standards, was >100 percent (statistically possible) no observable effect concentration (NOEC) [PPPL99a & 99d]. 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.)

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

6.1.3 Ground Water

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

The permit was issued effective April 1, 1989, and the expiration date was extended to December 31, 1996. In July 1994, DOE-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 [PPPL00b].

A. NJPDES Quarterly Ground Water Monitoring Program in 1999

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 1999, (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).

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)	5.68	6.17	5.70	6.45	4.69	7.25	*0.4*
Trichloroethene (TCE)	<1	<1	2.10	1.96	<1	1.05	*1.0*
1,1-dichloroethane	<5	<5	1.34 T	1.16T	<5	<5	*70*

T = Detected below the method detection level.

Detention basin inflows or influents were monitored twice each year, in May and August (App. A Tables 21 & 28), pursuant to PPPL NJPDES ground water discharge permit, NJ0086029. Volatile organic compounds were detected at Inflow 2 in concentrations above the GWQS for tetrachloroethene (5.02 µg/L), bromodichloromethane (1.05 µg/L) and chloroform (1.21 µg/L *vs.*GWQS 6 µg/L). Located on the north side of the detention basin, Inflow 2 receives ground water from the D site TFTR and MG 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 MG, LSB, and 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. At Inflow 1, no volatile organic compounds were detected.

Based on 12 months of flow data, greater than 78 million gallons of water were discharged from the detention basin in 1999. 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 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). A 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].

Exhibit 6-3. Ground-water sampling

In 1999, 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]. Volatile organic compounds (probably from degreasers /solvents) were detected in 11 of the 15 wells/sumps sampled. The highest concentrations of tetrachloroethylene (PCE) were found in MG sump at 114 µg/L and MW-19S at 111 µg/L. The de-watering sumps located in the D-site MG and TFTR basements draw ground water radially from the shallow aquifer, thus containing any contaminants in the ground water.

In 1999, PPPL submitted the Phase IV Remedial Investigation Report. This report documents the additional subsurface characterization and sampling conducted in the Former Annex Building Area. PPPL also submitted a Remedial Action Selection Report detailing the selected remedy for ground water contamination at the site. The selected remedy relies on continued operation of PPPL's foundation dewatering system to contain and extract contaminated ground water. In addition, limited natural attenuation processes that degrade into non-toxic by-products have been documented in the subsurface at PPPL.

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 with 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&OD 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 23.01 million gallons in 1999 (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
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
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 corrosion inhibitors are the primary water treatment at the canal pump house. Located at the canal pump house, the filter-backwash, discharge number DSN003, 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.

C. 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.

D. 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, 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 1999, PPPL estimates a total discharge of 6.00 million gallons of sanitary sewage to the

South Brunswick sewerage treatment system [Kir00b**]**.

In 1996, Stony Brook Regional Sewerage Authority (SBRSA) issued an Industrial Discharge License (22-96-NC) to PPPL and DOE-PG. 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 1999, PPPL performed monthly radiological and non-radiological analyses to meet the license requirements (App. A. Table 13). In August 1999, the COD concentration (1,200 mg/L) exceeded the monthly average of 1,000 mg/L. SBRSA issued PPPL an NOV for this COD exceedance. PPPL investigated the potential source for the COD; no definitive cause was found.

E. Spill Prevention Control and Countermeasure

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.

F. Herbicides and Fertilizers

During 1999, PPPL's M&OD managed the use of herbicides by outside contractors. These materials are applied in accordance with state and federal regulations. Chemicals are applied by State-licensed applicators. In 1999, 1,000 pounds of fertilizers were applied to the PPPL site.

In addition to the fertilizer, the quantities applied during 1999 were as follows: herbicides - Surflan (2 gal.), Dimension (5 gal.), Roundup (10 gal.), and Dissolve (20 pounds) and insecticide – Dursban (10 quarts) [Kin00b]. No herbicides or fertilizers are stored on site; therefore, no disposal of these types of regulated chemicals is required by PPPL.

G. Polychlorinated Biphenyls (PCBs)

At the end of 1999, 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 [Pu00].

H. Hazardous Wastes

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) was submitted to the NJDEP for 1998-1999. 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

In May 1999, PPPL submitted a report to NJDEP detailing the occurrence of a chlorofluorocarbon-12 (R-12) release from Chiller A on D-site [Fi99a]. Approximately 1,400 pounds of R-500 (a mixture of R-12 and R-152A) was released to the atmosphere due to a leak of an estimated 5 pounds per day from the system. Once the loss of refrigerant R-500 was found, the chiller was checked for leaks and the system thoroughly inspected. Local room monitors had not alarmed and were found to be out-of-calibration. A leaking valve was repaired, the monitors re-calibrated, and the system was maintained and placed back into operation once it was deemed tight.

A second unplanned release was reported to NJDEP in June 1999 [Fi99b]. A newly installed fast-fill cascade system for natural gas (NG) refueling (for vehicles powered by NG) leaked. About 250 cubic feet of NG leaked from six faulty "O" rings. These six rings were replaced by the contractor, who installed the tanks; the system was successfully pressure checked with nitrogen for tightness before being filled with NG and made operational.

A third incident that required reporting to the NJDEP Hotline was the discharge on the ground of latex paint and residual gasoline (from fire-fighting extinguisher class) [Fi99c]. Both were located at or near the Emergency Services Unit building (ESU). In June 1999, these discharges were identified; the paint (exterior painting of ESU Building) was cleaned up and removed; the residual gasoline release was investigated by soil sampling, which revealed no contamination. Training was given to the ESU staff, and the procedure for fire extinguisher training was revised.

A fourth report to NJDEP Hotline was the discovery of insecticide containers on a roadway on C-site [Fi99d]. One container was intact, one was empty, and a third was leaking on the gravel roadway. The insecticide, DursbanPro®, was used by PPPL's landscape contractor. The spill minor was removed, and the contractor was instructed to secure all items in their vehicles prior to traveling around the site.

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 1999 [PPPL00a]. 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 required for 1999.

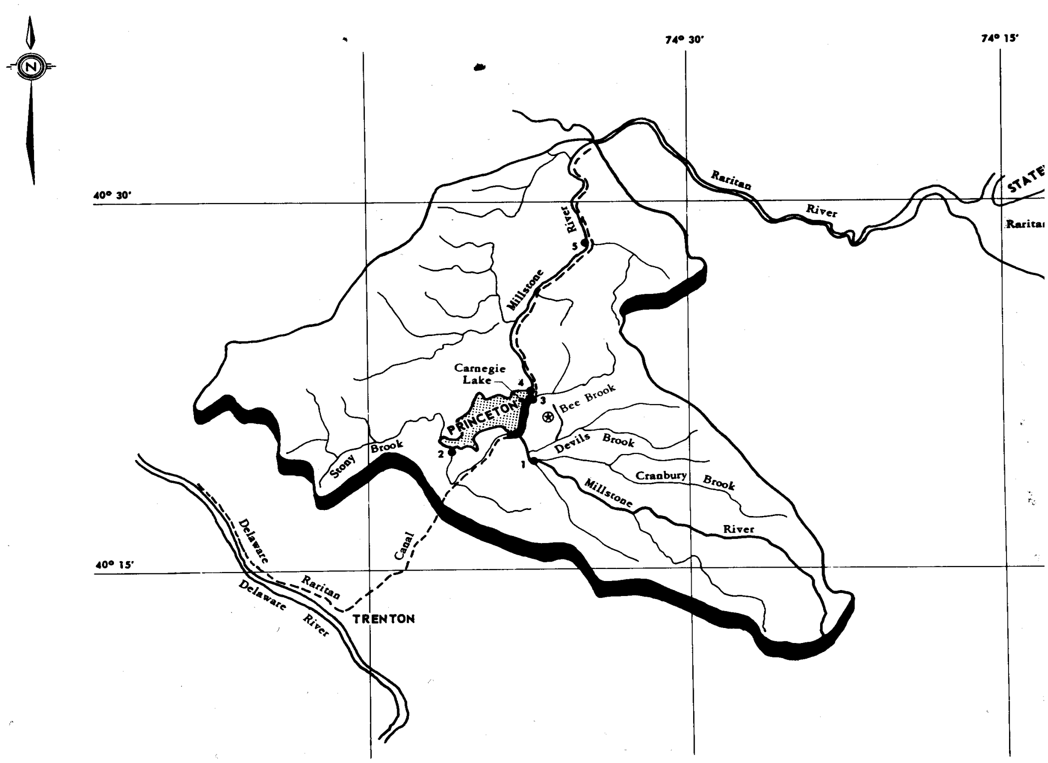
Chapter 7

SITE HYDROLOGY

The 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 southerly in a wide flood plain, and discharges into Devil's Brook at the entrance to Mill Pond [Sa80].

Exhibit 7-1 Millstone River Watershed Basin



The 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, with 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 housing developments, industrial parks, 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.

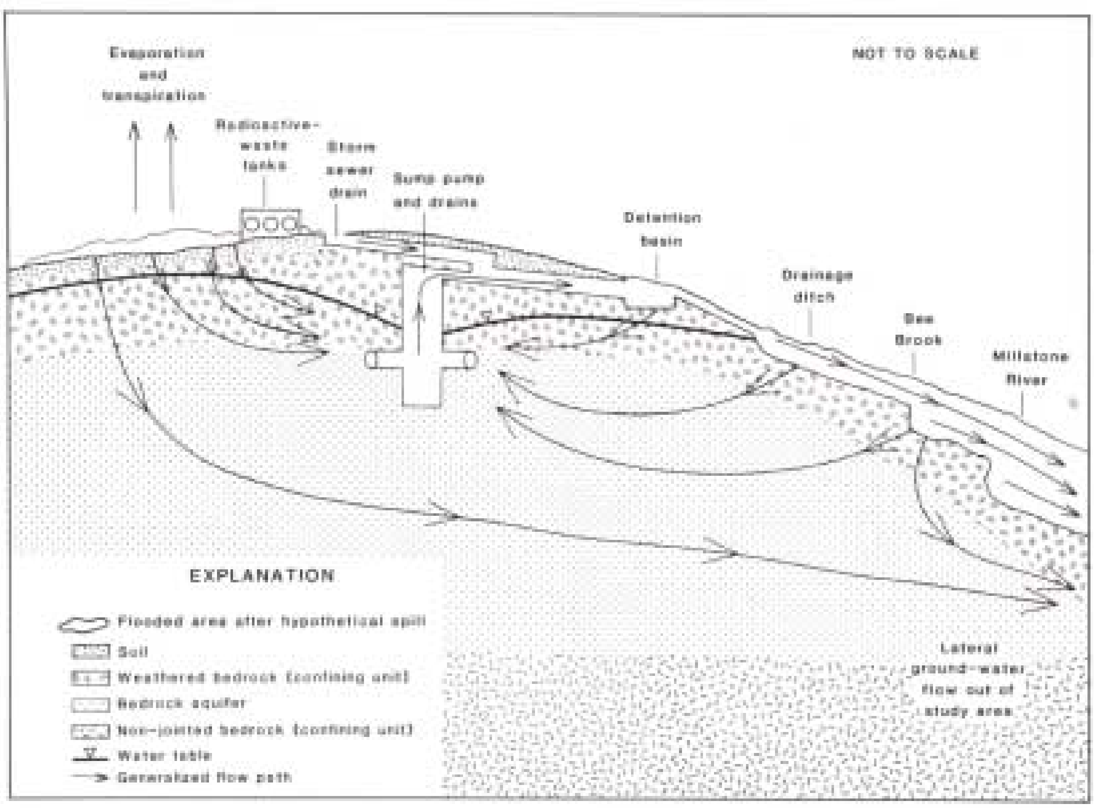
In the slightly higher elevations (above 70 feet), the sandy loams are better drained and belong to the Sassafras series. The extensive farmlands and nurseries of the area indicate this soil provide a good environment for agricultural purposes, both today and in the past.

An upland forest type with Oak forest dominant 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 more poorly drained areas have a low ground cover of ferns, grasses, and leaf litter.

All of PPPL's stormwater 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 MSL) 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.

Chapter 8

GROUND WATER AND DRINKING WATER PROTECTION

The basis of PPPL's Ground Water Program the "Groundwater Protection Management Plan" (GPMP), required by 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 parallel with two ground-water investigations; an investigation of volatile organic compounds, 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 areas where spills occurred or may have occurred. In all, PPPL has installed a total of 44 wells to monitor ground-water quality. Remedial investigations and remedial alternative assessment 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 PCE, TCE, and their natural degradation products are present in a number of shallow and intermediate-depth wells on C site (Exhibit 8-1). 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 were removed.

By mid-1995, the remaining USTs 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 shallow cone of depression drawing ground water toward them (Exhibit 8-2). 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.

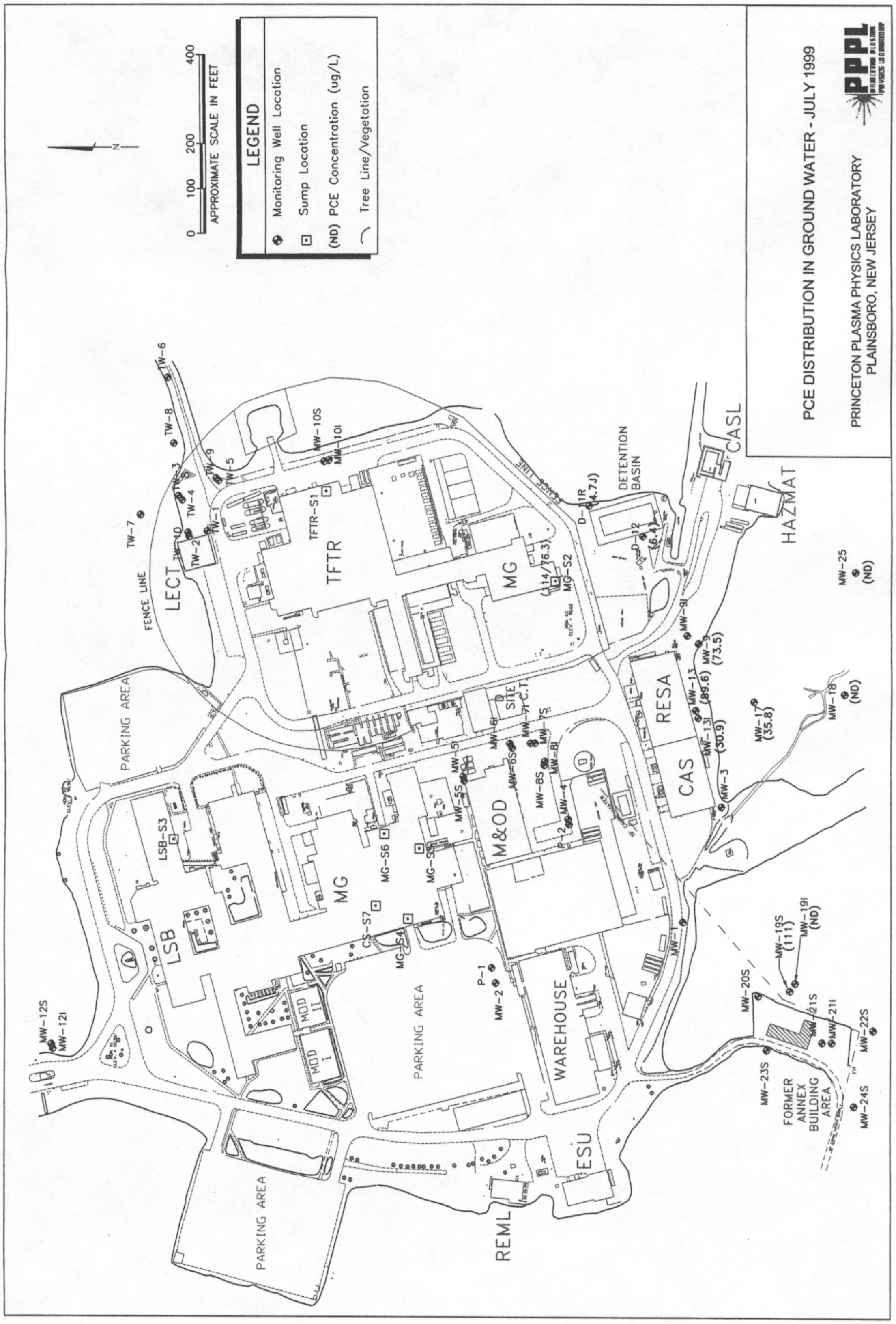


Exhibit 8.1 PCE Distribution in Ground Water – July 1999

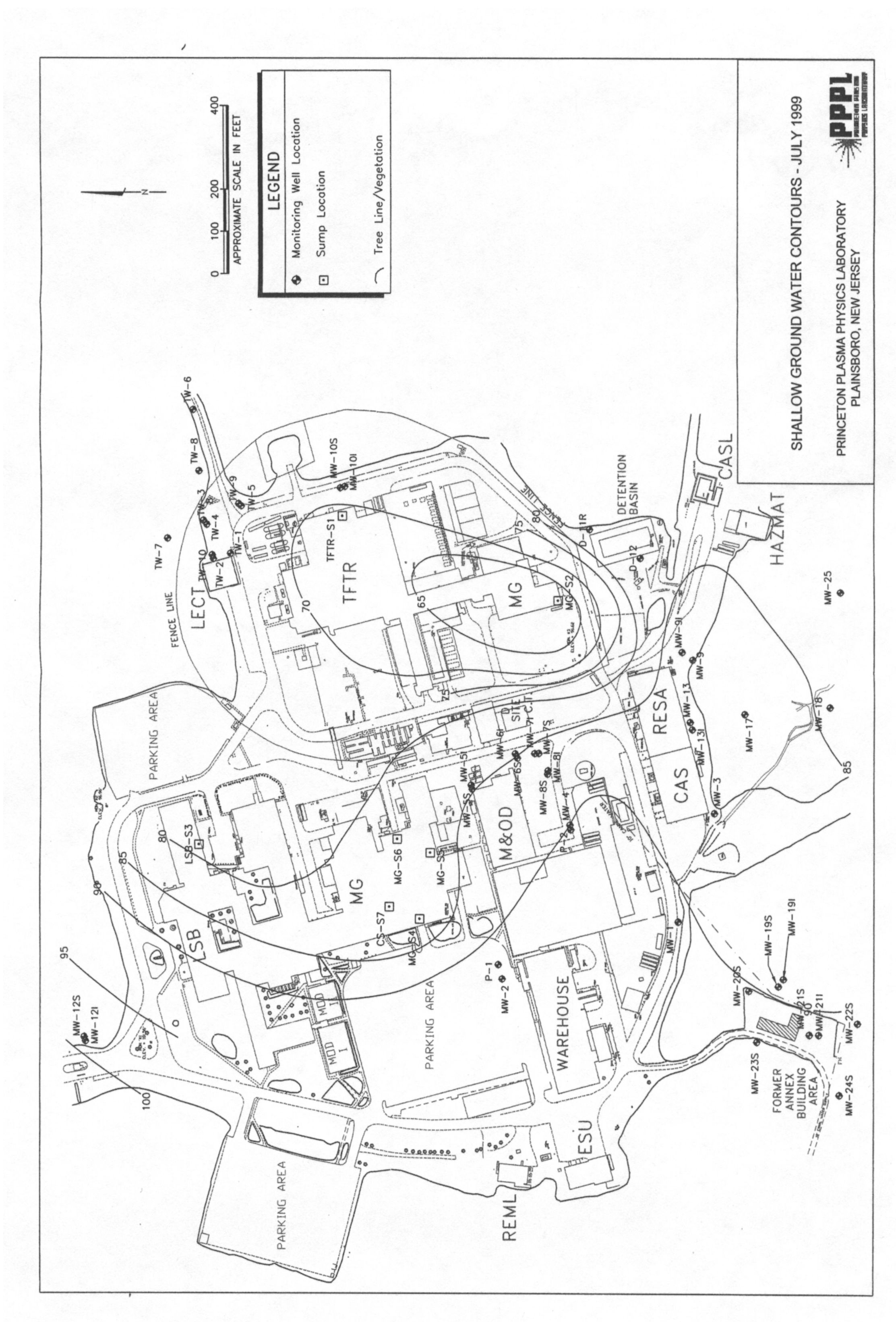


Exhibit 8-2. Shallow Ground Water Contours - July 1999

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 (TFTR and D site MG sumps) 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 1999, 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) VOCs in ground water do not pose a risk to site workers or the surrounding public;
5) Natural attenuation processes are active as evidenced by presence of degradation compounds in ground water down gradient of source.

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. Comparing the past 5 years' data (1995 to 1999, Exhibit 8-3) to the NJ Ground Water Quality Standards (NJGWQS) shows how low a potential exists for PPPL's detention basin to adversely impact ground water. PPPL will continue to monitor the wells regularly to ensure that the proposed remedy remains effective [Sh99]. NJDEP reviewed the Phase IV report and granted PPPL's request for continued monitoring.

Exhibit 8-3. Five-Year Maximum Monitoring Results 1995-1999

	Inflow 1	Inflow 2	DSN001	Well D-12
Tetrachloro-ethylene	4.43	2.19	1.96	10.6
Trichloroethylene	<1.0	<1.0	<1.0	5.43
c-1,2-Dichloro-ethlyene	<1.0	<1.0	<1.0	3.4

Notes: 1995-1999 data is used for 5-year maximum.
PCE and TCE- NJ Ground water quality standard is 1.0 µg/L; cis-1,2-Dichloroethylene is 10 µg/L .
Sampling locations shown in Exhibit 4-3.

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 January 1999: 1,041 pCi/L at TW-8, 982 pCi/L at TW-1 and 964 pCi/L at TW-5 (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 in the ground water monitoring.

Chapter 9

QUALITY ASSURANCE

Analysis of environmental samples for radioactivity was accomplished on-site by the Radiological Environmental Monitoring Laboratory (REML). REML procedures follow DOE's Environmental Measurements Laboratory's EML HASL-300 Manual [Vo82] or other nationally recognized standards. Approved analytical techniques are documented in REML procedures [REML90].

PPPL participates in the DOE Environmental Monitoring Laboratory (EML) program as part of maintaining its radiological certification. For non-radiological parameters, PPPL receives proficiency evaluation samples from outside laboratory suppliers (Environmental Resource Associates, SPEX, and Ultra). These programs provide blind samples for analysis and return the test results at the end of the study.

In 1984, PPPL initiated a program to have its REML certified by the State of New Jersey through the EPA Quality Assurance (QA) program. REML complies with EPA and NJDEP QA requirements for certification. In March 1986, REML facilities and procedures were reviewed and inspected by EPA / Las Vegas and NJDEP. The laboratory was certified for tritium analysis in urine (bioassays) and water and has been re-certified in these areas annually since 1988.

In 1999, REML performed DOE semi-annual performance evaluation tests for radionuclides in water. REML passed all tests for tritium and gamma in water (App. A, Table 29).

In 1999, PPPL followed its internal procedures, EN-OP-001—"Surface Water Sampling Procedure," and EN-OP-002—"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].

Chapter

10

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Appendix

A

TABLES

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

CONDITION		PUBLIC	EXPOSURE(t	CCUPATION/	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.

(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 1999

START DATE	WEEK	INCH	MONTHLY TOTAL (IN)	MONTH	ACCUMLATION
1/4	1	0.90			0.90
1/11	2	1.90			2.80
1/18	3	1.88			4.68
1/25	4	0.08	4.75	January	4.75
2/1	5	1.20			5.95
2/8	6	0.33			6.28
2/15	7	1.15			7.43
2/22	8	0.90	3.58	February	8.33
3/1	9	0.95			9.28
3/8	10	1.30	Snow Storm		10.58
3/15	11	2.15			12.73
3/22	12	0.18			12.90
3/29	13	0.23	4.80	March	13.13
4/5	14	1.43			14.55
4/12	15	0.28			14.83
4/19	16	0.75			15.58
4/26	17	0.10	2.55	April	15.68
5/3	18	0.24			15.91
5/10	19	0.00			15.91
5/17	20	2.54			18.45
5/24	21	1.25			19.70
5/31	22	0.00	4.03	May	19.70
6/7	23	0.05			19.75
6/14	24	0.35			20.10
6/21	25	0.45			20.55
6/28	26	1.53	2.38	June	22.08
7/5	27	0.00			22.08
7/12	28	0.05			22.13
7/19	29	0.04			22.16
7/26	30	0.00	0.09	July	22.16
8/2	31	0.40			22.56
8/9	32	3.14			25.70
8/16	33	0.55			26.25
8/23	34	2.48			28.72
8/30	35	0.15	6.71	August	28.87
9/6	36	0.90			29.77
9/13	37	8.55	Hurricane Floyd		38.32
9/20	38	0.40			38.72
9/27	39	0.85	10.70	September	39.57
10/4	40	1.15			40.72
10/11	41	0.35			41.07
10/18	42	0.90			41.97
10/25	43	0.00	2.40	October	41.97
11/1	44	0.50			42.47
11/8	45	0.00			42.47
11/15	46	1.40			43.87
11/22	47	0.70			44.57
11/29	48	0.35	2.95	November	44.92
12/6	49	1.35			46.27
12/13	50	0.50			46.77
12/20	51	0.50			47.27
12/27	52	0.00	2.35	December	47.27

Table 3. D –Site Tritium Stack Releases in Curies in 1999

Week Ending	HTO (Ci)	HT (Ci)	Weekly Total Ci	Month	Annual total Ci
1/6	0.247	0.026	0.273		**0.273**
1/13	0.362	0.235	0.597		**0.870**
1/20	0.554	0.391	0.945		**1.815**
1/27	2.361	2.807	5.168	**January**	**6.983**
2/3	6.410	1.186	7.596		**14.579**
2/10	0.313	0.019	0.331		**14.910**
2/17	0.266	0.012	0.278		**15.188**
2/24	13.450	0.715	14.165	**February**	**29.353**
3/3	0.205	0.012	0.217		**29.570**
3/10	0.931	0.017	0.948		**30.518**
3/17	0.603	0.009	0.612		**31.130**
3/25	0.329	0.098	0.427		**31.557**
3/31	0.199	0.009	0.208	**March**	**31.765**
4/7	0.246	0.015	0.261		**32.026**
4/14	0.075	0.003	0.079		**32.105**
4/21	0.156	0.013	0.169		**32.274**
4/28	0.201	0.009	0.210	**April**	**32.484**
5/5	0.190	0.011	0.201		**32.685**
5/12	0.087	1.670	1.757		**34.441**
5/19	0.232	0.015	0.247		**34.688**
5/26	0.238	0.010	0.248	**May**	**34.936**
6/3	0.286	0.020	0.305		**35.241**
6/9	1.080	0.286	1.366		**36.607**
6/17	4.893	3.025	7.918		**44.526**
6/23	0.196	0.006	0.202		**44.728**
6/30	0.281	0.017	0.298	**June**	**45.026**
7/8	0.158	0.009	0.168		**45.194**
7/14	0.067	0.005	0.072		**45.266**
7/21	0.108	0.006	0.114		**45.379**
7/28	0.292	0.060	0.352	**July**	**45.732**
8/4	0.278	0.015	0.293		**46.025**
8/11	0.155	0.014	0.169		**46.193**
8/18	0.248	0.013	0.261		**46.455**
8/25	0.248	0.013	0.261	**August**	**46.716**
9/1	0.217	0.012	0.229		**46.945**
9/9	0.266	0.011	0.277		**47.222**
9/15	0.179	0.009	0.188		**47.410**
9/22	0.475	0.106	0.581		**47.991**
9/29	1.090	0.433	1.523	**September**	**49.514**
10/6	0.861	0.569	1.430		**50.944**
10/13	2.250	2.490	4.740		**55.684**
10/20	0.138	0.006	0.144		**55.827**
10/27	0.155	0.007	0.162	**October**	**55.990**
11/3	0.118	0.006	0.124		**56.114**
11/10	0.501	0.093	0.594		**56.708**
11/17	4.770	1.470	6.240	**November**	**62.948**
12/1	4.180	0.283	4.463		**67.411**
12/8	0.163	0.007	0.170		**67.580**
12/15	7.429	3.552	10.981		**78.561**
12/22	0.845	1.790	2.635		**81.196**
12/29	0.130	0.164	0.294	**December**	**81.490**
	59.712	**21.779**		**1999 Total**	**81.491**

Table 4. Air Tritium (HT) Concentrations (in picoCuries/meter³) Collected On-Site in 1999

Week Ending	T1	T2	T3	T4
1/11	4.740	6.770	7.397	6.494
1/19	1.362	5.015	1.080	2.844
1/25	4.628	6.958	4.963	97.009
2/1	16.504	6.715	5.874	4.960
2/8	1.487	2.359	4.025	4.577
2/15	0.936	3.066	1.286	0.138
2/22	2.480	2.355	2.511	2.793
3/2	2.113	2.350	2.191	1.954
3/9	2.799	2.349	3.737	2.275
3/16	1.820	2.132	1.972	1.724
3/29	1.119	1.098	2.791	1.788
4/5	2.218	2.254	2.111	1.855
4/12	2.500	2.535	7.007	2.338
4/19	1.738	2.476	2.468	1.612
4/26	7.980	6.253	7.052	4.549
5/3	19.965	2.900	2.043	1.881
5/10	2.009	1.911	16.124	1.797
5/17	1.777	3.157	2.874	1.671
5/25	18.503	17.811	17.959	16.372
6/1	1.630	2.184	2.164	1.472
6/7	2.149	3.209	8.084	1.393
6/14	27.237	4.682	5.295	11.915
6/22	1.976	2.704	19.757	1.846
6/28	19.430	3.360	3.276	161.393
7/6	7.720	9.914	11.794	6.721
7/14	2.698	3.573	4.674	1.947
7/19	2.885	3.033	2.207	2.190
7/27	6.689	2.843	1.725	2.089
8/2	2.190	2.189	3.575	3.136
8/9	2.411	1.707	2.576	1.718
8/16	2.219	2.236	2.207	2.143
8/23	2.399	2.215	2.120	3.903
8/30	2.820	2.009	5.210	2.145
9/8	1.435	1.462	1.949	1.411
9/13	3.027	2.956	2.985	2.436
9/21	1.816	1.726	1.681	2.385
9/28	4.093	5.562	5.330	1.940
10/4	3.824	14.051	5.723	2.259
10/11	2.220	2.266	65.882	1.562
10/19	1.416	1.841	2.273	1.984
10/25	2.552	2.579	25.698	2.404
11/1	2.025	2.475	4.625	2.079
11/8	2.397	2.345	9.637	2.303
11/15	3.704	4.475	4.194	10.945
11/22	2.317	2.268	3.945	2.383
11/29	6.182	2.639	5.536	9.409
12/6	134.408	85.836	64.831	77.715
12/13	3.264	2.631	6.694	4.726
12/21	6.543	7.042	13.086	42.129

Table 5. Air Tritium (HTO) Concentrations (in picoCuries/meter^3) Collected On-Site in 1999

Week Ending	T1	T2	T3	T4
1/11	2.755	5.507	16.467	2.326
1/19	1.356	5.639	4.626	12.472
1/25	2.245	5.634	2.891	130.179
2/1	274.649	92.384	64.678	23.189
2/8	4.087	6.189	13.162	6.660
2/15	8.175	6.676	10.531	2.363
2/22	3.523	2.560	100.377	63.463
3/2	5.413	2.327	9.821	1.954
3/9	4.958	3.589	18.701	3.073
3/16	1.820	2.132	36.135	1.724
3/29	1.530	1.461	5.292	0.958
4/5	2.523	3.936	7.686	1.855
4/12	2.500	2.535	4.274	2.338
4/19	1.738	2.476	5.099	1.612
4/26	4.770	5.620	9.598	4.869
5/3	19.965	1.975	6.088	1.978
5/10	2.331	1.911	2.480	1.797
5/17	5.544	4.253	8.307	4.156
5/25	18.503	17.811	17.959	16.372
6/1	1.630	2.184	3.888	1.472
6/7	6.933	8.849	6.371	1.699
6/14	111.044	26.908	19.445	44.426
6/22	6.476	3.538	19.757	2.515
6/28	19.430	9.554	4.975	4.337
7/6	1.890	2.231	1.988	1.267
7/14	3.164	5.453	7.143	5.201
7/19	2.885	6.424	2.207	2.190
7/27	2.825	11.257	7.559	3.924
8/2	13.234	9.577	9.857	6.475
8/9	2.653	1.707	8.942	1.718
8/16	3.600	6.052	5.236	3.803
8/23	2.399	6.887	5.927	2.098
8/30	6.850	3.346	3.964	3.465
9/8	5.305	3.979	4.456	1.925
9/13	3.027	2.964	2.985	2.436
9/21	1.816	5.499	5.176	3.219
9/28	7.648	11.571	12.252	4.118
10/4	8.016	32.812	7.048	2.370
10/11	2.220	4.564	118.831	1.562
10/19	1.416	1.939	7.914	1.984
10/25	2.552	2.817	8.898	2.404
11/1	2.025	2.194	5.108	2.079
11/8	2.397	2.495	6.666	2.303
11/15	3.899	5.186	10.068	32.361
11/22	29.421	3.797	4.387	81.061
11/29	10.919	4.416	2.704	24.431
12/6	3.445	6.428	7.611	15.219
12/13	2.482	2.631	11.573	3.539
12/21	21.299	3.219	16.950	190.750

Table 6. Air Tritium (HT) Concentrations (in picoCuries/meter³) Collected Off-site in 1999

Week Ending	R1	R2	R3	R4	R5	R6
1/11	2.870	0.000	1.540	2.842	0.795	82.922
1/19	1.670	1.279	0.921	2.266	1.356	1.662
1/25	15.610	1.808	1.776	4.876	4.278	4.058
2/1	0.413	2.242	0.281	0.246		0.319
2/8	0.575	1.382	1.430	0.439	1.285	0.316
2/15	0.870	1.360	1.333	2.001	1.268	0.982
2/22	1.621	1.747	1.926	1.610	1.750	2.172
3/2	3.045	2.796	1.859	2.146	2.126	1.813
3/9	2.779	1.946	2.526	2.841	2.512	2.520
3/16	1.511	5.605	1.446	1.446	1.445	1.492
3/29	0.728	1.638	0.970	0.723	0.750	1.075
4/5	2.822	6.323	2.157	2.698	2.067	1.590
4/12	2.338	2.752	2.297	1.583	1.674	1.632
4/19	1.665	1.954	2.741	2.333	2.624	3.182
4/26	4.456	5.371	14.100	4.381	5.370	10.226
5/3	1.876	2.377	1.389	2.612	2.340	1.478
5/10	2.224	2.083	1.517	2.011	2.238	1.563
5/17	1.853	5.756	1.777	1.793	1.767	2.430
5/25	1.356	1.281	1.344	1.246	1.345	1.337
6/1	1.545	1.529	1.492	1.492	1.560	1.597
6/7	1.957	2.046	3.187	1.751	0.725	3.565
6/14	1.944	1.447	1.460	1.873	1.923	1.405
6/22	3.069	1.221	1.767	1.958	1.307	1.787
6/28	13.269	2.314	1.555	3.189	1.644	1.614
7/6	5.484	12.019	4.612	9.014	3.462	8.675
7/14	1.542	1.776	1.945	1.924	1.865	2.255
7/19	3.133	2.769	2.670	66.608	4.893	2.736
7/27	2.210	1.696	1.678	4.020	1.993	1.834
8/2	6.663	1.936	3.622	142.891	3.647	2.165
8/9	1.719	1.719	1.576		1.764	1.751
8/16	2.428	2.312	2.150	40.795	2.530	2.375
8/23	2.205	2.347	2.742	4.427	2.109	3.934
8/30	2.743	1.955	6.239	19.035	4.113	4.718
9/8	1.491	1.049	9.932	8.244	12.967	11.269
9/13	2.889	2.137	3.042		2.204	3.741
9/21	2.051	1.981	2.081	1228.651	2.884	4.483
9/28	1.829	1.715	2.661	8512.739	4.473	2.194
10/4	4.707	3.272	2.669	1086.229	3.906	3.749
10/11	2.154	1.583	3.833	19031.596	2.686	2.312
10/19	1.883	1.411	1.859	467.379	1.836	2.074
10/25	2.434	1.884	2.686	7091.127	1.952	2.473
11/1	2.279	3.032	2.317	213.505	2.374	3.708
11/8	1.664	2.392	3.323	3692.816	2.456	2.414
11/15	2.096	1.525	3.354	120.491	4.402	6.837
11/22	1.697	1.601		886.360	1.660	1.607
11/29	3.941	4.782	2.164	56.695	4.967	10.451
12/6	1.535	2.304	2.175	432.671	5.011	46.316
12/13	2.118	1.671	2.812	36.052	7.005	16.303
12/21	4.209	2.742	2.656	261.175	7.426	9.185

Table 7. Air Tritium (HTO) Concentration (in picoCuries/meter³) Collected Off-Site in 1999

Week Ending	R1	R2	R3	R4	R5	R6
1/11	2.726	1.205	2.301	4.698	0.000	23.579
1/19	0.062	1.633	1.843	2.277	0.386	0.608
1/25	22.922	1.871	4.505	4.748	2.480	1.232
2/1	1.442	9.813	0.423	1.789	0.196	1.160
2/8	0.689	0.727	0.000	1.832	0.594	1.853
2/15	0.000	1.089	0.674	1.444	0.842	0.000
2/22	1.621	1.747	1.926	1.610	1.750	12.390
3/2	2.162	2.796	1.859	2.146	2.126	1.813
3/9	2.779	1.946	2.526	2.841	2.512	2.520
3/16	1.511	1.778	1.446	1.446	1.445	1.492
3/29	0.728	1.638	0.970	0.723	0.750	1.075
4/5	2.443	1.912	2.157	1.557	2.067	1.590
4/12	2.338	2.752	2.297	1.583	1.674	1.632
4/19	1.665	1.954	2.741	2.333	2.624	3.182
4/26	2.917	1.907	2.427	1.902	3.086	3.700
5/3	1.876	1.508	1.389	2.612	2.340	1.478
5/10	2.224	2.083	1.517	1.517	2.238	1.563
5/17	4.068	2.481	1.777	1.793	2.015	1.760
5/25	1.356	1.281	1.344	1.246	1.345	1.337
6/1	1.545	1.529	1.492	1.492	1.560	1.597
6/7	1.970	3.978	4.490	1.206	2.060	4.449
6/14	1.944	1.447	1.460	1.873	1.923	1.405
6/22	1.316	1.221	3.007	1.958	1.307	1.705
6/28	3.144	2.314	1.555	1.554	1.644	1.614
7/6	2.067	1.303	1.888	1.257	1.306	1.349
7/14	4.016	1.637	1.945	1.924	2.268	4.078
7/19	3.133	2.867	2.670	2.006	3.098	2.736
7/27	5.068	1.696	2.564	1.728	1.677	1.834
8/2	3.090	1.936	3.052	3.992	2.140	2.165
8/9	1.719	1.719	1.576	1.604	1.764	1.751
8/16	3.117	6.282	2.150	2.469	1.622	2.375
8/23	2.205	1.473	4.674	2.070	4.922	5.108
8/30	4.834	2.077	5.173	4.905	2.385	5.173
9/8	3.452	1.049	6.278	4.293	6.667	15.574
9/13	2.889	2.137	3.042	0.000	2.204	3.803
9/21	2.914	1.981	2.682	2.964	2.813	4.570
9/28	2.920	1.715	1.768	12.492	1.708	2.371
10/4	2.285	1.831	2.768	3.620	2.449	2.424
10/11	3.242	1.583	2.621	4.534	3.452	2.312
10/19	3.208	1.411	1.859	2.196	1.836	1.405
10/25	3.538	1.884	2.686	8.320	1.952	2.473
11/1	2.672	3.032	2.317	1.601	2.374	2.333
11/8	1.664	3.096	3.323	2.819	2.456	2.414
11/15	2.096	1.525	2.037	1.904	2.026	2.083
11/22	1.697	1.601	1.601	1.642	1.660	1.607
11/29	2.319	2.646	2.164	2.105	2.174	1.496
12/6	1.535	15.030	2.175	2.976	2.557	2.312
12/13	2.118	1.671	2.812	1.908	2.691	2.048
12/21	17.088	1.696	1.796	2.249	2.616	11.994

Table 8. Surface Water Tritium Concentrations for 1999
(in picoCuries/Liter)

Sample Location	Bee Brook (B1)	Bee Brook (B2)	PPPL Basin (DSN001)
January			<272
February	<376	<376	<376
March			201
April			249
May	<153	<153	243
June			158
July			126
August	117	<25	<25
September			54
October			348
November	<206	<206	145
December			186

Sample Location	Potable Water (E1)	D&R Canal (C1)	D&R Canal (DSN003)
January			<272
February	<376	<376	<376
March			<101
April		<101	118
May	<25	<153	<153
June		<305	<30
July		<374	<37
August	<25	<25	<25
September			<38
October			<98
November	<206	<136	<136
December			<144

Sample Location	Millstone River (M1)	Cranbury Brook (P1)	Devil's Brook (P2)
January	<376	<376	<376
February			
March			
April	<153	<153	<153
May			
June			
July		<25	<25
August			
September			
October	<136	<136	<136
November			
December			

Table 9. Ground Water Tritium Concentrations for 1999
(in picoCuries/liter)

Well No. or Sump Location	TFTR Sump	D-site MG Sump	Well TW-1	Well TW-2	Well TW-3	Well TW-5	Well TW-7	Well TW-8
January	342	185	982			964	156	1,041
February	266	<137		383	243			
March	273	412						
April	260	324	970				<58	746
	351						335	
May	284	279	778	433	288	805	143	805
June	284	230	694		225	689		653
July	278	405						
August	<131	153	626	140	153	716		550
September	276	298						
October			609			507		486
November	180	155	511	202	147	524		526
December	<144	145						

Well No.	Well D-11R	Well D-12	Well MW-12S	Well MW-13I	Well MW-14	Well MW-15	Well MW-16	Well MW-17	Well MW-18
January		149	<127						
February	<134	167			<134	<134	<134		
March									
April		85	<128	<128				<128	<128
			<58						
May	<97	164	<97		<97	<100	<100		
June			<116						
July	<37	72							
August	<69	153	<102		<69		<69		
September									
October			<109						
November	<111	<111	<109		<111		<111		
December									

Table 10. Rain Water Tritium Concentrations (in picoCuries/liter) Collected On-Site in 1999

250 feet from Stack	R1E (East)	R1W (West)	R1S (South)	R1N (North)	R1ND (Duplicate)
January 19	315	<118	<118	<118	<118
February 5	<160	<160	<160	284	275
March 3	541	153	491	<123	<123
March 25	375	266	202	<103	<103
April 20	160	124	<103	<103	<103
May 20	135	135	243	<116	<116
June22	<58	77	140	<58	<58
July	-	-	-	-	-
August 16	-	**<48** **118**	<48	<48	<48
September 8	<0	<0	<0	<0	<0
October 8	72		508	151	<119
October 25	66	<111	211	183	<111
November 30	203	<108	122	145	116
December 15	341	1,377	5,264	<42	150

500 feet from Stack	R2E (East)	R2W (West)	R2S (South)	R2N (North)	R3N (Far field)
January 19	156	<118	<118	<118	<118
February 5	<160	<160	<160	194	<160
March 3	239	<123	234	<123	<123
March 25	139	<103	<103	<103	<103
April 20	<103	<103	104	<103	<103
May 20	<116	<116	<116	NS	<116
June 22	<58	<58	<58	<58	<58
July	-	-	-	-	-
August 16	<48	<48	<48	106	<48
September 8	<0	<0	<0	<0	<0
October 8	<119	214	171	NS	<119
October 25	<111	<111	<111	121	<111
November 30	<140	NS	<140	<140	<140
December 15	132	5,714	7,817	<108	<108

Table 11. Rain Water Tritium Concentrations (in picoCuries/liter) Collected Off-Site in 1999

	R1	R2	R4	R5	R6
January 5					<195
January 11				<661	
January 19		<661	<661	<661	
February 8				149	
February 22				<272	
March 1				<272	
March 16				<101	
March 29				<101	
April 14		<220	<220		<220
May 17				<23	
May 25	<23	<23	<23	<23	<23
June 22				<56	
July 6			<92		
July 14				99	
July 19					105
July 29		<98			
August 16	72	50	50	<43	<43
August 30	<46	<46	<46	<46	<46
September 20	196	316	203	<124	<124
October 4				<124	
October 11	<128	<128	538	<128	<128
October 28	<128	<128	<128	<128	
November 5					<128
November 22				<128	
November 30	<128	<128	<128	<128	
December 7				<246	<246

Table 12. Annual Range of Tritium Concentration at PPPL in Precipitation from 1985 to 1999

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 (38.7 w/out Floyd)	+0.8 (-7.8)

Table 13. Liquid Effluent Collection Tank Release Data for 1999

Sample Date	Tank #	Gallons Released	Tritium Sample LLD (pCi/L)	Tritium Sample Activity (pCi/L)	Total Tank Activity (Ci)	Annual Cumulative Activity (Ci)	Gross Beta Sample LLD (pCi/L)	Gross Beta Sample Activity (pCi/L)
1/7	3	12,000	328	13,900	0.000632	0.000632	196	147
3/17	3	13,350	334	17,900	0.000903	0.00154	195	48.6
5/5	3	10,500	319	9,080	0.000361	0.00190	195	20
6/4	3	12,315	312	275,000	0.0128	0.0147	195	942
7/6	2	12,900	277	94,000	0.00464	0.0193	196	38
7/9	3	10,950	330	101,000	0.00417	0.0235	195	255
7/29	2	13,200	324	37,000	0.00185	0.0254	195	310
8/17	2	12,750	305	307,000	0.0148	0.0402	196	1130
8/30	3	12,750	286	254,000	0.0122	0.0524	195	774
9/15	3	12,750	324	71,100	0.00343	0.0558	391	229
9/27	3	10,950	302	51,600	0.00214	0.0580	391	87.8
12/8	3	12,045	330	64,100	0.00292	0.0609	196	52.8
12/20	3	12,300	327	497,000	0.0231	0.0840	196	1,630

Table 14. Surface Water Analysis for Bee Brook, B1, in 1999

Sample Date	2/3/99	5/4 /99	8/5/99	11/11 /99
Ammonia-N, mg/L	<0.100	<0.100		<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<2.30		5.90
Chemical Oxygen Demand, mg/L	29.5	20.0	7.80	35.5
Chromium, mg/L	<0.010	<0.100		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<2.10		<2.10
pH, standard units	6.92	7.20	7.11	7.20
Phenolics, as phenol, mg/L	<0.005	<0.005		0.0350
Phosphorus, total, mg/L		<0.010	0.0600	
Temperature, ° C	6.5	13.9	20.6	10.8
Total Dissolved Solids, mg/L	236	<0.005		156
Total Suspended Solids, mg/L	2.00	<2.00	7.00	3.00
Turbidity, FTUs	39			

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 1999

Sample Date	2/4/99	5/4/99	8/5/99	11/11 /99
Ammonia-N, mg/L	<0.100	<0.100		<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<2.30		<2.00
Chemical Oxygen Demand, mg/L	29.0	12.5	11.4	9.00
Chromium, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500			<0.500
pH, standard units	7.18	8.07	7.18	7.43
Phenolics, as phenol, mg/L	<0.005	<0.005		0.008
Phosphorus, total, mg/L			0.120	
Temperature, ° C	8.0	14.7	21.8	13.2
Total Dissolved Solids, mg/L	220	212		194
Total Suspended Solids, mg/L	3.00	3.00	7.00	4.00
Turbidity, FTUs	30			

Location B2 = Bee Brook downstream of PPPL basin discharge

Table 16. Surface Water Analysis for Delaware & Raritan Canal, C1, in 1999

Sample Date	2/4/99	5/4 /98	8/5/99	11/2/99
Ammonia-N, mg/L	<0.100	<0.100		0.100
Biochemical Oxygen Demand, 5-day total, mg/L	4.10	<2.30		<2.10
Chemical Oxygen Demand, mg/L	14.0	39.0	7.20	7.00
Chromium, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.005
pH, standard units	7.04	6.10	7.14	7.75
Phenolics, as phenol, mg/L	<0.005	<0.005		0.0110
Phosphorus, total, mg/L			0.0800	0.0570
Temperature, ° C	5.8	15.1	28.2	13.6
Total Dissolved Solids, mg/L	120	314		152
Total Suspended Solids, mg/L	8.00	11.0	8.00	5.00
Turbidity, FTUs	25			

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 1999

Sample Date	2/3/99	5/4/99	8 /5/99	11/2/99
Ammonia-N, mg/L	0.250	0.470		0.520
Biochemical Oxygen Demand, 5-day total, mg/L	2.50	<2.30		<2.10
Chemical Oxygen Demand, mg/L	16.0	18.5	28.6	8.50
Chromium, total, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<0.500		<0. 500
pH, standard units	7.93	6.91	8.61	5.80
Phosphorus, total, mg/L			0.100	0.064
Temperature, ° C	6.9	15.0	27.8	14.8
Total Dissolved Solids, mg/L	166	200		176
Total Suspended Solids, mg/L	13.0	6	18.0	2.00
Turbidity, FTUs	0			

Location M1 = Millstone River at Route 1 bridge mid-span on northbound side
See Exhibit 4-3 for location.

Table 18. Surface Water Analysis for Elizabethtown Water, E1, in 1999

Sample Date	2/3/99	5/4/99	8/5/99	11/ 11 /99
Ammonia-N, mg/L	0.120	0.170		0.165
Biochemical Oxygen Demand, 5-day total, mg/L	<2.30	<2.30		<2.00
Chemical Oxygen Demand, mg/L	10.5	8.00	6.20	6.00
Chromium, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<0.500		<0.500
pH, standard units	7.19	6.98	6.65	6.36
Phenolics, as phenol, mg/L	<0.005	<0.005		<0.005
Phosphorus, total, mg/L			0.142	
Temperature, ◦C	5.9			
Total Dissolved Solids, mg/L	208	342		252
Total Suspended Solids, mg/L	<2.00	<2.00	<2.00	<2.00
Turbidity, FTUs	0			

Location E1 = Elizabethtown Water (potable) collected at Main Gate Security Booth
See Exhibit 4-3 for locations.

Table 19. Surface Water Analysis for Cranbury Brook (Plainsboro), P1, in 1999

Sample Date	2/3/99	5/4 /99	8/5 /99	11/2/99
Ammonia-N, mg/L	0.280	0.130		
Biochemical Oxygen Demand, 5-day total, mg/L	4.10	3.00		2.40
Chemical Oxygen Demand, mg/L	13.9	23.0	12.0	44.6
Chromium, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<0.500		<0.500
pH, standard units	7.31	7.00	6.17	6.18
Phenolics, as phenol, mg/L	<0.005	0.007		<0.005
Phosphorus, total, mg/L			<0.05	0.0770
Temperature, ◦C	7.5	15.7	23.6	15.5
Total Dissolved Solids, mg/L	108	266		258
Total Suspended Solids, mg/L	15.0	11.0	4.0	12.0
Turbidity, FTUs	0			

Location P1 = Cranbury Brook at George Davison Road, Plainsboro mid-span on bridge southbound
See Exhibit 4-3 for locations

Table 20. Surface Water Analysis for Devil's Brook (Plainsboro), P2, in 1999

Sample Date	2/3/99	5/4 /99	8/5/99	11/2/99
Ammonia-N, mg/L	21.1	<0.100		<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.40	<2.30		2.20
Chemical Oxygen Demand, mg/L	21.1	19.5	4.20	35.7
Chromium, mg/L	<0.010	<0.010		<0.005
Petroleum hydrocarbons, mg/L	<0.500	<0.500		<0.500
pH, standard units	7.26	6.49	6.67	5.94
Phenolics, as phenol, mg/L	<0.005	< 0.005		0.020
Phosphorus, total, mg/L			<0.05	<0.05
Temperature, ◦C	8.3	13.6	20.5	14.0
Total Dissolved Solids, mg/L	123	124		108
Total Suspended Solids, mg/L	4.00	2.00	2.00	5.00
Turbidity, FTUs	21			

Location P2 = Devil's Brook at Schalks Road overpass, adjacent to Amtrak railroad tracks
See Exhibit 4-3 for locations.

Table 21. Detention Basin Influents Analysis (NJPDES NJ0086029) in 1999

Location **Sample Date**	***Inflow 1*** **5/5 /99**	**Inflow 1** **8/5 /99**	**Inflow 2** **5/5/99**	**Inflow 2** **8/5 /99**
Ammonia-N, mg/L	<0.100	<0.100	<0.100	<0.100
Biochemical Oxygen Demand, 5-day total, mg/L	<2.50	<2.10	<2.50	<2.10
Chemical Oxygen Demand, mg/L	9.00	7.20	4.00	4.30
Chromium, mg/L	<0.010	<0.010	<0.010	<0.010
Petroleum hydrocarbons, mg/L	<0.500	<0.500	<0.500	<0.500
pH, standard units	9.09	8.10	7.63	7.07
Phenolics, as phenol, mg/L	<0.005	<0.005	<0.005	<0.005
Settleable solids, %	<0.200	<0.200	<0.200	<0.200
Temperature, °C	19.5		16.5	
Total Dissolved Solids, mg/L	224		10	152
Total Volatile Organics (GC/MS), □g/L		see Table 28		

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

Table 22. DSN001 - Detention Basin Outfall 1999 Surface Water Analysis (NJPDES NJ0023922)

Permit Limit	Units	Parameters	1/7	2/3	3/4	4/5	5/6	6/7	6/30
NA	mg/L	Ammonia-N		<0.100			<0.100		
NA	mg/L	Biochemical Oxygen Demand, 5-day total		<2.300			<2.30		
50 mg/L	mg/L	Chemical Oxygen Demand	6.50	7.50	7.50	6.00	11.0	13.0	
NL	mg/L	Chlorine Produced Oxidants as chlorine, free		<0.1			<0.1	<0.1	<0.1
NA	mg/L	Chromium, total		<0.010					
100	percent	Chronic Toxicity Test NOEC (% effluent) IC_{25} (% effluent) *Pimephales promelas*			100 >100				
NA	gpm	Flow	174.6	172.6	217.3	95.2	145.3	105.4	
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	8.48	7.86	7.15	7.64	7.93	7.70	7.40
NA	mg/L	Phenolics, as phenol		<0.005			<0.005		
	mg/L	Phosphorus, Total							0.123
	µg/L	Tetrachloroethylene							1.49
30 °C max.	°C	Temperature	7.4	12.0	11.2	13.9	15.9	20.3	22.2
NA	mg/L	Total Dissolved Solids		190			230		
50 mg/L	mg/L	Total Suspended Solids	<2.00	2.00	<2.00	3.00	4.00	<2.00	

Permit Limit	Units	Parameters	7/7	8/5	9/9	10/7	11/2	12/3
NA	mg/L	Ammonia-N					<0.100	
NA	mg/L	Biochemical Oxygen Demand, 5-day total		<2.20			<2.10	
50 mg/L	mg/L	Chemical Oxygen Demand	4.50	13.0	<5.00	47.6	<5.00	10.50
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) IC_{25} (% effluent) *Pimephales promelas*				100 >100		
NA	gpm	Flow	89.4	121.9	88.2	153.1	235.8	182.8
10 mg/L	mg/L	Petroleum Hydrocarbons	0.550	0.780	<0.500	<0.500	<0.500	<0.500
6.0-9.0	S.U.	pH	7.82	8.14	7.86	7.77	6.39	7.44
NA	mg/L	Phenolics, as phenol					0.008	
	mg/L	Phosphorus, Total		0.154			0.166	
	µg/L	Tetrachloroethylene		1.12			1.13	
30 °C max.	°C	Temperature	24.1	22.5	22.6	17.6	17.5	10.4
NA	mg/L	Total Dissolved Solids					240	
50 mg/L	mg/L	Total Suspended Solids	<2.00	3.00	2.00	2.00	16.0	<2.00

Blank indicates no measurement
NA = not applicable
NL = no limit

Table 23. D&R Canal Pump House - DSN003 1999 Monthly Surface Water Analysis (NJPDES NJ0023922)

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	1/7	2/4	3/6	4/5	5/7	6/10
NA	NA	mg/L	Ammonia-N		<0.100			<0.100	
NA	NA	mg/L	Biochemical Oxygen Demand		<2.30			<2.30	
NA	NA	mg/L	Chemical Oxygen Demand		70.0			15.0	
NL	NL	mg/L	Chlorine Produced Oxidants		<0.1			<0.1	<0.1
NA	NA	mg/L	Chromium		<0.010			<0.010	
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	7.39	7.57	7.13	7.94	6.89	6.85
NA	NA	mg/L	Phenolics, as phenol		<0.005			<0.005	
NA	NA	°C	Temperature	0.9	5.20	6.50	12.9	16.0	25.0
NA	NA	mg/L	Total Dissolved Solids		114			302	
20 mg/L	60 mg/L	mg/L	Total Suspended Solids	46	6.0	6.0	8.0	14.0	*

Permit Monthly Avg.	Limit Daily Max.	Units	Parameters	7/7	8/3	9/9	10/7	11/2	12/3
NA	NA	mg/L	Ammonia-N					<0.100	
NA	NA	mg/L	Biochemical Oxygen Demand					<2.10	
NA	NA	mg/L	Chemical Oxygen Demand		10.9			<5.00	
NL	NL	mg/L	Chlorine Produced Oxidants	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
NA	NA	mg/L	Chromium					<0.005	
10 mg/L	15 mg/L	mg/L	Petroleum Hydrocarbons	<0.500	0.950	<0.500	<0.500	<0.500	<0.500
NA	6.0-9.0	S.U.	pH	7.05	7.10	6.99	6.33	7.19	6.51
NA	NA	mg/L	Phenolics, as phenol					0.0110	
NA	NA	mg/L	Phosphorus, total		0.239			0.0770	
NA	NA	°C	Temperature	30.7	27.1	26.2	15.7	13.9	5.0
NA	NA	mg/L	Total Dissolved Solids					182	
NL	NL	mg/L	Total Suspended Solids		9.0			<2.0	

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 1999

Well No. **Date**	**MW-14** **2/11/99**	**MW-14** **5/5/99**	**MW-14** **8/3/99**	**MW-14** **11/4/99**	***NJPDES Permit Standard***
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			3.00	<5.00	*250*
Chromium, dissolved, hexavalent, mg/L			<0.010	<0.010	*0.05*
Conductivity, μmhos/cm^2	78.6	72.0	69.50	108	
Lead, total, mg/L			<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			1.68	1.60	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	5.38	4.42	5.82	5.62	
Phenolics as phenol, mg/L			<0.005	<0.005	*0.3*
Sulfate, mg/L	15.5	14.7	13.3	14.5	*250*
Total Dissolved Solids, mg/L	36.0	116	152	62.0	*500*
Total Organic Carbon, mg/L			<1.0		
Total Organic Halides, mg/L			0.0168		
Tritium, pCi/L			<69		

Well No. **Date**	**MW-15** **2/11/99**	**MW-15** **5/5/99**	***MW-15*** ***8/3/99***	**MW-15** **11/5/99**	***NJPDES Permit Standard***
			Well was	*removed*	
Ammonia-Nitrogen, mg/L		<0.100			*0.5*
Conductivity, μmhos/cm^2	96.3	77.4			
pH, units	6.15	7.14			
Sulfate, mg/L	9.20	8.20			*250*
Total Dissolved Solids, mg/L	38.0	104			*500*

Well No. **Date**	**MW-16** **2/11/99**	**MW-16** **5/5/99**	**MW-16** **8/3/99**	**MW-16** **11/5/99**	***NJPDES Permit Standard***
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			5.00	5.40	*250*
Chromium, dissolved, hexavalent, mg/L			<0.010	<0.010	*0.05*
Conductivity, μmhos/cm^2	459	358	439	582	
Lead, total, mg/L			<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			0.440	<0.500	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	6.61	5.42	5.98	6.36	
Phenolics as phenol, mg/L			<0.005	<0.005	*0.3*
Sulfate, mg/L	81.5	58.7	46.0	79.9	*250*
Total Dissolved Solids, mg/L	364	240	360	418	*500*
Total Organic Carbon, mg/L			2.70		
Total Organic Halides, mg/L			0.0623		
Tritium, pCi/L			<69		

Blank indicates no measurement.

Table 25. Ground Water Analysis for Wells D-11R and D-12 for 1999

Well No. Date	D-11R 2/11/99	D-11R 5/5/99	D-11R 8/3/99	D-11R 11/4/99	*NJPDES Permit Standard*
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			15.0	14.2	*250*
Chromium, dissolved hexavalent,mg/L			<0.010		*0.05*
Conductivity, µmhos/cm²	308	279	314	276	
Lead, total, mg/L			<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			<0.400	<0.500	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	7.64	6.96	5.64	6.57	
Phenolics as phenol, mg/L			<0.005	0.005	*0.3*
Sulfate, mg/L	9.10	8.70	10.1	10.2	*250*
Total Dissolved Solids, mg/L	176	204	118	190	*500*
Total Organic Carbon, mg/L			1.08		
Total Organic Halides, mg/L			16.4		
Tritium, pCi/L			<69		

Well No. Date	D-12 2/11/99	D-12 5/5/99	D-12 8/3/99	D-12 11/4/99	D-12 Duplic. (MW-11)	*NJPDES Permit Standard*
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			16.5	15.3	15.2	*250*
Chromium, dissolved hexavalent,mg/L			<0.010	0.0101	0.00660	*0.05*
Conductivity, µmhos/cm²	211	212	191	173	173	
Lead, total, mg/L			<0.005	<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			<0.400	<0.500	<0.500	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500			
pH, units	7.96	4.70	4.84	5.01	5.01	
Phenolics as phenol, mg/L			<0.005	<0.005	0.0110	*0.3*
Sulfate, mg/L	34.6	34.2	35	29.1	29.1	*250*
Total Dissolved Solids, mg/L	96.0	160	52	120	126	*500*
Total Organic Carbon, mg/L			1.50			
Total Organic Halides, mg/L			27.1			
Tritium, pCi/L			153			

Blank indicates no measurement.

Table 26. Ground Water Analysis for Wells TW-2 and TW-3 for 1999

Well No. **Date**	**TW-2** **2/11/99**	**TW-2** **5/5/99**	**TW-2** **8/3/99**	**TW-2** **11/4/99**	***NJPDES Permit Standards***
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			16.5	19	*250*
Conductivity, µmhos/cm^2	451	344	410	370	
Lead, total, mg/L			<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			<0.400	<0.500	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500		
pH, units	7.91	8.03	6.17	7.26	
Phenolics as phenol, mg/L			<0.005	<0.005	*0.3*
Sulfate, mg/L	20.9	20.1	13.5	18.0	*250*
Total Dissolved Solids, mg/L	236	232	388	260	*500*
Total Organic Carbon, mg/L			<1.0		
Total Organic Halides, mg/L			<0.005		
Tritium, pCi/L			140		

Well No. **Date**	**TW-3** **2/11/99**	**TW-3** **5/5/99**	**TW-3** **8/3/99**	**TW-3** **Duplic.** **(TW-11)**	**TW-3** **11/4/99**	***NJPDES Permit Standard***
Ammonia-Nitrogen, mg/L		<0.100	<0.100	<0.100	<0.100	*0.5*
Chloride, mg/L			17.0	18.0	19.1	*250*
Chromium, dissolved hexavalent,mg/L			<0.010	<0.010		*0.05*
Conductivity, µhos/cm^2	386	359	352	372	365	
Lead, dissolved, mg/L			<0.005	<0.005	<0.005	*0.05*
Nitrate-Nitrogen, mg/L			<0.400	<0.400	<0.500	*10*
Petroleum Hydrocarbon by IR, mg/L			<0.500	<0.500		
pH, units	7.96	5.63	7.70	7.50	7.27	
Phenolics as phenol, mg/L			<0.005	<0.005	0.009	*0.3*
Sulfate, mg/L	14.8	17.4	20.6	22.2	23.5	*250*
Total Dissolved Solids, mg/L	210	244	250	248	260	*500*
Total Organic Carbon, mg/L			<1.0	<1.0		
Total Organic Halides, mg/L			0.0098	<0.005		
Tritium, pCi/L			153			

Blank indicates no measurement.

Table 27. Summary of Ground Water Sampling Results – July 1999
Target Volatile Organic Compounds (µg/L)

Well No.	MW-3	MW-9S	MW-9I	MW-13S	MW-13I	MW-17	NJ GW Standard
Tetrachloroethylene	5.0 J	73.5	ND	89.6	30.9	35.8	1
Trichloroethylene	ND	1.2 T	ND	1.7 T	ND	ND	1
c-1,2-Dichloroethylene	ND	4.1 T	ND	3.6 T	1.8 T	1.4 T	70
1,1,1-Trichloroethane	ND	4.9 T	ND	4.1 T	4.0 T	ND	30
1,1-Dichloroethylene	ND	ND	ND	1.2 T	ND	ND	2
Chloroform	ND	1.3 T	ND	ND	ND	ND	6
Tentatively Identified Compounds							
1,1,2-trichloro-trifluoroethane	16	45	ND	47	54	ND	--

Well No.	MW-18	MW-19S	MW-19I	D-12	D-11R	MG-D Site	NJ GW Standard
Tetrachloroethylene	ND	111	ND	6.4	4.7 T	114	1
Trichloroethylene	ND	3.2 T	ND	1.9 T	ND	3.3 T	1
c-1,2-Dichloroethylene	ND	19.1	ND	2.3 T	ND	19.1	70
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	30
1,1-Dichloroethylene	ND	ND	ND	ND	ND	ND	2
Chloroform	ND	ND	ND	ND	ND	ND	6
Tentatively Identified Compounds							
1,1,2-trichloro-trifluoroethane	ND	ND	ND	ND	ND	ND	ND

Well No.	MW-25	MW-26*	MW-27*	TB 7/6/99	TB 7/7/99	NJ GW Standard
Tetrachloroethylene	ND	ND	76.3	ND	ND	1
Trichloroethylene	ND	ND	5.2	ND	ND	1
c-1,2-Dichloroethylene	ND	4.7 T	4.0 T	ND	ND	70
1,1,1-Trichloroethane	ND	ND	2.0 T	ND	ND	30
1,1-Dichloroethylene	ND	ND	3.1 T	ND	ND	2
Chloroform	ND	ND	ND	ND	ND	6
Tentatively Identified Compounds						
1,1,2-trichloro-trifluoroethane	ND	ND	ND	ND	ND	ND

ND - compound not detected, detection limit is 5.0 ug/L.
T- Estimated, concentration listed is below detection limit.
TB – Trip Blank

** MW-26 is duplicate sample from well MW-25 and MW-27 is a duplicate sample from the D-Site MG Building sump (MG-D Site).*

Ground water quality standards as published in N.J.A.C. 7:9-6.9, or interim criteria from NJDEP Memorandum dated 2/5/97.

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

Table 28. Volatile Organics Analytical Results from Wells, D-11R, D-12 and TW-3, Detention Basin Inflows 1 and 2— May and August 1999 (in µg/L)

Well No. May 1999	D-11R	D-12	TW-3	Trip Blank	NJ GW Standard
1,1-Dichloroethane	<5	1.34T	<5	<5	*70*
Chloroform	<1	<1	<1	<1	*6*
1,1,1-Trichloroethane	<1	<1	<1	<1	*30*
Trichloroethene	<1	2.10	<1	<1	*1*
Bromodichloromethane	<1	<1	<1	<1	
Tetrachloroethene	5.68	5.70	4.69	<1	*0.4*

Well No. August 1999	D-11R	D-12	TW-3	Inflow 1	Inflow 2	Trip Blank	NJ GW Standard
1,1-Dichloroethane	<5	1.16T	<5	<5	<5	<5	*70*
Chloroform	<1	<1	<1	<1	1.21	<1	*6*
1,1,1-Trichloroethane	<1	<1	<1	<1	<1	<1	*30*
Trichloroethene	<1	1.96	<1	<1	<1	<1	*1*
Bromodichloromethane	<1	<1	<1	<1	1.05	<1	
Tetrachloroethene	6.17	6.45	7.28	<1	5.02	<1	*0.4*

T- Estimated, concentration listed is below detection limit.
NA Not available
NL Not listed on NJDEP Ground Water Quality Standards

Table 29. Quality Assurance Data for Radiological and Non-Radiological Samples for 1999

Laboratory, Program, and Parameter	Reported Value	Actual Value	Acceptance Range
PPPL DOE-EML Tritium in water (Bequerel/Liter))			
March 1999	125.5	121.1	Pass
August 1999	78.9	80.7	Pass
PPPL Test Results			
Total residual chlorine (mg/L – ERA 9980)	0.49	0.669	0.502 –0.836
Total residual chlorine (mg/L) - SPEX	2.147	2.25	1.869-2.571
Total residual chlorine (mg/L) – Ultra	0.87	1.03	0.82-1.23
QC, Inc.'s Test Results			
Chromium	0.614	0.611	0.501-0.8721
Lead	0.215	0.211	0.173-0.249
Biochemical oxygen demand	40.1	48.4	32.4-58.6
Chemical oxygen demand	84.1	80.6	68.5-92.7
Phosphorus, total	1.59	1.29	11.1-1.47
Total organic carbon	30.2	31.2	26.5-35.9
Nitrate as N	8.45	8.35	7.43-9.27
Ammonia as N	12.5	13.1	11.0-15.2
Ortho-phosphate as P	5.42	5.47	4.65-6.29
Cyanide, total	0.522	0.615	0.449-0.781
Phenol	0.0735	0.0864	0.0657-0.107
pH	8.74	9.02	8.82-9.22
Total dissolved solids	510	583	507-659
Total hardness	269	261	224-298
Total suspended solids	52.0	55.6	47.3-63.9
Petroleum hydrocarbons	85.0	88.1	52.8-110

Appendix B

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