PREPARED FOR THE U.S. DEPARTMENT OF ENERGY,
UNDER CONTRACT DE-AC02-76-CHO-3073

PPPL-3159
UC-425

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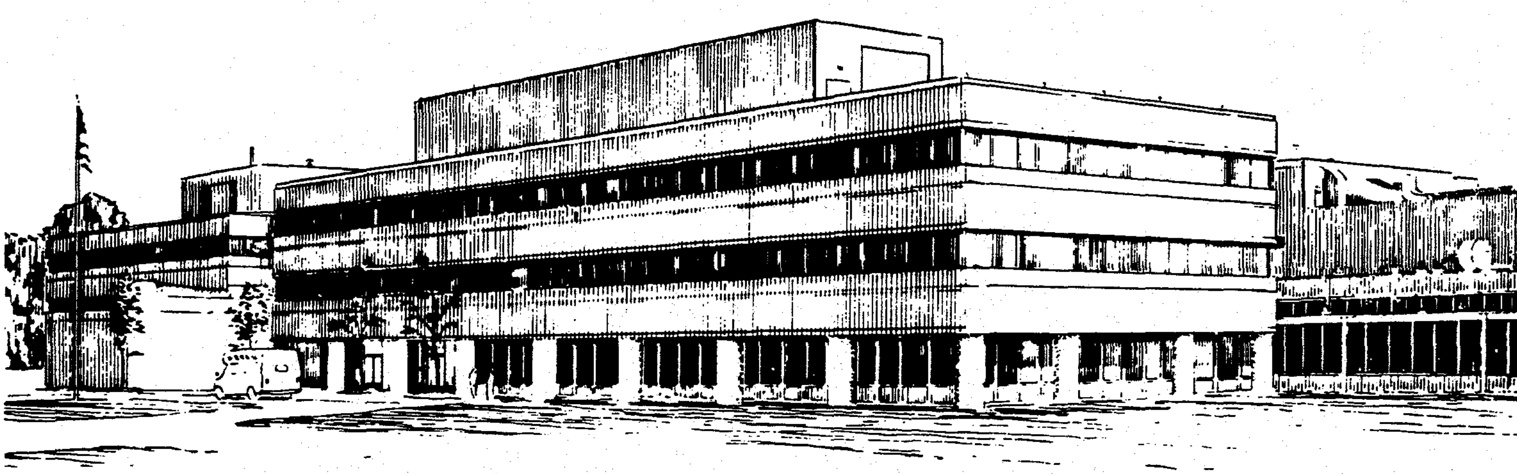
PRINCETON PLASMA PHYSICS LABORATORY (PPPL)

ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1994

Edited by V.L. Finley and M.A. Wieczorek

Issued
February 1996

PPPL PRINCETON PLASMA PHYSICS LABORATORY



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From:

Princeton Plasma Physics Laboratory
James Forrestal Campus
P. O. Box 451
Attn: V. Finley
Princeton, New Jersey 08543-0451

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V. L. Finley

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P.O. Box 451
Princeton, New Jersey 08543

Operated under Contract
DE-AC02-76-CHO-3073

Table of Contents

Page

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 3

2.1 General 3

2.2 Description of the Site 7

3.0 1994 COMPLIANCE SUMMARY 8

3.1 Environmental Compliance 8
- 3.1.1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 8
- 3.1.2 Resource Conservation and Recovery Act (RCRA) 8
- 3.1.3 National Environmental Policy Act (NEPA) 9
- 3.1.4 Clean Air Act (CAA) 9
- 3.1.5 National Emission Standards for Hazardous Air Pollutants (NESHAPs) 10
- 3.1.6 Clean Water Act (CWA) 10
- 3.1.7 National Pollutant Discharge Elimination System (NPDES) 11
- 3.1.8 Safe Drinking Water Act (SDWA) 12
- 3.1.9 Superfund Amendments and Reauthorization Act (SARA) Title III 13
- 3.1.10 Toxic Substance Control Act (TSCA) 14
- 3.1.11 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 14
- 3.1.12 Endangered Species Act (ESA) 14
- 3.1.13 National Historic Preservation Act (NHPA) 15
- 3.1.14 Federal Facility Compliance Act (FFCA) 15
- 3.1.15 Executive Orders (EO) 11988, "Floodplain Management" 16
- 3.1.16 Executive Orders (EO) 11990, "Protection of Wetlands" 16

3.2 Current Issues and Actions 17
- 3.2.1 Air Issues and Actions 17
- 3.2.2 NJPDES Surface Water Permit No. NJ0023922 Issues and Actions 18
- 3.2.3 NJPDES Ground-Water Permit No. NJ0086029 Issues and Actions 19
- 3.2.4 Tiger Team and Self-Assessments Issues and Actions 20

3.3 Environmental Permits 20
- 3.3.1 Clean Air Act (CAA) 22
- 3.3.2 Clean Water Act (CWA) 22
- 3.3.3 Resource Conservation and Recovery Act (RCRA) 23
- 3.3.4 Miscellaneous Permits 24

4.0 ENVIRONMENTAL PROGRAM INFORMATION 25

4.1 Summary of Radiological Monitoring Programs 25

4.2 Summary of Non-Radiological Monitoring Program 26

4.3 Environmental Permits 28

4.4 Environmental Impact Statements and Environmental Assessments 28

Page
4.5 Summary of Significant Environmental Activities at PPPL 29
4.5.1 TFTR D-T Monitoring Activities 29
4.5.2 Tritium Purification System 29
4.5.3 Waste Minimization Activities and Pollution Prevention Awareness 29
4.5.4 Hazardous and Radioactive Waste Facilities 30
4.5.5 Storm Water Management 30
4.5.6 Storage Tanks 31
4.5.7 Environmental Training 31

5.0 ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION 32

5.1 Radiological Emissions and Doses 32
5.1.1 Penetrating Radiation 32
5.1.2 Sanitary Sewage 33
5.1.3 Radioactive and Mixed Waste 33
5.1.4 Airborne Emissions 33

5.2 Unplanned Releases 34

5.3 Environmental Monitoring 34
5.3.1 Waterborne Radioactivity 34
5.3.2 Foodstuffs 35
5.3.3 Soil, Grass, and Vegetation 36

6.0 ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION 37

6.1 New Jersey Pollutant Discharge Elimination System (NJPDES) Program 37
6.1.1 Surface and Storm Water 37
6.1.2 Chronic Toxicity Characterization Study 38
6.1.3 Ground Water 38

6.2 Non-Radiological Programs 44
6.2.1 Non-Radiological Emissions Monitoring Programs 44
6.2.2 Continuous Release Reporting 48
6.2.3 Environmental Occurrences 48
6.2.4 SARA Title III Reporting Requirements 49

7.0 GROUNDWATER PROTECTION 50

8.0 QUALITY ASSURANCE 52

9.0 ACKNOWLEDGEMENTS 53

10.0 REFERENCES 54

11.0 TABLES 59

12.0 FIGURES 85

13.0 REPORT DISTRIBUTION LIST 112

List of Acronyms iii

List of Exhibits Contained in Text v

List of Acronyms

AFS	Air Facility Subsystem
AGT	above ground tank
AHC	aromatic hydrocarbons
AIRS	Aerometric Information Retrieval System
ALARA	as low as reasonably achievable
BOD	biological oxygen demand
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAS	Coil Assembly and Storage Building
CASL	Calibration and Service Laboratory
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFCs	chlorofluorocarbons
CFR	Code of Federal Regulations
Ci	Curie
CICADA	Central Instrumentation, Control, and Data Aquisition
cm	centimeter
COD	chemical oxygen demand
CWA	Clean Water Act
CY	calendar year
D	deuterium
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
DEP	Department of Environmental Protection (New Jersey)
DMR	discharge monitoring report
DOE	Department of Energy
DOE-EH	Department of Energy-Environment and Health
DOE-HQ	Department of Energy - Headquarters
DOE-OFE	Department of Energy - Office of Fusion Energy
DOE-PAO	Department of Energy - Princeton Area Office
DSN	discharge serial number
EA	Environmental Assessment
EDE	effective dose equivalent
EM-30	Waste Management - DOE
EM-40	Environmental Restoration - DOE
EML	Environmental Monitoring Laboratory
EO	Executive Order
EPA	Environmental Protection Agency (US)
ER/WM	Environmental Restoration/Waste Management
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health Division
F&EM	Facilities and Environmental Management Division
FCPC	Field Coil Power Conversion Building
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
FSAR	Final Safety Analysis Report
FSCD	Freehold Soil Conservation District (Middlesex and Monmouth Counties)
GBq	Giga Becquerel or 10^9Bq
GP	General Permit (Wetlands)
HMSF	Hazardous Material Storage Facility
HRS	Hazard Ranking System
HT	tritium (elemental)
HTO	tritiated water
HVAC	heating, ventilation, and air-conditioning
ICRF	Ion Cyclotron Radio Frequency
JFC	James Forrestal Campus
km	kilometer
kV	kilovolt (thousand volts)
LEC	liquid effluent collection (tanks)
LEPC	Local Emergency Planning Committee
LLNL	Lawrence Livermore National Laboratory
LOB	Laboratory Office Building
LOI	Letter of Interpretation (Wetlands)
MCHD	Middlesex County Health Department
MeV	million electron volts
MG	Motor Generator
mg/l	milligram per liter
MOU	Memorandum of Understanding

List of Acronyms

mR/h	milliRoentgen per hour
MSDS	Material Safety Data Sheet
msl	mean sea level
mSv	milliSievert
MW	monitoring well
n	neutron
NAAQS	National Ambient Air Quality Standards
NBPC	Neutral Beam Power Conversion Building
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic and Preservation Act
NIST	National Institute of Standards and Technology
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection (prior to 1991 and after July 1994)
NJDEPE	New Jersey Department of Environmental Protection and Energy (1991 to June 1994)
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
nSv	nanoSievert
OH	ohmic heating
P1, P2	piezometer 1 and 2
PBX-M	Princeton Beta Experiment - Modification
PCBs	polychlorinated biphenyls
PCE	perchloroethylene, tetrachloroethene, or tetrachloroethylene
pCi/L	picoCuries per liter
POTWs	publicly owned treatment works
ppb	parts per billion
ppm	part per million
PPPL	Princeton Plasma Physics Laboratory
RAA	Remedial Alternative Assessment
RACT	*reasonably achieveable 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
SAD	Safety Assessment Document
SARA	Superfund Amendments and Reauthorization Act of 1986
SBRSA	Stony Brook Regional Sewerage Authority
SDWA	Safe Drinking Water Act
SPCC	Spill Prevention Control and Countermeasure
SNAP	significant new alternatives policy
S&R	shutdown and removal (TFTR)
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
TR	trailer atmospheric monitors
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
UST	underground storage tanks
VOC	volatile organic compounds
χ/Q	atmospheric dilution factor (NOAA)
µg/l	micrograms per liter
µSv	microSievert

List of Exhibits Contained in the Text

Exhibit #	Title	Page
2-1	TFTR Neutron Production 1987-1994	4
2-2	Critical Pathways	5
2-3	Radiation Monitoring Program Covering Critical Pathways	6
3-1	1994 Release Reports	11
3-2	Hazard Class of Chemicals at PPPL	13
3-3	PPPL Environmental Permits	21
4-1	Radiological Air Monitoring Stations	25
4-2	Radiological and Non-Radiological Water Monitoring Stations	25
4-3	NJPDES NJ0086029 - Ground Water Discharge Standards and Monitoring Requirements for Ground Water Monitoring Wells	27
4-4	Proposed Soil Sampling for Site Investigation	28
6-1	Summary of 1990 Soil Gas Survey Results	39
6-2	Correlation between the Soil Gas Survey and Groundwater Data—Areas 1-5	40

NOTE: All exhibits contained in the text (except Exhibits 2-1 and 6-2) are text tables; all data tables are located in Section 11.0 beginning on page 59.

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1.0 EXECUTIVE SUMMARY

During Calendar Year 1994 (CY94), the Princeton Plasma Physics Laboratory's (PPPL) Tokamak Fusion Test Reactor (TFTR) set a world record of approximately 10.7 million watts of controlled fusion power, during the deuterium-tritium (D-T) plasma experiment on November 2, 1994. This record surpassed the goal of 10 million watts set for the TFTR project, and it represents another step forward to the reality of a commercial fusion reactor in the twenty-first century. For twenty-one years—since December 1973, when the goal of D-T experiments was presented to the Energy Research and Development Administration (ERDA-the predecessor of the Department of Energy or DOE)—PPPL has planned and designed, constructed, operated, and maintained TFTR culminating in the success of the D-T experiments. Experiments were conducted throughout 1994, with a previous record of 9.3 million watts of power set in May.

In 1994, PPPL designed and installed a closed-loop system for purifying and reusing tritium in the TFTR. The system called the Tritium Purification System or TPS is designed to remove tritium from the exhaust gases collected from TFTR. Using a pretreatment separation and cryogenic distillation process in the TPS, the tritium is separated from the other exhaust gases including other hydrogen isotopes. The recovered tritium can then be reused in combination with deuterium as fuel in the reactor for conducting the D-T experiments.

In CY94, PPPL's radiological monitoring program continued on-site and off-site air monitoring, and surface water, soil, and biota analyses for measuring radioactive baselines. Passive tritium air monitors were used in the four on-site area monitors, one stack monitor, and at off-site monitor locations. Six off-site locations within 1 km of TFTR have differential atmospheric tritium samplers (DATS), which are high sensitivity monitors that are able to detect changes in the ambient levels of tritium. A tritium stack monitor was in operation in the TFTR stack as required by National Emission Standard for Hazardous Air Pollutants (NESHAPs) regulations, with limits set by the U.S. Environmental Protection Agency.

The results of the radiological monitoring program for 1994 were: 1) Radiation exposure, via airborne and sanitary sewer effluents, have been measured at low levels; 2) The total maximum off-site dose from all sources—airborne, sanitary sewerage, and direct radiation—resulted in a total of 0.30 mrem/year at the site boundary, which is a fraction of the 10 mrem/year TFTR design objective and the 100 mrem/year DOE limit; and 3) The total airborne exposure at the nearest business is 0.064 mrem/year, which is well below the 10 mrem/year NESHAPs limit (see Table 2).

In 1993, the Environmental Assessment (EA) for Shutdown and Removal (S&R) activities of the Tokamak Fusion Test Reactor (TFTR) and the operation of the Tokamak Physics Experiment (TPX) was submitted to DOE for its review. Following the incorporation of comments on the EA received from DOE Headquarters, the document was submitted to the NJ Department of Environmental Protection (NJDEP) for its review in March 1994. A Finding of No Significant Impact (FONSI) for this Environmental Assessment was issued in December 1994.

The renewed New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit, NJ0023922, became effective on March 1, 1994. Two additional discharge locations as identified by Discharge Serial Numbers (DSN) were added: DSN002—a storm water discharge for the west side of C site, which does not flow to the detention basin, and DSN003—a filter back wash discharge from the Delaware & Raritan Canal pump house. Also, PPPL is required to conduct chronic toxicity testing for DSN001, which is the detention basin discharge.

The NJPDES ground-water (GW) permit, NJ0086029, expired on December 31, 1994. PPPL and DOE submitted the renewal application and ground-water quality report to the NJDEP in July 1994. PPPL continued to collect quarterly ground-water samples from seven monitoring wells and twice annual samples from the detection basin inflows. During 1994, PPPL installed the detention basin under-drain system and liner and made modifications to the outfall structure. The draft NJPDES GW permit being prepared by NJDEP reflects these changes to the basin.

PPPL continued its ground-water assessment program on C and D sites of the James Forrestal Campus, which is leased to the Department of Energy (DOE) by Princeton University. Since 1989, ground-water data has revealed contamination of low levels of volatile organic compounds (most probably from solvents) in three locations on-site. In February 1993, NJDEP Bureau of State Case Management's memorandum of understanding (MOU), *i.e.*, a voluntary agreement, was signed by Princeton University. The MOU obligates the University to investigate the James Forrestal Campus; PPPL and DOE prepared a work plan for a remedial investigation and remedial alternative assessment for C and D sites, which was submitted to NJDEP for its approval. In 1994, NJDEP began its review of the work plan, which included ground-water sampling, soil sampling, and water quality analyses for PPPL's ground-water sumps.

In 1994, PPPL completed the installation of six above-ground storage tanks: (1) gasoline, (4) diesel fuel, and (1) emergency holding tank. These above-ground storage tanks replaced six underground storage tanks, which were emptied and removed according to the NJDEP-approved plans.

PPPL has emphasized environment, safety, and health (ES&H) in accordance with DOE requirements at the facility. The expectations are that the Laboratory will excel in ES&H as it has demonstrated in its fusion research program. The efforts are geared not only to fully comply with applicable local, state, and federal regulations, but also to achieve a level of excellence that includes state-of-the-art monitoring and best management practices, as well as an institution that serves other research facilities with invaluable information gathered from such a unique program as fusion.

2.0 INTRODUCTION

2.1 General

This report gives the results of the environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for CY94. 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, as well as environmental initiatives, assessments, and programs that were undertaken in 1994. The objective of the Annual Site Environmental Report is to document evidence that PPPL's environmental protection programs adequately protect the environment and the public health.

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 develop and demonstrate the practical application of fusion power as an alternate energy source. In 1994, PPPL had one of its two large tokamak devices in operation—the Tokamak Fusion Test Reactor (TFTR). The Princeton Beta Experiment-Modification or PBX-M completed its modifications and upgrades and resumed operation in November 1991 and operated periodically during 1992 and 1993; it did not operate in 1994 for funding reasons (Fig. 1).

In December 1993, TFTR began conducting the deuterium-tritium (D-T) experiments and set new records by producing over ten million watts of energy in 1994. The engineering design phase of the Tokamak Physics Experiment (TPX), which replaced the cancelled Burning Plasma Experiment in 1992 as PPPL's next machine, began in 1993 with the planned start up set for the year 2001. In December 1994, the Environmental Assessment (EA) for the TFTR Shutdown and Removal (S&R) and TPX was submitted to the regulatory agencies, and a finding of no significant impact (FONSI) was issued by DOE for these projects.

The TFTR is a toroidal magnetic fusion energy research device in which a deuterium-tritium (D-T) plasma is magnetically confined and heated to extremely high temperatures by neutral-beam injectors and radio-frequency waves (Fig. 2). TFTR began its first full year of operation in CY83. During an eight-year period of deuterium-deuterium (D-D) operations, TFTR produced its greatest number of D-D neutrons in 1990 (Exhibit 2-1). The highest, total, number of neutrons produced in one year occurred in 1994 with 1.98×10^{20} neutrons produced from D-D and D-T operations. Neutron generation is an actual measurement based on data from neutron detectors.

Exhibit 2-1

TFTR Neutron Production 1987-1994

Year	Total Neutron Production
1987	3×10^{18}
1988	9.04×10^{18}
1989	6.4×10^{18}
1990	2.3×10^{19}
1991	1.56×10^{18}
1992	1.53×10^{19}
1993 (D-D)	7.2×10^{18}
1993 (D-T)	1.65×10^{19}
1994 (D-D)	1.3×10^{19}
1994 (D-T)	1.85×10^{20}

The D site is entirely fenced with controls that do not allow free access to the TFTR. As an unfenced site with access controls for security reasons, PPPL openly operates C site, allowing the public access for educational purposes. This free access of C site warranted a thorough evaluation of the on-site discharges, as well as the potential for off-site releases of radioactive and toxic non-radioactive effluents. An extensive monitoring program, which is tailored to these needs, was instituted and 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].

In the environmental monitoring program document is the requirement for adherence to the standards given in DOE Orders, in particular, DOE Order 5400.5, "Radiation Protection of the Public and the Environment" [DOE93a], which pertains to permissible dose equivalents and concentration guides and gives guidance on maintaining exposures "to as low as reasonably achievable" (ALARA). On December 14, 1993, 10 CFR 835, became effective and replaced DOE Order 5480.11, "Radiation Protection for Occupational Workers," guidelines for DOE nuclear facilities [DOE89]. While this regulation did not have a major impact on PPPL operations, the regulation did incorporate some changes in personnel monitoring requirements. Specific criteria for implementing the requirements on TFTR are contained in the TFTR Technical Safety Requirements document (OPR-R-23). These criteria are shown in Table 1.

The emphasis of the radiation monitoring program was placed on exposure pathways appropriate to fusion energy projects at PPPL. These pathways include external exposure from direct penetrating radiation. During D-T, external exposure from airborne radionuclides, such as ^{41}argon (^{41}Ar),

^{13}nitrogen (^{13}N), ^{16}nitrogen (^{16}N), and internal exposure from radionuclides, such as tritium (^{3}H) in air and water, are being monitored. Six major critical pathways are considered as appropriate (see Exhibit 2-2). Prompt radiation, that which is emitted immediately during operations, was also considered and is measured. The radiation monitoring program, as envisioned by the TFTR Final Safety Analysis Report [FSAR82], was updated to reflect the current environment around TFTR (see Exhibit 2-3). A tritium monitor was installed on the TFTR stack in late 1990. About 138.68 Ci (5.1 TBq) of tritium, as measured by the stack air monitor, were released from the stack in 1994.

Exhibit 2-2. Critical Pathways
Discharge Pathway

Path I.D.		
A1	Atmospheric --->	Whole Body Exposure
A2	Atmospheric --->	Inhalation Exposure
A3	Atmospheric --->	Deposition on Soil & Vegetation, Ingestion, Whole Body Exposure
L1	Liquid Water Way --->	Drinking Water Supply --> Man
L2	Liquid Water Way --->	External Exposure
L3	Liquid Water Way --->	Fish ---> Man

Preliminary meteorological data and its associated methodology were reported in Section 2 of the 1982 TFTR FSAR. Subsequently, improved methodologies were implemented. A new meteorological tower was erected and began operation in November 1983 (see Figs. 13, 15, 17, and 19 for comparison 1984 *versus* 1994 data) [Mc83, Ku95]. The improved measurements and methodologies are included in the updated FSAR prepared for deuterium-tritium operations. Data were collected for twelve months (1994) using the monitors on the tower (Figs. 12, 14, 16, and 18). Wind-rose plots from the data for the ten years (1984-94) are shown in Figs. 6-11.

A tracer gas-release test was conducted during the period from July to September 1988 to look at site-specific air-diffusion parameters. These tests were commissioned to determine actual site conditions *versus* model predictions in relation to future activities. The test results indicated that actual dispersion and dilution of effluents in the vicinity of PPPL are enhanced by up to a factor of 16 over that predicted by Nuclear Regulatory Commission approved standard Gaussian diffusion models [St89]. Additionally, as a result of these tracer gas-release tests, a 10-m wind speed and wind-direction sensor was added to the meteorological tower in 1990 to monitor PPPL on-site meteorology more precisely. The U.S. Environmental Protection Agency (EPA) was petitioned through the Princeton Area Office (DOE-PAO) to use the more realistic χ/Q values from these tests in the AIRDOS-EPA model used for the National Emission Standards for Hazardous Air Pollutants (NESHAPs) calculations. Approval was received in 1991.

Exhibit 2-3. Radiation Monitoring Program Covering Critical Pathways

Type of Sample	Critical Path I.D.	Sample Point Description	Sampling Frequency	Analysis
Surface	L1,L2,L3 & A3	1) Cooling Water Discharge Drainage 2) Bee Brook Upstream & Downstream 3) D&R Canal	Monthly	Tritium and Gamma Spectroscopy
Soil & Sod	A3	Within 1 km radius		Tritium and Gamma Spectroscopy
Biota (Fruits & Vegetables)	A3	Within 3 km radius	Seasonal	Tritium & Gamma Spectroscopy
Surface Water	L1, L2	Liquid Effluent Collection Tanks	As Required by Rate of Filling	Tritium and Gamma Spectroscopy, Volume
Air	A1-A3	Test Cell	Continuous	Activated Air (Gross b) ^3H (HT and HTO)
Air	A1-A3	Vault	Continuous	^3H (HT and HTO)
Air	A1-A3	HVAC Discharge (Stack)	Continuous	Activated Air (Gross b) HT and HTO, Particulates, Volume
Direct & Air (on-site)		4 Locations at TFTR Facility Boundary	Continuous	g, n, ^3H (HT and HTO), Gross b for activated air
Direct & Air (off-site)		6 Locations off-site within 1 km radius	Continuous (integrated)	^3H (HT and HTO)

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

The DOE Order 5400.1, "General Environmental Protection Program" [DOE90], requires PPPL to have an environmental monitoring plan that contains meteorological, air, water, ground water, and radiological plans [PPPL92]. This environmental monitoring plan was completed in CY91, with revisions made in CY92, and further revisions prepared in 1994.

2.2 Description of the Site

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. As shown in Fig. 3, the site is in central New Jersey within Middlesex County, with the municipalities of Princeton, Plainsboro, 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.

The PPPL is located on the C and D sites of the James Forrestal Research Campus of Princeton University (Fig. 4). The site is surrounded by undisturbed areas with upland forest, wetlands, and a minor stream (Bee Brook) flowing along its eastern boundary and by open, grassy areas and cultivated fields on the west. The general layout of the facilities at the C and D sites of Forrestal Campus is shown in Fig. 5; the specific location of TFTR is at D site.

A demographic study was completed in CY87 as part of the requirement for the Environmental Assessment for the former Burning Plasma Experiment (BPX) [Be87a]. Other information gathered and updated from previous TFTR studies included socioeconomic information [Be87b] and an ecological survey [En87].

3.0 1994 COMPLIANCE SUMMARY

3.1 Environmental Compliance

The Princeton Plasma Physics Laboratory's (PPPL) goal is to be in compliance with all applicable state, federal, and local environmental regulations. As a result of PPPL's self-assessments, DOE Chicago Operations Office appraisals, and DOE-HQ Tiger Team action plans, PPPL continues actions to enhance its compliance efforts and to fully document how PPPL is meeting the requirements. The compliance status of each applicable federal environmental statute is listed below:

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

The PPPL is not involved with CERCLA-mandated cleanup actions. As a result of the 1991 DOE-HQ Tiger Team assessment, an action plan was developed to conduct a more comprehensive documentation for CERCLA inventory of past hazardous substances. The CERCLA inventory was completed in 1993 [Dy93].

3.1.2 Resource Conservation and Recovery Act (RCRA)

The Laboratory is in compliance with all terms and conditions required of a hazardous waste generator. In 1994, PPPL shipped off site approximately 185 tons of waste to facilities permitted to treat, store, or dispose of hazardous wastes. The five largest sources of waste generated at PPPL were 1) New Jersey-regulated, oil-contaminated soil from the removal of five underground storage tanks, 2) purge water collected from ground water monitoring wells (above the New Jersey Groundwater Quality Standards—mainly for volatile organic compounds), 3) New Jersey-regulated, oil spill cleanup materials, 4) non-RCRA, New Jersey-regulated (manifested and handled within strict regulations) waste oil, and 5) batteries containing acid (hazardous under RCRA), which were sent to a recycler [PPPL95b].

PPPL is also in compliance with the requirements of the RCRA-mandated Underground Storage Tank Program (also see 3.1.6 and 3.3.3). Following 40 CFR 280 and New Jersey regulations, PPPL removed five underground storage tanks in 1994, and in January 1995, removed from service one tank, which was then abandoned in-place in accordance with the New Jersey Underground Storage Tank regulations. The diesel fuel tank for the D site emergency generator was filled with an inert material rather than removed, because it is located immediately adjacent to a high-voltage transformer yard. There are buried high-voltage lines in this area; however, no drawings exist, which accurately locate the lines. These underground storage tanks were replaced by six above-ground tanks. As directed by the the NJ Department of Environmental Protection (NJDEP)[1] State Case Manager, PPPL will submit the completed Site Assessment reports as part of the Remedial Investigation and Remedial Alternative Assessment Study in 1995.

3.1.3 National Environmental Policy Act (NEPA)

In August 1993, PPPL submitted to DOE for their review the Environmental Assessment (EA) for shutdown and removal (S&R) of the Tokamak Fusion Test Reactor (TFTR) and the operation of the Tokamak Physics Experiment (TPX). Comments on the Environmental Assessment were received from DOE Headquarters in December 1993, and changes were incorporated into the EA. The EA was submitted to the NJDEP for their review in March 1994. A Preliminary Finding of No Significant Impact (PFONSI) was issued by DOE in October 1994. In October 1994, a public meeting was held at PPPL. The DOE issued a Finding of No Significant Impact (FONSI) for this Environmental Assessment in December 1994.

Approximately 100 PPPL activities received NEPA reviews in 1994, with most 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 the TFTR Environmental Assessment, which was issued a Finding of No Significant Impact (FONSI) on January 17, 1992.

3.1.4 Clean Air Act (CAA)

The PPPL was in compliance with the requirements of the CAA in 1994. In April 1994, the 1993 Air Emission Survey was submitted to NJDEP who in turn submits the survey to the US Environmental Protection Agency (USEPA). The data are incorporated into a national database, the Aerometric Information Retrieval System (AIRS), and Air Facility Subsystem (AFS) where it becomes public information.

As a result of a self-assessment by PPPL, the DOE Tiger Team assessment findings, and the Clean Air Act Amendments (CAAA) of 1990, preparation of a detailed air emission inventory was completed in May 1994. The purpose of the inventory was to estimate significant air emissions from each source so that a manageable air emission control program could be established. The inventory includes air emission quantities, point and fugitive emission sources, air-emission producing activities, and permit applicability. The air emission inventory is updated on an annual basis and is currently under revision to reflect the NJDEP PPPL 1994 Air Emission Statement.

On September 27, 1993, PPPL and DOE/PAO submitted to the NJDEP permit applications for two above-ground storage tank vents. On October 25, 1993, NJDEP granted permission to construct, install, or alter control apparatus of equipment for the 25,000 gallon and 15,000 gallon above-ground tank vents. The air certificate to operate the 15,000 gallon tank was issued by NJDEP and received by DOE in March 1994. The air certificate for the 25,000 gallon above-ground storage tank was received in February 1995.

Currently, PPPL complies with the Stratospheric Ozone Protection Program of the Clean Air Act. More specifically, PPPL currently complies with Section 608 of the Act, which prohibits the venting of ozone-depleting substances through the use of certified refrigerant recovery units. In addition, PPPL safely disposes of equipment containing ozone-depleting substances by removing the refrigerant to specified levels before disposal of the equipment (see Section 3.1.6 for the description of an accidental release of Dichlorodifluoromethane, Freon® 12, or CFC 12). As required, PPPL and the DOE notified the USEPA in August 1993 and January 1994, that PPPL possesses and uses certified recovery equipment that meets the standards of the recovery equipment for disposal of small appliances. The 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.

3.1.5 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

The PPPL added a stack sampler to the Tokamak Fusion Test Reactor (TFTR) facility for tritium releases, which 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. Levels of tritium released during TFTR deuterium-tritium (D-T) operations were measured: 45.55 curies of tritiated water or HTO and 93.13 curies of elemental tritium or HT [Ja95]. In 1994 the effective dose equivalent to a person at the business nearest PPPL, due to radionuclide air emissions, was 0.064 mrem, much lower than the NESHAPs standard of 10 mrem/yr (Table 2). During their inspection of PPPL facilities in May 1994, representatives from USEPA Region II indicated that PPPL was in compliance with NESHAPs requirements.

3.1.6 Clean Water Act (CWA)

The PPPL is in compliance 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 reports for petroleum hydrocarbons (quarterly) and volatile organic compounds (annually) are submitted to NJDEP (see Section 6.1.3 C).

Under the CWA and "New Jersey Discharge of Petroleum and Hazardous Substances" regulation (New Jersey Administrative Code Title 7, Chapter 1E), PPPL reported five releases of petroleum,

petroleum products, or hazardous substances to the NJDEP in CY 1994. Of these five releases, four releases impacted permeable surfaces (gravel and soil) and involved minor amounts of petroleum products or hazardous substances; two gasoline spills (1 and 3 gallons), suspected hydraulic oil (algal film on detention basin), and diesel fuel oil from underground storage tanks (discovered during removal of tanks) (see Exhibit 3-1).

The fifth release was a discharge of Freon® 12 or dichlorodifluoromethane to the atmosphere. It is estimated that 1600 pounds of Freon® 12 from one chiller reservoir were released to the interior of the boiler room on C site and eventually to the ambient air outside the building. In addition to notifying the NJDEP Bureau of Discharge Prevention, the NJDEP Air Enforcement Program—Central Regional Office was also notified of the discharge.

Exhibit 3-1. 1994 Release Reports

NJDEP CASE #	PPPL #	TITLE	TYPE of RELEASE
94-4-2-1458-18	ER94-01	Freon® 12 Discharge	1600 pounds of Freon® 12 released to the atmosphere
94-5-26-0833-10	ER94-02	Vehicle Gasoline Leak	3 gallons of gasoline released to gravel and soil
94-6-8-1837-55	ER94-03	Suspected Oil in Basin Incident	Suspected release of hydraulic oil to basin. No oil was actually released.
94-9-13-1439-20	ER94-04	Employee Vehicle Gasoline Leak	1 gallon of gasoline released to gravel and soil
94-10-18-1445-41	ER94-05	#2 Diesel Fuel Detected in Soil During UST Excavation	80 ppm of petroleum hydrocarbons detected in soil located at bottom of excavated 1,000 gallon E5 underground storage tank

3.1.7 National Pollutant Discharge Elimination System (NPDES)

Early in 1994, PPPL operated under the conditions of an expired New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit (NJ0023922). The NJDEP issued the renewed surface water permit on January 21, 1994, effective date of March 1, 1994 [NJDEP94]. The NJPDES surface water permit will expire on February 28, 1999.

Following the issuance of storm water regulations in 1991, PPPL and DOE/PAO requested NJDEP to review the site's storm water runoff (DSN002) that does not drain to the detention basin. Identified as action of the 1991 DOE Tiger Team assessment, PPPL and DOE/PAO asked NJDEP about the filter backwash discharge (DSN003) at the Delaware & Raritan Canal pump house as a possible new discharge point. As a result of these inquiries, NJDEP directed DOE/PAO to submit a

NJPDES application for these discharge points. In March 1992, the application was submitted. These two locations were incorporated in the renewed permit, effective March 1, 1994, and designated as monthly sampling points.

The PPPL completed the identification of wastewater streams into the Stony Brook Regional Sewerage Authority (SBRSA) system. A site sanitary survey was completed in 1993 and updated in 1995. It is estimated that approximately 3 percent of the combined sewerage flow from PPPL is classified as industrial wastewater and 97 percent as domestic wastewater. In December 1993, SBRSA issued a draft industrial discharge permit to PPPL, for which PPPL and DOE/PAO submitted comments. In February 1995, SBRSA issued a revised final permit requiring sampling of only the liquid effluent collection (LEC) tank discharge. Following discussions with SBRSA, PPPL and DOE/PAO agreed to report LEC tank data to SBRSA on a monthly (tritium, pH, and temperature) and annual frequency.

Once in 1994 and twice in 1995, PPPL split samples with SBRSA for the analysis of the parameters listed in the draft permit. Monthly measurements for tritium, pH, and temperature are required; annual measurements are required for a longer list of parameters (see Table 29).

3.1.8 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 tests incoming water. In addition, periodic testing for potential problems within the on-site drinking water distribution system is undertaken. In 1994, PPPL installed a new backflow prevention system beneath the elevated water tower. In the event of a fire, PPPL can switch from the Delaware & Raritan Canal water (nonpotable) to potable water for its fire lines.

On a quarterly frequency, PPPL inspects and pressure tests the back flow prevention equipment at both locations: the main potable water connection and the new system beneath the elevated water tower. The back flow prevention equipment prevents contamination of the potable water supply *via* a large cross-connection. In the presence of a representative from the Middlesex County Health Department (MCHD), the systems are inspected each quarter at the point where Elizabethtown Water enters C site (main connection) and beneath the water tower. On an annual basis, these systems are totally disassembled, inspected, and tested in the presence of both MCHD and the Elizabethtown Water Company representatives. In order to maintain an uncontaminated potable water supply, other cross-connection equipment is tested annually.

3.1.9 Superfund Amendments and Reauthorization Act (SARA) Title III.

A. SARA Title III

Presently, under the requirements for SARA Title III, PPPL submits an annual inventory to be in compliance with CERCLA. This inventory reports the quantities of chemicals listed on the CERCLA regulations that are stored on site. Emergency Planning and Community Right to Know Act, Title III of the 1986 SARA amendments to CERCLA created a system for planning responses to emergency situations involving hazardous materials and for providing information to the public regarding the use and storage of hazardous materials. Under SARA Title III, PPPL provides to the applicable emergency response agencies: 1) an inventory of hazardous substances stored on the site; 2) Materials 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) to applicable emergency response agencies. Exhibit 3-2 lists hazardous compounds at PPPL, reported under SARA Title III for 1994 [PPPL1995a].

Exhibit 3-2. Hazard Class of Chemicals at PPPL

Compound	Fire	Sudden Release of Pressure	Reactive	Acute Health Hazard	Chronic Health Hazard
Bromotrifluoromethane		✔		✔	
Carbon dioxide		✔		✔	
Chlorodifluoromethane		✔		✔	
Dichlorodifluoromethane (CFC 12)		✔		✔	
Fuel Oil	✔				
Gasoline	✔				✔
Helium		✔			
Nitrogen		✔			
Petroleum Oil	✔				
Polychlorinated Biphenyls					✔
Sulfur Hexafluoride		✔			
Sulfuric acid			✔	✔	
Trichlorotrifluoroethane (CFC 113)				✔	

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.

The NJDEP administers the SARA Title III reporting for USEPA and has modified the Tier I form to include SARA Title III reporting requirements and NJDEP reporting requirements.

Because PPPL's use of chemicals listed on the Toxic Release Inventory (TRI) is below the threshold amounts, PPPL is technically not required to submit the TRI. Following DOE's guidance issued in 1994, PPPL completed the TRI cover page and laboratory exemption report and submitted these documents to DOE.

B. Federal Agency Hazardous Waste Compliance Docket

In the February 5, 1993, *Federal Register* [FR93], the U.S. Environmental Protection Agency (USEPA) published its new and/or revised list of facilities on the Federal Agency Hazardous Waste Compliance Docket. Princeton Plasma Physics Laboratory (PPPL) was listed on the docket for the first time, due to its being a hazardous waste generator and because all federal facilities must be listed. A meeting between DOE and USEPA Region II in March 1993 resulted in the DOE's submission of additional sampling data and pertinent information about PPPL [DOE93c]. In a letter to DOE, USEPA stated "...that as a docket facility, your site must be evaluated by USEPA for the National Priorities List (NPL) utilizing the Hazard Ranking System (HRS)" [EPA93]. Since that time, DOE and PPPL has received from USEPA no further requirements or requests for additional information.

3.1.10 Toxic Substance Control Act (TSCA)

The PPPL is in compliance 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 be implemented. The last PPPL polychlorinated biphenyls (PCBs) transformers were removed from the site in 1990. At the end of 1994, there were 653 PCB capacitors, which meet the regulation criteria, remaining on-site. These capacitors are located in buildings with concrete floors and are protected from the weather, and of the 653 capacitors, 640 capacitors also have secondary containment. There are no plans at this time to remove and/or replace these capacitors.

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

Application of herbicides, pesticides, and fertilizers is performed by certified subcontractors who meet all the requirements of FIFRA. The PPPL Facilities and Environmental Management Division (F&EM) monitors this subcontract (see Table 17).

3.1.12 Endangered Species Act (ESA)

The PPPL occupies 72 acres of the Forrestal Campus of Princeton University. In the 1975 "Final Environmental Statement for the Tokamak Fusion Test Reactor Facilities," the approved

"Environmental Assessment (EA) for the TFTR Deuterium-Tritium (D-T) Modifications," and the approved "TFTR Decommissioning and Decontamination (D&D) and Tokamak Physics Experiment (TPX) Environmental Assessment" have indicated that there are no endangered species on-site. [ERDA75] [DOE92] [DOE93b]

In the fourth quarter of 1992 and in the first quarter of 1993, the NJDEP, Division of Parks and Forestry, Natural Heritage Data Base [Dy93], reported that there are no records for rare plants, animals, or natural communities on the PPPL site. There are records for a number of occurrences of rare species that may be on or near waterways surrounding the site. As the Natural Heritage data is based on a literature search and on individuals' observations of endangered species in the vicinity of PPPL and is not based on site-specific surveys and/or observations, the data obtained from this database are not considered definitive. Should PPPL plan any "major construction activity," prior to the start of the activity, a survey will be conducted as part of a NEPA document, if required.

3.1.13 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].

3.1.14 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 [PPPL95c]. In early 1995, PPPL prepared its "Proposed Site Treatment Plan (PSTP) for Princeton Plasma Physics Laboratory (PPPL)."

PPPL has 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 the original accumulation containers, PPPL would notify the regulators and provide them with a revised "Site Treatment Plan" [PPPL95c].

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

The PPPL is in compliance with the EO 11988, "Floodplain Management." As a result of the Tiger Team assessment, it was suggested that the PPPL Hazardous Materials Storage Facility (HMSF) may be within the 500-year floodplain and therefore, unprotected from a 500-year storm event. Having received NJDEP and NEPA approvals, the construction of structures to protect the facility against a 500-year flood began in the spring of 1994. The upgrades to the HMSF were completed in late 1994.

Delineation of the 500-year floodplain and the 100-year floodplain was completed in February 1994. The 500-year and the 100-year flood plains are located at the 85-foot elevation and at the 80-foot elevation above mean sea level, respectively [NJDEP84] (see Fig. 42).

A Stream Encroachment Permit application is required for construction within the flood hazard area and the 100-year floodplain as regulated in NJAC 7:13 *et seq.* An application was filed with the NJDEP in August 1992 for the detention basin upgrade project, specifically, for the modifications to the discharge area. The permit was approved and became effective in November 1992 and remains in effect until November 23, 1997. The detention basin upgrade project, which includes the replacement of an existing headwall for the discharge of the detention basin, began in August 1994, and is expected to be completed in 1995.

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

The PPPL is in compliance with the EO 11990, "Protection of Wetlands." Formal study and delineation of the wetland boundaries within the PPPL 72-acre site are complete. Using infrared film for aerial photographs, the presence of wetland-type vegetation was found on the north and eastern boundaries of the Laboratory property. In July 1993, an "Application for a Letter of Interpretation" (LOI) for the entire 72-acre site was filed with the NJDEP Land Use Regulation Program. The LOI application included: US Geological Survey (USGS) topographic maps, National Wetlands Inventory maps, US Department of Agriculture (USDA) Soil Conservation maps, aerial photographs, and vegetation maps. These maps were used to prepare the delineation program and the target critical areas.

The wetland boundaries were flagged based on an analysis of the soil type, vegetation identification, and area hydrology, *i.e.*, depth to ground water. Soil profiles to determine soil type were conducted through soil borings, which were also analyzed for indications of seasonal high water table. A wetlands delineation map that indicated the boundary, sequential flag numbers, and soil boring locations was prepared (see Fig. 42).

On December 2, 1993, NJDEP conducted an on-site inspection to verify the wetlands boundaries, which were proposed in the LOI application. In a letter dated January 13, 1994, PPPL and DOE/PAO received formal notification from NJDEP that the wetlands boundary lines were determined to be accurate as shown in the LOI wetlands delineation plan. In addition, the NJDEP determined that the wetlands on the PPPL site are of "intermediate resource value" and that the standard transition area of buffer zone required to be adjacent to the wetlands is 50 feet. The exception to the 50-foot transition area and "intermediate resource value" determination is the area of C site to the west and southwest—the swales that convey storm water to the wetlands south of C site. These areas are classified as wetlands of "ordinary resource value," which have no transition area requirement, *i.e.*, there is no 50-foot transition area required next to the wetlands boundary.

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 US Army Corps of Engineers retains the right to re-evaluate and modify the wetlands boundary determinations at any time.

In September 1993, PPPL prepared applications for Statewide General Freshwater Wetlands Permits (GP 1 and 7) and a Transition Area Waiver application for the fire protection improvements to the Hazardous Materials Storage Facility (HMSF), the HMSF upgrade, and 26 kV line equipment and property maintenance projects. The applications were submitted to NJDEP on January 31, 1994. Approval of the applications by the NJDEP was received during the second quarter of CY94. The fire protection improvements and HMSF modifications were completed in 1994.

3.2 Current Issues and Actions

3.2.1 Air Issues and Actions

During a NJDEP inspection, the boiler room located in the Facility & Environmental Management (F&EM) Division building was visited. Originally, the #2, #4, and #5 boilers were designed to burn fuel oil only. In the 1980's, when natural gas became more readily and economically available, #2, #4, and #5 boilers were modified to be both oil and gas-fired. As a result of that inspection, on January 12, 1994, NJDEP issued PPPL and DOE/PAO a Notice of Violation (NOV) and a fine of $1200 for not applying for permits to change the equipment on two oil-fired boilers (Boilers #4 and #5). Although burning natural gas produces less air pollutants than burning fuel oil, the $1200 fine, which PPPL paid, was an administrative penaly and not a fine for environmental harm.

Permit amendments are a requirement for the installation of new equipment, which enable the boilers to burn both fuel oil and natural gas. Amendments for boilers #2, #4, and #5 were prepared and submitted to NJDEP; permits were revised and re-issued. In September 1994, PPPL and DOE/PAO applied to NJDEP for proposed changes to Boiler #3—installation of equipment to burn both #4 fuel oil and natural gas. The permit was issued, and the modifications were completed in November 1994.

Several small, fundamental projects at PPPL that capture the intent of Section 612, "Significant New Alternatives Policy Program (SNAP)," are underway. Alternative refrigerants and possible retrofits for large equipment that use ozone-depleting substances are being explored. Proposed activities are planned to be part of PPPL's Waste Minimization and Pollution Prevention program. PPPL is continuing to examine substitute degreasing compounds.

The proposed operating permit program regulations, which were published on September 7, 1993, will become effective in 1995. Due to PPPL's potential to emit 25 tons of nitrogen oxides (NO_X), these regulations may be applicable. Because of the onerous requirements of the proposed operating permit regulations, PPPL is re-examining its applicability to the Operating Permit Program and the Emission Statement regulations. Under the operating permit, fugitive emissions, and point source emissions are reported to the NJDEP through the emission statement reporting requirements. These emission types include volatile organic compounds, carbon monoxide, sulfur dioxide, and lead compounds. When the final regulations are promulgated, PPPL will be required to submit an operating permit application to the NJDEP, and to the USEPA 30 days after the permit is considered administratively complete.

3.2.2 NJPDES Surface Water Permit No. NJ0023922 Issues and Actions

During CY1994, no non-compliances were reported for any parameter measured at DSN001 (D2) and at DSN003 (Delaware & Raritan Canal pump house filter backwash) (see Tables 15 and 16). At DSN002, which is located at the southwestern boundary of C site, three total suspended solid (TSS) exceedances were reported for this stormwater discharge point for the July, August, and Setpember 1994 samples. These exceedances were attributed to natural sediments in the ditch and not to PPPL activities or soil disturbances. The PPPL and DOE/PAO submitted a request to NJDEP for modifications to the permit addressing this issue. As of March 1995, NJDEP is in the process of drafting these modifications to the NJPDES permit.

During the NJDEP's review of the TFTR deuterium-tritium (D-T) Environmental Assessment (EA), an issue regarding the elevated temperature in Bee Brook at location B2 was raised. The New Jersey Surface Water Quality Standards limit the temperature of the discharged water to a maximum increase of 2.8°C (5.0°F) above ambient water temperature at any time. It has been noted that there are times in the winter when the delta t (Δt or the difference in temperature between the discharged and surface waters) was greater than the 2.8°C limit. The PPPL suspected the higher temperature was caused by the ground water pumped to dewater various building foundations. The temperature of groundwater measures a near constant 12.8° C (55°F) all year round, while in the winter the surface water temperatures drop to as low as 0°C (32°F). At present, the estimated amount of groundwater pumped to dewater the TFTR and D site MG buildings is about 80,000 gallons per day.

A consultant's study, conducted during the winter of 1993-4, concluded that the cause of the temperature exceedances was the amount and temperature of the groundwater entering the detention basin. To reduce the water temperature, the consultant's recommendation was to operate the basin in the flow-through mode; it was believed that an increase in the retention time would provide increased heat dissipation and thus decrease the water temperature prior to its release [AAC94b]. To determine the effectiveness of the flow-through operation of the basin, PPPL is monitoring the temperature of the detention basin and Bee Brook. Initial measurements show that the increased retention time does not result in a sufficient decrease in the water temperature.

3.2.3 NJPDES Ground-Water Permit No. NJ0086029 Issues and Actions

In 1989, PPPL and DOE/PAO requested an adjudicatory hearing on the requirements of the New Jersey Pollutant Discharge and Elimination System (NJPDES Permit No. NJ0086029) discharge to groundwater permit. The PPPL and DOE/PAO protested the placement of three monitoring wells on A and B sites of the James Forrestal Campus; the basis for the protest was that these locations are not on DOE leased-property, but are on property under Princeton University's control. Despite a pending adjudicatory hearing, the DOE/PAO and PPPL have complied with all permit-mandated activities. These activites included the installation of five ground-water monitoring wells, quarterly sampling of seven wells, twice annual sampling of the basin inflows, and the hydrological study as discussed below.

The ground water discharge permit (NJ0086029) expired on December 31, 1994. The 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 [Fi94c]. In this application, the PPPL and DOE/PAO requested that NJDEP delete from the permit the three off-site wells, for which the adjudicatory hearing was requested. As of March 1995, NJDEP has not issued a new NJPDES ground water permit; PPPL and DOE/PAO continue to comply with the requirements of the expired permit.

One of the requirements of the NJPDES permit was to conduct a site-wide hydrological study. Based on the quarterly ground-water monitoring data and the site-wide hydrological studies (presence of volatile organic compounds in ground water), NJDEP required further investigation of James Forrestal Campus. A Memorandum of Understanding (MOU) was signed by Princeton University in February 1993. Princeton University has responsibility for investigating A/B sites, and PPPL and DOE/PAO have responsibility for C/D sites.

On March 21, 1994, NJDEP, Princeton University, PPPL and DOE/PAO representatives met to discuss the Proposed Work Plan for conducting a Remedial Investigation/ Remedial Alternative Analysis (RI/RAA) at C/D sites. Limited sampling was approved by NJDEP; soil samples in the area of the former sewage treatment sand beds and ground water samples were collected and analyzed during 1994. The revised work plan for the RI/RAA was submitted to NJDEP in September 1994; "conditional approval" was received from NJDEP in January 1995. After NJDEP review and approval of the RI/RAA results, PPPL and DOE/PAO will begin the approved remedial action, if required.

3.2.4 Tiger Team and Self-Assessments Issues and Actions

The PPPL was audited by a DOE Tiger Team between February 11, 1991, and March 12, 1991. During PPPL's own self-assessment performed in late 1990, PPPL had identified over 70 percent of the Tiger Team findings. There were 54 environmental findings, none of which represented situations that presented an immediate risk to public health or to the environment or that warranted an immediate cessation of operations. Of these findings, 38 were related to requirements of DOE Orders, federal or state regulations, or PPPL directives or procedures. Sixteen of the findings were related to best-management practices. In addition, there were 166 safety and health concerns and 26 management concerns. An Action Plan was finalized by PPPL in April 1991 and approved and officially released by DOE/HQ in April 1992. Of the 612 milestones addressing the 300 Tiger Team findings and concerns, 92 percent have been completed as of March 1995.

3.3 Environmental Permits

The PPPL Environment, Nuclear Licensing, and Permitting Division of the Support Services Department maintains a list of Environmental permits (see Exhibit 3-3) which is updated monthly. A discussion of the environmental permits required by the applicable statutes is as follows:

Exhibit 3-3 PPPL Environmental Permits

Permit No.	Permit Type	Issue Date	Expiration Date	Status
0086029	NJPDES Groundwater	4/1/89	**12/31/94**	In compliance. Renewal application submitted to DEP 7/5/94. Sent letter on 2/22/95 on basin liner. Feb 95 sampling completed.
0023922	NJPDES Surface water	1/21/94 Effective 3/01/94	02/28/99	In compliance. Requested permit mod. for DSN002 - stormwater outfall; Jan. 1995 TSS exceedance.
092187	TFTR Diesel Exhaust	10/24/89	10/24/99	Current. NJ Air Plant Id. No. 15952.
096074	C-site Diesel Exhaust	6/28/90	6/28/95	Current. *Renewal in progress.*
094831	Hot Cell Degreaser Vent	3/30/90	6/16/97	Current. *Permit modifications in progress.*
090735	FCPC Building Degreaser Vent	6/6/89	5/31/95	Cancelled.
826	Elizabethtown Water Physical Connection	4/1/93	3/31/95	Current.
148539	UST Registration	4/1/93	3/31/95	*All UST cancelled.*
089962	Diesel Tank E8 Vent	11/22/88	11/22/93	*Cancelled.*
061295	Boiler #2 Stack Vent	3/31/82	*4/23/95*	Current. NJDEP will revise permit for both fuel types 1/95.
061296 *118817*	Boiler #3 Stack Vent Mod. to Boiler #3	3/31/82 10/21/94	1/25/95 1/18/95	Current. Rec'd temporary 90-day permit.
061297	Boiler #4 Stack Vent	3/31/82	*4/23/95*	Current. Rec'd temporary 90-day permit.
061299	Boiler #5 Stack Vent	3/31/82	*4/23/95*	Current. Rec'd temporary 90-day permit.
061298	Oil Storage Tank Vent No. 2	3/31/82	3/31/97	Cancelled.
0128306	Medical Waste Generator	7/22/91	7/21/95	Current.
DR-18A	D&R Canal Water Use Agreement	7/1/84	6/30/2009	Current.
12471	REML Laboratory Certification	7/1/91	6/30/95	Current - Tritium only (*pH, temp., NJDEP audit 3/10/95*)
111580	CAS Dust Collector	3/10/93	3/10/98	Current.
113444	FED Dust Collector	7/23/93	7/23/98	Current.
113445	Shop Dust Collector	7/23/93	7/23/98	Current.
92-7082-4N	TWA - Detention Basin Modifications	2/26/93	2/25/95	Construction permit. Notification of bypass.
1218-92-0003.2	Wetlands Permit General Permit 11	7/15/93	3/16/97	9/94 construct outfall gravel—basin mods.
separate list	Well Permits	NA	NA	Current.
114785	Air Permit - AGT 15,000 gal. Diesel Oil	10/25/93	10/25/98	Current.
119065	Air Permit - AGT 25,000 gal.# 4 Oil	10/25/94	10/25/99	Current.
1218-92-0002.3SE	Stream Encroachment	11/23/92	11/23/97	Current. Headwall construction. compl.
22-93-NC	SBRSA Industrial Discharge Permit	2/15/95	2/25/96	Final Permit comments sent to SBRSA.
1218-91-0001.5 1218-91-0001.3	Wetlands Permits (GP7 and GP1)	4/6/94	3/16/97	GP7-Fire main installation; GP1 26kV line maintainance.
1218-91-0001.2	Wetlands—Letter of Interpretation	1/13/94	1/13/99	Wetlands Delineation Plan completed 5/94.
92-0363	FSCD- Detention basin modifications	6/16/93	12/16/96	FSCD reps. visited site in Sept.; will re-inspect.
95-0025	FSCD-Radwaste Facility			*2/22/95-deficiency notice from FSCD.*

3.3.1 Clean Air Act (CAA)

The Laboratory maintains permits for four boiler vent stacks; one fuel-oil, above-ground storage tank vent (25,000 gallon tank); one diesel, above-ground storage tank vent (15,000 gallon tank); one degreaser vent; three dust collectors; and two emergency, diesel-generator exhaust stacks (see Exhibit 3-3). Each permit for these emissions is current, and equipment under the permit is operated within specifications. An air permitting program is presently in place: the PPPL Environment, Safety, and Health (ES&H) procedure, EN-OP-004, is used to implement compliance with the air permit program.

In July 1994, the Field Coil Power Conversion (FCPC) degreaser permit was terminated. Also terminated was the permit for the underground storage tank E-1 vent in November 1994. Permit modifications for the C and D site diesel generators were submitted to NJDEP for the change from No. 2 fuel oil to No. 1 fuel oil. The change in fuel type was due to the change from underground to above-ground storage tanks, which could potentially change the temperature of the fuel and in turn impact its ability to flow.

3.3.2 Clean Water Act (CWA)

The Laboratory maintains two permits under the New Jersey Pollution Discharge Elimination System (NJPDES) for discharges to surface water (NJ0023922) and ground water (NJ0086029). The permits are for a detention basin, which discharges to Bee Brook, and for infiltration of the detention basin waters to ground water. The NJDEP issued a new expiration date for the ground water discharge permit extending it from March 31, 1994, to December 31, 1994. An adjudicatory hearing was requested for the ground water permit, because certain permit conditions are contested (see Section 3.2). Although the expiration date for the ground-water permit has already passed, PPPL and DOE/PAO maintains full compliance with the permit, including those protested conditions.

In the fall of 1994, the detention basin was lined with a geosynthetic membrane to eliminate potenial discharges to ground water. Because the water in the basin no longer impacts ground water, PPPL and DOE/PAO requested that the NJPDES ground-water monitoring program be revised to reflect this change. At a minimum, the need to sample the inflows to the basin twice annually should be revised.

In February 1994, PPPL received its final surface water permit (NJ0086029) from the NJDEP. The surface water permit was modified to include two new discharge points: 1) stormwater flow from the western side of C site that does not drain to the detention basin (DSN 002); and 2) the filter back wash discharge at the Delaware & Raritan Canal pump house (DSN 003). Also included in the permit conditions are a requirement for chronic toxicity characteristic study (bioassays) and chronic toxicity biomonitoring of the discharge water, a toxicity reduction evaluation, and chlorine-produced oxidant analysis.

In 1994, NJDEP inspectors twice audited PPPL's surface water discharges. The first NJDEP inspection of 1994 occurred on March 1, 1994. The result of that inspection was the issuance of a Notice of Violation (NOV) for a total suspended solids exceedance (72 mg/l versus 50 mg/l limit) in November 1993; the total suspended solids exceedance was reported in the November 1993 Discharge Monitoring Report that was sent to NJDEP in December 1993. No penalty or fines were assessed. The results of a second inspection, which occurred on November 16, 1994, was given a conditionally acceptable rating by the NJDEP, based on the total suspended solids exceedances that occurred during the summer of 1994 at DSN 002.

In 1994, to fulfill the Chronic Toxicity Characterization Study requirement of the NJPDES surface water discharge permit, quarterly chronic toxicity testing was conducted for two species: *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow). The results of these tests were 100 percent survival of all test organisms with one exception of *P. promelas* during the fourth quarterly testing. In January 1995, PPPL and DOE/PAO submitted to NJDEP the results of these quarterly chronic toxicity tests and is awaiting NJDEP approval for the next requirement of the chronic toxity testing program.

3.3.3 Resource Conservation and Recovery Act (RCRA)

The PPPL maintains USEPA Identification Number (NJ1960011152), which identifies its status as a RCRA large quantity generator. The Laboratory is in compliance with all terms and conditions required of a "generator" status. The Laboratory's hazardous waste is generated from various cleaning processes, disposal of chemicals no longer needed, spill cleanup materials and contaminated soils, purge water from monitoring wells, and small, miscellaneous, research-related waste streams. These wastes are stored at the Hazardous Materials Storage Facility for less than 90 days, *i.e.*, no RCRA Part B is required. Although non-RCRA wastes, waste oil and other waste petroleum products are regulated as hazardous wastes under New Jersey regulations, N.J.A.C. 7:26-1.1 *et seq*, "Division of Waste Management Regulations."

Mixed and radioactive waste management is the responsibility of the Environmental Restoration/Waste Management Branch of the Facilities & Environmental Management Division. Storage of these wastes are confined to the area known as the Radioactive Waste Storage Area (formerly in the D site Boneyard, now located in the RESA building on C site), the liquid effluent collection tank area, and within controlled areas of the TFTR building.

During 1994, PPPL maintained four underground storage tanks (USTs) located on C and D sites. The installation of five above-ground storage tanks began in April 1994 and was completed in December 1994. The removal of five USTs began in April 1994 and was completed by the end of FY94. Because of its proximity to buried electrical lines, the sixth UST was abandoned in place in January 1995. The Site Assessment report is being prepared for submittal to NJDEP. Fuel-contaminated soil was removed from the excavations of four of the USTs.

3.3.4 Miscellaneous Permits

The PPPL maintains permits for medical waste generation (waste generated from the dispensary) as required by the NJDEP and for the purchase of potable water from the Elizabethtown Water Company. An agreement is in place with the New Jersey Water Authority until the year 2009 to draw water from the Delaware and Raritan canal system for cooling-water needs and fire-fighting capabilities. PPPL is in compliance with the terms and conditions of these permits.

Soil erosion and sediment control plans are submitted for construction projects, which disturb soil in an area greater than 5,000 square feet. During 1994, PPPL had several projects which required certified Soil Erosion and Sediment Control Plans: detention basin modifications, fire-protection sprinkler line installation and modifications to the Hazardous Material Storage Facility. During the construction of the detention basin modifications, the subcontractor inadvertently caused sand from the detention basin to be released to the drainage ditch (Ditch #5), which flows to Bee Brook. The Freehold Soil Conservation District and NJDEP were notified of the disturbance; permission was granted to remove the sand from the waterway and from the banks of the ditch. This work was completed, and the area has been restored to the pre-existing conditions.

4.0 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 TFTR site established baselines prior to machine operation. In 1994, the following air stations were monitored:

Exhibit 4-1.
Radiological Air Monitoring Stations

Station Name	Number/Description
Remote Environmental Air Monitoring (REAM)-off site	Stations 1- 6: Tritium
TFTR radiological monitoring system (RMS) on D site	8 Neutron detectors and gamma ionization detectors and passive tritium monitors at TR 1-4:
Radiological monitoring system (RMS) at property line stations	2 Neutron detectors and gamma ionization detectors at Northeast (RMS-NE) and Southeast (RMS-SE)

On-site (Fig. 20) and off-site (Fig. 21) radiological water samples are collected at the same locations as the non-radiological water samples and analyzed for HTO (Exhibit 4-2).

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

Station #	Location	Description
B1	Off-site	Bee Brook Upstream of discharge from basin
B2	Off-site	Bee Brook Downstream of discharge from basin
C1	Off-site	Delaware & Raritan Canal (Plainsboro)
D1	On-site	D site Manhole-stormwater sewer
D2	On-site	DSN001 Surface Water Discharge from the basin
E1	On-site	Elizabethtown Water Company - potable water supply
M1	Off-site	Millstone River -Plainsboro and West Windsor boundary- Route 1
P1	Off-site	Plainsboro Surface Water - Millstone River
P2	Off-site	Plainsboro Surface Water - Devils Brook

Biota are also analyzed for tritium in water recovered from fruit and vegetable samples (Fig. 37). The tritium content of the biota, and in general, the soil mirror the tritium content in the precipitation, which can be highly variable over the year.

The most recent and comprehensive assessment of population distribution in the vicinity of PPPL was completed for the 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 (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 0.081 mrem (0.81 mSv) for CY94 (see Table 2). Detailed person-rem calculations for the surrounding population were not performed because the value would be insignificant in comparison to the approximately 100 mrem (1 mSv) each individual receives from the natural background, exclusive of radon, in New Jersey. However, scaling and estimating[2] were performed and yielded a value of 4.6 person rem (0.046 person-Sievert) out to 80 km (see Table 2).

4.2 Summary of Non-Radiological Monitoring Program

In January 1994, the NJDEP renewed the NJPDES surface water permit, No. NJ0023922, which became effective on March 1, 1994. Under the requirements of the renewed NJPDES surface water permit (NJ0023922), PPPL continued to monitor monthly the discharge of the detention basin, discharge serial number—DSN001 or D2. Once each month, DSN001 is monitored for temperature, pH, petroleum hydrocarbons, total suspended solids, chemical oxygen demand, chlorine-produced oxidants, and flow. Additional parameters measured are biological oxygen demand, phenols, ammonia-nitrogen, and total dissolved solids. Monthly data exists for D2 beginning in 1984.

Monthly sampling of two new discharge points was required: DSN002—a storm water and emergency fire protection system discharge (Fig. 20) and DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house (Fig. 21).

As a requirement of the renewed permit, a chronic toxicity characterization study was conducted to test the DSN001 effluent. Based on the results of the characterization study, the NJDEP will establish toxicity concentrations for the detention basin effluent water, which includes chemically-treated boiler and cooling tower blowdown. Study results were submitted in 1994 and 1995. The NJDEP will determine the extent of permit limitations, if any, that will be required for subsequent routine chronic toxicity monitoring at PPPL. Two test species were used, the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). In three of five tests sequences, the fathead minnow had 100 percent survival; the water flea had 100 percent survival in all tests.

The NJDEP required a monitoring program to determine if the ground water is being impacted from the five former underground storage tanks removed in 1989. Originally, PPPL had a total of eleven underground storage tanks; five tanks were removed in 1989, five more tanks were removed in 1994, and one tank was abandoned in-place in 1995. In accordance with the ground-water monitoring program requirements (but separate and distinct from the NJPDES groundwater

[2] Scaling was done using the ratio of the actual released amount of airborne radionuclides to the quantitties cited in the TFTR D-T EA multiplied by the calculated dose. For calculating the liquid component, assumptions are described in Table 3, Note 14. Other sources are negligible contributors.

discharge permit requirements), 10 UST wells, located near the former tanks, were monitored for total petroleum hydrocarbons (TPHs) quarterly and annually (August) for volatile organic compounds. Monthly, 30 wells were measured for water elevation, and contour maps were prepared for each month. By measuring the water elevation in these wells each month, the elevations can be used to track the changes in direction of ground water and fluctuations in water elevations across the site. The contour maps and analytical results were submitted in four quarterly reports to NJDEP [AAC94a, c, d, and e].

Under a different program as required by the NJPDES ground water discharge permit, No. NJ0086029, 7 ground water monitoring wells were sampled quarterly in 1994 (Exhibit 6-2 and Fig. 17). Exhibit 4-3 presents the required parameters, wells, frequency, and permit standard. This discharge permit expired on December 31, 1994. One hundred and eighty days prior to its expiration, the permit renewal application was submitted to the NJDEP in July 1994 [Fi94c]. The NJDEP is drafting a new ground-water discharge permit.

Exhibit 4-3.
NJPDES NJ0086029
Ground Water Discharge Standards and Monitoring Requirements for Ground Water Monitoring Wells

Parameters (these wells only)	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 (hex.) & 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 Organics - (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 from 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.*).

In 1993, Princeton University entered into an agreement with the Department of Environmental Protection to investigate and to potentially remediate ground-water contamination. In September 1994, PPPL prepared a revised work plan for the remedial investigation required under the

Memorandum of Understanding (MOU) and submitted it to the NJDEP (see Sections 3.1 and 6.1.3 C for further discussion of the MOU).

In March 1995, NJDEP granted conditional approval of the work plan and the sampling program began. In 1994, NJDEP had approved the collection of one round of ground water samples from 34 monitoring wells (these wells include the 10 UST wells, the 4 of 7 NJPDES wells and 17 other wells on C and D sites), 2 former production wells, 2 piezometers, and 6 sumps on C and D sites. All ground water samples were analyzed for volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), pH, and conductance. Six of the 34 wells were selected for common ion analyses. A confirmatory round of ground water samples was performed when the results exceeded the New Jersey Ground Water Quality Standards for volatile organic compounds, mainly tetrachloroethene and trichloroethene.

Soil samples were collected at 7 locations identified as Areas of Potential Environmental Concern (APEC) in Exhibit 4-4. The soil samples were collected by hand auger except at the reduction pits where a Geoprobe® was used to collect the soil samples. Exhibit 4-4 presents the analyses by location:

Exhibit 4-4.
Soil Sampling for Site Investigation

Areas of Potential Environmental Concern (APEC)	No. Samples	Analyses
C site cooling tower, former reduction pits: 6 borings each at 0 to 0.5 foot and at 6 foot depths	12	Chromium - hexavalent and total
Former treatment plant sand/sludge drying beds	5	TPH, PCBs, metals
CAS/RESA buildings	2	VOCs
Warehouse building	2	VOCs
Northeast of TFTR/Mockup buildings	2	VOCs
Radiological Environmental Monitoring Laboratory(REML)	4	VOCs
138 kV switchyard/OH capacitor yard	2	PCBs

4.3 Environmental Permits

The environmental permits held by DOE/PAO for PPPL are listed in Exhibit 3-3 and are discussed in Section 3.3, "Environmental Permits," of this report.

4.4 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements were prepared in 1994.

In 1993, an Environmental Assessment (EA) was prepared for the Tokamak Fusion Test Reactor Shutdown and Removal (S&R) and the Tokamak Physics Experiment (TPX). This document was submitted to the NJDEP for their review and to DOE/HQ for approval. In 1994, a public meeting was held to discuss the TFTR Shutdown and Removal Project and TPX. Following the resolution of questions and/or comments received from the public, the proposed action in the EA received a Finding of No Significant Impact (FONSI).

4.5 Summary of Significant Environmental Activities at PPPL

4.5.1 TFTR D-T Monitoring Activities

To support deuterium-tritium (D-T) operations, PPPL modified the radiation monitoring program that was performed on a routine basis during D-D operations. An extensive supplemental monitoring regime was continued including a combination of several, supplemental neutron and photon detection systems, Thermoluminescent Dosimeters (TLD), and increased operational health physics support. Through the use of several Pressurized Ionization Chambers (PIC) and portable neutron monitoring devices, the health physics division was able to effectively map the photon and neutron fields present during the high power D-T plasmas. In addition to the neutron and photon monitoring plan, health physics extensively mapped radiation fields associated with a coolant system located in the basement of the TFTR building. Fields caused by fluorine activation within the TFTR coolant Fluorinert were measured at discrete intervals after D-T plasmas.

4.5.2 Tritium Purification System

In 1994, the Laboratory installed a closed-loop system for purifying and reusing tritium in the TFTR. The system called the Tritium Purification System or TPS is designed to remove tritium from the plasma gases that are collected on the neutral-beam cryogenic pumping panels. The system is in the testing phase prior to being fully operational. The exhaust gases contain hydrogen isotopes and traces of other gases such as carbon dioxide and hydrocabons that may be mixed with nitrogen and argon. The hydrogen isotopes (hydrogen, deuterium, tritium) are separated from the other gases in the pre-treatment section of the TPS. Then the hydrogen isotopes are separated using a cryogenic distillation process. The tritium recovered by the TPS can then be reused in combination with deuterium as a fuel in the TFTR [PPPL94].

4.5.3 Waste Minimization Activities and Pollution Prevention Awareness

The "PPPL Waste Minimization/Pollution Prevention Plan" was revised in accordance with DOE Order 5400.1. A hazardous waste bar-coding and tracking system was completed and implemented. The hazardous waste recycling program continued with approximately 9,000 lbs of hazardous waste recycled. The hazardous waste recycled consisted of lead-acid batteries, mercury containing batteries and equipment, other types of batteries, and Freon®. An evaluation of PPPL's solid waste stream was undertaken to identify opportunities for improvment and increases in efficiency. The results were incorporated into the latest solid waste contract, let in early 1995. A secondary goal of the evaluation was to determine if PPPL employees adequately segregate solid waste for recycling. Employee segregation was found to be adequate with room for improvement. An employee Pollution Prevention Awareness Program is planned for 1995. In addition, during 1994, negotiations with the sanitary waste hauler resulted in a significant increase in the variety of materials accepted for recycling by the hauler.

4.5.4 Hazardous and Radioactive Waste Facilities

In 1994, PPPL made changes to the Hazardous Material Storage Facilities (HMSF) in order to protect it from the effects of a 500-year flood. These modifications were required under the Federal Emergency Management Act (FEMA) because of temporary storage of hazardous waste materials in that facility. Modifications included the construction of a concrete berm around the facility's perimeter and the addition of office space. Because the HMSF is adjacent to the delineated wetlands and is in the transition zone, a transition area waiver was obtained from the NJDEP prior to construction.

A new Radioactive Waste Storage Building was proposed to replace the trailers on D site located in the Boneyard, which temporarily housed radioactive waste and activated materials. A Temporary Radioactive Waste Storage Building was also proposed for D site to house equipment and materials from the TFTR shutdown and removal activities. For both projects Soil Erosion and Sediment Control Plan approvals from the Freehold Soil Conservation District were obtained.

4.5.5 Storm Water Management

PPPL received all the necessary permits for the detention basin liner installation and upgrades in 1993. In the fall of 1994, the detention basin liner was installed in order to prevent soil and ground water contamination from an unexpected release of chemicals, *e.g.*, oil, into the basin. It is a best management practice identified during the 1988 DOE/HQ Environmental Survey. An under-drainage system was installed to remove ground water, which would cause the liner to float; ground water is pumped from beneath the liner into the basin.

From the inventory of all storm water discharge sources and possible contaminants to storm water, a Stormwater Pollution Prevention Plan (SPPP) is being developed. Once implemented, the SPPP will focus on best management practices as a control on the quality of the storm water discharged from PPPL. A Storm Water Management Plan, which will focus on the quantity of stormwater discharged, is in preparation; when completed, it, in conjunction with the SPPP, will be used to control the rate of flow and the quality of the storm water discharged from PPPL.

4.5.6 Storage Tanks

In January 1994, NJDEP approved the closure application for the 6 remaining underground storage tanks (UST). Prior to the removal of the USTs , 6 above ground storage tanks (AGT) were installed to replace the older storage tanks. The 6 USTs were removed in the summer-fall of 1994 . Petroleum-contaminated soil was removed from around four of the six underground tanks removed. The Site Assessment Report will be submitted to the NJDEP with the Remedial Investigation/Remedial Alternative Assessment Report in September 1995.

4.5.7 Environmental Training

Approximately thirty PPPL employees and/or subcontractors attended the on-site training course, "Health and Safety for Hazardous Waste Site Investigation Personnel," commonly referred as the 40-hour OSHA HAZWOPER course. This course was taught by instructors from the Environmental and Occupational Health Sciences Institute (EOHSI) of Piscataway, New Jersey. EOSHI is jointly sponsored by the University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School and Rutgers, the State University of New Jersey, and through a grant from the Department of Energy, EOHSI provides training for DOE facility employees. Related training was also taught by EOHSI instructors for the Confined Space training course.

5.0 ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

5.1 Radiological Emissions and Doses

5.1.1 Penetrating Radiation

The TFTR commenced high power Deuterium-Tritium operations in December 1993, which continued through Calendar Year 1994 (CY94). These operations are a potential source of neutron and gamma/x-ray exposure. The Princeton Beta Experiment Modification (PBX-M) did not operate in CY94.

Laboratory policy states that when occupational exposures have the potential to exceed 1,000 mrem per year (10 mSv/y), the appropriate project manager must petition the PPPL Environment, Safety, and Health (ES&H) Executive Board for 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, as a result of experimental device operation, are also very low and acceptable.

The design objective for TFTR is to remain less than 10 mrem per year (0.1 mSv/y) above natural background at the PPPL site boundary from all operational sources of radiation. The TFTR produces D-D (2.4 MeV) and D-T (14.0 MeV) neutrons and gamma/x-rays in the range of 0 to 10 MeV.

In December 1993, D-T operations commenced. In 1993, the number of neutrons produced was 7.2×10^{18} and 1.65×10^{19} [Ja94] for D-D and for D-T operations, respectively. In 1994, TFTR continued an extensive D-T operations schedule and increased the neutron production to 1.3×10^{19} and 1.85×10^{20} [Ja95] D-D and D-T operations, respectively.

The TFTR real-time site boundary monitors are Reuter-Stokes Sentri 1011 pressurized ionization chambers and ^{3}He-moderated neutron detectors. The electronics in the ionization chambers were modified to allow the integration of any prompt radiation resulting from a TFTR machine pulse which may be above natural background. Data are stored and processed using the Central Instrumentation, Control, and Data Acquisition (CICADA) computer system. Four of these monitoring stations are placed at the TFTR facility boundary and two are located at the PPPL property line (see Figs. 20 and 21). In addition, eight ionization chambers of lower sensitivity, paired with neutron monitors, are located nearer the TFTR device (four outside the test cell wall, three in the basement, and one on the roof). These eight detector locations are for personnel safety and are to be used as indicators of environmental conditions. However, data collected from them are used to help correlate the environmental measurements. Besides the moderated ^{3}He, and fission neutron detectors, passive area dosimeters were also used for monitoring neutron dose equivalents at various locations throughout the TFTR facility. Monitors are calibrated and traceable to the National Institute of Standards and Technology (NIST).

5.1.2 Sanitary Sewage

Drainage from TFTR 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 gamma emitters. All samples for 1994 showed the effluent amount and concentrations of radionuclides (tritium) to be within the allowable limits set by New Jersey regulations (1 Ci/y for all radionuclides) and by 40 CFR 141.16 and DOE Order 5400.5 (2×10^6 pCi/liter for tritium).

5.1.3 Radioactive and Mixed Waste

In CY94, low-level radioactive waste and mixed waste were stored on-site, either in the D site Boneyard or within a controlled area of TFTR. Five shipments of low-level radioactive waste were made in 1994. The low-level radioactive and low-level radioactive mixed waste shipments made in 1994 consisted of 677 cubic feet (ft^3) of material, with an activity of 8,885 Curies (Ci).

5.1.4 Airborne Emissions

A. Differential Atmospheric Tritium Samplers (DATS)

A Differential Atmospheric Tritium Sampler (DATS) is used to measure elemental (HT) and oxide (HTO) tritium at the TFTR stack, as well as, eleven (11) remote environmental sampling locations. All of the aforementioned sampling is performed continuously and has been performed since TFTR was commissioned.

The projected dose equivalent at the site boundary based on emissions of 45.55 Ci of tritiated water (HTO), and 93.13 Ci of elemental tritium (HT), and 14.45 Ci of Argon-41 (^{41}Ar) (produced by neutron activation of the test cell air during TFTR experiments) was 0.3 mrem (3.0×10^{-6} Sv)(see Table 2), based on the use of the COMPLY Code [EPA89]. Installed in 1992, the stack sampling system continues to provide tritium emissions data for 1994 (Table 5 and Figs. 38 and 39) for any tritium concentrations exceeding the minimal detectable levels of the DATS. Engineering changes to ensure representative sampling of tritium have been completed and the stack sampling system has been accepted by EPA for use in complying with NESHAPS. Measurements at the TFTR D site facility boundary have shown ambient levels in the range of 1 to 123 pCi/m^3 of elemental and oxide tritium concentrations (Figs. 23 and 25). Measurements from the off-site monitoring stations are shown in Figs. 22 and 24, "Air Tritium (HT)" and "Air Tritium (HTO)," respectively. These measurements were made with the DATS [Gr88b]. ^{41}Ar is a potential air activation product from neutrons produced from D-D and D-T reactions. Its maximum calculated production in 1994 was 14.45 Ci (534.6 GBq), with an estimated dose equivalent at the nearest off-site business of 0.016 mrem (160 nSv) using NOAA χ/Q data (see Table 2).

In November 1983, a three-level, 60-meter tower was installed for gathering meteorological data. Data have been collected and recorded for eleven years. The wind-rose data for the eleven years of tower operation are shown in Figs. 7, 9, and 11. Analysis indicates that the site is dominated by neutral to moderately stable conditions, with moderately unstable to extremely unstable conditions occurring less than a few percent of the time. Average surface winds are about 2.1 m/s and rise to about 4.1 m/s at 60 m [Ko86].

5.2 Unplanned Releases

There were no unplanned releases in CY94.

5.3 Environmental Monitoring

5.3.1 Waterborne Radioactivity

A. Surface Water

Surface-water samples at eight locations (four on-site and four off-site) have been analyzed for tritium and photon emitters (Table 6). Five of these locations have been monitored since CY82. Downstream sampling occurs after the mixing of effluent and ambient water is complete. Locations are indicated on Figs. 20 and 21.

Sample analysis has shown no unusual background radionuclides. Tritium analysis by liquid scintillation methods has shown tritium values to be less than the background level of 210 pCi/liter (7.77 Bq/liter) on all samples analyzed to date (Figs. 28-36), with one exception at Station D2. In October 1994, probably due to the release of tritium oxide, tritium was detected above 210 pCi/liter (367.3 pCi/liter), at this station, located on C site. An increase in tritium oxide in stack effluent and tritium concentration in precipitation was also observed in the period preceding the elevated surface water concentration. Tritium enrichment procedures are used on some samples to provide increased sensitivities.

The 1994 rain water samples collected and analyzed ranged from less than 32.2 to 1130.4 pCi/liter (see Table 4 and Fig. 26), which varies from the 1993 range of 24.5 to 145 pCi/liter (see Table 3). The reason for these variations can be explained as follows: TFTR began full D-T operations and as a result normal operational tritium losses occur. The extensive Radiological Environmental Monitoring Program at PPPL has shown that instrument sensitivities are capable of differentiating between the variation caused by the D-T program. Normally, there is a variation of HTO in rain water as the stratosphere slowly turns over, with very little exchange between the stratosphere and troposphere in the winter months [Os88]. The peak values are slowly decreasing over the years, which is consistent with the decay of tritium with no large inventories being added.

In April 1988, PPPL initiated the collection of precipitation and monitored levels. While 1988 was a dry year, 1989 and 1990 were relatively wet years with over 55 inches (140 cm) and 50.3 inches (128 cm) of precipitation in 1989 and 1990, respectively. The years 1991, 1992, and 1993 had average amounts of total precipitation: 1991 - 45 inches (114 cm), 1992 - 42 inches (107 cm), 1993 - 42.7 inches (109 cm), and 1994 - 50 inches (Table 4 and Fig. 19)[Ch94].

B. Ground Water

Typically, five on-site wells—D-11 and D-12 on C site, and TW-1, TW-3, and TW-10 on D site (Fig. 20) are sampled. The ground water results for 1994 (Table 7 and Fig. 27), with the onset of D-T operations, were slightly elevated in TW-1 showing tritium concentrations ranging from 100.7 to 246.4 pCi/liter. TW-10 was less than 100 pCi/liter (3.7 Bq/liter)—averaging 48.8 pCi/liter, as expected. Slow moving ground water tends to dilute the concentration of [because the pool of water tends to average out] HTO added by precipitation. This is evident when the large variation of tritium concentrations noted in precipitation is not seen in the ground water.

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 1994, tritium measurements of potable water ranged from 33.8 to 145.5 pCi/liter. Although slightly elevated from 1993 measurements, these tritium levels are lower than surface (Fig. 33) and well waters (Fig. 27). In addition, only naturally occurring, gamma-emitting radioisotopes have been detected.

5.3.2 Foodstuffs

Foodstuffs collected and analyzed in CY94 during the growing season included zucchini, strawberries, tomatoes, cucumbers, green peppers, eggplant, and pumpkin. These fruits and vegetables were collected from area farmers or gardens. The variation shown in detected HTO levels of 27.4 to 82.4 pCi/liter (see Fig. 37 and Table 8) is consistent with background concentrations of tritium in biota.

5.3.3 Soil, Grass, and Vegetation

Surface soils and vegetation are among the best indicators of tritium deposition after a release [Jo74], [Mu77], [Mu82], [Mu90]. Therefore, the baselines were established using these matrices. Off-site sampling locations were established in late 1985 (see Fig. 21). In 1991, some sampling points were relocated because of construction during 1990 in some local sampling areas. Also, the sampling points were relocated to be near the air-monitoring stations.

For those soil and grass samples collected in 1994 from off-site locations, the concentrations ranged from 35.9 pCi/liter to 378.3 pCi/liter. The increases observed in the soil samples correlate with the elevated levels in oxide stack releases and precipitation concentrations. Gamma spectroscopy analyses of grass samples showed only naturally occurring, gamma-emitting radioisotopes.

6.0 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 the permit conditions of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, NJ0023922, PPPL submitted to the NJDEP monthly discharge monitoring reports (DMRs) for DSN001 (PPPL designation-D2), DSN002, and DSN003 (see Tables 14-16). During CY94, PPPL was within the allowable limits for all testing parameters at DSN001 and DSN003. The last exceedance at DSN001 was reported in November 1993 for the total suspended solids result of 73 mg/l (50 mg/l is the permit limit).

Stormwater discharge is sampled at DSN002, which is located at the southwestern edge of the site. During a precipitation event which causes runoff following a 72-hour dry period, a sample for petroleum hydrocarbons is collected at 15, 30, and 45 minutes after the onset of the discharge (Table 15); all other samples are collected at 15-minute interval. Exceedances of the total suspended solid limit (50 mg/l) were reported in July (100 mg/l), August (190 mg/l), and September (82 mg/l). The probable cause of the exceedances appears to be naturally occurring sediments from the bottom of the ditch, which are stirred up during heavy flow. Presently, DOE/PAO and PPPL are working with the DEP's Stormwater Permitting Branch to revise the NJPDES permit and to develop a Stormwater Pollution Prevention Plan.

The detention basin inflows or influents are monitored twice each year, in May and August (see Table 13), pursuant to the PPPL NJPDES ground water discharge permit, NJ0086029. Volatile organic compounds were detected at inflow 1 and 2 in concentrations slightly above the method detection limits for volatile organic analyses—1,2-Dichloroethane (2.3μg/l) and tetrachloroethene (3 μg/l) at Inflow 1 and chloroform (3 μg/l) at Inflow 2. Located on the west side of the detention basin, Inflow 1 receives water from the C site MG basement sumps, C and D site cooling tower and boiler blowdown, as well as stormwater. 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 stormwater from the transformer yard sumps.

Based on 10 months of flow data, greater than 86.5 million gallons of water were discharged from the detention basin in CY94. Bypass of the detention basin occurred during the liner installation and modifications to the outfall head wall in September and October 1994, and therefore, no flow measurements were made. A permanent oil boom in the basin and a fence around the perimeter of the basin were also installed. The project will be completed with the installation of the basin oil sensors and the outfall flume, which have been delayed. Presently, the basin is being operated in a flow-through mode.

6.1.2 Chronic Toxicity Characterization Study

In 1994, chronic toxicity testing for DSN001 effluent began. Four quarterly reports on the survival results for the test species, *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow), were submitted to DEP. For all tests but one, the survival rate, as defined by the NJ water quality-based effluent standards, was 100 percent for both species. During the December test, the fathead minnows survived in the 25 percent dilution, *i.e.*, mortality was observed in the 50 and 100 percent effluent tests. Chronic toxicity testing is continuing on a quarterly frequency for the fathead minnow only, with results submitted to DEP. The DEP chose the fathead minnow as the most sensitive species for the Chronic Toxicity Biomonitoring requirements (Table 14).

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 permit also contained a requirement for conducting a hydrological study of the site, including soil sampling or a soil gas survey.

The permit, NJ0086029, was issued effective April 1, 1989, and expired on December 31, 1994. The DOE-PAO submitted to DEP the NJPDES permit renewal application in July 1994. 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 [Fi94c].

A. Hydrological Studies from 1989 to 1993

In 1989, DOE/PAO and PPPL prepared a work plan for the hydrological study. The purpose of that study was to delineate and define the sources of contamination for ground-water contaminants which were detected during the USGS study (see Figs. 40 and 41) [USGS87] [DOE89c] [PPPL89d,f] [NJDEP90]. The DEP gave its approval of the plan with the following conditions [NJDEP90a]:

- Soil sampling and/or soil gas survey.
- Determining the Direction of Ground Water Flow — ground water modeling must be performed.
- TFTR Cone of Influence — must identify details of dewatering activities.
- Detention Basin Impact — must monitor the impact to ground water of unlined basin.
- Contaminant Source Location — on-site historical usage of solvents/hazardous substances must be investigated.

The soil gas survey was completed in September 1990. [Ne90] Soil vapors were tested for three volatile organic compounds and one group of compounds: tetrachloroethene (PCE), trichloroethene (TCE), trichloroethane (TCA), and aromatic hydrocarbon compounds (AHC). The selection of the three compounds—PCE, TCE, and TCA (solvents commonly used to clean metal)—was based on their past use at PPPL. AHC are compounds present in petroleum products, such as gasoline and fuel oil.

Results from this site-wide survey identified anomalies in five areas (see Exhibit 6-2):

AREA #	LOCATION
1	North and east of the Plant Maintenance and Engineering Building [now known as the Facilities & Environmental Management Division (F&EM)], including the cooling tower area.
2	Through the eastern half of the Receiving Warehouse Building and extending southward toward the Coil Assembly and Storage Building (CAS).
3	Southwestern corner of the CAS Building.
4	Northeast of the TFTR Neutral Beam Power Conversion and Mockup Buildings.
5	West of TFTR Field Coil Power Conversion (FCPC) Building.

In Exhibit 6-1, the results of the soil gas survey are summarized. All four compounds were detected in only Area 1; the three chlorinated solvents were detected in both Areas 2 and 4. Only PCE was detected in Area 3, and only TCA was found in Area 5.

Exhibit 6-1.
Summary of 1990 Soil Gas Survey Results

Area Number	PCE	TCE	AHC	TCA
1	✓	✓	✓	✓
2	✓	✓		✓
3	✓			
4	✓	✓		✓
5				✓

In December 1990, the ground-water quality study began with the drilling of sixteen ground-water monitoring wells and two piezometers. Samples were collected in January 1991 and analyzed for volatile organic compounds, semi-volatile organic (base/neutral) compounds, polychlorinated biphenyls (PCBs) and pesticides, metals, and total petroleum hydrocarbons. The results of this study showed a correlation of the soil gas survey results and ground water for the following areas only: *in Area 1*—where five underground storage tanks were removed in 1990, semi-volatile organics in ground water correlated with aromatic hydrocarbons in the soil survey, and *in Areas 1 and 3* —volatile organic compounds (PCE, TCE, and TCA) were detected in both the ground water samples and in the soil gas survey. [MP91a,b] [DOE91b,d,e] No correlation between ground-

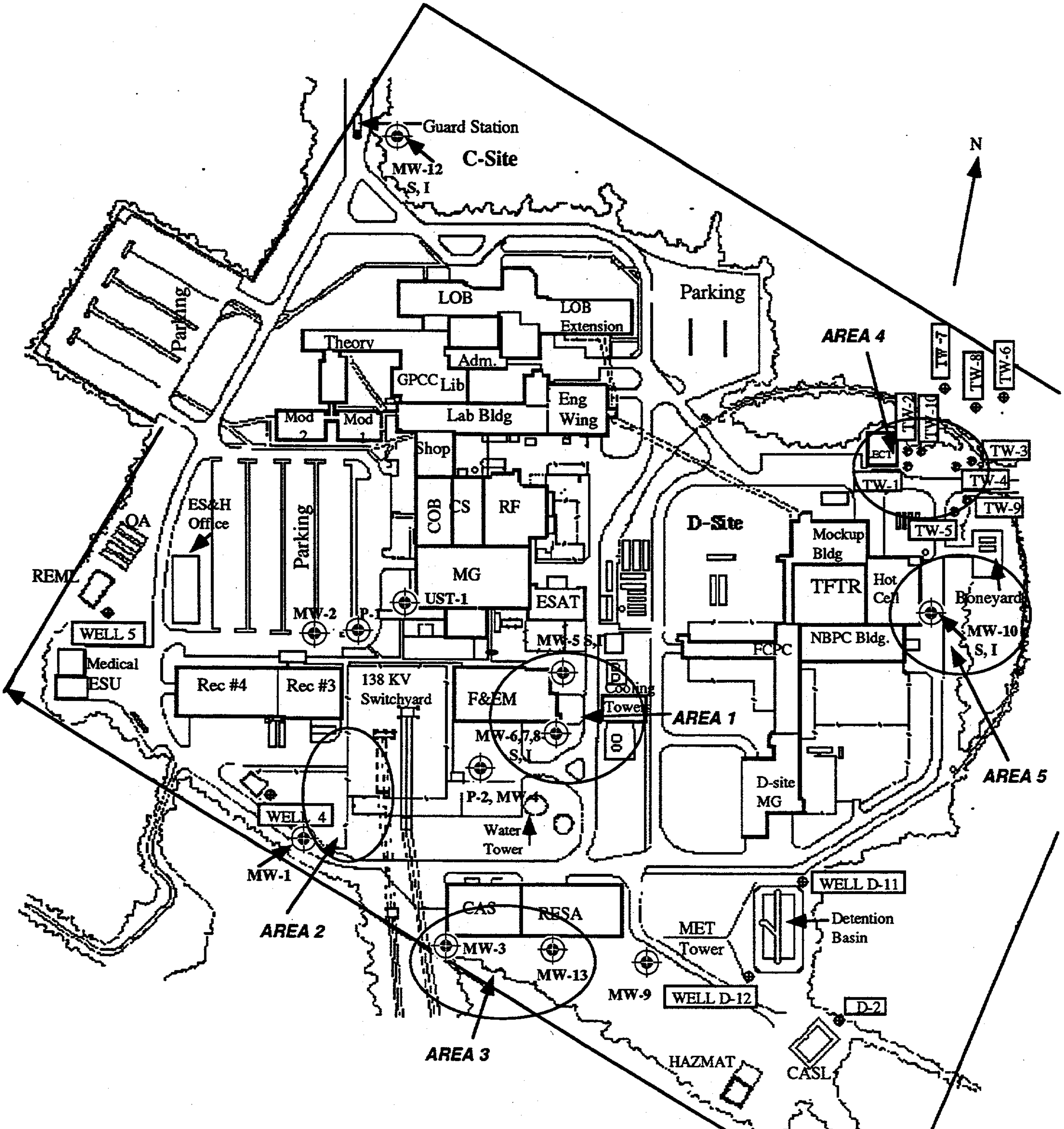

Exhibit 6-2. Correlation between the Soil Gas Survey and Groundwater Data - Areas 1-5

water quality and soil gas survey results were shown for Areas 2 and 5; no ground-water samples were collected in Area 4, thus, a relationship could not be assessed.

In January 1993, ground water samples from the wells sampled in January 1991 including the NJPDES wells were collected [DOE93c] [MP93]. This study confirmed the presence of chlorinated solvents and other compounds that were detected in the same wells in 1991. The study also showed that dissolved contaminants have not migrated to areas previously found having no contaminants above the detection limits. In those wells where contamination was found in 1991, the concentrations were found to be lower in the 1993 samples.

The sump pump systems beneath the D site buildings (TFTR and D site MG building) continue to control the ground-water movement by creating a shallow cone of depression. Influenced by the cone of depression, the direction of ground water on C and D sites is radially toward the sump pump systems (see Figures 40 and 41). The modelling effort was postponed, but it may be included in a future ground-water study and/or cleanup assessment report.

To assess the detention basin's impact on ground water, water levels in the detention basin and nearby wells (D-11, D-12, and MW-9—as the control well) were measured in March 1991 [MP91c] [DEP91a] [DOE91c]. The results revealed that the basin did not appear to discharge to the surrounding ground water, but instead ground water was discharging to the basin at all times except when water in the basin was at the maximum height. (These results were obtained prior to the lining of the basin in 1994.) Because a mounding effect was not observed, any contamination that reaches the detention basin would not flow into the surrounding ground water except when the basin was at the maximum water height; at that time, the flow reverses and water then would flow from the basin into the ground water.

In 1991, "Solvent and Hazardous Constituent Usage Survey" was prepared. It documented that a large quantity of tetrachloroethene (PCE) was stored and ultimately used in the CAS/RESA buildings [MP91f] [DEP91b] [DOE91g]. Also documented was the presence of petroleum hydrocarbons and solvents in most buildings at PPPL. The solvent, 1,1,1-trichloroethane (TCA) was and is widely used throughout the site. Substitute solvent and/or degreaser products for the commonly used halogenated solvents are available and used wherever appropriate.

B. NJPDES Quarterly Ground Water Monitoring Program

In this section, the NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1994 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.

Since November 1989, the three A and B site wells—MW-14, MW-15, and MW-16—are sampled quarterly (see Tables 21 and 26). All the results were below the permit standards with one exception: in August 1994, the 4-Bromophenyl-phenyl Ether (base/neutral compound) was detected at 110 μg/l for MW-14. The cause of this anomaly is unknown. These wells are also sampled by Princeton University's environmental contractor, [EN91], and are included in the University's ground water monitoring program. In the NJPDES permit renewal application, PPPL and DOE-PAO made a formal request to DEP that these wells be removed from the ground-water permit requirements.

The C and D site wells—D-11, D-12, TW-2, and TW-3—have been sampled quarterly since November 1989. In 1994, all ground water results, except for volatile organic compounds, were below the permit standards (see Tables 22-26). Volatile organic compounds in the ground-water samples are discussed in the following paragraph and in the following section "Regional Ground Water Monitoring Program."

The detection of tetrachloroethene (PCE) was observed in at least one ground-water sample analyzed for volatile organic compounds from November 1989 to August 1994, except during the May 1990 event. Of twelve sampling events, PCE was detected in wells D-11 and/or D-12 ten times. In well TW-3, PCE was detected in eight of the twelve sampling events. However, higher concentrations of PCE were found in this well at concentrations of 26 μg/l and 36 μg/l. Other VOCs have been detected either in levels below the method detection limits (J or T values) or sporadically, *e. g.*, 1,1-dichloroethane in well D-12.

The detention basin inflows are sampled twice annually, in May and August. PCE was found four times in Inflow 2 samples: August 1990, September 1991, August 1993, and August 1994. The compound 1,1,1-trichloroethane (TCA) was detected once in Inflow 2 during August 1990. PCE was detected once in Inflow 1 during August 1993.

C. Regional Ground Water Monitoring Program

In 1993, a Memorandum of Understanding (MOU) was signed between Princeton University, the land owner of the James Forrestal Campus, and the NJ Department of Environmental Protection (NJDEP). In this MOU, a remedial investigation and remedial alternative assessment were required. For C and D site, PPPL's environmental subcontractor prepared a draft work plan for the remedial investigation, which included a ground-water investigation [HLA94]. In June 1994, samples from thirty-four ground-water monitoring wells, two piezometers, the C and D site ground-water sumps, and the former production wells were collected (Tables 27 and 28). Analyses included volatile organic compounds, total petroleum hydrocarbons, specific conductance, pH, and temperature. Selected samples will be analyzed for the common ions: total dissolved solids, chloride, fluoride, nitrate (as N), sulfate, total alkalinity, hydroxide alkalinity, carbonate alkalinity, bicarbonate, bromide, calcium, magnesium, potassium, and sodium.

The Regional Ground Water Monitoring Program studies are previously discussed in Section 6.1.3 A, "Hydrological Studies from 1989 to 1993," of this report. Evaluating the data from these studies, the NJPDES Quarterly Ground Water Monitoring Program, and the remedial investigation results, an overall pattern appears for the volatile organic compounds (VOCs) found in the ground water monitoring wells at PPPL. In Table 30, the VOC that is mostly commonly detected and present in the highest concentrations is tetrachloroethene (PCE at 200 μg/l in well MW-13)). The potential source of the PCE appears to be located near the CAS/RESA buildings to the south (Area 3), where VOCs were historically used and stored. MW-13, located next to the CAS/RESA buildings, is upgradient of the other wells located in Area 1 and also the basin (see Exhibit 6-2). The highest concentrations of contaminants would be expected in those wells closest to the source. As ground water is being pulled toward D site by the sump pump system, VOCs would be detected in lower concentrations in wells located between the CAS/RESA buildings and D site.

The second area where PCE is detected in the ground water is an area due north of TFTR (Area 4-undeveloped wetlands), as indicated by the TW wells 1, 2, 3, and 7 (Table 30). The source of PCE in Area 4 is as yet unknown.

The C and D site sump pump systems (LOB-S3, MG-S2, MG-S4, MG-S5, and MG-S6) were also sampled at the same time the wells were sampled in June 1994 (Tables 27 and 30). The occurrence of PCE in all the sumps except MG-S5 can be attributed to the PCE present in the ground water.

Since August 1991, PPPL collects ground-water samples from wells located near the former underground storage tanks for annual analysis of volatile organic compounds (VOCs) and quarterly total petroleum hydrocarbons (TPHCs). Ground water samples are collected from wells P-2, MW-4, MW-5S, MW-5I, MW-6S, MW-6I, MW-7S, MW-7I, MW-8S, and MW-8I and analyzed for TPHCs. Also, once a month, ground-water elevations are measured in these wells and in wells MW-1, MW-2, P-1, UST-1, MW-3, MW-9, and MW-13. Beginning in March 1994, the remaining thirteen (total of thirty) ground-water monitoring wells on C and D sites were added to the monthly water elevation measurements. This additional data provides the ground water flow for the entire PPPL site.

In each quarterly report, the results of the analytical data and monthly contour maps are submitted to NJDEP (see Tables 19 and 20) [MP91g,h] [MP92a,c] [RES92a,b][RES93a,b,c] [AAC94a,c,d,e]. The results of the VOC analyses are discussed above. For thirteen quarters, total petroleum hydrocarbons were detected predominately in the intermediate (I wells) ground-water zone. In general, the intermediate wells are bedrock wells open from 30 to 45 feet below grade or at elevations of 45 to 60 feet above mean sea level (msl).

When evaluating the monthly contour maps and elevation data, the average annual ground-water elevations are calculated for each well. The wells are then grouped by elevation (see Table 18). Also included are the two detention basin wells, D-11 and D-12, which are located in the southern portion of the site. The water in the upgradient well, MW-1, is at the 88-foot elevation; the next closest well, UST-1, at 87 feet was removed in 1994 when the underground storage tank (E-5) was removed. The next group of wells—MW-3, P-2. MW-13, and P-1—are at the 86-foot elevation. From two wells in this group, MW-3 and MW-13, concentrations of PCE well above the standard (25 and 200 μg/l, respectively) were detected in the ground water. The ground-water elevations for all other wells are between 85 and 82 feet. For all of these wells, except MW-8I, lower concentrations of PCE are found, ranging from 3.6 to 76 μg/l.

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 and with DOE orders or programs.

6.2.1 Non-Radiological Emissions Monitoring Programs

A. Airborne Effluents

The 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 will expire on March 31, 1997. In March 1994, as a result of a NJDEP site inspection by the Bureau of Air Enforcement Operations, PPPL responded to a Notice of Violation (NOV), by submitting alterations and amendments to the four boiler permits. Without notice to DEP in 1987, PPPL modified boilers #2, #4, and #5 to burn natural gas in addition to burning #6 fuel oil. In 1988, boiler #3 was modified to burn #4 fuel oil instead of #6 fuel oil. In September 1994, PPPL submitted a permit amendment for boiler #3 to convert it to burn natural gas in addition to burning #4 fuel oil. The DEP granted approval and this modification was completed in late 1994.

PPPL has an air permit for the vapor degreaser located in the TFTR hot cell that uses Freon® 113 to degrease metal parts. It is the one remaining degreaser that requires an air permit. PPPL is investigating alternatives for the chlorofluorocarbon 113, which is an ozone-depleting substance.

Five air permits are maintained by the PPPL: two permits for two aboveground storage tanks and three permits for three dust collectors. The aboveground storage tank permit No. 114785 was issued on October 25, 1993, and expires on October 25, 1998. The aboveground storage tanks (25,000 and 15,000 gallon capacities) emit volatile organic compounds from #4 fuel oil and diesel oil, respectively. The F&EM and CAS dust collector emissions originate from general woodworking operations. The Shop building dust collector emissions originate from metal working operations.

Measurements of actual boiler emissions are not required. Emissions were initially calculated and then recalculated for the amendments and alterations to the boiler permits, using NJDEP and AP-42 [EPA] formulas. These formulas are based on the appropriate boiler emission factors, percent sulfur content of the fuel and number of gallons of oil burned per hour in each boiler. To optimize boiler efficiency and to reduce fuel cost in accordance with DOE Order 4330.2D, "In-House Energy Management," [DOE88b] PPPL utilizes an ENERAC POCKET 50® combustion-efficiency analyzer to indicate the boiler efficiency, oxygen content, flue-gas temperature, and carbon-dioxide content of the stack gas for both oil and natural gas fuels. Boiler operators maintain a record of this information in a log book.

For the TFTR emergency generator diesel engine and the C site emergency diesel generator, permit Nos. 092187 and 096074, respectively, emissions are calculated using formulas from the NJDEP and AP-42. The boiler and emergency diesel generators are the largest sources of air emissions at PPPL. Limited by the total fuel consumption per year or by the hours of operation per year, these sources will emit below the 25 tons per year of nitrogen oxides threshold.

The NJDEP Air Emission Statement for 1993 was completed and submitted to NJDEP. Under the definition of a major facility (one which emits >25 tons of nitrogen oxides annually), PPPL is limited by the total amount of fuel consumed by the boilers and by the total number of hours operated by the emergency diesel generators. Therefore, the potential to emit greater than 25 tons of nitrogen oxides (NO_x) each year from the four boilers and the diesel generators is greatly reduced.

PPPL uses and maintains four recovery units for maintenance, service, and repair of appliances containing ozone-depleting substances in order to minimize the release of these substances to the environment. Currently, PPPL is preparing environmental procedures that will address best management practices to reduce fugitive emission sources of refrigerants that contain chlorofluorocarbons (CFCs), which are ozone depleters.

B. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. The PPPL used approximately 28.6 million gallons in FY94 [Gu95]. Since CY84, water-quality analysis was performed at the input to PPPL to measure non-radioactive pollutants (Table 11, E1 location), as well as to measure potential radioactive pollutants exclusive of radium or radon (Table 6). In 1994, a new cross-connection was installed beneath the water tower to provide potable water to the tower for the fire-protection system and other systems.

C. Process (non- potable) Water

In 1986, a multimedia sand filter with crushed carbon was installed to allow the D site cooling tower make-up water to be changed from potable water to process-water (non-potable) supply. In 1987, PPPL made a changeover from potable water to the 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. The present agreement gives PPPL the right to draw up to one million gallons of water per day for process and fire-fighting purposes for the period beginning July 1984 and ending on September 30, 1996.

Filtration to remove solids, chlorination, and corrosion inhibitor is the primary water treatment at the canal pump house. Located at the pump house at the canal, the filter-backwash, discharge number (DSN003) is a separate discharge point in the NJPDES surface-water permit and is monitored once monthly (Table 16). The PPPL used approximately 42.5 million gallons of canal water during FY94 [Gu95]. A sampling point (C1) was established to provide baseline data for process water coming on-site. Table 10 indicates results of water quality analysis at the canal.

D. Surface Water

Surface water is monitored for potential non-radioactive pollutants both on-site and at surface-water discharge pathways (upstream and downstream) off-site. Other sampling locations—Bee Brook, Ditch #5, Delaware & Raritan Canal, Elizabethtown Water Company, Millstone River, and Plainsboro sampling points (See Figs. 20 and 21 and Tables 9-12)—are not required by regulation, but are a part of PPPL's environmental monitoring program.

E. Sanitary Sewage

Sanitary sewage is discharged to the publicly-owned treatment works operated by South Brunswick Township, which is part of the Stony Brook Regional Sewerage Authority (SBRSA). During 1994, due to malfunctioning metering devices, an estimated volume was agreed upon by PPPL, South Brunswick Sewerage Authority, and the Township of Plainsboro. 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 FY94, PPPL estimates a total discharge of 17.5 million gallons of sanitary sewage to the South Brunswick sewerage treatment system [Gu95].

In late 1993, SBRSA issued a draft industrial discharge permit to PPPL that became effective on February 15, 1994. DOE-PAO and PPPL submitted comments on this draft permit and met with SBRSA representatives to discuss those comments. In June 1994, PPPL began to collect samples at manhole #11 (sewerage outfall); sampling at the liquid effluent collection (LEC) tanks began in early 1995. The data are submitted to SBRSA monthly and annually for the LEC tank data and sewerage outfall, respectively (see Table 29).

F. Spill Prevention Control and Countermeasure

PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was revised in 1992 [MP92b]. The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan. Revision of the Plan is scheduled for 1995.

G. Herbicides, Fertilizer, and Pesticides

During CY94, the use of herbicides, pesticides, and fertilizers was managed by PPPL's Facilities Environmental Management Division (F&EM) utilizing outside contractors. These materials are applied in accordance with state and federal regulations. Chemicals are applied by certified applicators.

Table 17 lists the quantities applied during CY94. The amount of herbicides increased during 1994, due to site-wide application for control vegetation. Future site-wide use of herbicides is not expected. No herbicides, pesticides, or fertilizers are stored on site; therefore, no disposal of these types of regulated chemicals is required by PPPL.

H. Polychlorinated Biphenyls (PCBs)

At the end of 1994, PPPL's inventory of equipment containing polychlorinated biphenyls (PCBs) was 653 large, regulated capacitors. No PCB capacitors were removed in 1994. However, as they are taken out of service, the disposal records would be listed in the Annual Hazardous Waste Generators Report [PPPL95b].

I. Hazardous Wastes

In 1986, PPPL built a facility called the Hazardous Materials Storage Facility (HMSF) in the southeast quadrant of the site. Its location places the facility within the 500-year flood plain as was determined by the aerial survey and site mapping of 1993. Changes to the HMSF were designed, environmental permits for the construction of concrete berms, the reconstruction of the driveway, and the addition of offices were obtained, and modifications were completed in FY94.

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) has been submitted for 1994 in accordance with EPA requirements [PPPL95b]. A description of Resource Conservation and Recovery Act (RCRA) compliance is found in Section 3.1.2 of this report.

J. DOE-HQ Environmental Survey

In 1988, a comprehensive environmental survey was conducted by DOE-HQ and outside subcontractors. No significant environmental impact findings were noted at PPPL during this survey. In 1989, a plan of action for findings was forwarded to DOE. With the installation of the detention basin liner in 1994—the longest-lead time item—all findings have been closed out.

Soil sampling for petroleum hydrocarbons from former spills and for chromium in soils from previous use in cooling towers was accomplished in November 1988 [DOEx]. At the time the data was evaluated from this sampling, DOE determined that no follow-up action by PPPL was warranted. In 1994, DEP, however, re-reviewed the data and required further soil sampling around the C site cooling tower for chromium contamination.

6.2.2 Continuous Release Reporting

Under CERCLA's reporting requirement for the release of a listed hazardous substance 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

Five releases were reported to the NJDEP Hotline, and confirmation reports submitted in CY94 (Exhibit 3-1). In accordance with reporting requirements, notifications were made to the NJDEP, because these release events posed a potential threat to the environment. No reports to the National Response Center (NRC) were made since there were no releases that exceeded the reportable quantities (RQ) for any listed substance.

Of the five reported releases, two releases were gasoline leaks from employees vehicles in amounts between 1 to 3 gallons onto an unpaved surface [Fi94a,d]. Each incident was cleaned up immediately upon being reported. One incident was the release of diesel fuel during the removal of an underground storage tank, which had contained diesel fuel. The fourth incident involved a suspected hydraulic oil leak, which was found to be an algal film on the detention basin and not related to a hydraulic oil leak [Fi94b].

The fifth release that was reported to the DEP was a release of about 1600 pounds of Freon ®12 or dichlorodifluoromethane from a chiller reservoir located in the boiler room on C site. The Freon® 12 eventually was discharged into the atmosphere. [Wi94a]. The equipment that leaked the Freon® was repaired.

6.2.4 SARA Title III Reporting Requirements

The 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 1994 SARA Title III report to NJDEP in February 1995 [PPPL95a] No significant changes from the previous year were noted. Though PPPL does not exceed the threshold amounts for the chemicals listed on the Toxic Release Inventory (TRI), PPPL completed the TRI cover page and laboratory exemptions report for 1994, and submitted these documents to DOE.

The SARA Title III report included information about twelve compounds used at PPPL. Of the twelve, five compounds are in their gaseous form and are classified as sudden release of pressure hazards, and two are also acute health hazards. There are eight liquid compounds; nitrogen is used in both gaseous and liquid forms. Fuel oil, gasoline, and petroleum oil are flammables; Bromotrifluoromethane, dichlorodifluoromethane, and sulfuric acid are acute health hazards; sulfuric acid is reactive. PCB's and gasoline are listed as chronic health hazards.

7.0 GROUNDWATER PROTECTION

The focus of PPPL's Ground Water Program is the "Groundwater Protection Management Plan" (GPMP), required by DOE Order 5400.1, "General Environmental Protection Program." The purpose of the GPMP is to provide a written plan, for use as a management tool, to ensure the protection of ground water investigations conducted at the site. Implementation of the GPMP has taken place in parallel with several ground water investigations conducted on-site. These investigations have been performed as required by NJDEP to address potential impacts from former underground storage tanks (USTs) and the detention basin. Prior to NJDEP-required investigations, the U.S. Geological Survey (USGS) performed an investigation in the vicinity of TFTR to evaluate the effects of a potential spill of radioactive water. Also, PPPL conducted a soil vapor survey, which was used to locate monitoring wells. To evaluate potential ground-water impacts from on-site activities, ground-water investigations at the site have resulted in monitoring of 31 wells and two piezometers. Remedial investigations and remedial alternative assessment studies at PPPL are on-going as required by conditions of the Memorandum of Understanding (MOU).

The results of the investigations cited above are summarized in the following sections of this report: Section 6.1.3 (A)— "Hydrological Studies from 1989 to 1993;" Section 6.1.3 (B) —"NJPDES Quarterly Ground Water Monitoring Program;" and Section 6.1.3 (C) — "Regional Ground Water Monitoring Program."

Generally, all the parameters measured in the above investigations meet the New Jersey Ground Water Quality Standards. The exceptions are the detection of two volatile organic compounds consistently found in certain wells: tetrachloroethene and trichloroethene in sixteen of thiry-two ground-water monitoring wells. In 1990, PPPL initiated, as required by the New Jersey Pollutant Discharge Elimination System (NJPDES) permit, a hydrologic investigation to characterize the ground water quality and determine ground water flow and direction. Numerous studies and tasks were performed to meet this requirement and are discussed in the above sections in this report. The ground water monitoring results showed the presence of volatile organic compounds (VOCs) —mainly, tetrachloroethene, trichloroethene, and trichloroethane—in a number of shallow wells on C site; in a number of intermediate depth wells, petroleum hydrocarbons were detected. These VOCs are commonly used or contained in solvents or metal degreasing agents, all of which have been used or are still in use at PPPL. The source of the petroleum hydrocarbons are believed to have originated from former underground storage tanks, which were removed when PPPL detected petroleum hydrocarbons in the surrounding soils. In 1994, the remaining USTs were removed and replaced with above ground storage tanks.

The correlation between the soil gas survey conducted in 1990 and the ground-water data collected from 1991 through 1994 exist for Areas 1 and 3 (see Exhibit 6-2). In *Area 1*, adjacent to the Facilities and Environmental Management (F&EM) Division, the presence of chlorinated solvents, trichloroethane, trichloroethene, and tetrachloroethene, and total petroleum hydrocarbons were confirmed through monitoring the ground water. In *Area 3*, south of the Coil Storage and Assembly (CAS) and Research Equipment Storage and Assembly (RESA) buildings, ground water was contaminated with the three chlorinated solvents. Only tetrachloroethene was detected in the soil gas survey.

In *Area 2*, south of the Receiving Warehouse, there was no apparent correlation between the findings of the soil gas survey and ground-water quality; while the soil gas survey indicated the presence of the three chlorinated solvents, ground water was found to be uncontaminated in this area. Also in *Area 5*, east of TFTR, no correlation was found between the presence of trichloroethane during the soil gas survey and its absence in the ground water. Of the three chlorinated solvents found during the soil gas survey in *Area 4*, northeast of TFTR and the Mockup Buildings—only tetrachloroethene was also detected in ground-water samples.

From the beginning of NJPDES ground-water permit sampling in 1989 to 1995, no semi-volatile or base/neutral organic compounds have been detected in the seven wells located on A, B, C, or D sites of the James Forrestal Campus (JFC) except one. In August 1994, the compound, 4-Bromophenyl-phenyl Ether, was detected in well D-12 on C site at 15 μg/L and in well MW-14 on B site at 110 μg/L. Elimination of the ground-water monitoring requirements under the NJPDES permit for the three wells (MW-14, MW-15, and MW-16) located on A and B sites of JFC was requested in the permit renewal application in July 1994.

The presence of foundation dewatering sumps on D site largely influence the ground water gradient. The sumps create a shallow cone of depression, drawing the ground water, which would under normal conditions flow to the south/southeast toward Bee Brook. It appears that all the ground water on the site, except on the edges of the site, is drawn radially toward the D site sumps.

In January 1995, NJDEP granted "conditional" approval of the work plan, which meant that NJDEP had additional conditions they wanted included in the work plan. The regional ground water quality investigation is in progress under the conditions of the MOU. PPPL and DOE/PAO are responsible for the conduct of this investigation at C and D sites.

8.0 QUALITY ASSURANCE

Analysis of environmental samples for radioactivity was accomplished in-house by the Radiological Environmental Monitoring Laboratory (REML). The REML procedures follow the DOE's Environmental Measurements Laboratory's EML HASL-300 Manual [Vo82] or other nationally recognized standards. Approved analytical techniques are documented in the REML procedures [REML90]. The PPPL participates in the EPA (Las Vegas) program as part of maintaining its certification. These programs provide blind samples for analysis and subsequent comparison to values obtained by other participants, as well as to known values.

Since CY84, PPPL initiated a program to have its REML certified by the state of New Jersey through the EPA Quality Assurance (QA) program. The REML complies with the EPA and NJDEP QA requirements for certification. In March 1986, the REML facilities and procedures were reviewed and inspected by EPA/Las Vegas and the NJDEP. The laboratory was certified for tritium analysis in urine (bioassays) and water and has been recertified in these areas annually since 1988. While the certification application for gamma spectroscopy was made in 1990 and all the EPA blind samples were measured within accepted limits, a NJDEP site inspection of the REML is needed for NJDEP to authorize this certification. Also, PPPL has applied for pH and temperature certification from NJDEP.

In 1994, PPPL revised internal procedures, EN-OP-001 and EN-OP-002, "Surface Water Sampling Procedure" and "Ground Water Sampling Procedures," respectively, and developed EN-OP-008, "Stormwater Sampling Procedures." In these procedures are detailed descriptions of all the NJPDES permit-required sampling and analytical methods for the collection of samples, the analyses of these samples, and the quality assurance/quality control requirements. All subcontractor laboratories and/or PPPL employees are required to follow these procedures. Chain-of-custody forms are required for all samples; holding times are closely checked to ensure that the analysis was performed within the established holding time and that the data is valid. Field blanks are required for all ground water sampling, and trip blanks are required for all volatile organic compound analyses. The subcontractor laboratories used by PPPL participate in a state of New Jersey QA program and must follow their own internal quality assurance plans [NAC and EMSL].

9.0 ACKNOWLEDGMENTS

Steve Elwood and Jerry Gilbert of Health Physics Division for Section 5.0, "Environmental Radiological Program Information," and the tables and figures included in this document: the data for radiation analysis, in-house radiochemical analyses, and the meteorological data, instrument installation, and calibration.

Jerry Levine of Environmental, Nuclear Licensing, and Permitting Division for the NESHAPs calculations and emissions and dose data.

Bill Slavin of Safety Division for the SARA Title III and Toxic Release Inventory information.

Bob Gulay of Facilities & Environmental Management Division for the on-site water-utilization information.

Long Puo-Ku of Engineering Analysis Division for the Wind roses and meteorological figures.

Dan Jassby of TFTR Project for the neutron generation data.

Mark Snyder and Jim Scott of Environmental Restoration/Waste Management Division for the waste minimization and pollution prevention and hazardous-waste disposal information.

Dietmar Krause of Photographic Division for numerous figure reproductions.

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

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11.0 TABLES

Table #	Title	Page
Table 1.	TFTR Radiological Design Objectives and Regulatory Limits	60
Table 2.	Summary of Emissions and Doses from TFTR for 1994	61
Table 3.	AnnualRange of Tritium in Precipitation from 1985 to 1994	62
Table 4.	Precipitation and Tritium in Precipitation at PPPL for 1994	63
Table 5.	Tritium Concentrations from the TFTR Stack for 1994	64
Table 6.	Tritium Concentrations in Surface Water for 1994	66
Table 7.	Tritium Concentrations in Groundwater for 1994	67
Table 8.	Tritium Concentrations in Biota Moisture for 1994	67
Table 9.	Surface Water Analysis for Bee Brook, Locations B1 and B2 for 1994	68
Table 10.	Surface Water Analysis for D&R Canal, C1, and Ditch #5, D1 for 1994	68
Table 11.	Surface Water Analysis for Potable Water Supply, E1, and Millstone River, M1 for 1994	69
Table 12.	Surface Water Analysis for Plainsboro, Locations P1 and P2 for 1994	69
Table 13.	Detention Basin Influent Analysis (NJPDES) for 1994	69
Table 14.	Monthly Surface Water Analysis for Ditch #5, Location D2 (NJPDES DSN001) for 1994	70
Table 15.	Monthly Surface Water Analysis for Stormwater, Location DSN002 (NJPDES NJ0023922)	71
Table 16.	Monthly Surface Water Analysis for the Canal Pump House, Location DSN003 (NJPDES NJ0023922)	71
Table 17.	Fertilizer, Pesticides, and Herbicide Application for 1994	72
Table 18.	Average Ground Water Elevation by Well Group for 1994	72
Table 19.	Total Petroleum Hydrocarbon Results from Quarterly Ground Water Monitoring Program for 1994	72
Table 20.	Ground Water Monitoring Program Results - August 1994	73
Table 21.	Ground Water Analysis for Well MW-14, MW-15, and MW-16 for 1994	74
Table 22.	Ground Water Analysis for Wells D-11 and D-12 for 1994	75
Table 23.	Ground Water Analysis for Well TW-2 and TW-3 for 1994	76
Table 24.	Ground Water Volatile Organics Analytical Results from Wells D-11, D-12, and TW-3 - May 1994	77
Table 25.	Volatile Organics Analytical Results from Wells D-11 and D-12, D Site Sumps, and Detention Basin Inflows - August 1994	78
Table 26.	NJPDES Wells Ground Water Base Neutral Analytical Results - August 1994	79
Table 27.	Volatile Organic Compounds Exceeding NJDEP Ground Water Quality Standards for Class II-A Aquifers-June 1994	80
Table 28.	Summary of Common Ion Analysis of Ground Water on C and D Sites - June 1994	81
Table 29.	Sanitary Sewer Sampling and Analytical Results for 1994	83
Table 30	Volatile Organic Compounds Exceeding NJDEP Groundwater Quality Standards for Class II-A Aquifers (highest detected concentrations)	84

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

CONDITION		PUBLIC EXPOSURE[b]		OCCUPATIONAL EXPOSURE	
		REGULATORY LIMIT	DESIGN OBJECTIVE	REGULATORY LIMIT	DESIGN OBJECTIVE
<u>ROUTINE OPERATION</u> 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		
<u>ACCIDENTS</u> 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 the radiation safety guidelines, practices and procedures included in PPPL ESHD 5008, Section 10.

(b) Evaluated at the 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 12 for emergency personnel exposure limits.

Table 2. Summary of Emissions and Doses from TFTR for 1994

Radionuclide & Pathway	Quantity Released in 1994[1]	EDE at the Site Boundary	EDE at the Nearest Business[2]	Population Dose within 80 KM[3]
Tritium (air)	45.55 Ci HTO[4], 93.13 Ci HT	1.2×10^{-1} mrem[5]	3.4×10^{-2} mrem[6]	4.5 person-rem[7]
Ar-41 (air)	14.45 Ci[4]	5.8×10^{-2} mrem[8]	1.6×10^{-2} mrem[6]	8.4×10^{-2} person-rem[9]
N-13 (air)	9.81 Ci[4]	2.7×10^{-2} mrem[8]	7.6×10^{-3} mrem[6]	3.3×10^{-3} person-rem[9]
N-16 (air)	0.75 Ci[4]	5.0×10^{-5} mrem[8]	1.4×10^{-5} mrem[6]	Negligible
Cl-40 (air)	1.21 Ci[4]	9.9×10^{-3} mrem[8]	2.8×10^{-3} mrem[6]	Negligible
S-37 (air)	1.22 Ci[4]	1.3×10^{-2} mrem[8]	3.6×10^{-3} mrem[6]	Negligible
Direct & Scattered Neutrons & Gamma Radiation	------------	6.7×10^{-2} mrem[10]	1.7×10^{-2} mrem[11]	Negligible
Tritium (HTO) (water)	2.88×10^{-1} Ci[12]	5.8×10^{-3} mrem[13]	------------	7.9×10^{-3} person-rem[14]
Total	------------	3.0×10^{-1} mrem	8.1×10^{-2} mrem	4.6 person-rem
Background	------------	600 mrem[15]	600 mrem[15]	1.6×10^{6} person-rem

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[1]Tritium (HTO and HT) quantities are as measured by the TFTR passive stack monitor; Ar-41, N-13, N-16, Cl-40, and S-37 quantities are based on production of 1.3 E19 D-D neutrons, and 1.85 E20 D-T neutrons in 1994, using methodology of JL-542, Rev.1, 2/5/93 for releases during D-T operation.

[2]At Princeton Bank Building, 351 meters east of TFTR stack.

[3]Based on year 1995 population figures as utilized for TFTR D-T EA. See Table 4 of Bentz and Bender, 1987.

[4]Measured for tritium (see footnote #1); per note, D. Jassby to V. Finley, 3/13/95 for other air emissions (i.e., source of neutron production data).

[5]Based on NOAA X/Q [Start, 1989] and JL-457, 7/2/92, Table 1 (1% of HT releases are assumed to convert to HTO); (45.55 Ci x 2.6 E-03 mrem/Ci) + (0.9313 Ci x 2.6 E-03 mrem/Ci) + (92.1987 Ci x 1.05 E-07 mrem/Ci).

[6]Based on 28% of the NOAA X/Q at the site boundary [Start, 1989].

[7]Scaling from values used for the TFTR D-T EA, we get (138.68 Ci/500 Ci) x 16.2 person-rem = 4.5 person-rem.

[8]Based on NOAA X/Q [Start, 1989] and JL-457, 7/2/92, Table 1; Ar-41: 14.45 Ci x 4.0 E-03 mrem/Ci. N-13: 9.81 Ci x 2.8 E-03 mrem/Ci. N-16: 0.75 Ci x 6.71 E-05 mrem/Ci. Cl-40: 1.21 Ci x 8.2 E-03 mrem/Ci.

S-37: 1.22 Ci x 1.08 E-02 mrem/Ci.

[9]Scaling from values used for the TFTR D-T EA, we get for Ar-41: (14.45 Ci/115 Ci) x 0.67 person-rem = 8.4 E-02 person-rem; for N-13: (9.81 Ci/434 Ci) x 0.149 person-rem = 3.3 E-03 person-rem.

[10]Based on 1994 neutron production (see Note 1) and neutron and gamma radiation dose per neutron given in Table 4 of PPPL Report PPPL-3020, "Measurements of TFTR D-T Radiation Shielding Efficiency," 11/94.

[11]Based on inverse square decrease between site boundary (176 meters) and nearest business (351 meters).

[12] Released from Liquid Effluent Collection Tanks (LECT) to Stony Brook Sewer Authority treatment facility via PPPL sanitary sewer system.

[13] Based on usage of 1 E10 liters/yr for Stony Brook treatment facility, as per TFTR D-T EA, the dose to a person who drank all his/her water from the waterway (Millstone River) into which the treatment facility discharged in 1993 would be [(2.88 E-01 Ci/yr)(/1 E10 l/yr)] x [(4 mrem)/(2 E-08 Ci/l)] = 5.8 E-03 mrem

[14] Based on use of Millstone River as drinking water source for 500,000 people for 1 day per year (estimate by Elizabethtown Water Company of actual use is a few hours once every several years).

[15] Based on 100 mrem annual background dose exclusive of radon, plus dose due to exposure to average radonconcentration in Plainsboro homes (Memo, J. Greco to J. Levine, 11/13/90, "Radon Dose Equivalent," JMG-160).

Table 3.

Annual Range of Tritium Concentration in Precipitation

Year	Tritium Range
1985	45 to 160
1986	40 to 140
1987	26 to 144
1988	34 to 105
1989	7 to 90
1990	14 to 94
1991	10 to 154
1992	10 to 83.8
1993	24.5 to 145
1994	32.2 to 1130.4

Tritium Range measured in pCi /liter

Table 4. 1994 Precipitation and Tritium in Precipitation at PPPL

START DATE	WEEK	INCH	INCH/ MONTH	MONTH	ACCUMU-LATION	Tritium Concentration
3-Jan	1	1.150			1.150	
10-Jan	2	0.900			2.050	
17-Jan	3	1.600			3.650	32.18
24-Jan	4	2.550	6.200	January	6.200	
31-Jan	5	0.000			6.200	1072.47
7-Feb	6	0.000			6.200	103.31
14-Feb	7	1.350			7.550	110.07
21-Feb	8	1.100	2.450	February	8.650	
28-Feb	9	1.300			9.950	218.60
7-Mar	10	2.300			12.250	51.43
14-Mar	11	0.450			12.700	82.23
21-Mar	12	2.000			14.700	606.84
28-Mar	13	1.050	7.100	March	15.750	52.51
4-Apr	14	0.850			16.600	
11-Apr	15	1.150			17.750	50.84
18-Apr	16	0.000			17.750	130.13
25-Apr	17	0.050	2.050	April	17.800	
2-May	18	1.450			19.250	
9-May	19	0.350			19.600	100.88
16-May	20	0.750			20.350	112.61
23-May	21	1.200			21.550	91.04
30-May	22	0.000	3.750	May	21.550	66.07
6-Jun	23	1.900			23.450	57.66
13-Jun	24	0.000			23.450	37.01
20-Jun	25	0.450			23.900	
27-Jun	26	3.450	5.800	June	27.350	1130.40
4-Jul	27	0.000			27.350	161.37
11-Jul	28	0.750			28.100	
18-Jul	29	2.350			30.450	176.68
25-Jul	30	4.200	7.300	July	34.650	124.90
1-Aug	31	0.800			35.450	132.94
8-Aug	32	1.150			36.600	
15-Aug	33	3.205			39.805	51.85
22-Aug	34	1.305			41.110	88.01
29-Aug	35	0.300	6.760	August	41.410	
5-Sep	36	0.000			41.410	
12-Sep	37	1.000			42.410	46.17
19-Sep	38	0.900			43.310	
26-Sep	39	0.250	2.150	Sept.	43.560	278.28
3-Oct	40	0.050			43.610	156.05
10-Oct	41	0.000			43.610	
17-Oct	42	0.800			44.410	
24-Oct	43	0.000	0.850	October	44.410	250.82
31-Oct	44	0.150			44.560	
7-Nov	45	0.550			45.110	45.40
14-Nov	46	0.250			45.360	38.99
21-Nov	47	1.650			47.010	131.36
28-Nov	48	1.050	3.650	Nov.	48.060	55.06
5-Dec	49	1.750			49.810	298.16
12-Dec	50	0.450			50.260	288.62
19-Dec	51	0.750			51.010	
26-Dec	52	0.250	3.200	Dec.	51.260	153.46

Tritium concentration measured in pCi/l or picoCuries per liter.

Table 5. Tritium Concentrations from the TFTR Stack for 1994

Sample Start Date/Time	Sample Stop Date/Time	Total Stack Volume Release (m3)	HTO Concentration (pCi/m3)	HT Concentration (pCi/m3)	Total Stack HTO Release (pCi)	Total Stack HT Release (pCi)
1/6	1/10	2.29E+05	5.57E+05	7.81E+04	1.28E+11	1.79E+10
1/6	1/10	3.56E+06	7.13E+05	1.78E+05	2.54E+12	6.34E+11
1/10	1/13	2.67E+06	8.90E+05	1.76E+05	2.38E+12	4.71E+11
1/13	1/17	1.85E+06	6.75E+05	8.49E+04	1.25E+12	1.57E+11
1/13	1/17	1.76E+06	4.87E+05	3.52E+04	8.57E+11	6.19E+10
1/17/	1/20	2.73E+06	9.04E+05	0.00E+00	2.47E+12	0.00E+00
1/20	1/24	7.65E+04	7.22E+05	3.06E+04	5.52E+10	2.34E+09
1/20	1/24	3.61E+06	3.86E+05	3.71E+04	1.39E+12	1.34E+11
1/24	1/27	1.84E+06	5.22E+05	1.12E+05	9.58E+11	2.05E+11
1/24	1/27	1.00E+06	4.92E+05	2.26E+04	4.93E+11	2.27E+10
1/27	1/31	3.66E+06	1.59E+05	2.85E+04	5.82E+11	1.04E+11
1/31	2/3	2.76E+06	4.79E+04	3.21E+03	1.32E+11	8.86E+09
2/3	2/7	7.65E+04	4.25E+04	6.52E+03	3.25E+09	4.99E+08
2/3	2/7	3.56E+06	4.22E+04	2.61E+03	1.50E+11	9.29E+09
2/7	2/10	9.18E+05	2.18E+05	3.60E+06	2.00E+11	3.30E+12
2/7	2/10	1.85E+06	1.91E+05	1.61E+05	3.54E+11	2.99E+11
2/10	2/14	3.64E+06	1.10E+05	3.38E+03	3.99E+11	1.23E+10
2/14	2/17	2.71E+06	1.88E+05	5.70E+03	5.11E+11	1.55E+10
2/17	2/21	3.82E+04	4.19E+04	1.05E+04	1.60E+09	4.03E+08
2/17	2/21	3.65E+06	8.27E+04	4.83E+03	3.02E+11	1.76E+10
2/21	2/24	1.84E+06	5.77E+04	8.89E+03	1.06E+11	1.63E+10
2/21	2/24	8.72E+05	6.98E+04	5.83E+03	6.08E+10	5.08E+09
2/24	2/28	3.64E+06	4.47E+04	1.39E+04	1.63E+11	5.05E+10
2/28	3/3	2.89E+06	2.42E+04	5.48E+04	7.01E+10	1.59E+11
3/3	3/7	5.73E+04	3.73E+04	3.85E+04	2.14E+09	2.21E+09
3/3	3/7	3.50E+06	6.32E+04	3.99E+04	2.21E+11	1.40E+11
3/7	3/10	2.75E+06	3.19E+04	1.47E+05	8.77E+10	4.05E+11
3/10	3/14	3.60E+06	4.12E+04	2.82E+05	1.48E+11	1.02E+12
3/10	3/14	1.66E+05	6.14E+04	7.21E+04	1.02E+10	1.20E+10
3/14	3/17	3.58E+06	8.60E+04	2.64E+05	3.08E+11	9.46E+11
3/17	3/21	7.65E+04	4.80E+04	1.72E+04	3.67E+09	1.31E+09
3/17	3/21	3.59E+06	2.85E+05	1.44E+05	1.02E+12	5.18E+11
3/21	3/24	2.82E+06	1.98E+05	1.35E+05	5.58E+11	3.81E+11
3/24	3/28	3.60E+06	4.23E+04	5.56E+04	1.52E+11	2.00E+11
3/24	3/28	4.97E+04	7.68E+04	1.80E+05	3.82E+09	8.92E+09
3/28	3/31	2.75E+06	3.62E+04	4.11E+04	9.94E+10	1.13E+11
3/31	4/4	3.66E+06	2.35E+04	4.39E+04	8.61E+10	1.61E+11
4/4	4/7	1.77E+06	2.02E+04	3.04E+04	3.57E+10	5.37E+10
4/4	4/7	9.56E+05	2.49E+04	2.34E+04	2.38E+10	2.23E+10
4/7	4/11	3.65E+06	2.56E+04	8.69E+02	9.35E+10	3.17E+09
4/7	4/11	5.35E+04	3.28E+04	6.18E+04	1.76E+09	3.31E+09
4/11	4/14	2.75E+06	3.48E+04	3.19E+04	9.58E+10	8.78E+10
4/14	4/18	9.56E+04	2.27E+04	4.87E+04	2.17E+09	4.66E+09
4/14	4/18	3.59E+06	2.61E+04	3.44E+04	9.39E+10	1.24E+11
4/18	4/21	2.78E+06	2.01E+04	3.29E+04	5.60E+10	9.13E+10
4/21	4/25	1.80E+06	2.49E+04	3.18E+03	4.47E+10	5.71E+09
4/21	4/25	3.82E+04	2.49E+04	7.61E+04	9.52E+08	2.91E+09
4/25	4/28	2.74E+06	2.37E+04	4.31E+04	6.50E+10	1.18E+11
4/28	5/2	1.03E+05	2.65E+04	1.78E+05	2.73E+09	1.84E+10
4/28	5/2	3.62E+06	3.65E+04	1.84E+05	1.32E+11	6.68E+11
5/2	5/5	2.71E+06	2.01E+04	2.69E+05	5.45E+10	7.31E+11
5/5	5/9	3.61E+06	4.96E+04	6.45E+04	1.79E+11	2.33E+11
5/5	5/9	1.15E+05	2.20E+04	3.13E+05	2.52E+09	3.59E+10
5/9	5/12	2.71E+06	3.97E+04	2.73E+05	1.07E+11	7.38E+11
5/12	5/16	9.18E+04	2.08E+04	1.90E+05	1.91E+09	1.74E+10
5/12	5/16	3.59E+06	7.87E+04	2.00E+05	2.83E+11	7.20E+11
5/16	5/19	2.71E+06	1.71E+04	2.87E+05	4.63E+10	7.79E+11
5/19	5/23	3.59E+06	3.32E+04	4.32E+05	1.19E+11	1.55E+12
5/19	5/23	1.15E+05	2.35E+04	3.35E+05	2.70E+09	3.84E+10
5/23	5/26	2.72E+06	2.47E+04	3.14E+05	6.71E+10	8.56E+11

Table 5 (continued). Tritium Concentrations from the TFTR Stack for 1994

Sample Start Date/Time	Sample Stop Date/Time	Total Stack Volume Release (m3)	HTO Concentration (pCi/m3)	HT Concentration (pCi/m3)	Total Stack HTO Release (pCi)	Total Stack HT Release (pCi)
5/26	5/27	4.40E+05	6.79E+05	4.13E+05	2.99E+11	1.82E+11
5/26	5/27	5.16E+05	7.51E+05	5.32E+05	3.88E+11	2.74E+11
5/27	5/31	1.53E+05	5.29E+04	7.22E+05	8.09E+09	1.10E+11
5/27	5/31	3.52E+06	2.43E+04	4.97E+05	8.56E+10	1.75E+12
5/31	6/2	1.80E+06	2.70E+05	3.62E+05	4.85E+11	6.50E+11
6/2	6/3	1.28E+06	1.24E+05	4.35E+05	1.58E+11	5.57E+11
6/3	6/6	2.29E+06	5.18E+04	4.44E+05	1.19E+11	1.02E+12
6/3	6/6	7.65E+04	1.35E+05	2.15E+04	1.04E+10	1.64E+09
6/6	6/9	2.70E+06	1.63E+04	5.38E+05	4.39E+10	1.45E+12
6/9	6/13	3.62E+06	1.30E+04	7.77E+05	4.71E+10	2.81E+12
6/13	6/16	2.83E+06	1.72E+05	8.45E+05	4.88E+11	2.39E+12
6/16	6/20	3.58E+06	7.60E+04	5.58E+05	2.72E+11	2.00E+12
6/20	6/23	2.89E+06	9.76E+05	3.34E+05	2.82E+12	9.65E+11
6/23	6/27	3.55E+06	8.57E+05	2.29E+05	3.04E+12	8.14E+11
6/27	6/30	2.84E+06	4.71E+05	3.73E+05	1.34E+12	1.06E+12
6/30	7/5	4.50E+06	4.89E+04	4.11E+05	2.20E+11	1.85E+12
7/5	7/7	1.93E+06	2.80E+04	5.94E+05	5.40E+10	1.15E+12
7/7	7/11	3.57E+06	2.30E+04	6.33E+05	8.20E+10	2.26E+12
7/11	7/14	2.87E+06	4.24E+04	9.03E+05	1.22E+11	2.59E+12
7/14	7/18	3.54E+06	5.75E+04	1.54E+06	2.03E+11	5.45E+12
7/18	7/20	1.51E+06	8.79E+04	5.78E+06	1.33E+11	8.75E+12
7/18	7/20	4.09E+05	6.61E+04	3.08E+06	2.70E+10	1.26E+12
7/20	7/21	8.98E+05	5.75E+04	3.07E+06	5.17E+10	2.76E+12
7/21	7/22	9.67E+05	4.46E+04	2.40E+06	4.32E+10	2.32E+12
7/22	7/25	2.70E+06	3.94E+04	6.63E+05	1.06E+11	1.79E+12
7/25	7/28	2.72E+06	1.57E+05	3.21E+05	4.28E+11	8.74E+11
7/25	7/28	3.82E+04	7.63E+04	3.44E+05	2.92E+09	1.32E+10
7/28	8/1	3.57E+06	3.63E+04	2.95E+05	1.30E+11	1.06E+12
8/1	8/4	2.91E+06	1.83E+04	1.90E+05	5.31E+10	5.51E+11
8/4	8/8	1.61E+05	2.64E+04	2.09E+05	4.25E+09	3.36E+10
8/4	8/8	3.53E+06	4.43E+04	1.80E+05	1.56E+11	6.34E+11
8/8	8/11	2.69E+06	8.78E+04	9.05E+05	2.36E+11	2.44E+12
8/11	8/15	3.57E+06	4.49E+04	5.61E+05	1.60E+11	2.00E+12
8/15	8/18	2.87E+06	5.98E+04	3.78E+05	1.71E+11	1.08E+12
8/18	8/22	3.54E+06	3.01E+04	3.39E+05	1.06E+11	1.20E+12
8/22	8/25	2.89E+06	1.14E+05	1.13E+06	3.30E+11	3.27E+12
8/25	8/29	3.51E+06	4.49E+04	7.30E+05	1.58E+11	2.57E+12
8/29	9/1	2.84E+06	4.65E+04	2.77E+05	1.32E+11	7.88E+11
9/1	9/6	1.06E+06	2.90E+04	8.93E+04	3.07E+10	9.45E+10
9/1	9/6	3.61E+06	4.42E+04	1.27E+05	1.60E+11	4.58E+11
9/6	9/8	1.77E+06	5.37E+04	1.73E+05	9.52E+10	3.07E+11
9/8	9/12	3.56E+06	2.66E+04	4.21E+04	9.45E+10	1.50E+11
9/8	9/12	1.15E+05	2.16E+04	9.26E+04	2.48E+09	1.06E+10
9/12	9/15	2.74E+06	3.81E+04	4.74E+04	1.04E+11	1.30E+11
9/15	9/19	3.57E+06	3.90E+04	1.81E+04	1.39E+11	6.46E+10
9/19	9/22	2.70E+06	4.09E+05	3.33E+04	1.11E+12	8.99E+10
9/22	9/26	3.53E+06	5.95E+04	1.83E+05	2.10E+11	6.47E+11
9/26	9/29	2.86E+06	6.20E+04	7.61E+03	1.77E+11	2.18E+10
9/29	10/3	3.57E+06	3.12E+04	8.38E+03	1.12E+11	3.00E+10
10/3	10/6	2.91E+06	2.14E+04	1.35E+04	6.23E+10	3.94E+10
10/6	10/10	3.51E+06	2.39E+04	1.16E+04	8.38E+10	4.08E+10
10/10	10/13	2.79E+06	2.58E+04	8.98E+03	7.19E+10	2.51E+10
10/13	10/17	3.63E+06	2.78E+04	4.86E+03	1.01E+11	1.76E+10
10/17	10/20	2.92E+06	3.01E+04	5.58E+05	8.79E+10	1.63E+12
10/20	10/24	3.51E+06	1.36E+05	3.91E+05	4.76E+11	1.37E+12
10/20	10/24	1.03E+05	3.14E+04	1.23E+05	3.25E+09	1.27E+10
10/24	10/27	2.77E+06	9.68E+04	4.06E+04	2.68E+11	1.12E+11
10/27	10/31	3.57E+06	3.61E+04	1.02E+05	1.29E+11	3.63E+11
10/31	11/3	2.86E+06	1.24E+05	8.64E+05	3.53E+11	2.47E+12

Table 5 (continued). Tritium Concentrations from the TFTR Stack for 1994

Sample Start Date/Time	Sample Stop Date/Time	Total Stack Volume Release (m3)	HTO Concentration (pCi/m3)	HT Concentration (pCi/m3)	Total Stack HTO Release (pCi)	Total Stack HT Release (pCi)
11/3	11/7	3.57E+06	7.80E+04	9.82E+05	2.79E+11	3.50E+12
11/7	11/10	5.73E+04	1.87E+05	3.34E+05	1.07E+10	1.92E+10
11/7	11/10	2.86E+06	2.31E+05	2.44E+05	6.61E+11	6.97E+11
11/10	11/14	3.55E+06	6.88E+04	1.06E+04	2.44E+11	3.77E+10
11/14	11/17	2.89E+06	7.81E+04	1.90E+04	2.26E+11	5.50E+10
11/17	11/21	3.54E+06	1.16E+05	1.39E+04	4.11E+11	4.92E+10
11/21	11/28	1.80E+05	4.87E+04	9.69E+03	8.76E+09	1.74E+09
11/21	11/28	6.40E+06	2.04E+05	5.09E+04	1.31E+12	3.25E+11
11/28	12/1	2.70E+06	5.13E+04	1.69E+04	1.38E+11	4.56E+10
12/1	12/5	3.55E+06	1.36E+05	4.52E+04	4.82E+11	1.61E+11
12/5	12/8	2.86E+06	8.48E+04	2.76E+04	2.43E+11	7.91E+10
12/8	12/12	3.54E+06	9.99E+04	5.40E+04	3.54E+11	1.91E+11
12/12	12/15	1.53E+05	1.20E+05	5.46E+04	1.84E+10	8.35E+09
12/12	12/15	2.73E+06	1.48E+05	2.68E+04	4.06E+11	7.33E+10
12/15	12/19	3.82E+06	3.84E+05	1.36E+04	1.47E+12	5.19E+10
12/19	12/22	2.46E+06	4.76E+04	9.86E+03	1.17E+11	2.42E+10
12/22	12/27	2.71E+06	2.54E+04	7.61E+03	6.88E+10	2.07E+10
12/22	12/27	1.93E+06	1.40E+04	3.63E+04	2.70E+10	7.01E+10
12/27	1/3/95	4.63E+06	2.68E+04	6.11E+03	1.24E+11	2.83E+10
12/27	1/3/95	1.93E+06	3.02E+04	4.17E+03	5.83E+10	8.05E+09
Total					**4.30E+13**	**9.28E+13**

Table 6. Tritium Concentrations in Surface Water for 1994

Sampling Date	B1	B2	C1	D1	D2	BMW
1/25	2.01E+02	1.87E+02	5.31E+01	4.59E+02	1.66E+02	2.97E+01
2/18	6.40E+01	9.27E+01	5.50E+01	1.46E+02	1.60E+02	3.65E+01
3/7	2.00E+02	2.07E+02	4.01E+01	9.24E+01	1.90E+02	5.63E+01
4/1	1.27E+02	9.99E+01	6.37E+01	1.12E+02	1.45E+02	3.91E+01
4/20	5.67E+01	7.75E+01	5.43E+01	5.57E+01	1.13E+02	3.33E+01
4/27	5.32E+01	6.65E+01	5.58E+01	6.28E+01	1.33E+02	4.04E+01
5/23	7.44E+01	9.98E+01	6.37E+01	6.87E+01	1.04E+02	3.55E+01
6/10	6.60E+01	8.10E+01	6.97E+01	5.68E+01	8.49E+01	4.39E+01
7/7	8.78E+01	1.36E+02	0.00E+00	7.53E+01	1.41E+02	4.51E+01
8/1	7.66E+01	1.38E+02	0.00E+00	7.29E+01	2.70E+02	6.48E+01
8/26	7.63E+01	1.21E+02	4.94E+01	9.04E+01	0.00E+00	3.92E+01
9/9	1.14E+02	1.89E+02	1.03E+02	1.53E+02	1.64E+02	4.71E+01
10/3	4.65E+01	4.91E+01	3.90E+01	4.55E+01	3.67E+02	0.00E+00
11/9	8.95E+01	8.07E+01	6.14E+01	4.20E+01	6.81E+01	0.00E+00
12/14	4.93E+01	1.09E+02	3.80E+01	4.67E+01	7.63E+01	4.83E+01
12/1	3.96E+01	9.40E+01	3.03E+01	3.58E+01	1.14E+02	1.80E+01

BMW = baseline measurement
All measurement values are in pCi/Liter.
Blank indicate sample not collected.

Table 6 (continued). Tritium Concentrations in Surface Water for 1994

Sampling Date	E1	P1	P2	M1	BMW
1/25	4.08E+01	3.67E+01	5.15E+01	3.01E+01	2.97E+01
2/18	3.83E+01	3.51E+01	5.63E+01	2.97E+01	3.65E+01
3/7	6.27E+01	5.36E+01	6.39E+01	4.56E+01	5.63E+01
4/1	4.19E+01	4.83E+01	4.25E+01	3.00E+01	3.91E+01
4/20	4.76E+01	4.01E+01	4.51E+01	4.99E+01	3.33E+01
4/27	5.13E+01	6.23E+01	6.21E+01	3.53E+01	4.04E+01
5/23	6.06E+01	4.77E+01	6.18E+01	5.89E+01	3.55E+01
6/10	5.26E+01	4.76E+01	6.64E+01	5.11E+01	4.39E+01
7/7	6.01E+01	5.62E+01	7.12E+01	5.39E+01	4.51E+01
8/1	3.38E+01	5.47E+01	6.75E+01	6.05E+01	6.48E+01
8/26	4.37E+01	6.46E+01	6.31E+01	4.29E+01	3.92E+01
9/9	1.06E+02	8.12E+01	1.32E+02	7.70E+01	4.71E+01
10/3	3.38E+01	5.09E+01	3.46E+01	9.90E+01	0.00E+00
11/9	1.46E+02	1.30E+02	1.88E+02	1.73E+02	0.00E+00
12/14	5.12E+01	3.22E+01	3.77E+01	3.51E+01	4.83E+01
12/1	0.00E+00	2.53E+01	4.81E+01	2.42E+01	1.80E+01

BMW = baseline measurement
All measurement values are in pCi/Liter.
Blank indicate sample not collected.

Table 7. Tritium Concentrations in Ground Water for 1994

Collection Date	D11	D12	TW1	TW3	TW10
February			100.69		33.86
May			246.38		49.31
August	238	129	234.87	130.37	59.12
November			163.15		52.72

All measurement values are in pCi/Liter.
Blanks indicate that no sample was collected.

Table 8. Tritium Concentrations in Biota Moisture for 1994

Sample Type	Stultz Farm	Stultz Farm Dup.	Control
Strawberries	7.48E+01	8.24E+01	6.36E+01
Tomatoes	2.74E+01	5.31E+01	4.03E+01
Cucumber	4.87E+01	5.43E+01	4.79E+01
Zucchini	4.32E+01	5.00E+01	4.91E+01
Eggplant	5.65E+01	6.28E+01	5.82E+01
Green Pepper	4.29E+01	5.23E+01	6.53E+01
Pumpkin	4.10E+01	5.45E+01	4.49E+01

All measurement values are in pCi/Liter.
Blanks indicate that no sample was collected.

Table 9.
Surface Water Analysis
for Bee Brook, Locations B1 and B2 for 1994

Parameters, Units	B1 5/11/94	B1 8/03/94	B2 5/11/94	B2 8/03/94
Chromium, mg/l	<0.01	<0.02	<0.01	<0.02
pH, units	6.62	6.92	6.72	7.50
Phenolics as phenol, mg/l	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/l	<20	<20.0	300	<20.0
Biochemical Oxygen Demand 5-day total, mg/l	5.0	2.9	10	2.6
Temperature, °C	No data*	25.9	No data*	26.7
Petroleum Hydrocarbons by IR, mg/l	<1.0	<1.0	<1.0	<1.0
Ammonia-N, mg/l	<0.05	<0.50	<0.05	<0.50
Total Suspended Solids, mg/l	<5.0	<5.0	12	<5.0
Total Dissolved Solids, mg/l	49.0	64.0	210	110.0
Flow, Approximate GPM	Not Detected	Not Detected	893.40	729.60

* Temperature probe was not properly connected to the temperature meter. No temperature data was collected.

Table 10.
Surface Water Analysis
for D&R Canal, C1, and Ditch #5, D1 for 1994

Parameters, Units	C1 5/11/94	C1 8/03/94	D1 5/11/94	D1 8/03/94
Chromium, mg/l			<0.01	<0.02
pH, units	6.95	7.74	6.71	7.37
Phenolics as phenol, mg/l	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/l	<20	<20.0		<20.0
Biochemical Oxygen Demand 5-day total, mg/l	<1	3.8	<1	2.8
Temperature, °C	18	29.5	17	27.8
Petroleum Hydrocarbons by IR, mg/l	<1.0	<1.0	<1.0	<1.0
Ammonia-N, mg/l	<0.05	<0.50	<0.05	<0.50
Total Suspended Solids, mg/l	7.0	<5.0	<5.0	<5.0
Total Dissolved Solids, mg/l	120.0	41.0	140.0	87.0
Flow, Approximate GPM			1364.44	1,238.77

Blank indicates no measurement.
* Not available due to equipment problem

Table 11.
Surface Water Analysis
for the Millstone River—M1 for 1994

Parameters, Units	M1 5/11/94	M1 8/03/94
pH, units	6.33	7.31
Phenolics as phenol, mg/l	<0.05	<0.05
Chemical Oxygen Demand, mg/l	<20	<20.0
Biochemical Oxygen Demand 5-day total, mg/l	11	4.5
Temperature, °C	19	29.2
Petroleum Hydrocarbons by IR, mg/l	<1.0	<1.0
Ammonia-N, mg/l	<0.5	<0.50
Total Suspended Solids, mg/l	8	<5.0
Total Dissolved Solids, mg/l	130	87.0

Table 12.
Surface Water Analysis
for Plainsboro—P1 and P2 for 1994

Parameters, Units	P1 5/11/94	P1 8/03/94	P2 5/11/94	P2 8/03/94
pH, units	6.06	6.90	6.10	6.90
Phenolics as phenol, mg/l	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/l	20	<20.0	41	20.0
Biochemical Oxygen Demand 5-day total, mg/l	13	3.2	10	4.2
Temperature, °C	19	29.1	20	26.7
Petroleum Hydrocarbons by IR, mg/l	<1	<1.0	<1.0	<1.0
Ammonia-N, mg/l	<0.05	<0.50	<0.05	<0.50
Total Suspended Solids, mg/l	20	<5.0	<5	<5.0
Total Dissolved Solids, mg/l	120	87.0	140	66.0

Table 13.
1994 Detention Basin Influents Analysis
(NJPDES NJ0086029)

Parameters, Units	Inflow 1 5/11/94	Inflow 1 8/03/94	Inflow 2 5/11/94	Inflow 2 8/03/94
pH, units	6.65	7.81	6.68	7.42
Phenolics as phenol, mg/l	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/l	<20.0	<20.0	<20.0	<20.0
Biochemical Oxygen Demand 5-day total, mg/l	2.0	3.5	2.0	2.5
Petroleum Hydrocarbons by IR, mg/l	<1.0		<1.0	
Ammonia-N, mg/l	<0.50	<0.50	0.56	<0.50
Settleable Solids, %	<0.25	0.010	<0.25	<0.010
Total Dissolved Solids, mg/l	170.0	90.0	270.0	110.0
Total Suspended Solids, mg/l		<5.0		<5.0
Chromium, mg/l	<0.01	<0.02	<0.01	<0.02
Total Volatile Organics by GC/MS µg/l				
Methylene Chloride		7.0		6.0
1,2-Dichloroethane		2.3		
Chloroform				3.0

Blank indicates no measurement.
* Not available due to equipment problem.

Table 14.
Monthly Surface Water Analysis
for Ditch #5, Location D2
(NJPDES NJ0023922-DSN001) for 1994

Permit Limit	Parameters, Units	1/14	2/8	3/8	4/19	5/11	6/14
NA	Chromium total,mg/l	<0.01	<0.01	<0.01	<0.005	<0.01	<0.005
6.0 - 9.0	pH, units	6.80	7.00	7.40	6.23	6.53	7.62
NA	Phenolics as Phenol, mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
50 mg/l	Chemical Oxygen Demand, mg/l	13.0	<5.0	<5.0	<20.0	<20.0	20.0
NA	Biochemical Oxygen Demand, 5-day total, mg/l	80.0	<3.0	<4.0	6.00	16.0	1.0
10 mg/l	Petroleum Hydrocarbons by IR, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NA	Chlorine Produced Oxidants as chlorine, free, mg/l					<0.1	
NA	Chronic Toxicity NOEC (% effluent): *C. dubia* *P. promelas*					100 100	
NA	Ammonia-N, mg/l	<0.50	<0.50	<0.50	<0.50	<0.05	<0.50
50 mg/l	Total Suspended Solids, mg/l	11.0	8.9	9.6	<5.0	<5.0	<5.0
NA	Total Dissolved Solids, mg/l	300.0	2600.0	290.0	200.0	120.0	260.0
30°C max.	Temperature°C	9.0	8.0	10.0	13.4	1	25.2
NA	Flow, GPM	2,695	5,443	4,897	3,223	4,337	8,140

1 Temperature probe was not properly connected to temperature meter. No data was collected.
Blank indicates no measurement.

Permit Limit	Parameters, Units	7/5	8/3	9/6	10/4	11/1	12/6
NA	Chromium total,mg/l	<0.005	<0.02	<0.05	2.2	<0.05	<0.05
6.0 - 9.0	pH, units	7.45	6.96	7.90	7.04	7.63	7.20
NA	Phenolics Phenol, mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
50 mg/l	Chemical Oxygen Demand, mg/l	20.0	<20.0	12.0	25.0	7.5	6.4
NA	Biochemical Oxygen Demand, 5-day total, mg/l	5.8	2.9	<1.0	<1.0	<1.0	<2.0
10 mg/l	Petroleum Hydrocarbons by IR, mg/l	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NA	Chlorine Produced Oxidants as chlorine, free, mg/l		<0.1		<1.0[3]		
NA	Chronic Toxicity NOEC (% effluent: *C. dubia* *P. promelas*		100 100		100 100		100 25
NA	Ammonia-N, mg/l	1.1	<0.50	<0.50	<0.50	<0.50	<0.50
50 mg/l	Total Suspended Solids, mg/l	8.0	<5.0	5.0	46.0	3.0	2.0
NA	Total Dissolved Solids, mg/l	170.0	140.0	46.0	210.0	170.0	160.0
30°C max.	Temperature°C	24.8	28.1	20.8	17.3	17.3	13.7
NA	Flow, GPM	7,755	9,271	2	2	673	<28

2 No flow from the detention basin due to effluent bypass conditions during the detention basin upgrade project.
3 Chlorine produced oxidant (CPO) sample was collected on December 9, 1994 from DSN001. This sample was analyzed outside of the required analytical hold time for CPO.

Table 15. Monthly Surface Water Analysis for Stormwater, Location DSN002 (NJPDES NJ0023922) for 1994

Permit Limit	Parameters, Units	3/15	5/12	6/27	7/18	8/5	9/22	11/21
50 mg/l	Total Suspended Solids, mg/l	9.9	<5.0	17.0	**100.0**	**190.0**	**82.0**	30.0
15 mg/l	Petroleum Hydrocarbons- 15 min., mg/l	<1.0	<1.0	<1.0	<1.0	1.3	<1.0	<1.0
15 mg/l	Petroleum Hydrocarbons- 30 min., mg/l	1.3		<1.0	<1.0	<1.0	<1.0	<1.0
15 mg/l	Petroleum Hydrocarbons- 45 min., mg/l	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0
6.0 - 9.0	pH, units	6.23	6.34	6.70	6.87	6.64	8.52	6.93
100 mg/l	Chemical Oxygen Demand, mg/l	<5.0	<20.0	73.0	95.0	43.0	47.0	25.0
NA	Temperature °C	7.30	13.7	27.4	24.8	26.2	15.7	12.8
NA	Phenolics, as phenol, mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
NA	Ammonia-N, mg/l	<0.5	0.22	<0.5	<0.5	<0.5	<0.5	<0.5
NA	Total Dissolved Solids, mg/l	140.0	140.0	35.0	120.0	100.0	86.0	43.0
NA	Biochemical Oxygen Demand, mg/l	<4.0		8.9	9.8	16.0	12.4	2.3
NA	Chromium, mg/l	<0.01	<0.01	<0.005	<0.01	0.051	0.11	0.069

No rain event to cause a stormwater flow at DSN002 in April, October, and December 1994.
Bold type indicates permit limit exceeded. Blank indicates no measurement.

Table 16. Monthly Surface Water Analysis for the Canal Pump House, Location DSN003 (NJPDES NJ0023922) for 1994

Permit Limit							
Monthly Average	Daily Maximum	Parameters, Units	3/8	4/19	5/11	6/14	7/5
NL	NL	Chlorine Produced Oxidants, mg/l			0.1		
20 mg/l	60 mg/l	Total Suspended Solids, mg/l	<5.0	6.0	7.0	8.0	6.0
10 mg/l	15 mg/l	Petroleum Hydrocarbons, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
NA	6.0 - 9.0	pH, units	7.60	6.22	6.70	7.32	7.27
NA	NA	Chemical Oxygen Demand, mg/l	<5.0				
NA	NA	Temperature °C	3	15.2	24	31	30.2
NA	NA	Phenolics, as phenol, mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
NA	NA	Ammonia-N, mg/l	<0.5	0.11	<0.5	<0.5	<0.5
NA	NA	Total Dissolved Solids, mg/l	120.0	84.0	150.0	130.0	100.0
NA	NA	Biochemical Oxygen Demand, mg/l	5.4	13.0	3.0	2.0	1.2
NA	NA	Chromium, mg/l	<0.01	0.010	<0.01	<0.005	<0.005

Permit Limit							
Monthly Average	Daily Maximum	Parameters, Units	8/3	9/6	10/4	11/1	12/6
NL	NL	Chlorine Produced Oxidants, mg/l	<0.1				
20 mg/l	60 mg/l	Total Suspended Solids, mg/l	<5.0	1.0	6.0	6.0	6.0
10 mg/l	15 mg/l	Petroleum Hydrocarbons, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
NA	6.0 - 9.0	pH, units	7.35	7.66	7.37	7.59	6.85
NA	NA	Chemical Oxygen Demand, mg/l					
NA	NA	Temperature °C	28.2	17.8	15.0	13.8	7.30
NA	NA	Phenolics, as phenol, mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
NA	NA	Ammonia-N, mg/l	<0.5	<0.5	<0.5	<0.5	<0.5
NA	NA	Total Dissolved Solids, mg/l	71.0	120.0	240.0	150.0	83.0
NA	NA	Biochemical Oxygen Demand, mg/l	4.1	<1.0	<1.0	<1.0	4.4
NA	NA	Chromium, mg/l	<0.02	<0.05	<0.05	<0.05	<0.05

Flow is estimated to be 7,500 gallons per day (gpd) based upon the rating of the pumps in the canal pump house the duration of the cycle and the number of cycles per day.
Blank indicates no measurement.
NL - No Limit

Table 17. Application of Pesticides, Herbicides, and Fertilizers in 1994

Pesticides	Amounts Used
Diazion 4 D 1%	0.5 gallon
Conquer 0.05	6.5 gallons
CB-40 1%	9 ounces
Ficam Plus WP 1%	30 ounces
Ficam Plus 0.05	1 gallon
Dione Dust 1%	84 ounces
Maki Bate	24 ounces
Wasp Freeze 0.05	36 ounces
Demon EC 0.05	2.25 gallons
Herbicides and Fertilizers	**Amounts Used**
Pennant	10 gallons
Princep	20 gallons
Roundup	30 gallons
25-3-9 + TEAM	1,400 pounds
Lime	8,700 pounds

Table 18. Average Ground Water Elevation by Well Group for 1994 in Feet Above MSL

88	87	86	85	84	82
MW-1	UST-1	MW-3	MW-2	MW-9	D-12
		P-2	MW-4	MW-8I	MW-5I
		MW-13	MW-7S	MW-6I	MW-7I
		P-1		MW-6S	MW-5S
				D-11	
				MW-8S	

MSL - mean sea level
MW - monitoring well
S - shallow depth well
I - intermediate depth well
P - piezometer
UST - underground storage tank well
D - detention basin well

Table 19. Total Petroleum Hydrocarbons Results from Quarterly Ground Water Monitoring Program for1994 (in mg/l)

Well Number	2/16/94	5/18/94	8/23/94	11/22/94
P-2	0.63U	0.57U	**0.87**	0.54U
MW-4	0.56U	0.6U	NS	0.54U
MW-5S	0.58U	0.58U	**0.62**	0.55U
MW-5I	**4.2**	0.58U	0.56U	0.59U
MW-6S	0.58U	0.59U	0.57U	0.57U
MW-6I	0.57U	0.56U	0.64U	0.56U
MW-7S	0.56U	0.61U	0.58U	0.67U
MW-7I	**0.8**	0.56U	0.6U	0.64U
MW-8S	0.61 U	0.6U	**1.2**	0.57U
MW-8I	**0.73**	0.67U	0.6U	0.67U

U - Indicates a compound was analyzed for but not detected.
For results marked with a "U," the numerical value is the compound method detection limit.
NS - Indicates well was not sampled.

Table 20. Ground Water Monitoring Program Results — August 1994 (in µg/l)

Parameter	DEP GW Quality Criteria	P-2 8/23/94	MW-5S 8/23/94	MW-5I 8/23/94	MW-6S 8/23/94	MW-6I 8/23/94
Target VOC						
1,1-Dichloroethene	*1*	2U	2U	2U	**2**	2U
1,1-Dichloroethane	*70*	1U	1U	1U	**17**	1U
1,1,1-Trichloroethane	*30*	1U	1U	1U	**16**	1U
Trichloroethene	*1*	1U	1U	**7**	**3**	1U
Tetrachloroethene	*0.4*	1U	**2**	**5**	**15**	1U
Toluene	*1,000*	1U	1U	1U	1U	1U
Xylenes	*40*	1U	1U	1U	1U	1U
Total Target VOC		0	**2**	**12**	**53**	0
Non-Target SVOCs		0	14	0	0	6
Non-Target VOCs		0	0	0	0	19

Parameter	DEP GW Quality Criteria	MW-7S 8/23/94	MW-7I 8/23/94	MW-8S 8/23/94 3	MW-8I 8/23/94	Trip Blank 8/23/94	Field Blank 8/23/94
Target VOC							
1,1-Dichloroethene	*1*	**3**	2U	2U	2U	2U	2U
1,1-Dichloroethane	*70*	**14**	**6**	**2**	1U	1U	1U
1,1,1-Trichloroethane	*30*	**26**	1U	1U	1U	1U	1U
Trichloroethene	*1*	**6**	**2**	**3**	1U	1U	1U
Tetrachloroethene	*0.4*	**27**	**2**	**18**	1U	1U	1U
Toluene	*1,000*	1U	1U	**3**	1U	1U	1U
Xylenes	*40*	1U	1U	**3**	1U	1U	1U
Total Target VOC		**76**	**10**	**29**	0	0	0
Non-Target SVOCs		411.46	0	0	0	0	0
Non-Target VOCs		5	21	0	0	0	0

Target VOCs are Priority Pollutant VOCs.
Non-Target are VOCs detected other than those priority pollutants.
VOC - volatile organic compounds, 40 CFR Method 624
U - Indicates a compound was alanyzed but not detected. For results marked "U," the numerical value is the compound detection limit.

Table 21. Ground Water Analysis for Wells MW-14, MW-15, and MW-16 for 1994

Parameters Units	NJPDES Permit Standard	MW-14 2/15	MW-14 5/9	MW-14 8/2	MW-14 11/2
Chromium, mg/l	*0.05*			<0.025	<0.025
Lead, dissolved, mg/l	*0.05*			<0.0025	0.0067
pH, units		6.80	5.50	4.70	5.81
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			1.2	1.4
Total Organic Carbon, mg/1				5	
Total Organic Halides, mg/l				<0.01	
Petroleum Hydrocarbon by IR, mg/1			<0.05	<1	
Ammonia-Nitrogen, mg/1	*0.5*			<0.5	<0.5
Chloride, mg/1	*250*			3.8	3.8
Total Dissolved Solids, mg/1	*500*	23	<5	52	70
Sulfate, mg/1	*250*	18	21	24	12
Conductivity, mmhos/cm^2		70	85	62.8	121

Parameters Units	NJPDES Permit Standard	MW-15 2/15	MW-15 5/9	MW-15 8/2	MW-15 11/2
Chromium, mg/l	*0.05*			<0.025	<0.025
Lead, dissolved, mg/l	*0.05*			<0.0025	0.0029
pH, units		5.40	6.10	6.02	6.13
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			1.2	0.83
Total Organic Carbon, mg/1				1.0	
Total Organic Halides, mg/l				<0.01	
Petroleum Hydrocarbon by IR, mg/1			<0.05	<1	
Ammonia-Nitrogen, mg/1	*0.5*			<0.5	<0.5
Chloride, mg/1	*250*			5.7	4.7
Total Dissolved Solids, mg/1	*500*	34	<5	94	91
Sulfate, mg/1	*250*	8.1	10	37	5
Conductivity, mmhos/cm^2		55	246	97	120

Parameters Units	NJPDES Permit Standard	MW-16 2/15	MW-16 5/9	MW-16 8/2	MW-16 11/2
Chromium, mg/l	*0.05*			<0.025	<0.025
Lead, dissolved, mg/l	*0.05*			0.01	<0.0025
pH, units		6.90	5.58	6.43	6.28
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			2.0	1.1
Total Organic Carbon, mg/1				5.0	
Total Organic Halides, mg/l				<0.01	
Petroleum Hydrocarbon by IR, mg/1			<0.05	<1	
Ammonia-Nitrogen, mg/1	*0.5*			<0.5	<0.5
Chloride, mg/1	*250*			7.6	7.5
Total Dissolved Solids, mg/1	*500*	150	76	280	270
Sulfate, mg/1	*250*	50	46	93	44
Conductivity, mmhos/cm^2		220	79	435	476

Blank indicates no measurement.

Table 22. Ground Water Analysis for Wells D-11 and D-12 for 1994

Parameters Units	NJPDES Permit Standard	D-11 2/15	D-11 5/9	D-11 8/2	D-11 11/2
Chromium, mg/l	0.05				
Lead, dissolved, mg/l	0.05			0.0028	*
pH, units		5.70	6.23	6.56	*
Phenolics as phenol, mg/1	0.3			<0.05	*
Nitrate-Nitrogen, mg/1	10			1.2	*
Total Organic Carbon, mg/1				2.0	
Total Organic Halides, mg/l				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	0.5		<0.05	<0.5	*
Chloride, mg/1	250			31	*
Total Dissolved Solids, mg/1	500	180	140	24	*
Sulfate, mg/1	250	27	40	48	*
Conductivity, mmhos/cm^2		290	330	293	*
Tritium, pCi/L				238	

Parameters Units	NJPDES Permit Standard	D-12 2/15	D-12 5/9	D-12 8/2	D-12 11/2
Chromium, mg/l	0.05			<0.025	<0.025
Lead, dissolved, mg/l	0.05			<0.0025	<0.0025
pH, units		5.50	5.17	5.49	5.46
Phenolics as phenol, mg/1	0.3			<0.05	<0.05
Nitrate-Nitrogen, mg/1	10			<0.05	<0.05
Total Organic Carbon, mg/1				2.0	
Total Organic Halides, mg/l				0.023	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	0.5		<0.05	<0.5	<0.5
Chloride, mg/1	250			30	26
Total Dissolved Solids, mg/1	500	100	70	130	98
Sulfate, mg/1	250	37	41	48	34
Conductivity, mmhos/cm^2		160	231	215	215
Tritium, pCi/L	**			129	

*Did not yield sufficient water for sample collection.
Blank indicates no measurement.
** The lower limit of detection (LLD) is 14.1 p Ci/L.

Table 23. Ground Water Analysis for Wells TW-2 and TW-3 for 1994

Parameters Units	NJPDES Permit Standards	TW-2 2/25	TW-2 5/9	TW-2 8/12	TW-2 11/9
Chromium, mg/l	*0.05*				
Lead, dissolved, mg/l	*0.05*			0.045	0.012
pH, units		7.10	7.17	7.64	7.40
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			<0.05	<0.05
Total Organic Carbon, mg/1				1.0	
Total Organic Halides, mg/l				0.045	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.05	<0.5	<0.5
Chloride, mg/1	*250*			17	20
Total Dissolved Solids, mg/1	*500*	210	170	200	240
Sulfate, mg/1	*250*	10	23	77	1.2
Conductivity, mmhos/cm^2		300	382	372	405
Tritium, pCi/L					

Parameters Units	NJPDES Permit Standards	TW-3 2/28	TW-3 5/9	TW-3 8/2	TW-3 11/9
Chromium, mg/l	*0.05*				
Lead, dissolved, mg/l	*0.05*			0.039	<0.0025
pH, units		7.10	6.90	7.09	7.56
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			<0.05	<0.05
Total Organic Carbon, mg/1				2.0	
Total Organic Halides, mg/l				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.05	<0.5	<0.5
Chloride, mg/1	*250*			28	19
Total Dissolved Solids, mg/1	*500*	230	190	220	200
Sulfate, mg/1	*250*	10	37	71	12
Conductivity, mmhos/cm^2		340	447	448	403
Tritium, pCi/L				130	

Blank indicates no measurement.

Table 24. Ground Water Volatile Organics Analytical Results from Wells D-11, D-12, and TW-3— May 1994 (In µg/l)

Parameter	DEP GW Quality Criteria	D-11 5/9/94	D-12 5/9/94	TW-3 5/9/94	Trip Blank	Field Blank
Methyl Chloride (Chloromethane)	*30*	<10	<10	<10	<10	<10
Methyl Bromide (Bromomethane)	*10*	<10	<10	<10	<10	<10
Vinyl Chloride	*0.08*	<10	<10	<10	<10	<10
Chloroethane		<10	<10	<10	<10	<10
Methylene Chloride	*400*	**5 T**	**4 T**	**5 T**	**4 9**	**4 T**
Acrolein	*NA*	<100	<100	<100	<100	<100
Acrylonitrile	*0.06*	<50	<50	<50	<50	<50
1,1-Dichloroethane	*70*	<5	<5	<5	<5	<5
1,2-Dichloroethane	*0.3*	<5	<5	<5	<5	<5
1,1-Dichloroethene	*1*	<5	<5	<5	<5	<5
1,2-trans-Dichloroethene	*100*	<5	<5	<5	<5	<5
1,2-Dichloropropane	*0.5*	<5	<5	<5	<5	<5
1,3-trans-Dichloropropene	*0.2*	<5	<5	<5	<5	<5
Chloroform	*6*	<5	<5	<5	**4 T**	<5
1,1,1-Trichloroethane	*30*	<5	<5	<5	<5	<5
1,1,2-Trichloroethane	*3*	<5	<5	<5	<5	<5
Trichloroethene	*1*	<5	**3 T**	<5	<5	<5
Carbon Tetrachloride	*0..4*	<5	<5	<5	<5	<5
Bromodichloromethane	*0.3*	<5	<5	<5	<5	<5
Chlorodibromomethane		<5	<5	<5	<5	<5
Benzene	*0.2*	<5	<5	<5	<5	<5
2-Chloroethyl Vinyl Ether		<50	<50	<50	<50	<50
Bromoform	*4*	<5	<5	<5	<5	<5
Tetrachloroethene	*0.4*	**4 T**	**1 5**	<5	<5	<5
1,1,2,2-Tetrachloroethane	*2*	<5	<5	<5	<5	<5
Toluene	*1,000*	<5	<5	<5	<5	<5
Chlorobenzene	*4*	<5	<5	<5	<5	<5
Ethylbenzene	*700*	<5	<5	<5	<5	<5

T Value reported is less than criteria detection or method detection limit.

Table 25. Volatile Organics Analytical Results from Wells TW-3, D-11 and D-12, and Detention Basin Inflows 1 and 2— August 1994 (in µg/l)

Parameter	*DEP GW Qual. Criteria*	*TW-3 8/2/94*	*D-11 8/2/94*	*D-12 8/2/94*	*Inflow 1 8/3/94*	*Inflow 2 8/3/94*	*Trip Blank 8/2/94*	*Field Blank 8/2/94*
Methyl Chloride (Chloromethane)	*30*	<2.2	<2.2	<2.2	<2	<10	<2.2	<2.2
Methyl Bromide (Bromomethane)	*10*	<5.9	<5.9	<5.9	<6	<10	<5.9	<5.9
Vinyl Chloride	*0.08*	<3	<3	<3	<3	<10	<3	<3
Chloroethane		<5.3	<5.3	<5.3	<5	<10	<5.3	<5.3
Methylene Chloride	*400*	**9.4**	**8.1**	**7.7**	**7**	**4T**	**13**	**13**
Acrolein	*NA*	<100	<100	<100	<100	<100	<100	<100
Acrylonitrile	*0.06*	<50	<50	<50	<50	<50	<50	<50
1,1-Dichloroethane	*70*	<1.6	<1.6	**3**	<2	<5	<1.6	<1.6
1,2-Dichloroethane	*0.3*	**3.4**	**2.6**	<1.5	**2.3**	<5	<1.5	**1.9**
1,1-Dichloroethene	*1*	<2.1	<2.1	<2.1	<2	<5	<2.1	<2.1
1,2-trans-Dichloroethene	*100*	<1.4	<1.4	<1.4	<1	<5	<1.4	<1.4
1,2-Dichloropropane	*0.5*	<1.7	<1.7	<1.7	<2	<5	<1.7	<1.7
1,3-trans-Dichloropropene	*0.2*	<1.6	<1.6	<1.6	<2	<5	<1.6	<1.6
Chloroform	*6*	<1.4	2.1	<1.4	<5	**3**	<1.4	<1.4
1,1,1-Trichloroethane	*30*	<1.4	<1.4	<1.4	<1	<5	<1.4	<1.4
1,1,2-Trichloroethane	*3*	<1.5	<1.5	<1.5	<1	<5	<1.5	<1.5
Trichloroethene	*1*	<1.1	<1.1	**2.9**	<1	<5	<1.1	<1.1
Carbon Tetrachloride	*0..4*	<1.2	<1.2	<1.2	<5	<5	<1.2	<1.2
Chlorodibromomethane	*0.3*	<1.1	<1.1	<1.1	<2	<5	<1.1	<1.1
Bromodichloromethane		<1.6	<1.6	<1.6	<5	<5	<1.6	<1.6
Benzene	*0.2*	<1.2	<1.2	<1.2	<5	<5	<1.2	<1.2
2-Chloroethyl Vinyl Ether		<50	<50	<50	<50	<50	<50	<50
Bromoform	*4*	<2.5	<2.5	<2.5	<5	<5	<2.5	<2.5
Tetrachloroethene	*0.4*	**3.5**	**3.4**	**16**	<5	**3.7**	<3.4	<3.4
1,1,2,2-Tetrachloroethane	*2*	<1.5	<1.5	<1.5	<2	<5	<1.5	<1.5
Toluene	*1,000*	<5.1	<5.1	<5.1	<5	<5	<5.1	<5.1
Chlorobenzene	*4*	<1	<1	<1	<1	<1	<1	<1
Ethylbenzene	*700*	<1.3	<1.3	<1.3	<1	<5	<1.3	<1.3

T Value reported is less than criteria detection or method detection limit.

Table 26. Ground Water Base Neutrals Analytical Results— August 1994 (in µg/l)

Parameter	D-11 8/2/94	D-12 8/2/94	MW-14 8/2/94	MW-15 8/2/94	MW-16 8/2/94	TW-2 8/2/94	TW-3 8/2/94	Field Blank 8/2/94
Acenaphthene	<6.6	<6.6	<6.6	<6.6	<2.7	<2.7	<2.7	<2.7
Acenaphthylene	<5.1	<5.1	<5.1	<5.1	<2.4	<2.4	<2.4	<2.4
Anthracene	<5	<5	<5	<5	<1.9	<1.9	<1.9	<1.9
Benzidine	<50	<50	<50	<50	<10	<10	<10	<10
Benzo (a)anthracene	<4.2	<4.2	<4.2	<4.2	<3	<3	<3	<3
Benzo (a)pyrene	<3.6	<3.6	<3.6	<3.6	<2.5	<2.5	<2.5	<2.5
Benzo (b)fluoranthene	<2.3	<2.3	<2.3	<2.3	<2.9	<2.9	<2.9	<2.9
Benzo (k)fluoranthene	<2	<2	<2	<2	<2.6	<2.6	<2.6	<2.6
Benzo (g,h,i)perylene	<10	<10	<10	<10	<2.5	<2.5	<2.5	<2.5
Bis(2-chloroethoxy)Methane	<3.8	<3.8	<3.8	<3.8	<2.6	<2.6	<2.6	<2.6
Bis(2-chloroethyl)Ether	<3.8	<3.8	<3.8	<3.8	<2.8	<2.8	<2.8	<2.8
Bis(2-chloroisopropyl)Ether	<3.9	<3.9	<3.9	<3.9	<2.9	<2.9	<2.9	<2.9
Bis(2-ethylhexyl)Phthalate	<5.9	<5.9	<5.9	<5.9	<3.4	<3.4	<3.4	<3.4
4-Bromophenyl-phenyl Ether	<3.9	**15**	**110**	<3.9	<3	<3	<3	<3
N-Butylbenzl Phthalate	<10	<10	<10	<10	<3.5	<3.5	<3.5	<3.5
2-Chloronaphthalene	<10	<10	<10	<10	<3	<3	<3	<3
4-Chlorophenyl Phenyl Ether	<7.3	<7.3	<7.3	<7.3	<2.5	<2.5	<2.5	<2.5
Chrysene	<3.8	<3.8	<3.8	<3.8	<2.9	<2.9	<2.9	<2.9
1,2,5,6-Dibenzanthracene	<8.4	<8.4	<8.4	<8.4	<2.8	<2.8	<2.8	<2.8
1,2-Dichlorobenzene	<3.5	<3.5	<3.5	<3.5	<2.6	<2.6	<2.6	<2.6
1,3-Dichlorobenzene	<3	<3	<3	<3	<2.6	<2.6	<2.6	<2.6
1,4-Dichlorobenzene	<3.4	<3.4	<3.4	<3.4	<2.7	<2.7	<2.7	<2.7
3,3-Dichlorobenzidine	<3.5	<3.5	<3.5	<3.5	<4	<4	<4	<4
Diethyl Phthalate	<10	<10	<10	<10	<1.3	<1.3	<1.3	<1.3
Dimethyl Phthalate	<8.3	<8.3	<8.3	<8.3	<2	<2	<2	<2
Di-n-butyl Phthalate	<10	<10	<10	<10	<2	<2	<2	<2
2,4-Dinitrotoluene	<10	<10	<10	<10	<3.1	<3.1	<3.1	<3.1
2,6-Dinitrotoluene	<6.6	<6.6	<6.6	<6.6	<62.8	<2.8	<2.8	<2.8
Di-n-octyl Phthalate	<4.4	<4.4	<4.4	<4.4	<3.8	<3.8	<3.8	<3.8
1,2-Diphenylhydrazine	<10	<10	<10	<10	<3.2	<3.2	<3.2	<3.2
Fluoranthene	<7	<7	<7	<7	<2.6	<2.6	<2.6	<2.6
Fluorene	<7.2	<7.2	<7.2	<7.2	<2.6	<2.6	<2.6	<2.6
Hexachlorobenzene	<4	<4	<4	<4	<3.1	<3.1	<3.1	<3.1
Hexachlorobutadiene	<4.5	<4.5	<4.5	<4.5	<2.6	<2.6	<2.6	<2.6
Hexachlorocyclopentadiene	<5	<5	<5	<5	<10	<10	<10	<10
Hexachloroethane	<2.4	<2.4	<2.4	<2.4	<2.3	<2.3	<2.3	<2.3
Indeno (1,2,3-cd)pyrene	<8.5	<8.5	<8.5	<8.5	<3.7	<3.7	<3.7	<3.7
Isophorone	<4.1	<4.1	<4.1	<4.1	<2.6	<2.6	<2.6	<2.6
Naphthalene	<5.7	<5.7	<5.7	<5.7	<2.9	<2.9	<2.9	<2.9
Nitrobenzene	<3.5	<3.5	<3.5	<3.5	<2.3	<2.3	<2.3	<2.3
N-nitrosodimethylamine	<5.6	<5.6	<5.6	<5.6	<10	<10	<10	<10
N-Nitroso-di-n-propylamine	<5.2	<5.2	<5.2	<5.2	<2.5	<2.5	<2.5	<2.5
N-Nitrosodiphenylamine	<5.6	<5.6	<5.6	<5.6	<2.6	<2.6	<2.6	<2.6
Phenathrene	<4.8	<4.8	<4.8	<4.8	<2.1	<2.1	<2.1	<2.1
Pyrene	<3.2	<3.2	<3.2	<3.2	<5.9	<5.9	<5.9	<5.9
1,2,4-Trichlorobenzene	<6.3	<6.3	<6.3	<6.3	<2.5	<2.5	<2.5	<2.5

Table 27. Volatile Organic Compounds Exceeding NJDEP Groundwater Quality Standard for Class II-A Aquifers — June 1994

Well# or Sump #	PCE (µg/L)	TCE (µg/L)	Benzene (µg/L)	TPH (mg/L)
Standard	**0.4**	**1.0**	**0.2**	**NN**
PQL	1	1	1	1
D-11	1.9	<1	<1	<1
D-12	11	1.7	<1	<1
TFTR-S1	3	<1	<1	<1
MG-S2	30	2.1	<1	<1
LOB-S3	2.3	<1	<1	<1
MG-S4	2.3	2.1	<1	2B
MG-S5	<1	<1	<1	1
MG-S6	11	<1	<1	<1
MW-1	<1	<1	<1	1
MW-2	<1	<1	<1	1
MW-3	25	<1	<1	<1
MW-5I	3.6	5.2	<1	<1
MW-6S	2.8	<1	<1	<1
MW-7I	7.4	3	0.8 T	<1
MW-7S	12	2	<1	<1
MW-8S	14	1.6	<1	<1
MW-9	78	1.7	<1	<1
MW-13	120	1.8	<1	<1
TW-1	1.7	<1	<1	<1
TW-2	2.2	<1	<1	<1
TW-3	14	<1	<1	<1
TW-4	<1	<1	<1	2
TW-6	<1	<1	<1	2
TW-7	30	1.3	<1	<1
TW-10	<1	<1	<1	1

PCE = Perchloroethene, tetrachloroethene, or tetrachloroethylene
TCE = 1,1,1-Trichloethene or 1,1,1-Trichloroethylene
TPH = Total petroleum hydrocarbons
PQL = Practical Quantiation Limit
NN = None Noticeable
B = Compound also detected in the field blank
T = Value reported is less than criteria detection

Table 28. Summary of Common Ion Analysis of Ground Water on C and D Sites — June 1994 (in mg/l)

Parameters,	Limit	MW-1	MW-2	MW-3	MW-4	MW-5I	MW-5S	MW-6I
Conductivity, mmhos/cm^2		260	130	190	320	250	245	355
pH, units		6.17	6.06	6.19	6.6	7.55	6.51	6.65
Ammonia-N	0.5							
Chloride	250	68	37	11	31	43	60	41
Total Dissolved Solids	500	210	110	180	240	310	200	270
Sulfate	250	18		25	5.4	14	11	1.9
Nitrate-N	10	1.3	94	71				
Total Organic Carbon	no limit			7.9	0.2			2
Total Organic Halides	no limit	0.014	0.040	0.027	0.018	0.037	0.031	0.053
Petroleum Hydrocarbon	none detected					**1.9**		

Parameters,	Limit	MW-6S	MW-7I	MW-7S	MW-8I	MW-8S	MW-9	MW-10I
Conductivity, mmhos/cm^2		180	360	580	310	600	115	160
pH, units		6.71	6.88	7.02	7.12	6.14	6.51	6.88
Ammonia-N	0.5		0.84B	1.5B				
Chloride	250	4.2	42	70	210	**300**	6	14
Total Dissolved Solids	500	270	290	460	**520**	280	120	170
Sulfate	250	3.5	4.3	78	15	8.3	22	11
Nitrate-N	10	2.6		2.2	0.76		0.25	
Total Organic Carbon	no limit							
Total Organic Halides	no limit	0.023	0.027	0.021	0.037	0.021	0.022	0.040
Petroleum Hydrocarbon	none detected							**2.1**

Parameters	Limit	MW-12I	MW-12S	MW-13	MW--13D	P-1	P-2	UST-1
Conductivity, mmhos/cm^2		225	240	175	NS	260	520	600
pH, units		7.21	6.7	6.23	NS	5.6	6.2	5.31
Ammonia-N	0.5							
Chloride	250	5.9	40	8	8	93	130	46
Total Dissolved Solids	500	180	170	190	170	130	410	79
Sulfate	250	15	15	15	12	13	170	27
Nitrate-N	10	1.3	1.1			1.7	0.62	0.91
Total Organic Carbon	no limit	1.3	1.7	2.0	2.9	2.0	1.8	2.8
Total Organic Halides	no limit	0.012	0.028	0.020	0.030	0.030	0.29	0.36
Petroleum Hydrocarbon	none detected							

Limit NJDEP Groundwater Quality Standard for Class II-A Aquifers
B - also detected in blank
NS - not sampled

Table 28. Summary of Common Ion Analysis of Ground Water on C and D Sites — June 1994 (in mg/l)

Parameters,	Standard	Field 6/6	Field 6/7	MW-7S	MW-7I	MW-10I	MW-12S	MW-12I
Alkalinity, Hydroxide		<1	<1	<1	<1	<1	<1	<1
Alkalinity, Total		<1	<1	102	163	35	78	119
Bicarbonate		<1	<1	102	163	35	78	119
Bromide		<1	<1,000	1,300	<1,000	<1,000	<1,000	<1,000
Carbonate		<1	<1	<1	<1	<1	<1	<1
Chloride	250	<500	<500	78,000	72,000	39,000	30,000	6,300
Fluoride	2	<500	<500	<500	<500	<500	<500	<500
Nitrate-N	10	<0.04	<0.04	2.32	0.04	0.04	1.31	1.32
Sulfate	250	<1,000	<1,000	69,000	8,100	6,900	14,000	12,000
Total Dissolved Solids	500	<10	<10	508	438	125	254	244

Parameters,-Metals	Standard	Field 6/6	Field 6/7	MW-7S	MW-7I	MW-10I	MW-12S	MW-12I
Calcium		<888*	<888*	62,900	66,900 *	4,450B	23,800 *	32,200 *
Magnesium		<515*	<515*	28,900	24,700 *	637B	12,300 *	17,700 *
Potassium		<1,120	<1,120	1,540 B	2,390B	1,370B	1,800B	<1,120 *
Sodium	50	<975*	<975*	20,300	15,900 *	29,700	22,200 B	9,150*

Parameters	Standard	MW-13	Duplic.	Well 4	Well 5	Well 5MS	Well 5MSD
Alkalinity, Hydroxide		<1	<1	<1	<1	<1	NA
Alkalinity, Total		51	51	85	43	42	NA
Bicarbonate		51	51	<1	43	42	NA
Bromide		<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Carbonate		<1	<1	85	<1	<1	NA
Chloride	250	9,000	8,800	40,000	4,600	4,500	4,600
Fluoride	2	<500	<500	<500	<500	<500	<500
Nitrate-N	10	0.04	0.04	0.13	1.15	1.19	NA
Sulfate	250	19,000	19,000	13,000	14,000	13,000	14,000
Total Dissolved Solids	500	180	172	238	130	127	NA

Parameters,-Metals	Standard	MW-13	Duplic.	Well 4	Well 5	Well 5MS	Well 5MSD
Calcium		11,000 *	11,000 *	29,900	13,400	NA	NA
Magnesium		6,330*	6,350*	10,100	6,250	NA	NA
Potassium		3,330 B	3,750B	2,560B	1,540B	NA	NA
Sodium	50	16,200 *	16,000 *	12,400	7,160	NA	NA

Standard = NJDEP Groundwater Quality Standard for Class II-A Aquifers.
B = Compound also detected in trip, field, and/or method blank.
NA = Not analyzed.
* = Duplicate analysis was not within control limits.

Table 29.
Sanitary Sewer Sampling and Analytical Results

PARAMETER	June 1994 Manhole #11	November 1994 Manhole #11	December 1994 Manhole #11	January 1995 Manhole #11	February 1995 Manhole #11	February 1995 Manhole #11	March 1995 LEC #3
BOD, 5 day total, mg/l	130				123		12
COD, mg/l	390				260		46
Color, pt/co unit	45				100		30
Nitrogen, Ammonia, mg/l	13				11		<0.5
pH	7.23 - min. 7.81 - max.		8.75	8.18	7.26 - min. 7.40 - max.	7.86	7.19
Oil & Grease, mg/l	17				7		<5
Phosphorus, Total, mg/l	16				5.2		0.69
Phenolics as phenols, mg/l	<0.05				<0.05		<0.05
Temperature, °C	23		18.5	12	14	9	13.4
Sulfide, mg/l[1]	<0.06		2.8	<1	1.8	0.47	
Sulfide, mg/l[2]		0.14			0.19		0.093
Total Cyanide, mg/l	0.021				<0.01		<0.01
TSS, mg/l	91				80		4
Specific Conductivity, umhos/cm			569	412		601	
Silver, mg/l	<0.005				<0.05		<0.05
Arsenic, mg/l	<0.005				<0.005		<0.0025
Barium, mg/l	<0.4				0.056		<0.05
Cadmium, mg/l	<0.0025				<0.02		<0.02
Chromium, mg/l	0.0079				<0.05		<0.05
Copper, mg/l	0.12				0.088		0.063
Iron, mg/l	0.98				0.45		0.94
Mercury, mg/l	<0.001				<0.001		<0.001
Nickel, mg/l	<0.1				<0.05		<0.05
Lead, mg/l	0.0087				<0.1		<0.1
Selenium, mg/l	<0.005				<0.005		<0.005
Zinc, mg/l	0.61				0.16		0.088

1 Std. Mthds. 16th Edition Methods, Iodometric Method

2 Std. Mthds. 16th Edition Methods, Methylene Blue Method

Table 30.
Volatile Organic Compounds Exceeding
NJDEP Groundwater Quality Standards for Class II-A Aquifers
(highest detected concentration)

AREA Fig. 6-1	Well or Sump #	Chloroform µg/l	TCA µg/l	TCE µg/l	PCE µg/l	1,1-Dichloro-ethene µg/l
	Standard	**6**	**30**	**1**	**0.4**	**2**
	PQL			1	1	
	D-11				1.9	
	D-12			5	16	13
	MG-S2			2.1	30	
	MG-S4			2.1	2.3	
	MG-S6				11	
	LOB-S3				2.3	
1	MW-5I			5.2	3.6	
1	MW-6S		34	6	15	
1	MW-7I	12		9	7.4	
1	MW-7S	11		10	12	
1	MW-8S	38		37	76	
3	MW-3				25	
3	MW-9			3	120	
3	MW-13			3.3	200	
4	TW-1				1.7	
4	TW-2				2.2	
4	TW-3				36	
4	TW-7			1.3	30	
5	TFTR Sump				3	

TCA=1,1,1-Trichloroethene or trichloroethylene
TCE=Trichlorothene or trichloroehtylene
PCE=Tetrachloroethene or tetrachloroethylene
PQL=Practical Quantitation Limit

12.0 FIGURES

Figure #	Title	Page
Figure 1.	The Princeton Beta Experiment-Modification (PBX-M)	86
Figure 2.	The Tokamak Fusion Test Reactor (TFTR)	87
Figure 3.	Region Surrounding the TFTR Site (50-mile radius shown)	88
Figure 4.	PPPL C and D Sites of the James Forrestal Campus	89
Figure 5.	Layout of James Forrestal Campus	90
Figure 6.	Wind Rose Joint Frequency Data for TFTR at 10 m - 1994	91
Figure 7.	Wind Rose Joint Frequency Data for TFTR at 10 m, 1984-1994	91
Figure 8.	Wind Rose Joint Frequency Data for TFTR at 30 m -1994	92
Figure 9.	Wind Rose Joint Frequency Data for TFTR at 30 m, 1984-1994	92
Figure 10.	Wind Rose Joint Frequency Data for TFTR at 60 m -1994	93
Figure 11.	Wind Rose Joint Frequency Data for TFTR at 60 m, 1984-1994	93
Figure 12.	Monthly Average Wind Speed at 30 m for 1994	94
Figure 13.	Annual Average Wind Speed at 30 m, 1984-1994	94
Figure 14.	Monthly Average Absolute Humidity for 1994	95
Figure 15.	Annual Average Absolute Humidity at TFTR Site, 1984-1994	95
Figure 16.	Monthly Average Temperature at 10 m for 1994	96
Figure 17.	Annual Average Temperature at TFTR, 1984-1994	96
Figure 18.	Monthly Average Vertical Lapse Rate for 1994	97
Figure 19.	Annual Total Precipitation from 1988 to 1994	97
Figure 20.	C and D Site Environmental Monitoring Locations	98
Figure 21.	Offsite Monitoring Locations	99
Figure 22.	1994 Air Tritium (HT) - REAM 1 to REAM 6	100
Figure 23.	1994 Air Tritium (HT) - TR 1 to TR 4	100
Figure 24.	1994 Air Tritium (HTO) - REAM 1 to REAM 6	101
Figure 25.	1994 Air Tritium (HTO) - TR 1 to TR 4	101
Figure 26.	1994 Tritium (HTO) in Rain Water	102
Figure 27.	1994 Tritium (HTO) in Ground Water	102
Figure 28.	1994 Tritium (HTO) Concentrations in Surface Water-B1	103
Figure 29.	1994 Tritium (HTO) Concentrations in Surface Water-B2	103
Figure 30.	1994 Tritium (HTO) Concentrations in Surface Water-C1	104
Figure 31.	1994 Tritium (HTO) Concentrations in Surface Water-D1	104
Figure 32.	1994 Tritium (HTO) Concentrations in Surface Water-D2	105
Figure 33.	1994 Tritium (HTO) Concentrations in Surface Water-E1	105
Figure 34.	1994 Tritium (HTO) Concentrations in Surface Water-P1	106
Figure 35.	1994 Tritium (HTO) Concentrations in Surface Water-P2	106
Figure 36.	1994 Tritium (HTO) Concentrations in Surface Water-M1	107
Figure 37.	1994 Tritium (HTO) in Biota	107
Figure 38.	TFTR Total Stack Tritium (HT/HTO) Release for Activities 1994	108
Figure 39.	TFTR Stack Tritium (HT/HTO) Concentrations for 1994	108
Figure 40.	Potentiometric Surface of the Bedrock Aquifer at PPPL	109
Figure 41.	Hydrogeologic Framework and Potential Flow Paths of Spilled Water	110
Figure 42.	PPPL Flood Plain and Wetlands Boundary	111

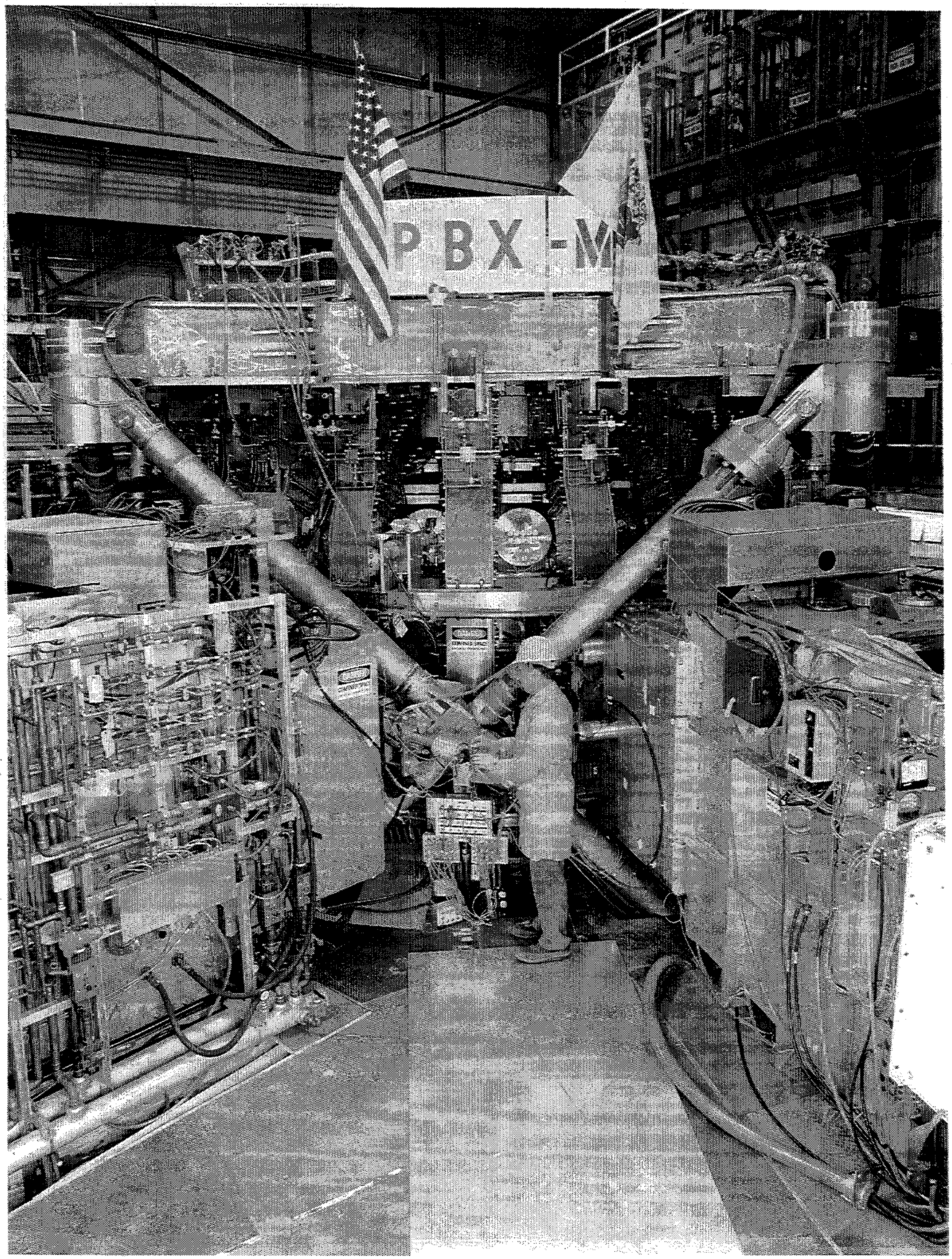


Figure 1. The Princeton Beta Experiment-Modification (PBX-M)

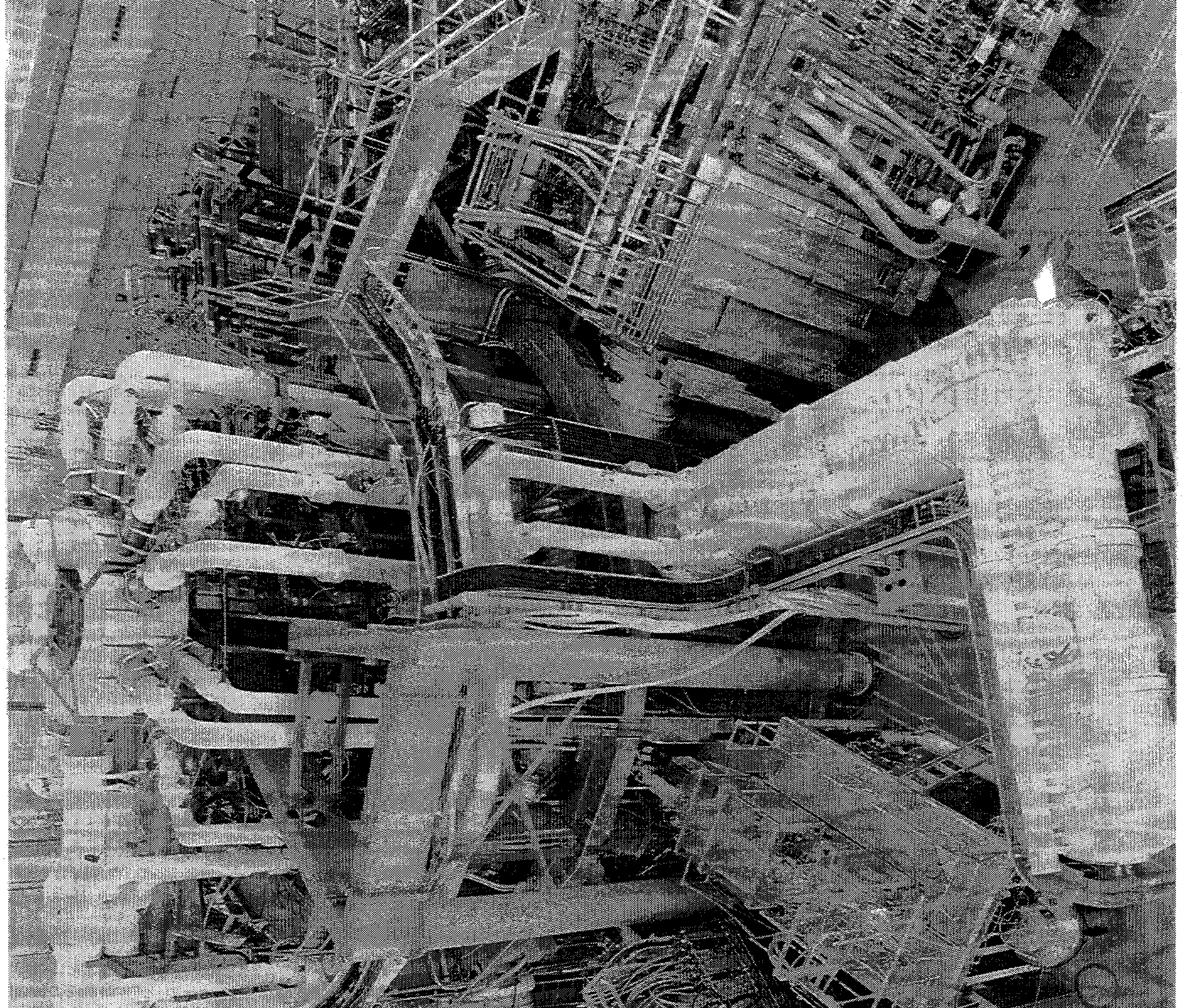


Figure 2. The Tokamak Fusion Test Reactor (TFTR)

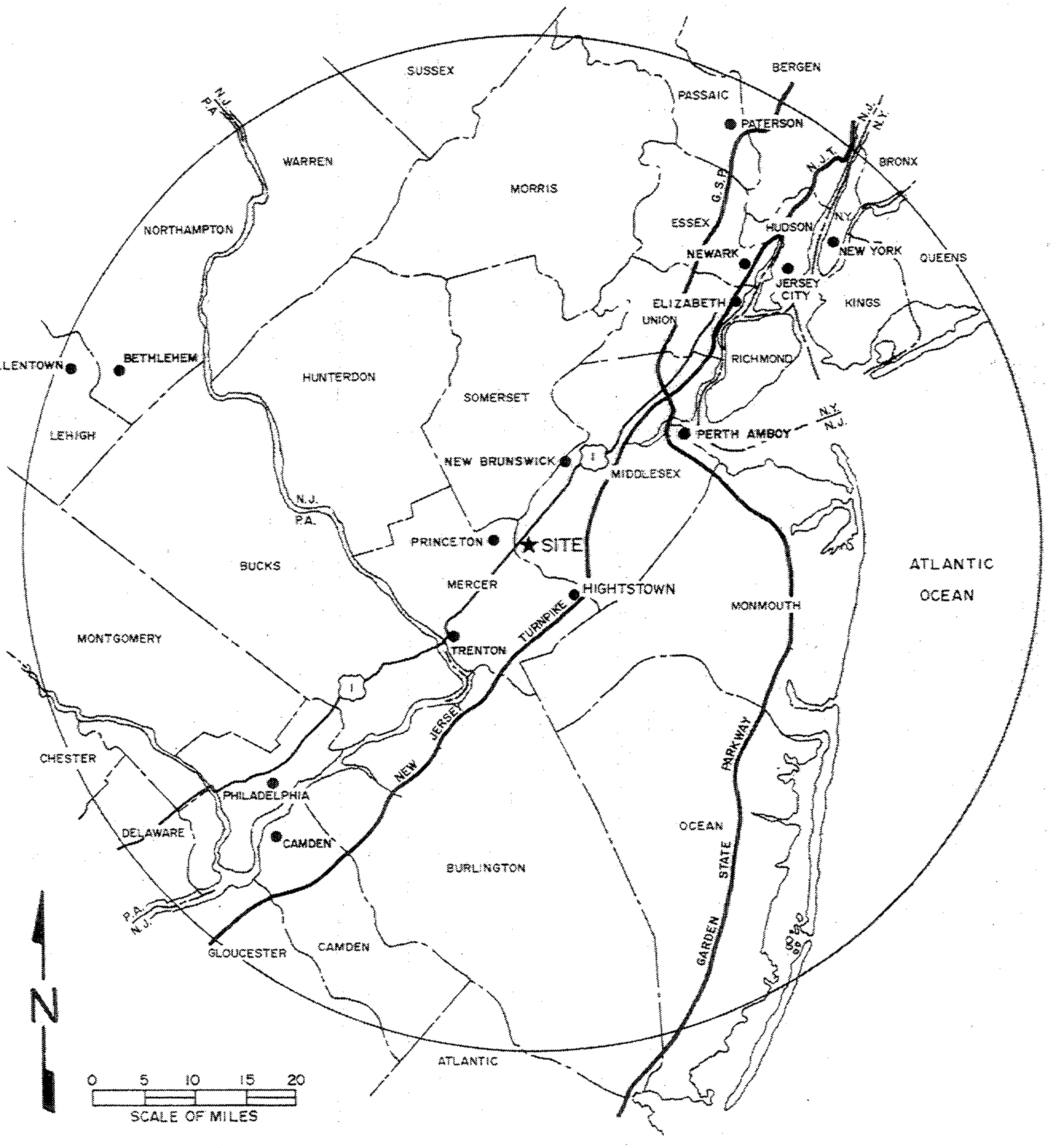


Figure 3. Region Surrounding the TFTR Site (50-mile radius shown)

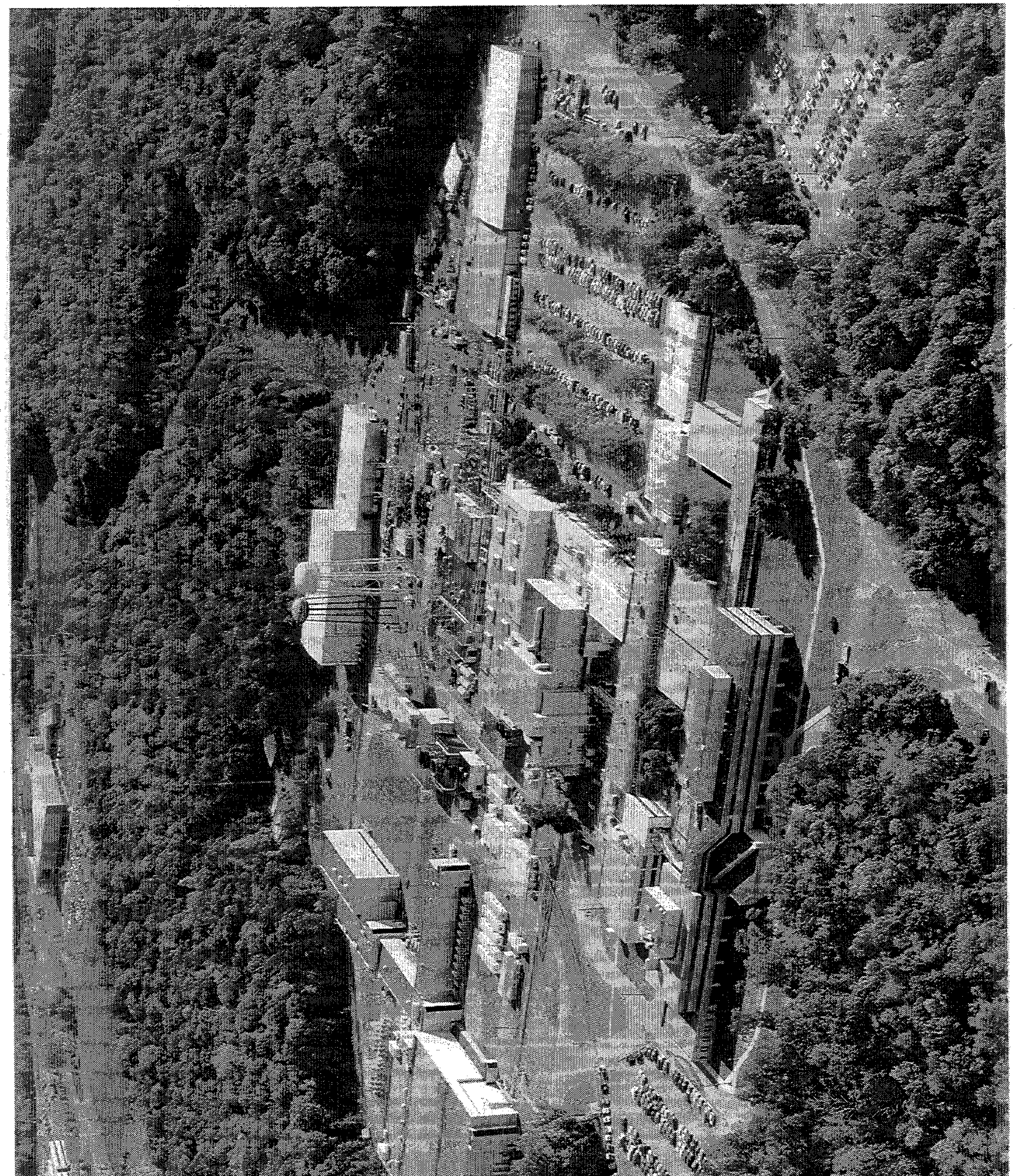


Figure 4. PPPL C and D Sites of the James Forrestal Campus

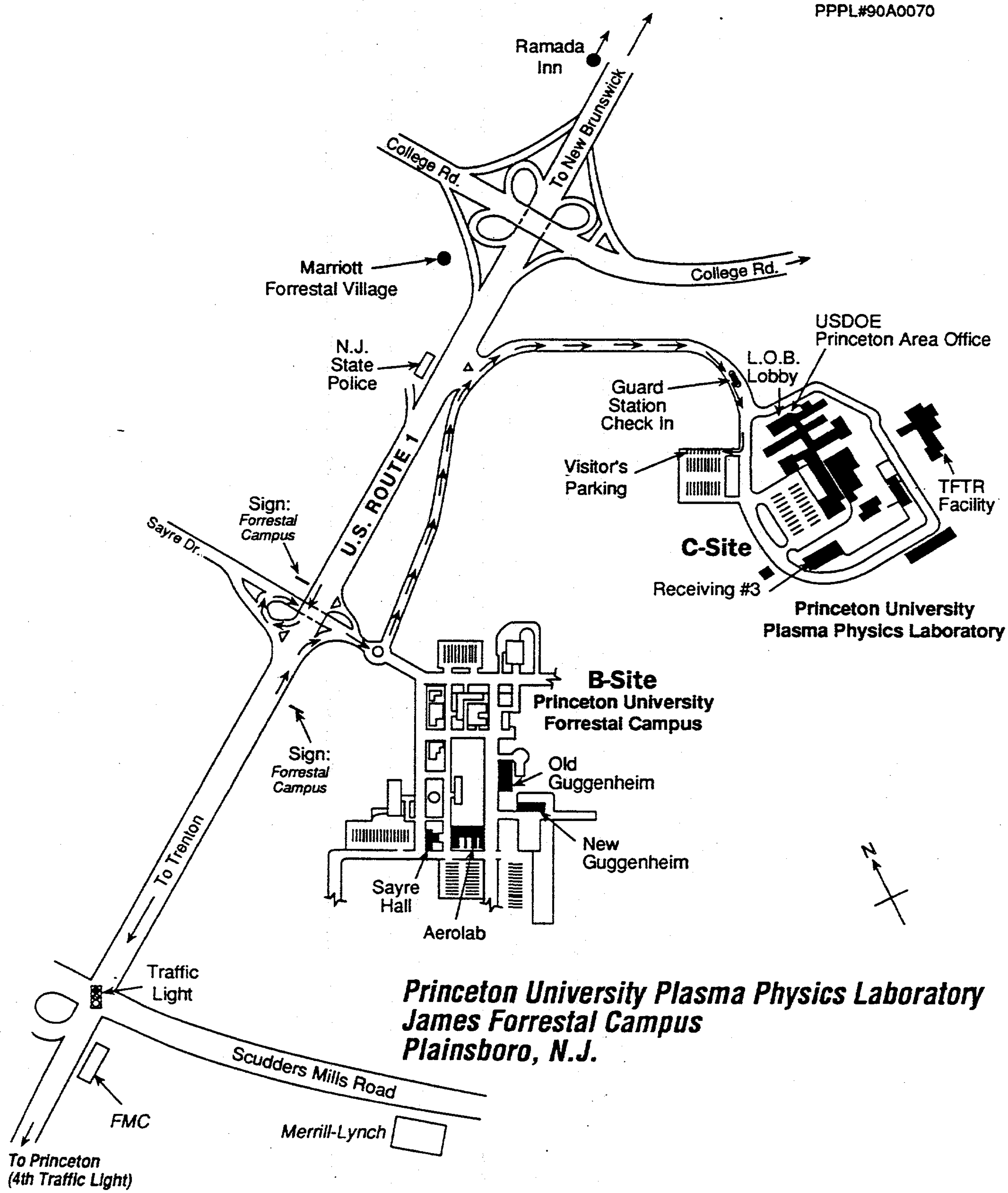


Figure 5. Layout of James Forrestal Campus

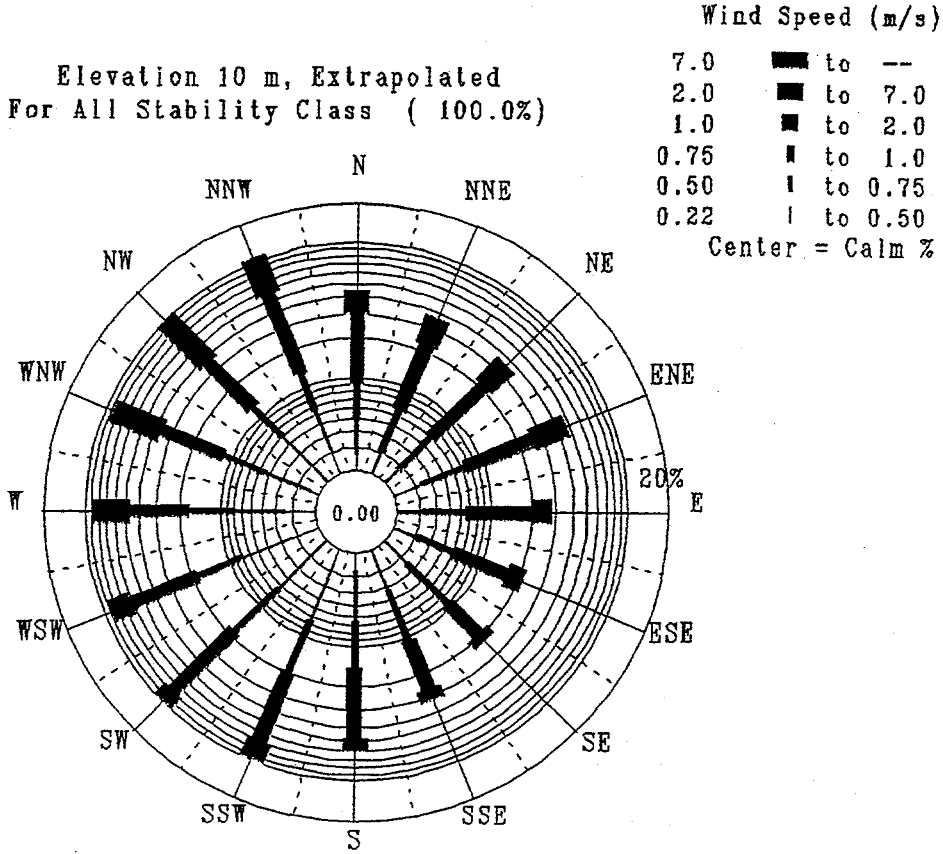


Figure 6. Wind Rose Joint Frequency Data for TFTR at 10 m - 1994

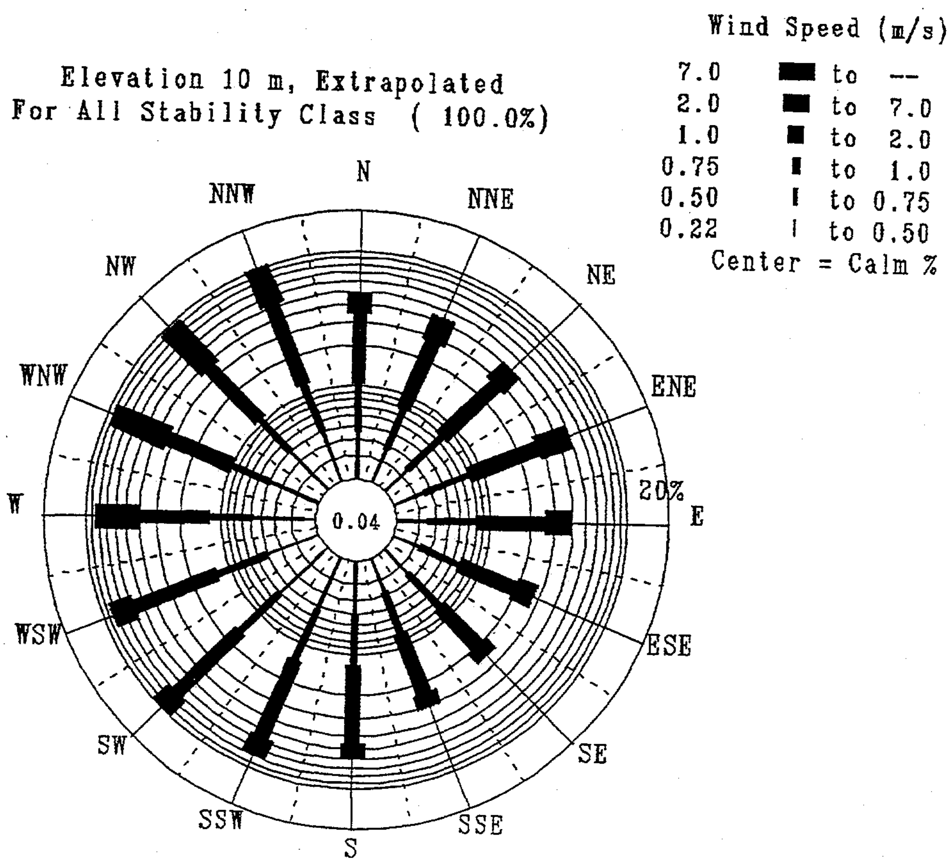


Figure 7. Wind Rose Joint Frequency Data for TFTR at 10 m, 1984-1994

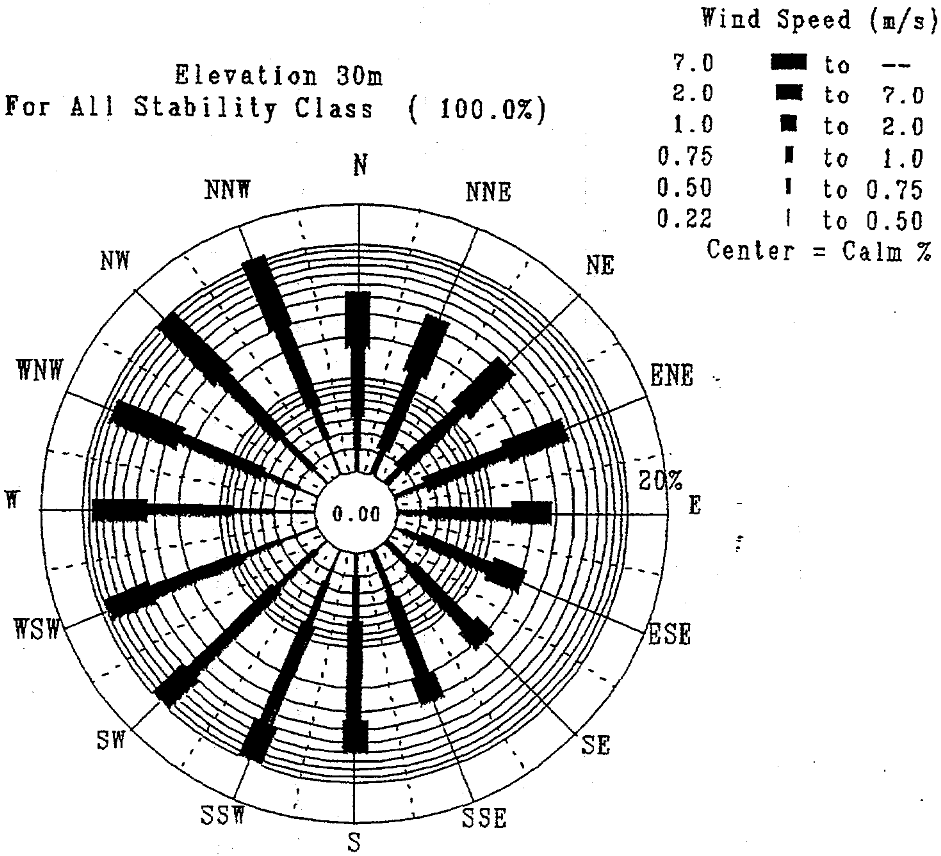


Figure 8. Wind Rose Joint Frequency Data for TFTR at 30 m - 1994

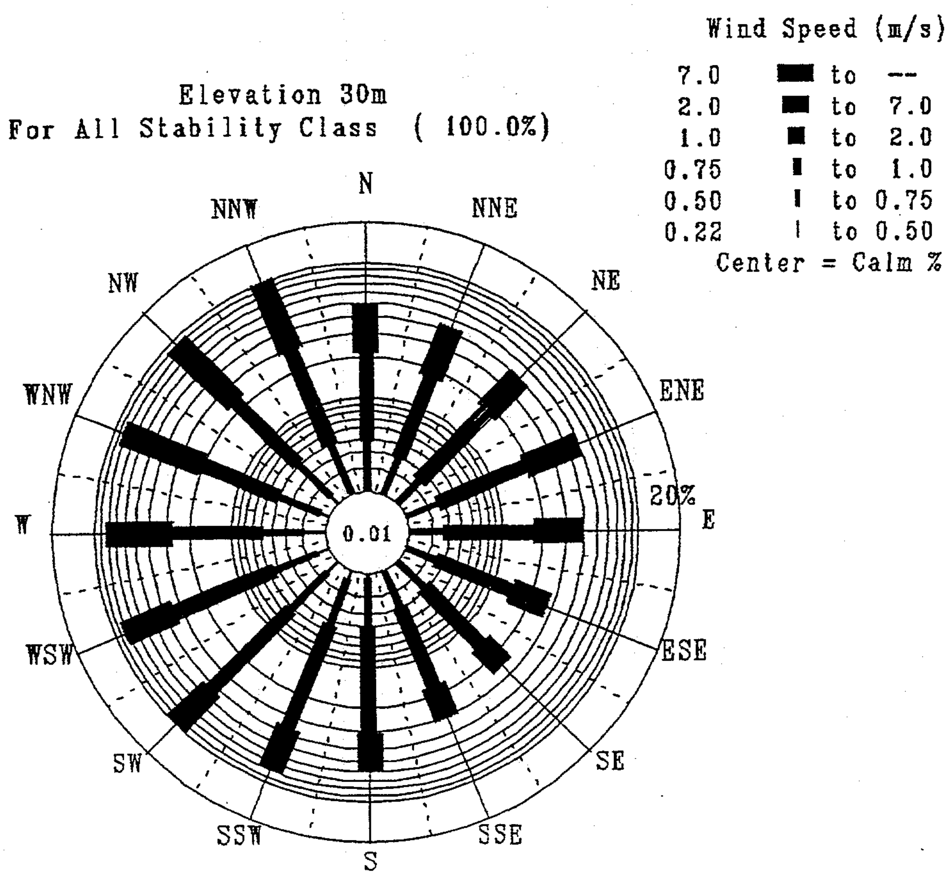


Figure 9. Wind Rose Joint Frequency Data for TFTR at 30 m, 1984-1994

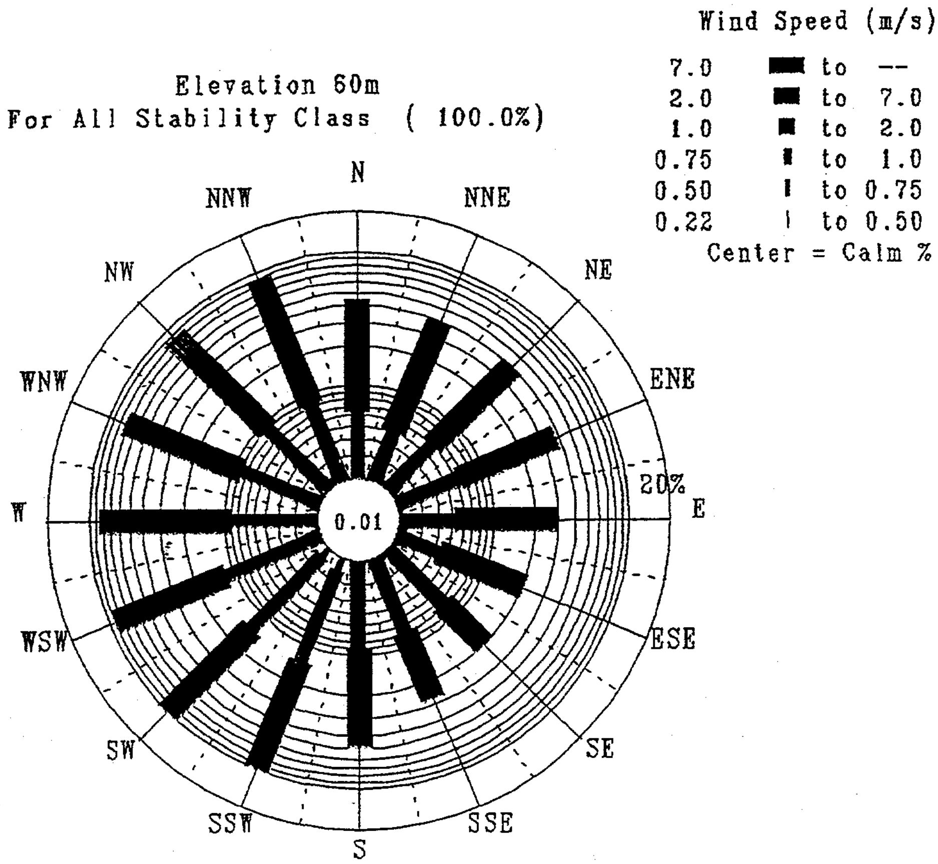


Figure 10. Wind Rose Joint Frequency Data for TFTR at 60 m - 1994

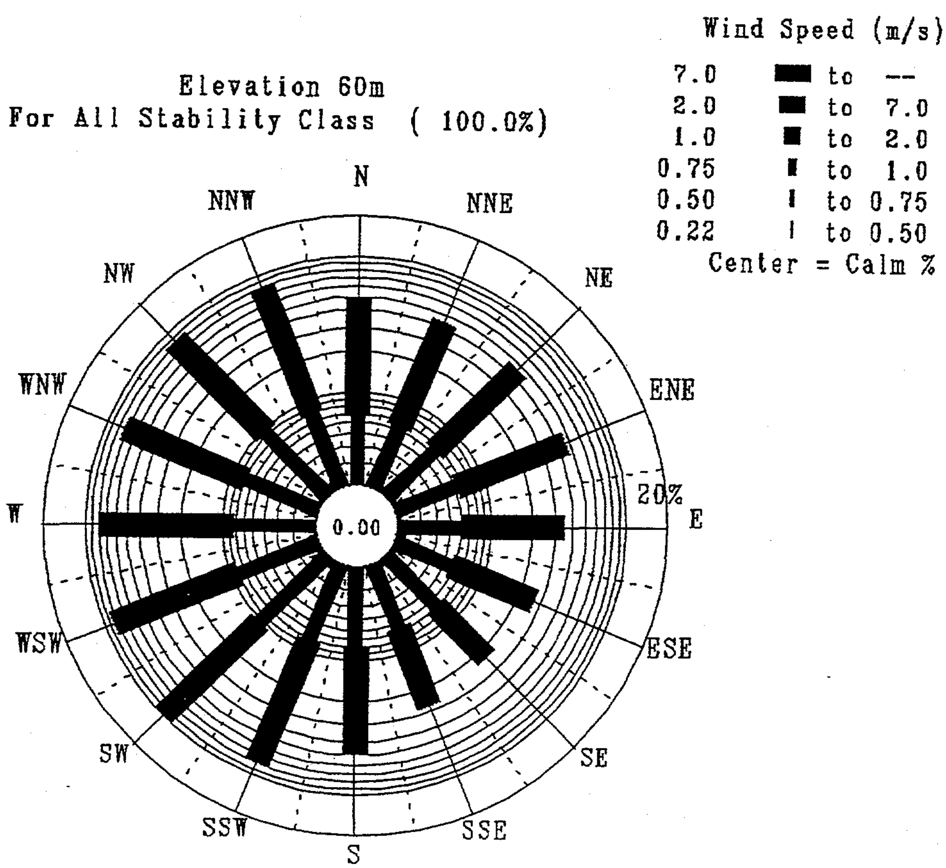


Figure 11. Wind Rose Joint Frequency Data for TFTR at 60 m, 1984-1994

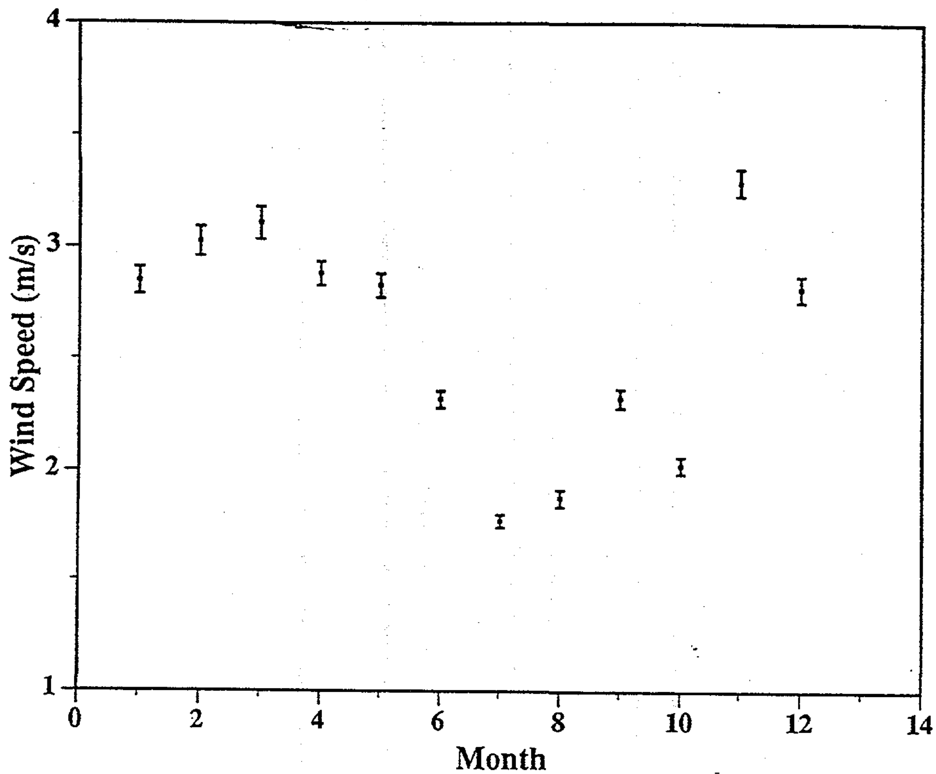


Figure 12. Monthly Average Wind Speed at 30 m for 1994

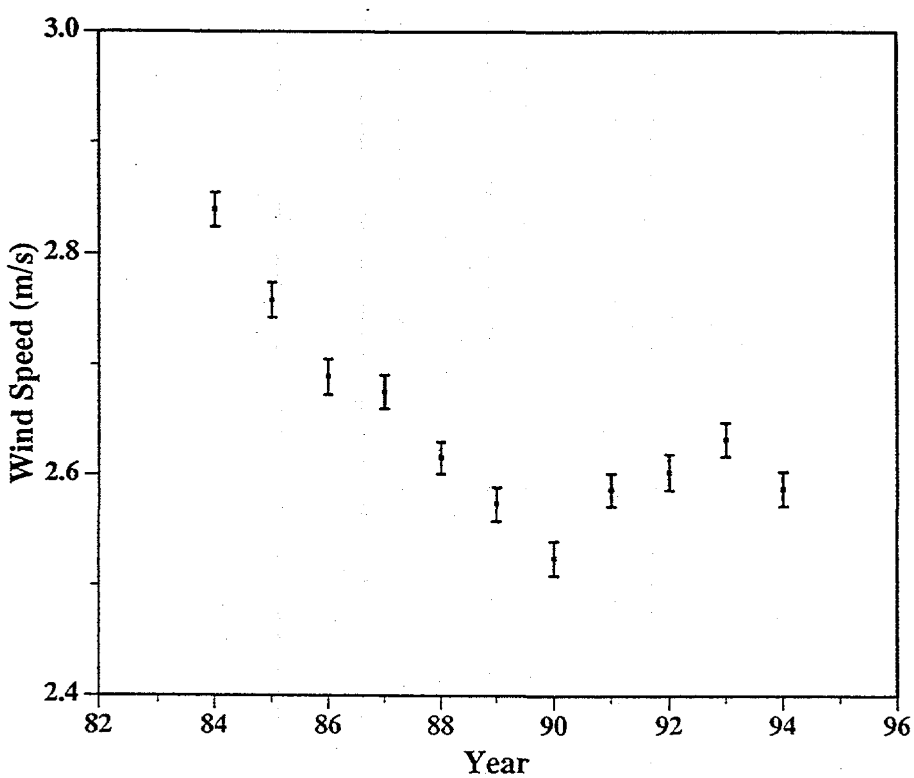


Figure 13. Annual Average Wind Speed at 30 m, 1984-1994

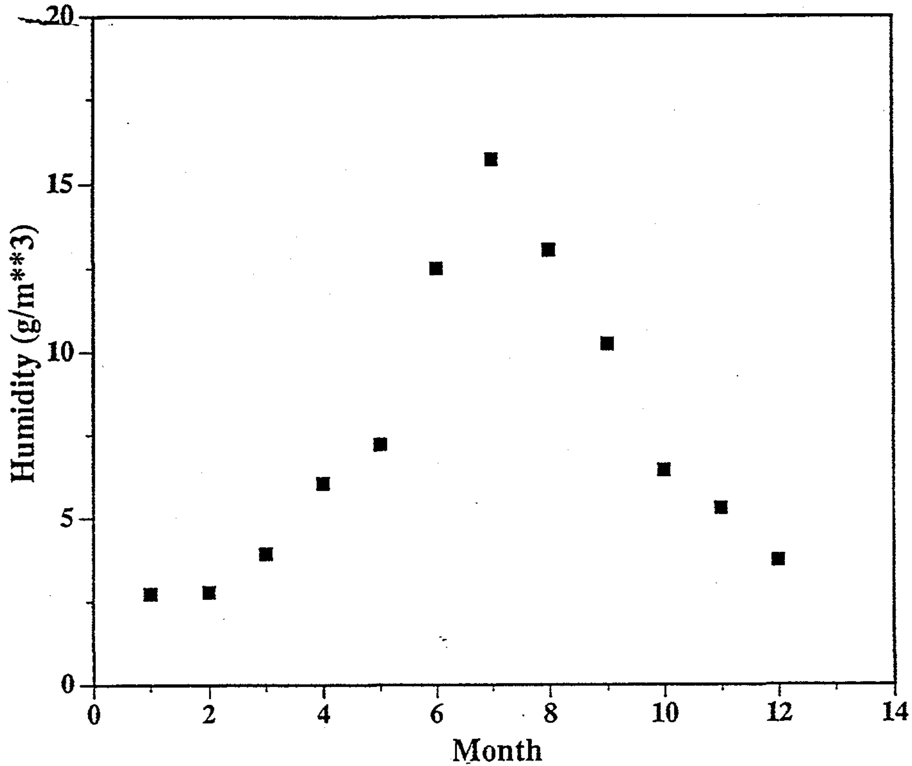


Figure 14. Monthly Average Absolute Humidity for 1994

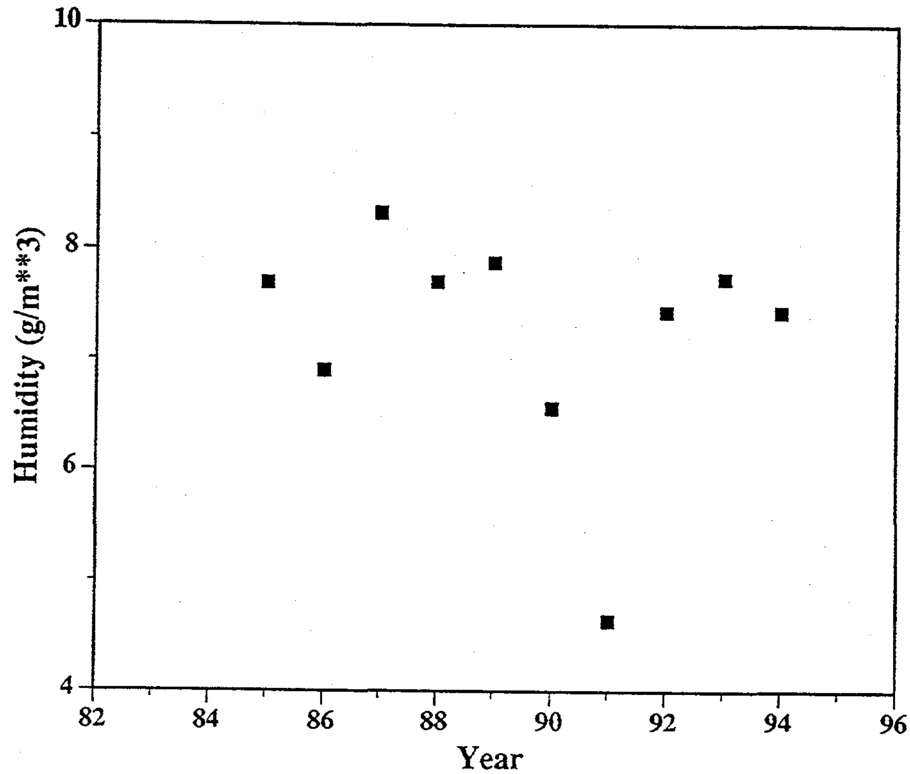


Figure 15. Annual Average Absolute Humidity at TFTR Site, 1984-1994

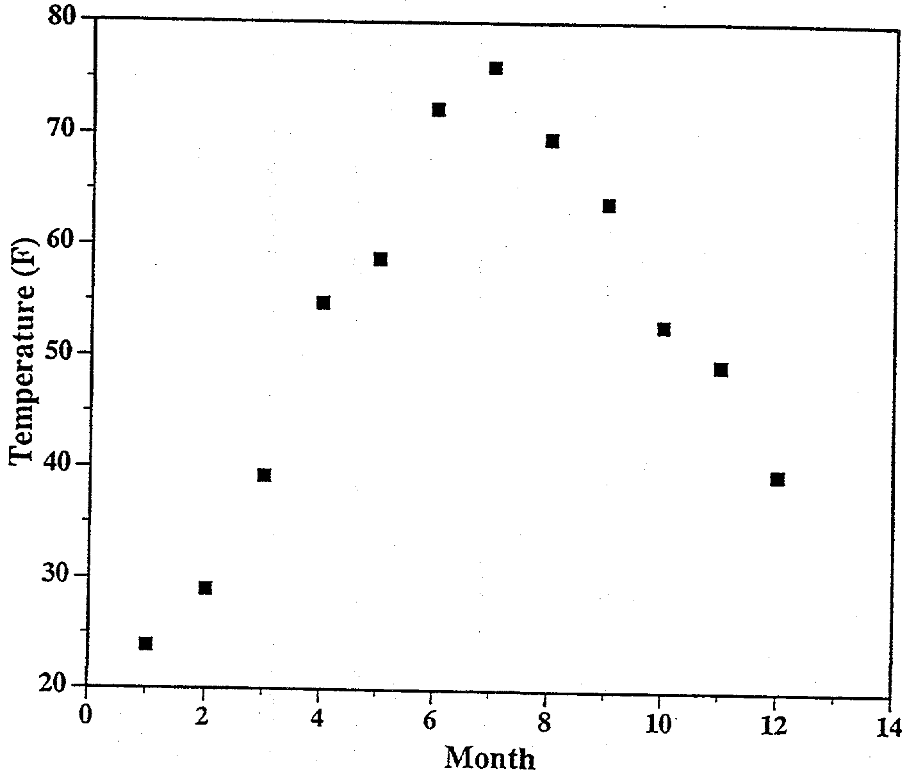


Figure 16. Monthly Average Temperature at 10 m for 1994

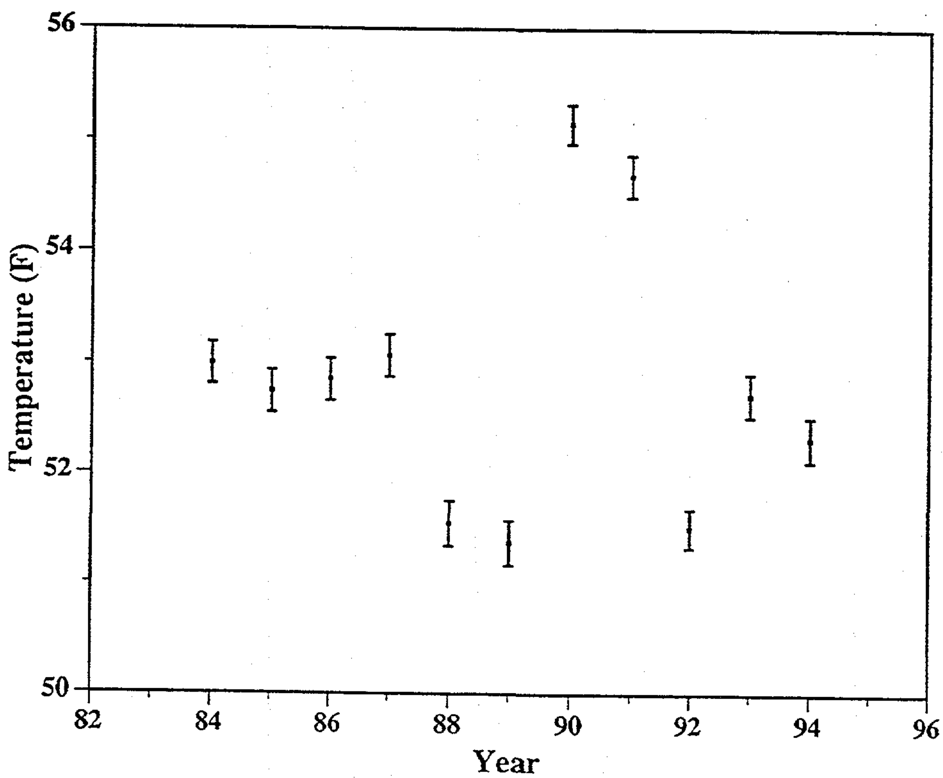


Figure 17. Annual Average Temperature at TFTR, 1984-1994

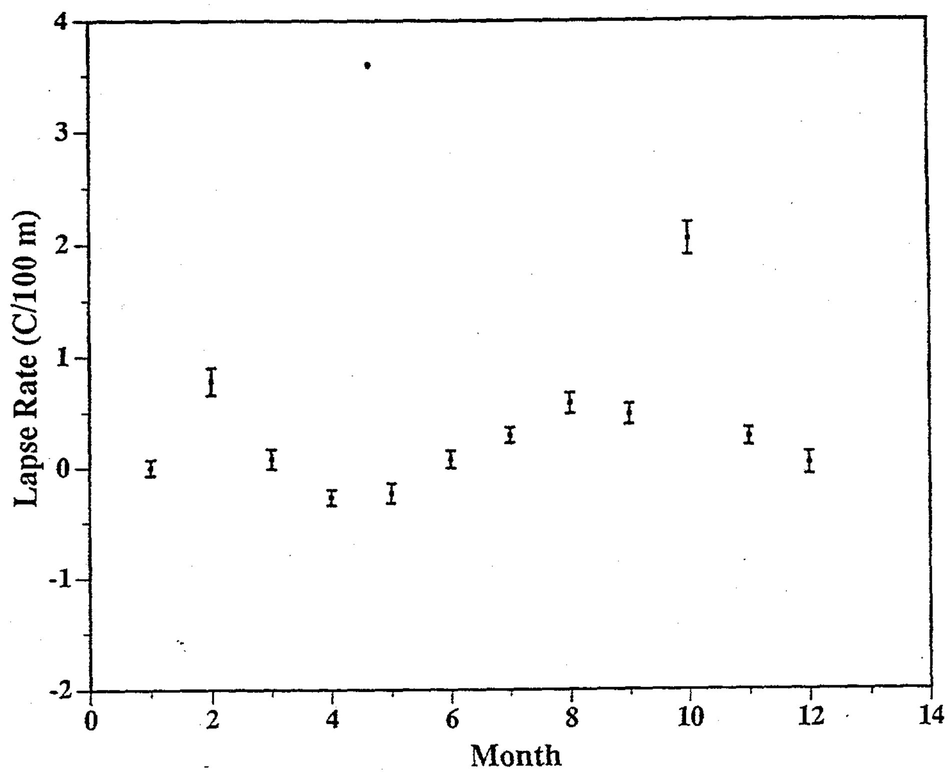


Figure 18. Monthly Average Vertical Lapse Rate for 1994

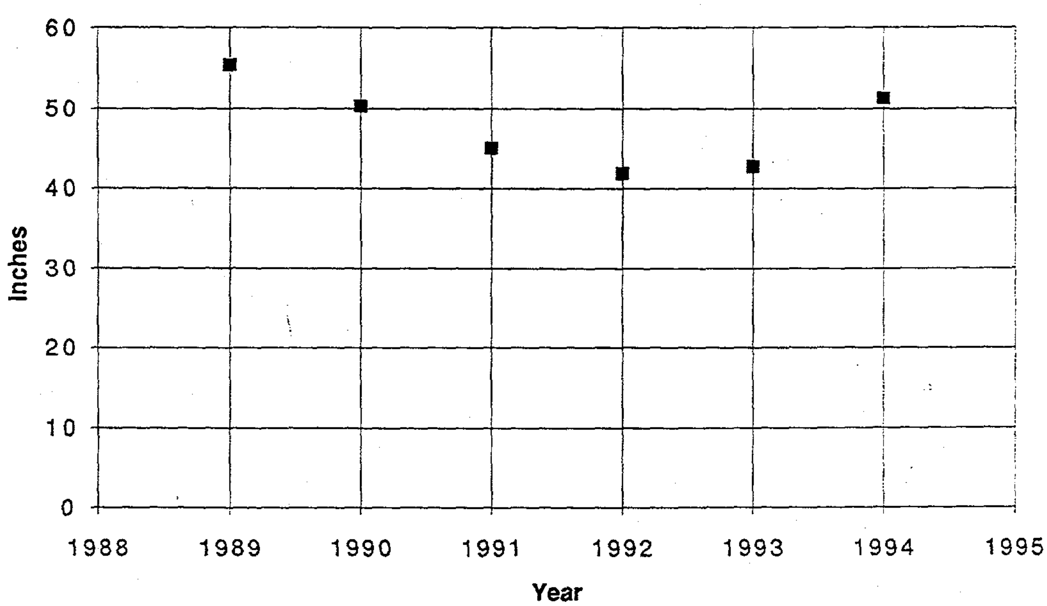


Figure 19. Annual Total Precipitation from 1988 to 1994

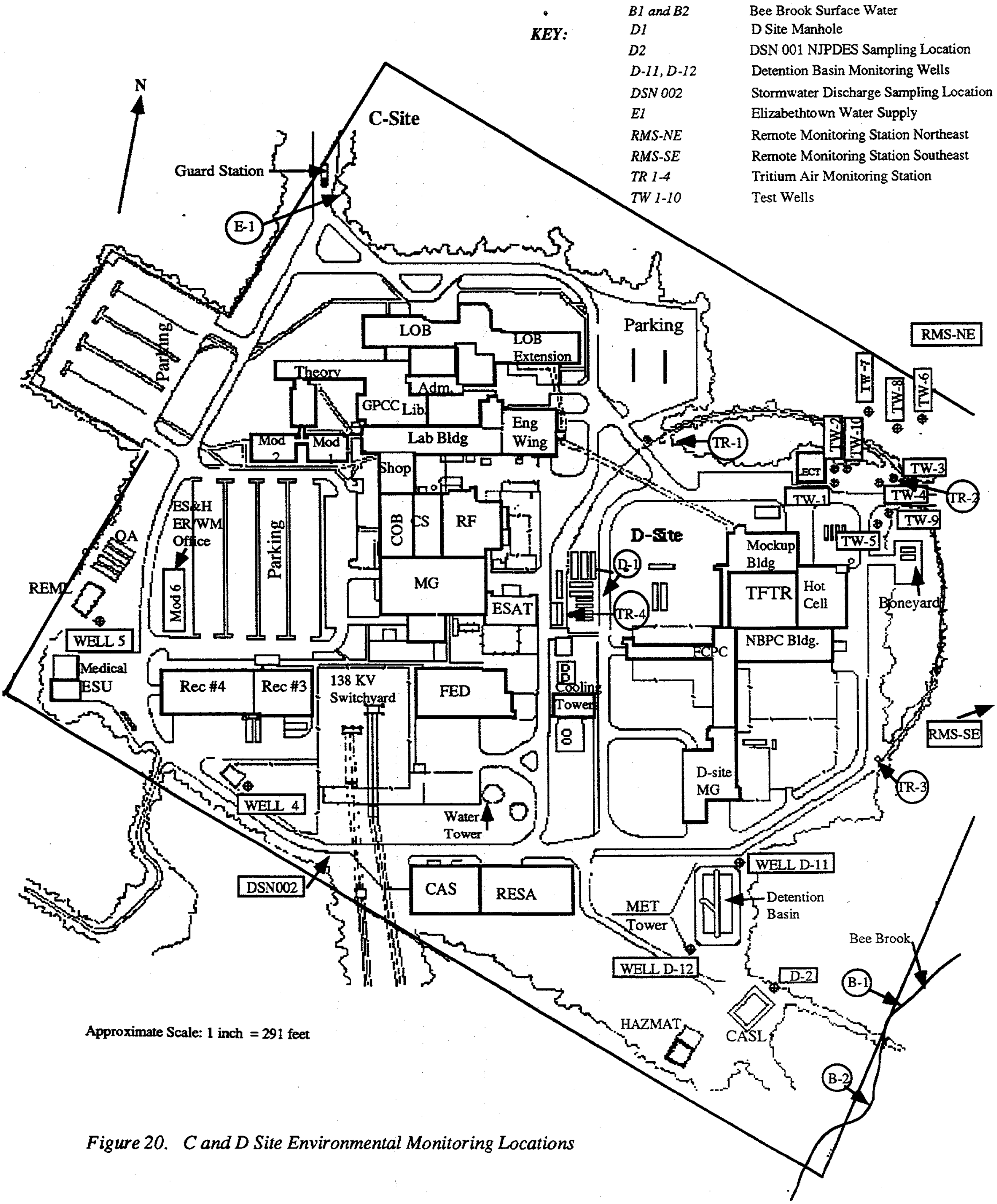


Figure 20. C and D Site Environmental Monitoring Locations

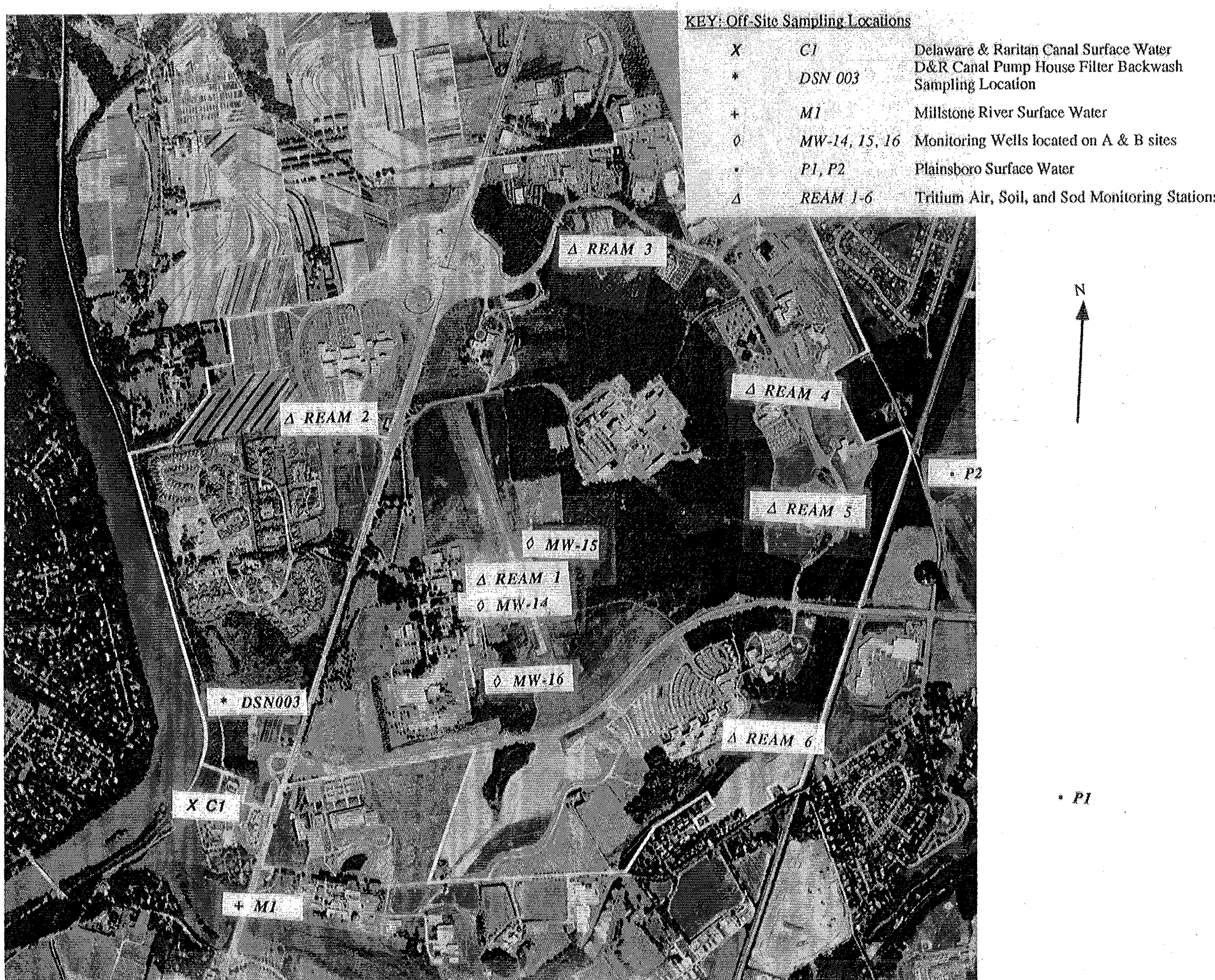


Figure 21. Offsite Monitoring Locations

Approximate Scale: 1 inch = 1908 feet

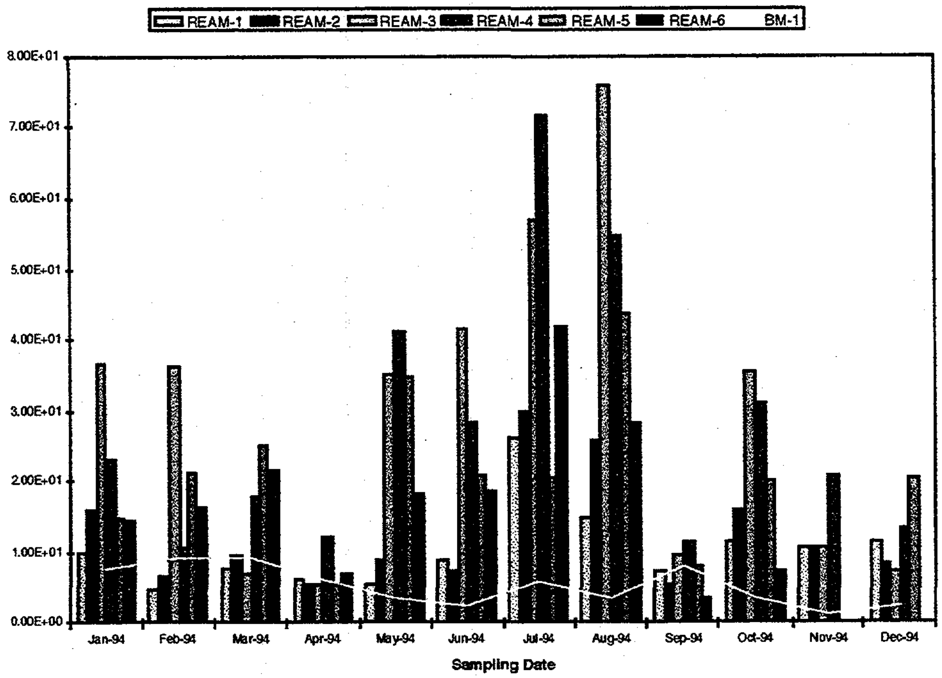


Figure 22. 1994 Air Tritium (HT) - REAM-1 to REAM-6

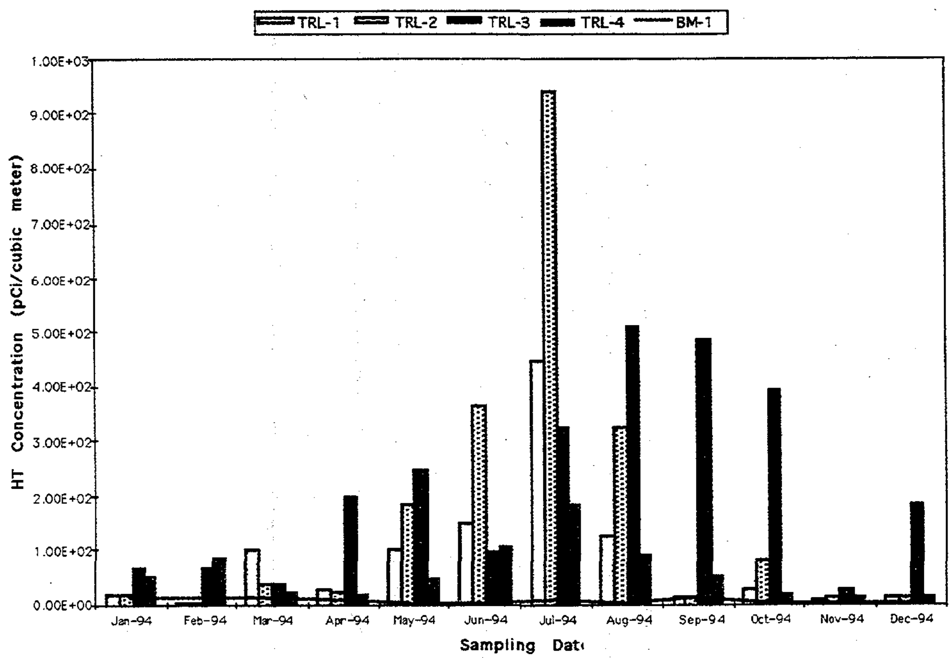


Figure 23. 1994 Air Tritium (HT) - TRL-1 to TRL-4

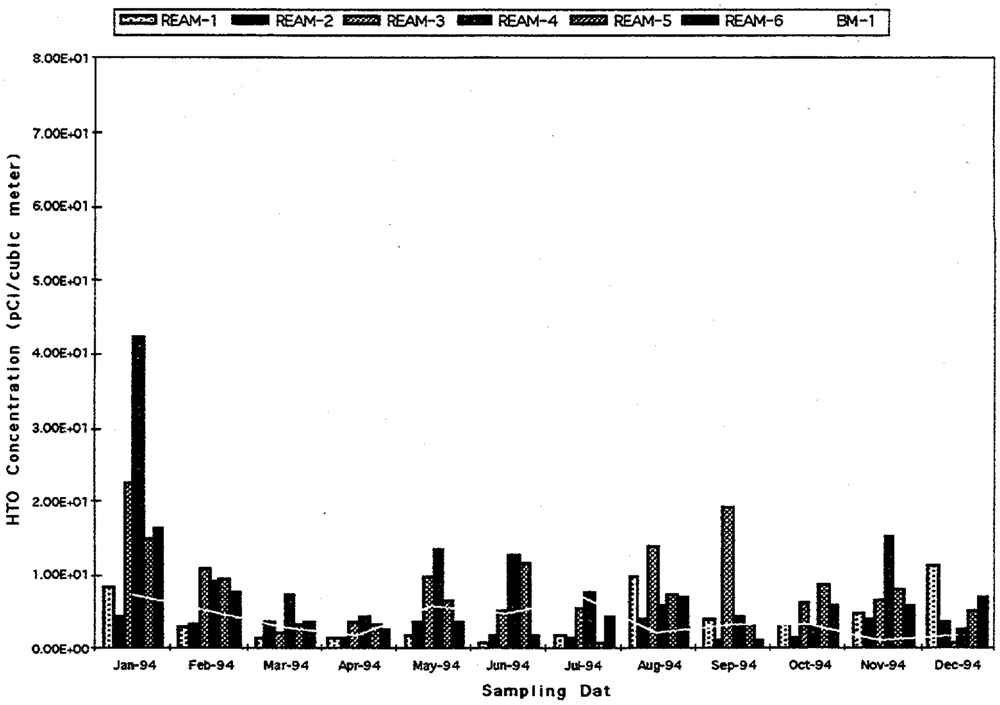


Figure 24. 1994 Air Tritium (HTO) - REAM-1 to REAM-6

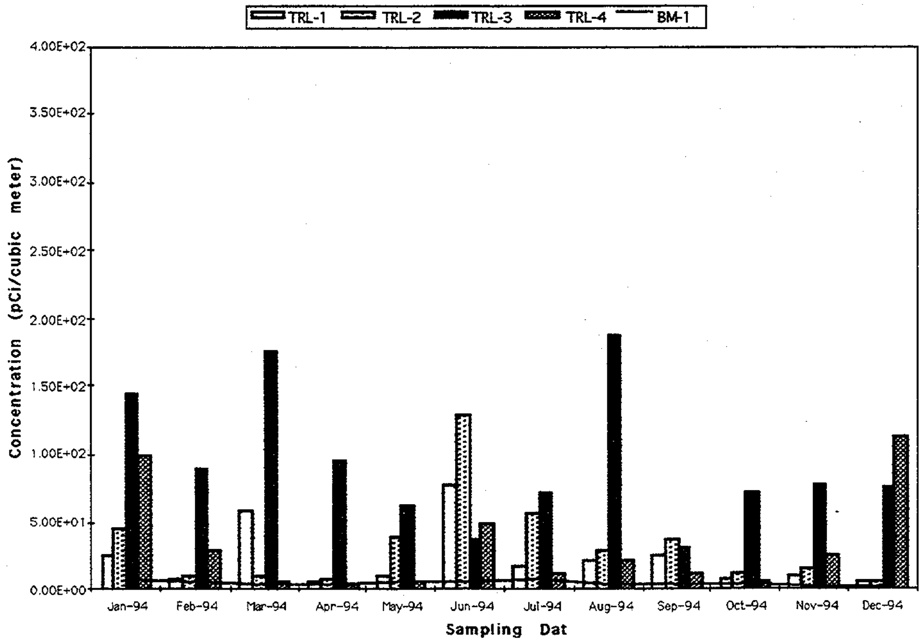


Figure 25. 1994 Air Tritium (HTO) - TRL-1 to TRL-4

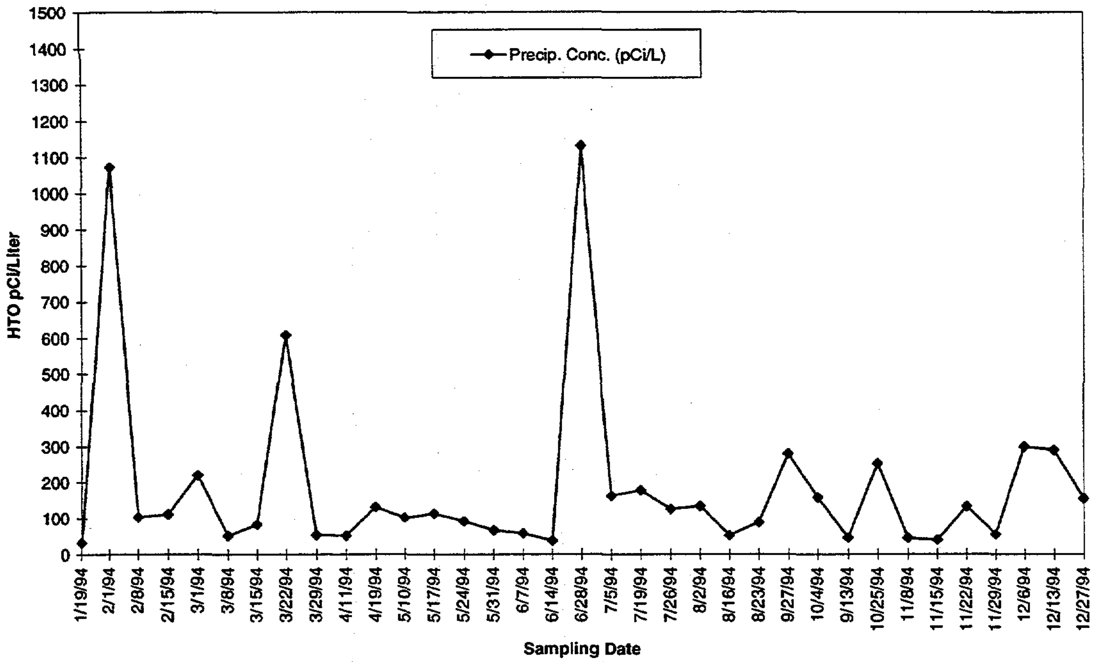


Figure 26. 1994 Tritium (HTO) in Rain Water

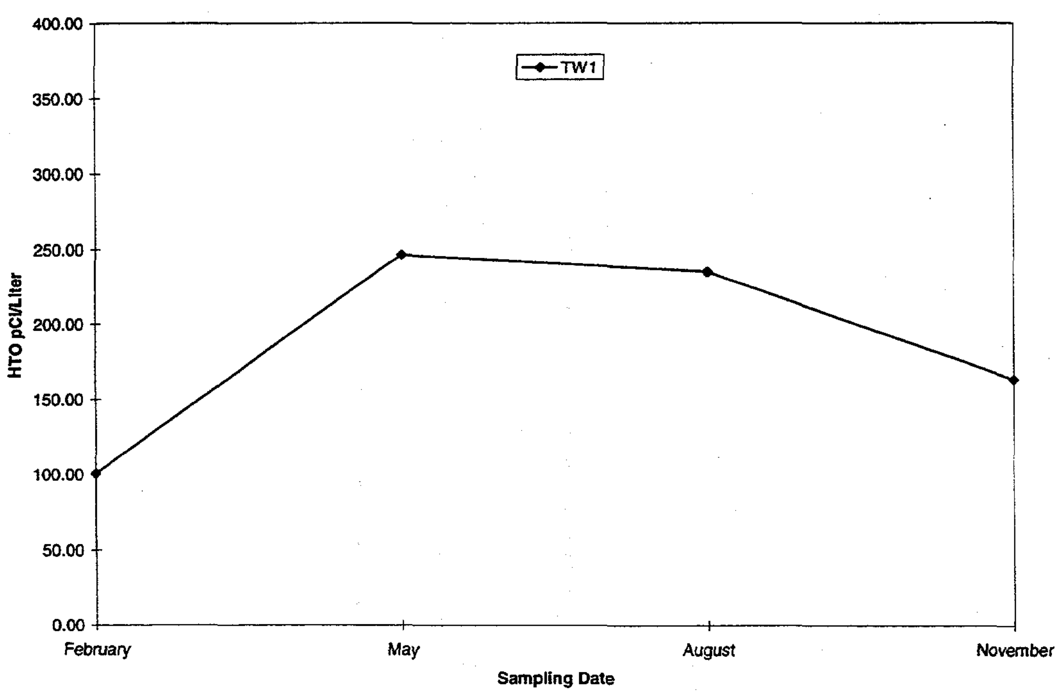


Figure 27. 1994 Tritium (HTO) in Ground Water

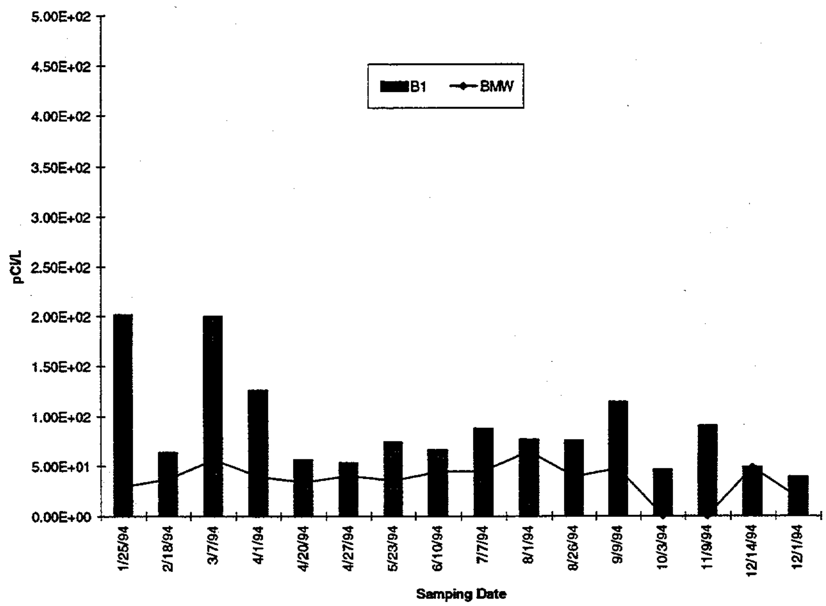


Figure 28. 1994 Tritium (HTO) Concentrations in Surface Water - B1

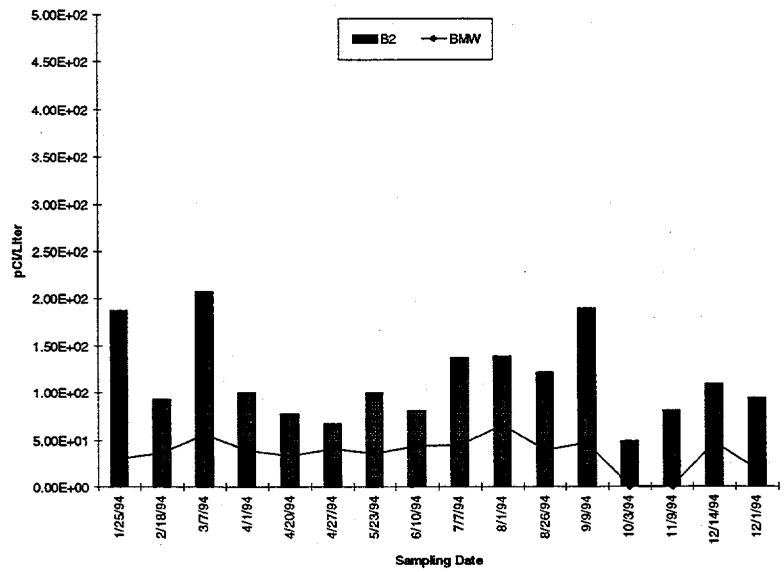


Figure 29. 1994 Tritium (HTO) Concentrations in Surface Water - B2

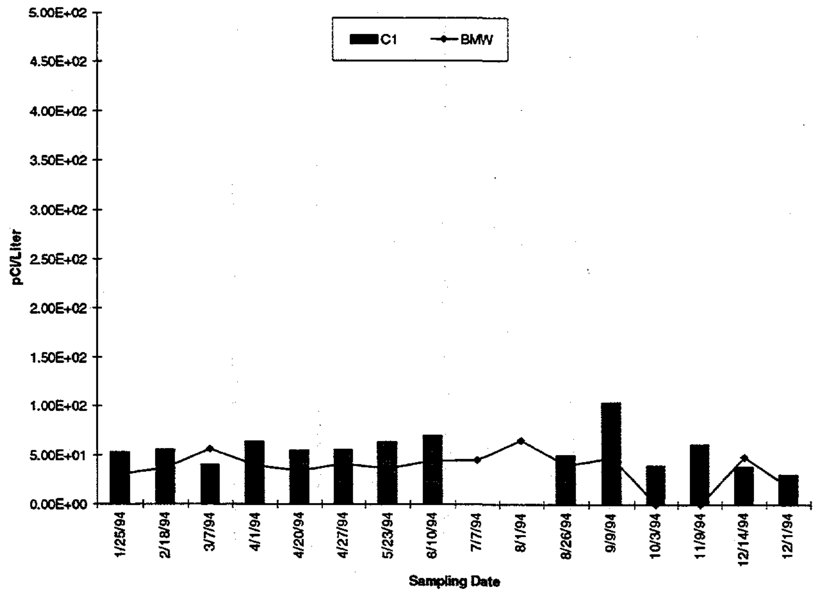


Figure 30. Tritium (HTO) Concentrations in Surface Water - C1

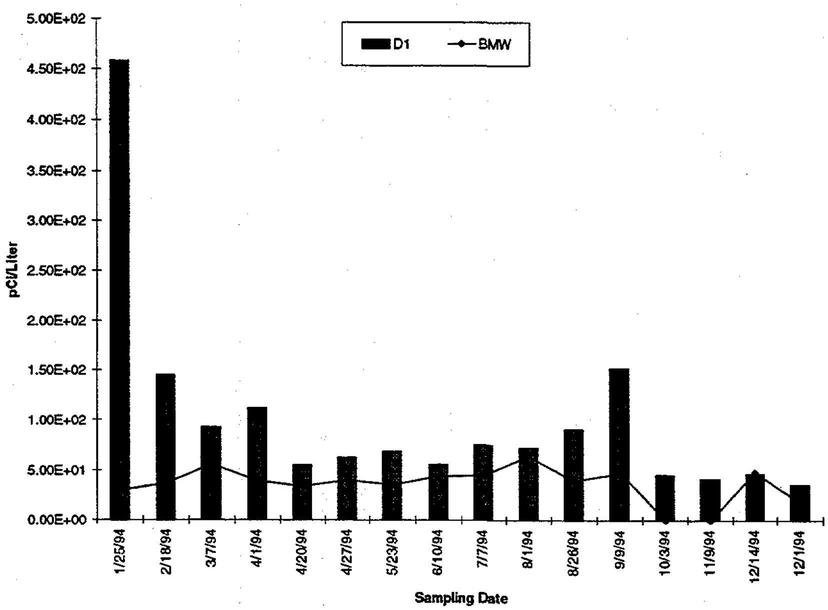


Figure 31. 1994 Tritium (HTO) Concentrations in Surface Water - D1

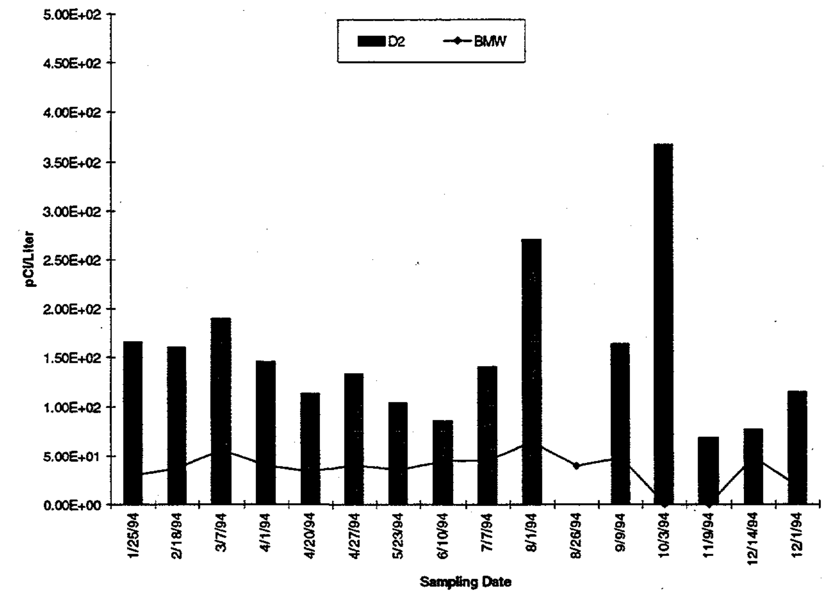


Figure 32. Tritium (HTO) Concentrations in Surface Water - D2

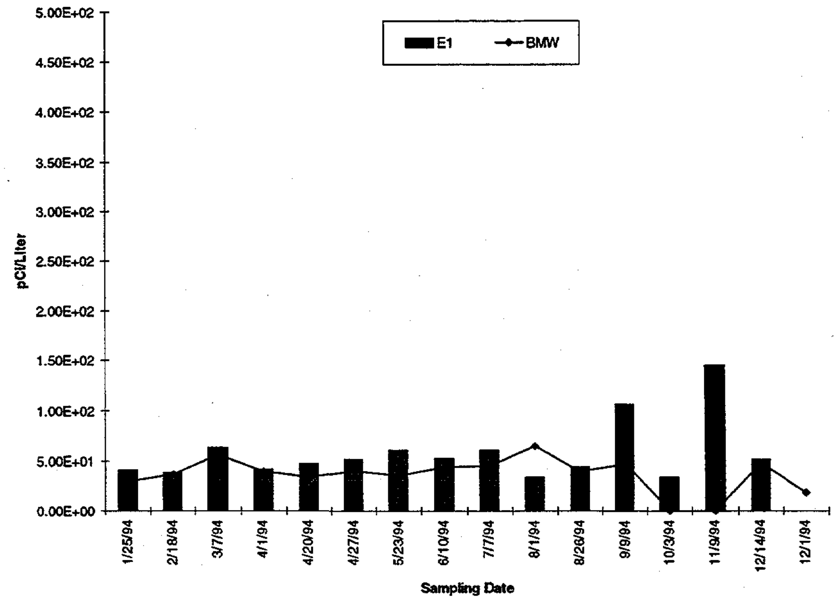


Figure 33. 1994 Tritium (HTO) Concentrations in Surface Water - E1

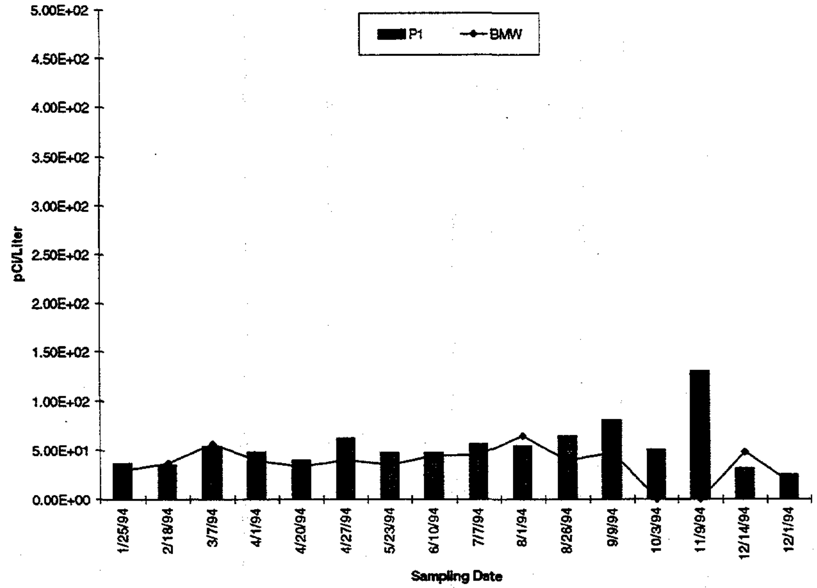


Figure 34. Tritium (HTO) Concentrations in Surface Water - P1

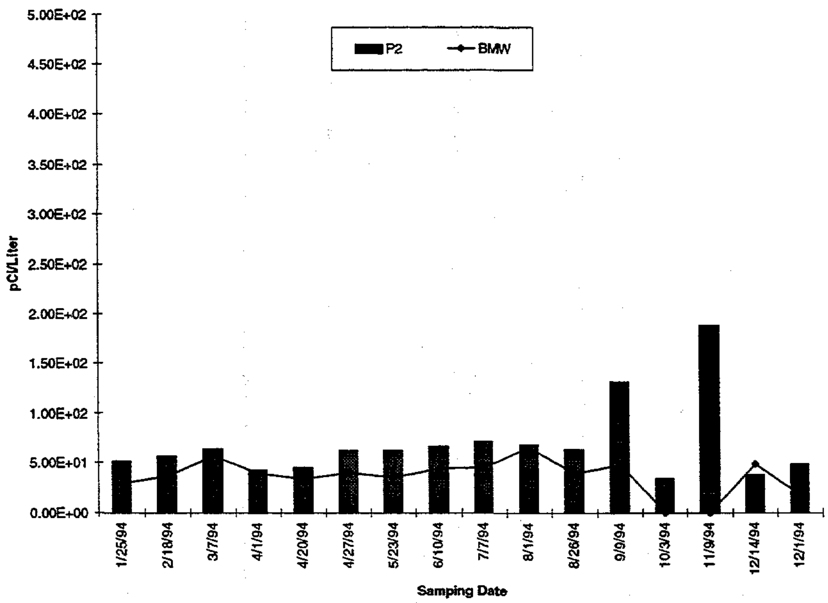


Figure 35. 1994 Tritium (HTO) Concentrations in Surface Water - P2

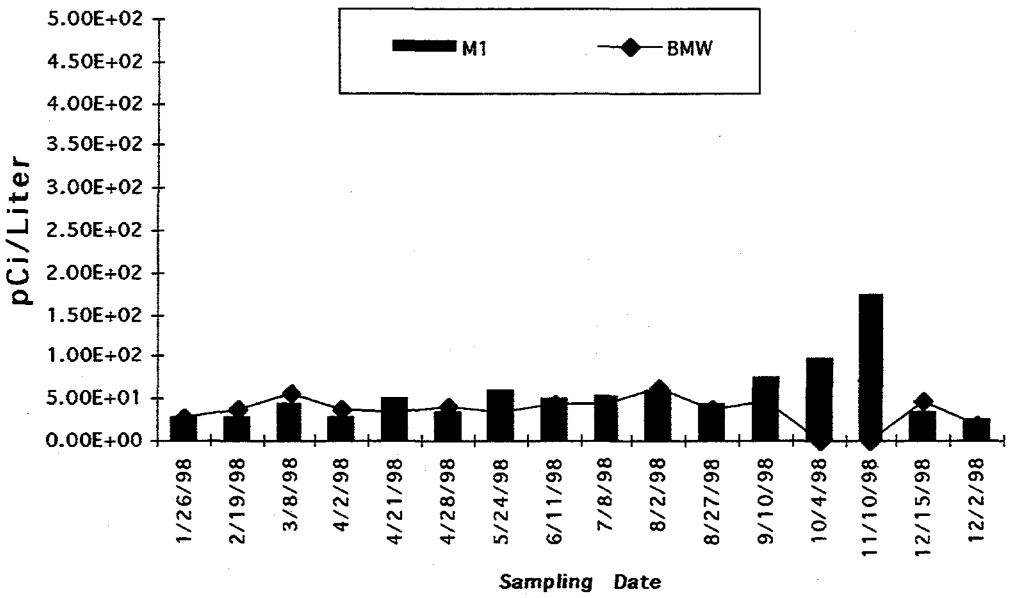


Figure 36. Tritium (HTO) Concentrations in Surface Water - M1

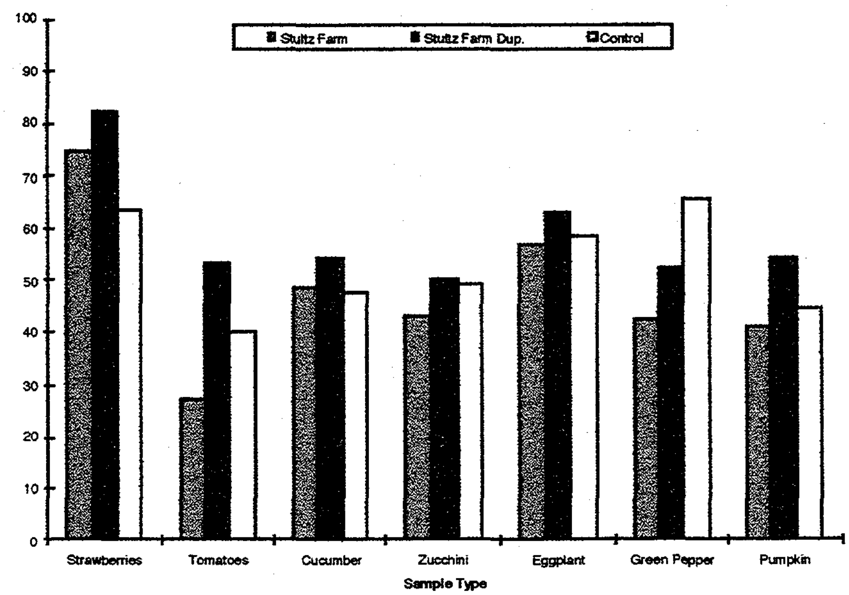


Figure 37. Tritium (HTO) in Biota

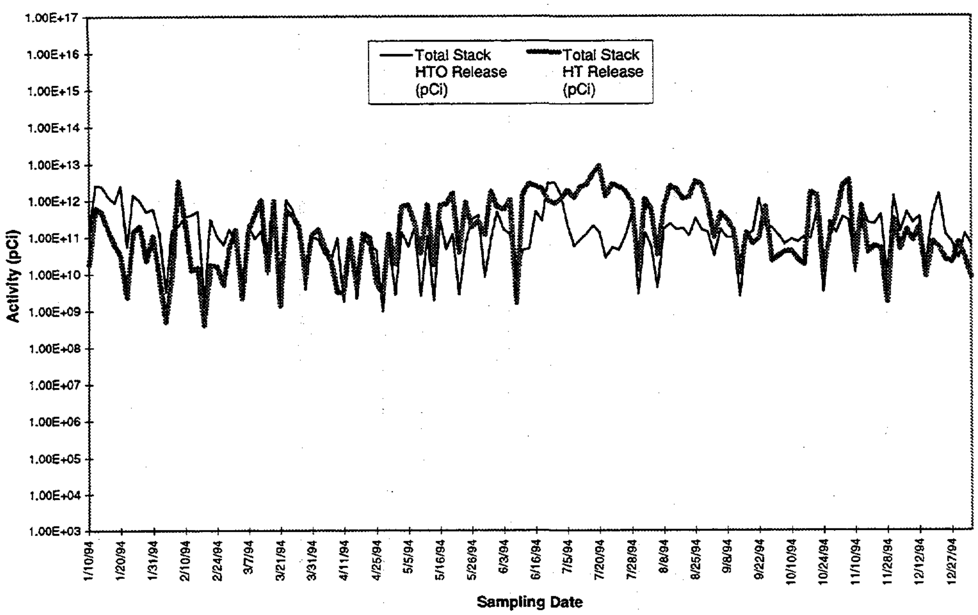


Figure 38. TFTR Total Stack Tritium (HT/HTO) Release for 1994

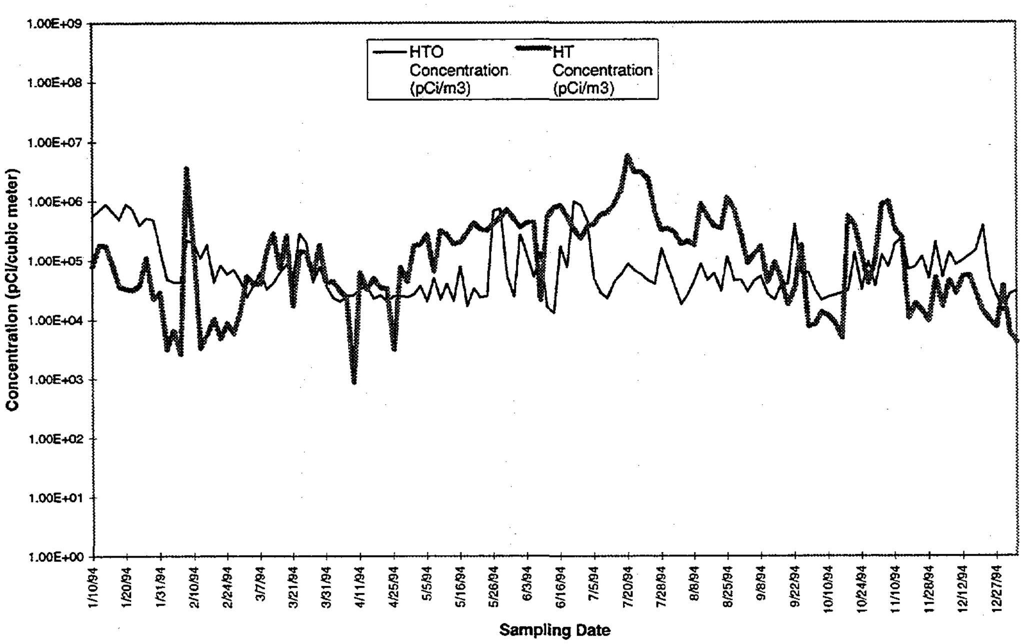
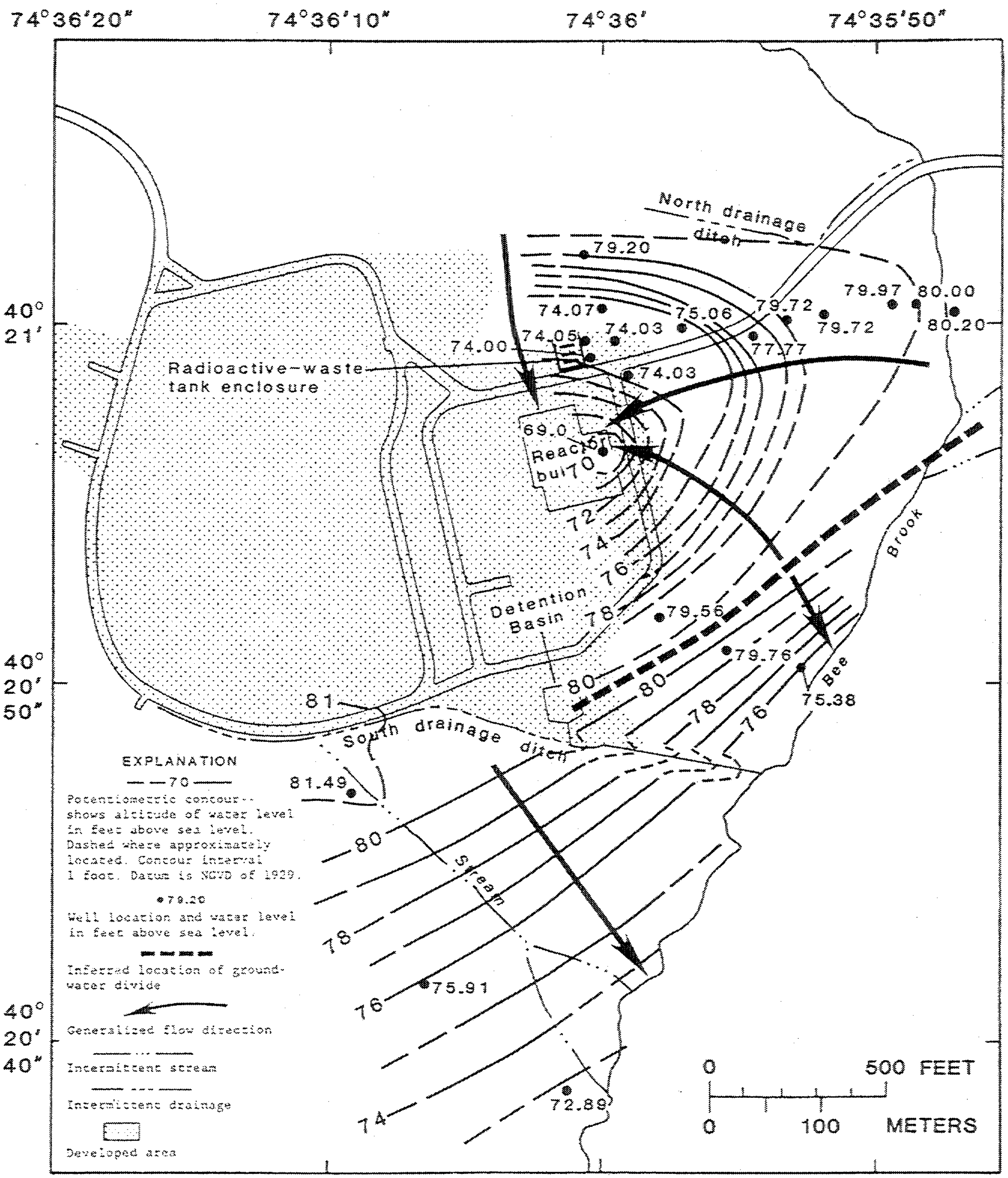


Figure 39. TFTR Stack Tritium (HT/HTO) Concentrations for 1994

93A0289



Base map modified from Air-Ography (1983)

Figure 40. Potentiometric Surface of the Bedrock Aquifer at PPPL

93A0288

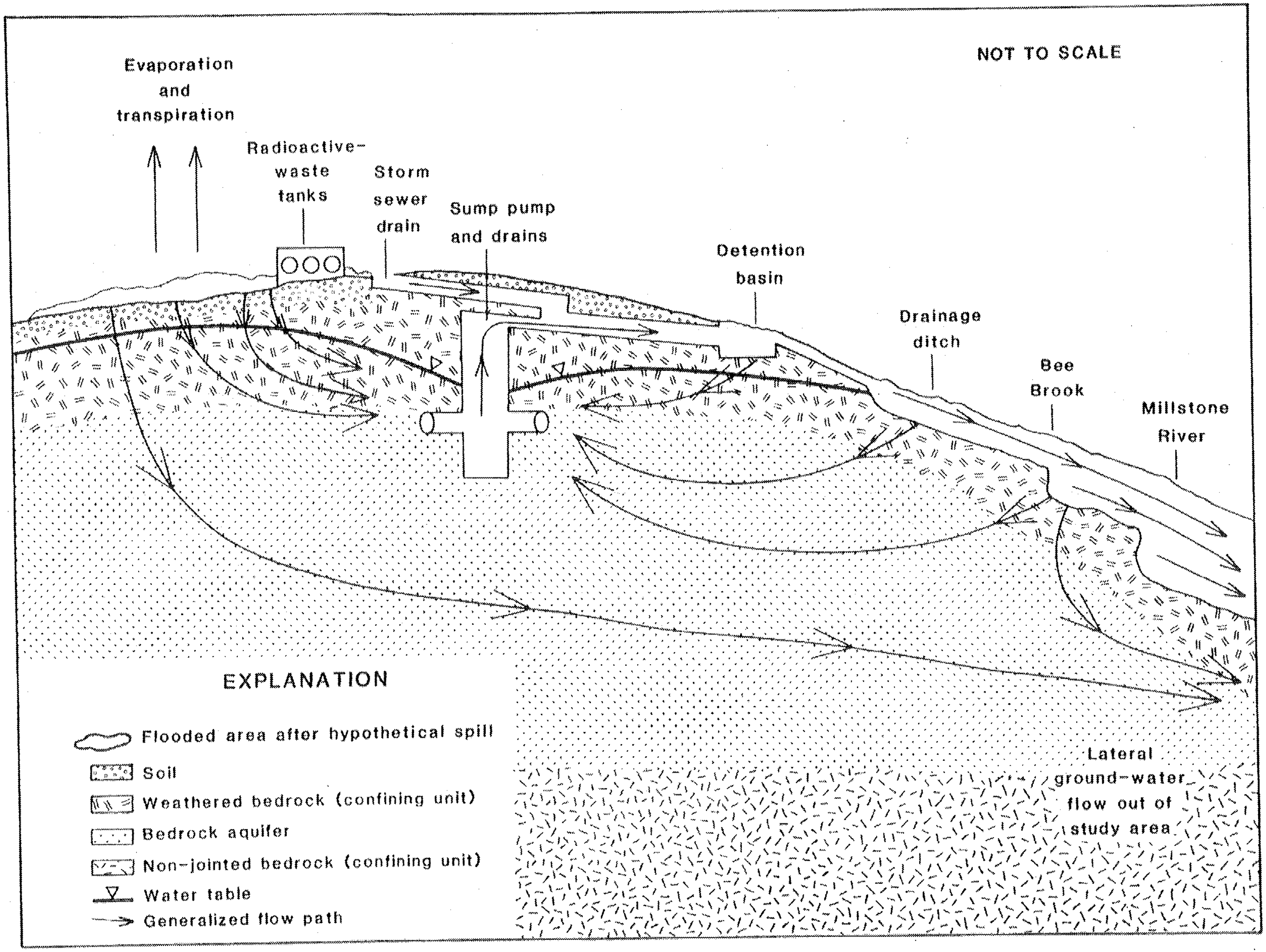


Figure 41. Hydrogeologic Framework and Potential Flow Paths of Spilled Water

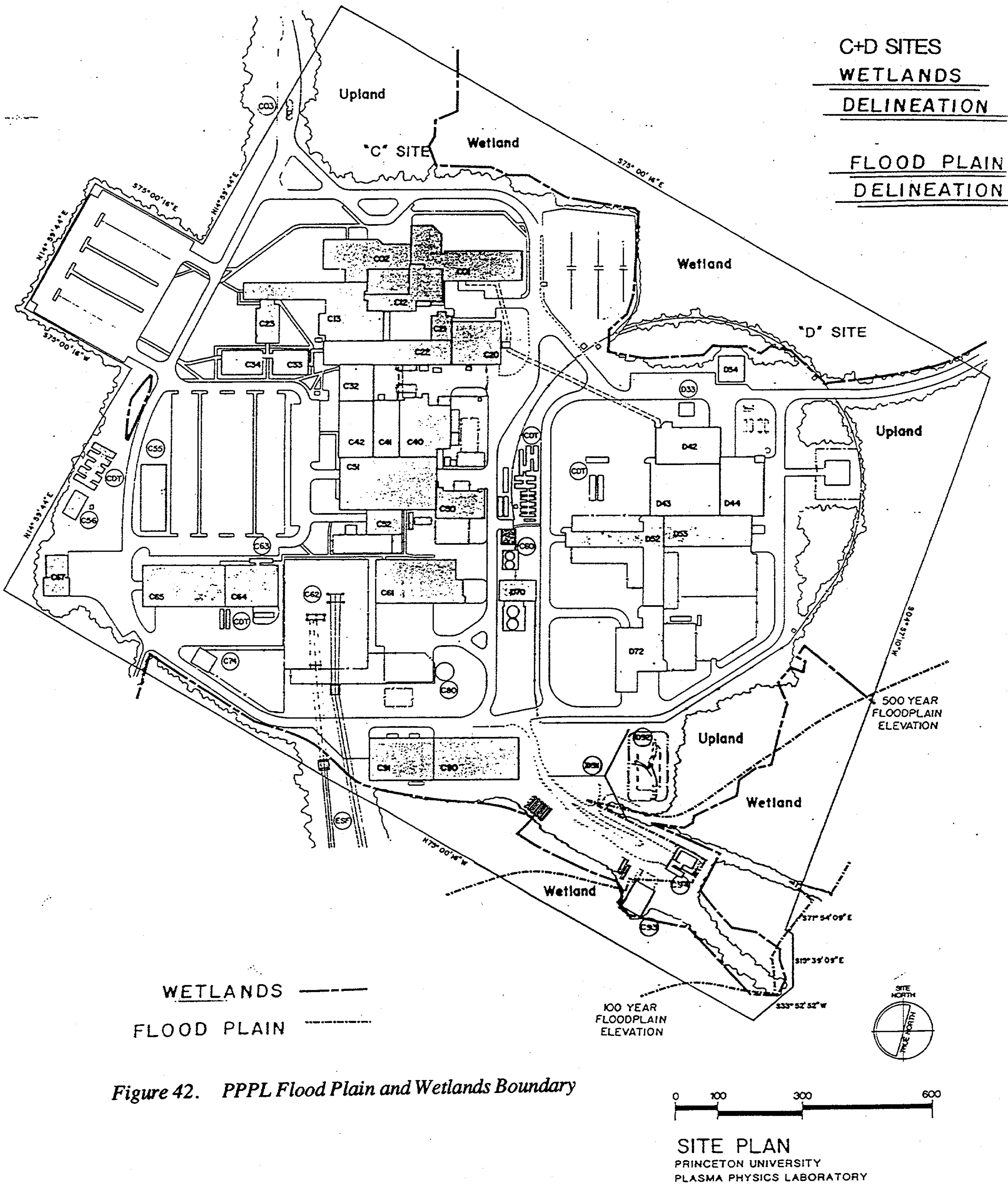


Figure 42. PPPL Flood Plain and Wetlands Boundary

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