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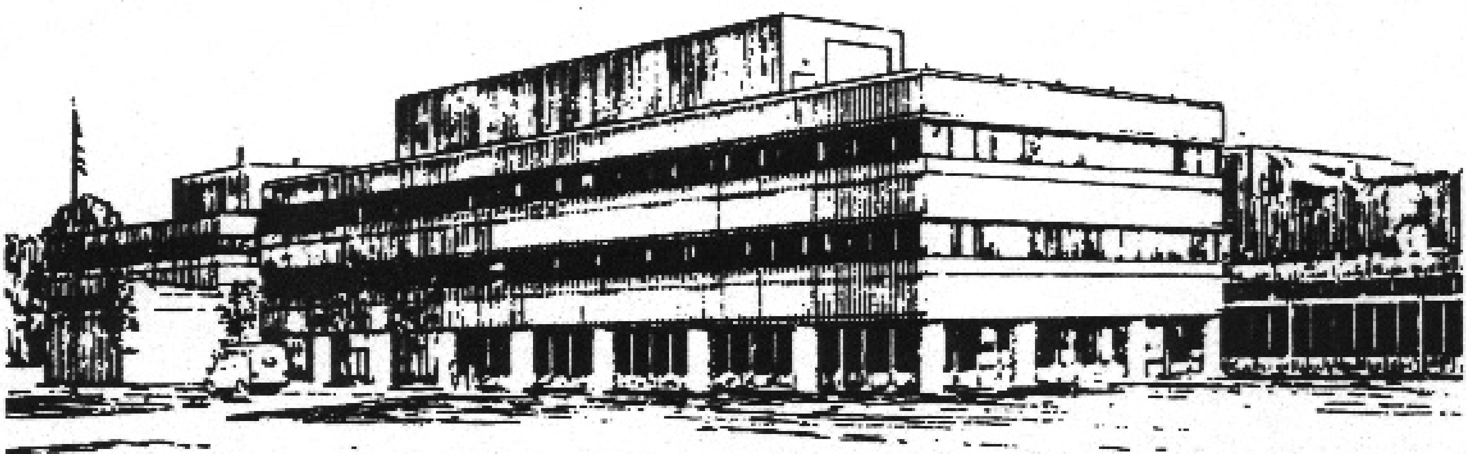
Princeton Plasma Physics Laboratory Annual Site Environmental Report for Calendar Year 1995

by

Virginia L. Finley and Marisa A. Wieczorek

February 1998

PPPL PRINCETON PLASMA PHYSICS LABORATORY



PRINCETON UNIVERSITY, PRINCETON, NEW JERSEY

PRINCETON PLASMA PHYSICS LABORATORY (PPPL)

ANNUAL SITE ENVIRONMENTAL REPORT

FOR CALENDAR YEAR 1995

By

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Operated under Contract
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List of Acronyms

AFS	Air Facility Subsystem
AGT	above ground tank
AHC	aromatic hydrocarbons
AIRDOS	Air Model for USEPA
AIRS	Aerometric Information Retrieval System
ALARA	as low as reasonably achievable
APEC	Areas of Potential Environmental Concern
Ar or Ar-41	Argon, Argon-41
BOD	biological oxygen demand
BN	Base neutral priority pollutant organic compounds
BPX	Burning Plasma Experiment
BTEX	Benzene, toluene, ethylbenzene, and xylenes
C	C site for James Forrestal Campus- part of PPPL site
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAS	Coil Assembly and Storage Building
CASL	Calibration and Service Laboratory
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
Cl or Cl-40	Chlorine, Chlorine-40
cm	centimeter
COD	chemical oxygen demand
CS	C site stellarator (PPPL)
CWA	Clean Water Act
CY	calendar year
D	deuterium
D&D	decontamination and decommissioning
D-D	deuterium-deuterium
D-T	deuterium-tritium
D-11, D-12	detention basin monitoring wells number 11 and 12
DATS	differential atmospheric tritium sampler
DEP	Department of Environmental Protection (New Jersey)
DMR	discharge monitoring report
DOE	Department of Energy
COE-CH	Department of Energy - Chicago Operations Office
DOE-EH	Department of Energy - Environment and Health
DOE-HQ	Department of Energy - Headquarters
DOE-OFE	Department of Energy - Office of Fusion Energy
DOE-PG	Department of Energy - Princeton Group
D&R	Delaware & Raritan Canal
DRCC	Delaware & Raritan Canal Commission
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 (DOE facility)
EMSL	EMSL, Inc. - subcontractor analytical laboratory for PPPL
ENLP	Environmental, Nuclear Licensing, and Permitting - group in Support Services Department (PPPL)
EO	Executive Order
EPA	Environmental Protection Agency (US)
EPCRA	Emergency Planning and Community-Right-toKnow Act (CERCLA)
ERDA	Energy Reserach and Development Agency predecessor of DOE
ER/WM	Environmental Restoration/Waste Management
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
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)
g	gamma

List of Acronyms

GBq	Giga Becquerel or 10^9Bq
GP	General Permit (Wetlands)
GPMP	Groundwater Protection and Monitoring Program
GW	Ground water
^3H	Tritium
HMSF	Hazardous Material Storage Facility
HQ	Headquarters
HRS	Hazard Ranking System
HT	tritium (elemental)
HTO	tritiated water
HVAC	heating, ventilation, and air-conditioning
ICRF	Ion Cyclotron Radio Frequency
IC_{25}	inhibition concentration 25 percent
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)
LLW	Lowq level waste (radioactive waste)
m	meter
MCHD	Middlesex County Health Department
MeV	million electron volts
MG	Motor Generator
mg/L	milligram per liter
MOU	Memorandum of Understanding
mrem	milli radiation equivalent man
mR/h	milliRoentgen per hour
MSDS	Material Safety Data Sheet
m/s	meters per second
msl	mean sea level
mSv	milliSievert
MW	monitoring well
n	neutron
N , N-13, N-16	Nitrogen, Nitrogen-13, Nitrogen-16
NAAQS	National Ambient Air Quality Standards
NB	Neutral beam
NBPC	Neutral Beam Power Conversion Building
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic and Preservation Act
NIST	National Institute of Standards and Technology
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection (prior to 1991 and after July 1994)
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
NOEC	No observable effect concentration - biomonitoring results
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elmination System
NPL	National Priorities List
NRC	National Response Center
NRC	Nuclear Regulatory Commission
NSTX	National Spherical Torus Experiment
nSv	nanoSievert
OH	ohmic heating
P1, P2	piezometer 1 and 2
PBX-M	Princeton Beta Experiment - Modification
PCAST	Presidential Committee of Advisors on Science and Technology
PCBs	polychlorinated biphenyls
PCE	perchloroethylene, tetrachloroethene, or tetrachloroethylene
pCi/L	picoCuries per liter
PFC	Princeton Forrestal Center
PG	Princeton Group - DOE group at PPPL
POTWs	publicly owned treatment works
ppb	parts per billion

List of Acronyms

ppm	part per million
PPPL	Princeton Plasma Physics Laboratory
PSTP	Proposed Site Treatment Plan for the Federal Facility Compliance Act
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
RMS	Remote monitoring station
RQ	Reportable quantity - release reporting to NRC
S or S-37	Sulfur, Sulfur-37
SAD	Safety Assessment Document
SARA	Superfund Amendments and Reauthorization Act of 1986
SBRSA	Stony Brook Regional Sewerage Authority
SDWA	Safe Drinking Water Act
SF_6	Sulfur hexafluoride
SPCC	Spill Prevention Control and Countermeasure
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
TPX	Tokamak Physics Experiment
TR	trailer atmospheric monitors
TRI	Toxic Reduction Inventory (CERCLA)
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
USEAP	US Environmental Protection Agency
USGS	US Geological Survey
UST	underground storage tanks
VOCs	volatile organic compounds
χ/Q	atmospheric dilution factor (NOAA)
µg/L	micrograms per liter
µSv	microSievert

List of Exhibits Contained in the Text

NOTE: The above exhibits (except Exhibits 2-1 and 6-2) are text tables. All data tables are located in Section 11.0 beginning on page 56.

1.0 EXECUTIVE SUMMARY

This report gives the results of the environmental activities and monitoring programs at the Princeton Plasma Physics Laboratory (PPPL) for Calendar Year 1995 (CY95). 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. This report will also summarize environmental initiatives, assessments, and programs that were undertaken in 1995. The objective of the Annual Site Environmental Report is to document that PPPL's environmental protection programs protect the environment and the public health to a level that meets or exceeds regulatory compliance.

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 alternative energy source. In 1995, PPPL had one of its two large tokamak devices in operation—the Tokamak Fusion Test Reactor (TFTR). The other device, the Princeton Beta Experiment-Modification or PBX-M (Fig. 1), did not operate in 1995 .

During CY95, the Princeton Plasma Physics Laboratory's (PPPL) Tokamak Fusion Test Reactor (TFTR) continued to conduct fusion experiments. Having set a world record on November 2, 1994, by achieving approximately 10.7 million watts of controlled fusion power during the deuterium-tritium (D-T) plasma experiments, researchers turned their attention to studying plasma science experiments, which included "enhanced reversed shear techniques." The enhanced reversed shear techniques involve a magnetic-field configuration, which dramatically reduces plasma turbulence and has possibilities of doubling TFTR record fusion power ouput. Also in 1995, the Magnetic Reconnection Experiment produced its first plasma, and the magnetic field for TFTR was increased to 6 Tesla. PPPL began its collaboration with the Korean fusion science and technology program.

In addition to surpassing the goal of 10 million watts set for the TFTR project, since November 1993 when deuterium-tritium experiments began in TFTR, more than 600 tritium shots were pulsed into the reactor vessel generating more than 4×10^{20} neutrons and 1.1 gigajoules of fusion energy. These achievements represent steps forward toward the reality of a commercial fusion reactor in the twenty-first century. For twenty-two 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.

In CY95, PPPL's radiological monitoring program continued to measure on-site and off-site tritium in air, and make comparisons with baseline data. Capable of detecting changes in the ambient levels of tritium in the air, highly sensitive monitors are located at six off-site stations within 1 km of TFTR and at a baseline location. On-site tritium levels in the air are monitored by a tritium monitor 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, and by four facility site boundary monitors. Also included in PPPL's radiological monitoring program are soil, biota, and surface, ground, and waste water monitoring.

The results of the radiological monitoring program for 1995 were: 1) radiation exposure, via airborne and sanitary sewer effluents, were measured at low levels; 2) the total maximum off-site dose from all sources—airborne, sanitary sewerage, and direct radiation—was 0.31 mrem/year— 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 was 0.082 mrem/year, which is well below the 10 mrem/year NESHAPs limit (see Table 2).

PPPL's non-radiological environmental monitoring program demonstrates compliance with applicable environmental requirements, which includes monthly surface water monitoring for New Jersey Pollutant Discharge Elimination System (NJPDES) discharge permit, NJ0023922. Three discharge locations are identified by Discharge Serial Numbers (DSN): DSN001—basin outfall, DSN002—a storm water discharge for the west side of C site, and DSN003—a filter back wash discharge from the Delaware & Raritan Canal pump house. Also, PPPL is required to conduct quarterly chronic toxicity testing at DSN001. As required by the NJPDES ground-water (GW) permit, NJ0086029, PPPL collects quarterly ground-water samples from seven monitoring wells and twice annual samples from the detention basin inflows .

In 1995, PPPL continued its remedial investigation and remedial alternative assessment for 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 chlorinated volatile organic compounds (most probably from solvents) in three locations on-site. In February 1993, Princeton University signed a voluntary agreement or Memorandum of Understanding (MOU) with the New Jersey Department of Environmental Protection. PPPL's work plan includes ground-water sampling, soil sampling, and water quality analyses of dewatering sumps. In 1995, PPPL completed soil sampling in the seven identified Areas of Potential Environmental Concern (APEC); PPPL collected two site-wide rounds of ground-water samples from monitoring wells and dewatering sumps.

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

Beginning in December 1993, TFTR conducted the deuterium-tritium (D-T) experiments and set new records by producing over ten million watts of energy in 1994. The TFTR (Fig. 2) 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. The TFTR began its first full year of operation in CY83; TFTR produced its greatest number of D-D neutrons in 1990 and 1995 (Exhibit 2-1). The highest, total, number of neutrons produced in one year occurred in 1995 when 2.27×10^{20} neutrons were 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 1987-1995

Year	*Deuterium-Deuterium Total Neutron Production*	*Year*	*Deuterium-Tritium 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	7.2×10^{18}	1993	1.65×10^{19}
1994	1.3×10^{19}	1994	1.85×10^{20}
1995	2.3×10^{19}	1995	2.04×10^{20}

In July 1995, the Department of Energy's U.S. Program for Fusion Energy Research and Development reviewed the "Report of the Fusion Review Panel," prepared by the President's Committee of Advisors on Science and Technology (PCAST). The report recommended three key priorities based on a budget-constrained strategy: "1) a strong domestic core program in plasma science and fusion technology...," 2) "a collaboratively funded international fusion experiment focused on the key next-step scientific issue of ignition and moderately sustained (circa 100 seconds) burn...," and 3) "an international program to develop practical low-activation fusion-reactor materials..." Specifically, for PPPL, the report stated "continue to operate TFTR for 3 years beyond its current scheduled shut down at the end of FY1995, at a somewhat reduced funding level of about $50 million per year..."

Due to the negotiation of the next phase of the ITER cooperation, the committee also recommended a 3-year construction delay of the Tokamak Physics Experiment or TPX, which was scheduled to begin in FY1996. The TPX program, which replaced the cancelled Burning Plasma Experiment in 1992 as PPPL's next machine, was also cancelled in 1995; this cancellation was due to a change in the direction of fusion research caused by funding cuts by Congress. Also placed on hold was the TFTR Decommissioning and Decontamination (D&D) project.

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 Figure 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 Campus (JCF) of Princeton University. 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. In an aerial photo (Fig. 5), the general layout of the facilities at the C and D sites of Forrestal Campus is viewed; the specific location of TFTR is at D site (on the left side of photo).

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].

The D site is surrounded completely with a chain-linked fence for the controlled 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].

The environmental monitoring program document contains 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]. The order 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 issuance of 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 argon-41 (Ar-41), nitrogen-13 (N-13), nitrogen-16 (N-16), and internal exposure from radionuclides, such as tritium (H-3) 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, described in 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 61.9 Ci (37.03 Ci HTO and 24.87 Ci HT, Table 2) (2.3 TBq) of tritium, as measured by the stack air monitor, were released from the stack in 1995.

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 meteorological tower was erected and began operation in November 1983 (see Figs. 12, 14, 16, and 18 for comparison 1984 *versus* 1995 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 (1995) using the monitors on the tower (Figs. 11, 13, 15, and 17). Wind-rose plots from the data for the ten years (1984-95) are shown in Figures 5-10.

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 Department of Energy-Princeton Group (DOE-PG) 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.

The DOE Order 5400.1, "General Environmental Protection Program" [DOE90], requires PPPL to have an environmental radiological and non-radiological 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 1995.

Exhibit 2-3. Radiation Monitoring Program Covering Critical Pathways

Type of Sample	Critical Path I.D. (Exhibit 2.2)	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

3.0 1995 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 part of PPPL's Project Mission Statement, PPPL initiates those actions that enhance its compliance efforts and 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 nor has been 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] and no further CERCLA actions were warranted by the results of the inventory.

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 1995, PPPL shipped off site approximately 42 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 removed from underneath the boiler room and HVAC room floors, 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. In January 1995, PPPL discontinued service from one tank, which was then abandoned in-place in accordance with the New Jersey Underground Storage Tank (UST) regulations. This tank was abandoned in-place rather than excavated because of its proximity to buried underground high-voltage power lines. As directed by the the NJ Department of Environmental Protection (NJDEP) State Case Manager, PPPL is required to submit the UST

Closure Report as part of the Remedial Investigation and Remedial Alternative Assessment Study. The UST Closure Report was completed and submitted to NJDEP in March, 1997 as part fo the Remedial Investigation Report.

3.1.3 National Environmental Policy Act (NEPA)

Approximately 50 PPPL activities received NEPA reviews in 1995, 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.

DOE/EA-1108, an Environmental Assessment for the National Spherical Torus Experiment, was prepared and issued to DOE for review in July 1995, and was transmitted by DOE-CH to NJDEP for review in September 1995. On December 8, 1995, the Environmental Assessment for the National Spherical Torus Experiment (NSTX) was approved and the finding of no significant impact (FONSI) was signed by the DOE Chicago Operations Office Manager.

3.1.4 Clean Air Act (CAA)

The PPPL was in compliance with the requirements of the CAA in 1995. In April 1995, the 1994 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.

In August 1995, PPPL submitted a request for Annual Emission Statement Non-Applicability to the NJDEP. In support of this non-applicability statement PPPL determined the maximum annual quantity of air contaminants 1)allowed to be emitted by permit from all permitted sources, 2) emitted from all unpermitted source operations operating at their maximum design capacity, and 3) emitted as fugitive emissions. The only regulated air contaminant that has the potential to be emitted by PPPL source operations above the air contaminant thresholds is nitrogen oxides (NO_X). The air contaminant reporting threshold for NO_X in accordance with NJAC 7:27-21.2 is 25 tons per year. PPPL determined that its potential to emit NOx from permitted sources operating under federally enforceable permit conditions is below this threshold. The NJDEP is currently in the process of reviewing the non-applicability statement.

In addition to filing the non-applicability statement, PPPL submitted a negative declaration for the New Jersey Operating Permit Program. The CAA Title V Operating Permit program is implemented through the state of New Jersey. The negative declaration for the PPPL site was submitted to the NJDEP in August 1995. The negative declaration was approved in March 1996 with an effective approval date of November 29, 1995. This effective approval date reflects the date that the TFTR emergency diesel generator operating hours were reduced and hence reduced the facility's potential to emit NO_X at the 25-ton per year threshold. The TFTR emergency diesel generator permit was the last of the PPPL permits to be amended as part of the negative declaration preparation.

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 a tri-annual basis and was partially revised during preparation of the negative declaration and non-applicability statement documents.

On January 27 and March 20, 1995, PPPL submitted an amendment for the TFTR and C site diesel generator permits, respectively, to the NJDEP to indicate a change in fuel type from #2 diesel to #1 diesel. The NJDEP approved the change in fuel type on September 25, 1995 for the TFTR generator and on June 20, 1995, for the C site generator.

In October 1995, PPPL requested of the NJDEP a total fuel use limit for all four boilers. The NJDEP granted that request and imposed a maximum annual fuel use limitation for the C site boilers of 227,370 gallons of #4 fuel oil and 88.6 million cubic feet of natural gas. Prior to this date each boiler was limited by a specific fuel use for #4 fuel oil and natural gas. This arrangement did not allow the boilers to operate at maximum efficiency because specific boilers would be restricted to burn oil during optimal environmental conditions.

In 1995, 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). 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.

As requested by NJDEP in March 1995, PPPL determined the amount of sulfur hexafluoride (SF_6) released annually from TFTR operations. The amount of SF_6 used to maintain the SF_6 systems can range from 28,060 pounds per year to 36,340 pounds per year. SF_6 is used in the modulator regulators, the ICRF, and the NB high voltage and ion source enclosures.

PPPL is working with the Procurement and Materiel Control Divisions to meet requirements of Executive Order 12843, "Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances." The ENLP and F&EM are working together to identify and inventory present and future uses of class I and class II ozone-depleting substances. The ENLP and F&EM groups will also assess existing and future needs for these substances.

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: 37.03 curies of tritiated water or HTO and 24.87 curies of elemental tritium or HT (see Table 2) [Ja96].

In 1995, the effective dose equivalent to a person at the business nearest PPPL, due to radionuclide air emissions, was 8.2×10^{-2} mrem, which is 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 three releases of petroleum, petroleum products, or hazardous substances to the NJDEP in CY 1995. Of these three releases (see Exhibit 3-1), two releases impacted permeable surfaces (gravel and soil) and involved petroleum products or hazardous substances: one pint to one quart of transmission fluid leak from an employee's vehicle and approximately 43 gallons of mineral oil spilled from a tank truck onto gravel. The tank truck held the remainder of the transformer oil while a capacitr was being removed. Soil sampling was conducted and about 30 yards of oil-contaminated soil was removed..

From November 1994 to April 1995, the chiller system was under investigation. Faulty leak detection equipment was cited for the difficulty in determining if leaks were actually occurring. The leak detection equipment was repaired, and all the leaks were found and also repaired. It was calculated that a total of 900 pounds of CFC 12 was released over the five month period. NJDEP was notified of the release, and the release confirmation report was prepared and submitted to NJDEP.

Exhibit 3-1. 1995 Release Reports

NJDEP CASE #	PPPL #	TITLE	TYPE of RELEASE
95-4-26-1209-27	ER95-01	Transmission Fluid Leak	1 pint to 1 quart of transmission fluid from an employee's car was released to gravel and soil
95-4-26-1331-02	ER95-02	Chlorofluorocarbon (CFC) 12 Leak	900 pounds of Freon® released to ambient air
95-12-15-1555-03	ER95-03	Mineral Oil Spill	43 gallons of mineral oil released to gravel and soil

3.1.7 National Pollutant Discharge Elimination System (NPDES)

In 1995, PPPL operated under the conditions of New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge permit (NJ0023922) (see Table 18). 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.

Effective March 1, 1994, the monitoring locations in the permit are the detention basin outfall, monitoring point DSN001, the site’s storm water runoff that does not drain to the detention basin—DSN002 (see Table 19), and the filter backwash discharge (DSN003) at the Delaware & Raritan Canal pump house (see Table 20). These three locations are designated as monthly sampling points (see Figures 19 and 20).

Due to natural scouring of the swale that leads to DSN002, at times the total suspended solids (TSS) limit is exceeded (twice during 1995). For that reason, PPPL and DOE-PG requested that the DEP consider eliminating the TSS limit from the permit conditions. PPPL and DOE-PG met representatives from the DEP Bureau of Standard Permitting and Stormwater Management to discuss this issue. PPPL and DOE-PG are awaiting the DEP’s decision on the total suspended solids limit at DSN002.

In 1995, the Radiological Environmental Monitoring Laboratory (REML) was inspected by NJDEP, Office of Quality Assurance, for New Jersey laboratory certification of pH and temperature measurements. Equipment calibration and records needed to be better documented; these deficiencies were corrected.

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-PG 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-PG agreed to report LEC tank data to SBRSA on a monthly (tritium, pH, and temperature) and annual (chemical oxygen demand) frequency. The SBRSA industrial discharge permit was renewed in February 1996 with the elimination of the annual sampling requirement. Monthly sampling for tritium, pH and temperature at the LEC tanks remains a requirement of the renewed permit.

During 1994 and 1995, PPPL and SBRSA performed split sampling three times for the parameters listed in the permit. The PPPL worked to eliminate the photo laboratory waste stream as an industrial flow to the sanitary sewer, subsequently accomplished. Filters were installed to remove silver from the photographic process wash and rinse water; a digital imaging system, which will eliminate all photo-processing waste water, will be implemented in the near term.

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 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 1995, 653 PCB capacitors, which meet the regulation criteria, are located within two buildings onsite. These buildings have concrete floors, and so the capacitors are located in protected areas away from the weather. Of the 653 capacitors, 640 capacitors also have secondary containment. There are no plans at this time to remove and/or replace these capacitors.

3.1.10 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 21).

3.1.11 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.

3.1.12 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].

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

The PPPL is in compliance with the EO 11988, "Floodplain Management." 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. 35).

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 1996.

In 1995, PPPL began preparing a site-wide stormwater management plan. It would include the proposed second cell detention basin, which was in the conceptual design phase. PPPL discovered that the Princeton Forrestal Center (PFC) the management group for Princeton University's corporate office and research complex, included the PPPL site in their Stormwater Management Plan. This plan was submitted to the Delaware Raritan Canal Commission (DRCC) in 1980 and a Certificate of Approval was signed on May 20, 1980. The 72-acre parcel that PPPL occupies is included in PFC's stormwater management plan-Phase I. The 72-acre parcel is part of the Bee Brook watershed and therefore includes PPPL in the PFC stormwater plan.

One condition of the PFC Storm Water Management Plan is that the average density of development not exceed a maximum of 60% impervious coverage in developable areas. PPPL meets the 60% impervious coverage limit and is in compliance with the stormwater requirements . PPPL determined that the second detention basin was not required.

3.1.14 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. 35).

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.

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

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

Exhibit 3-2. Summary of PPPL Reporting Requirements

EPCRA 302-303: Planning Notification	YES [✔]	NO [ ]	NOT REQ. [ ]
EPCRA 304: EHS Release Notification	YES [ ]	NO [ ]	NOT REQ. [✔]
EPCRA 311-312: MSDS/Chemical Inventory	YES [✔]	NO [ ]	NOT REQ. [ ]
EPCRA 313: TRI Inventory	YES [ ]	NO [ ]	NOT REQ. [✔]

In 1995, PPPL submitted an annual chemical inventory to be in compliance with SARA Title III or EPCRA 312. This inventory reports the quantities of chemicals listed on the CERCLA regulations that are stored on site.

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 3-3 lists hazardous compounds at PPPL, reported under SARA Title III for 1995 [PPPL1995a].

Exhibit 3-3. Hazard Class of Chemicals at PPPL

Compound	Fire	Sudden Release of Pressure	Reactive	Acute Health Hazard	Chronic Health Hazard
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 an annual submittal to DOE for 1995 that included the TRI cover page and laboratory exemption report.

3.1.16 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 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 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].

3.2 Current Issues and Actions

3.2.1 Air Issues and Actions

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.

In August 1995 PPPL submitted applications for negative declaration and non-applicability statement for the CAA Operating Permit Program and the NJDEP Annual Emission Statement respectively. In March 1996 the NJDEP granted the negative declaration for the Operating Permit program with an effective date of November 29, 1995. PPPL is currently awaiting approval of the Emission Statement non-applicability from the NJDEP.

In support of the negative declaration and non-applicability statement several amendments were made to existing permits. The TFTR emergency diesel generator was limited to 200 hours of operation per year and the boilers were limited to a ten ton per year emission rate based on fuel limitations. Through these amendments PPPL determined that its potential to emit NO_X from permitted sources is 23 tons per year. This estimate is based upon exagerated fuel consumption. The actual NO_X emissions from PPPL permitted sources based on actual fuel consumption and operating hours, during CY95 was 7.2 tons per year.

3.2.2 NJPDES Surface Water Permit No. NJ0023922 Issues and Actions

During CY1995, three non-compliances were reported for total suspended solids (TSS) measured at DSN002 (stormwater) and DSN003 (Delaware & Raritan Canal pump house filter backwash) (see

Tables 15 and 16). At DSN002 located at the southwestern boundary of C site, two TSS exceedances were reported for the stormwater discharge samples collected in January and March 1995. These exceedances were attributed to natural sediments in the ditch and not to PPPL activities or soil disturbances. The PPPL and DOE-PG submitted a request to NJDEP for modifications to the permit addressing this issue. Modification to DSN002 requirements within the PPPL surface water permit were made and distributed for public comment in February 1996. The exceedance of TSS at DSN003 may have been affected by the TSS concentration of the water in the D&R Canal at the time the sample was taken. Samples of both the discharge and the canal were collected and analyzed on six consecutive sampling events. Both sets of data were similar and neither displayed exceedances.

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 D site (TFTR and MG basements) and C site (LOB and CS basements) is about 300,000 gallons per day.

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

In 1989, PPPL and DOE-PG 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-PG 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-PG 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 [Fi94a]. In this application, the PPPL and DOE-PG requested that NJDEP delete from the permit the three off-site wells, for which the adjudicatory hearing was requested. As of March 1996, NJDEP has not issued a new NJPDES ground water permit; PPPL and DOE-PG continue to comply with the requirements of the expired permit. DOE-PG has requested that the NJDEP review past ground water data and reduce the frequency and number of sampling locations in the renewed permit. The NJDEP is currently reviewing the data and a decision to reduce sampling locations, sampling frequency and parameters is pending.

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) governing the investigation and remediation of the entire James Forrestal Campus was signed by Princeton University in February 1993. Princeton University has responsibility for investigating A/B sites, and PPPL and DOE-PG have responsibility for C and D sites.

The revised work plan for the RI/RAA was submitted to NJDEP in September 1994; with "conditional approval" was received in January 1995. Soil sampling was conducted in April 1995, and two rounds of ground water samples were collected in March and May 1995. Soil samples from only two areas of concern showed contaminants above the most stringent NJDEP Cleanup Criteria. They are: 1) next to the cooling tower former chromium reduction pits and 2) the C site drainage swale, which receives runoff from the 138 kV switch yard. After NJDEP review and approval of the RI/RAA results, PPPL will complete removal actions for soil and/sediment contamination in these areas.

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, 97 percent have been completed as of March 1996. All the environmental findings were completed.

3.3 Environmental Permits

The PPPL Environment, Nuclear Licensing, Permitting and Safety Division of the Support Services Department maintains a list of Environmental permits (see Exhibit 3-4) which is updated monthly. A discussion of the environmental permits required by the applicable statutes is found in the Sections 3.0 or 6.0, "Environmental Non-Radiological Program Information."

Exhibit 3-4. PPPL Environmental Permits

Permit No.	Permit Type	Effective Date	Expiration Date	Status
0086029	NJPDES Groundwater	4/1/89	12/31/96	In compliance. Renewal applic. submitted to DEP 7/5/94. Sent letter on 2/22/95 re: 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 exceed..
092187	TFTR Diesel Exhaust	10/24/89	10/24/99	Current.
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*. Id. No. 15952
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. Temporary 90-day permit.
061297	Boiler #4 Stack Vent	3/31/82	*4/23/95*	Current.Temporary 90-day permit
061299	Boiler #5 Stack Vent	3/31/82	*4/23/95*	Current.Temporary 90-day permit
061298	Oil Tank Vent #2	3/31/82	3/31/97	Cancelled.
0128306	Medical Waste Gener.	7/22/91	7/21/95	Current.
DR-18A	D&R Canal Water Use	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	F&EM 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 & .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 Aug.; Project completed
95-0025	FSCD-Radwaste Facility	4/12/95	4/12/97	FSCD reps. visited on 8/21/95. Need to notify of Project complet.

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 1995, the following air stations were monitored:

Exhibit 4-1. Radiological Air Monitoring Stations

Station Name	Number/Description	Figure
Remote Environmental Air Monitoring (REAM)-off site	Stations *REAM 1- 6*: Tritium	21
TFTR radiological monitoring system (RMS) on D site	8 Neutron detectors and gamma ionization detectors and passive tritium monitors at *TR 1-4*:	20
Radiological monitoring system (RMS) at property line stations	2 Neutron detectors and gamma ionization detectors at Northeast (*RMS-NE*) and Southeast (*RMS-SE*)	20

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

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

Station #	Location/Figure #	Description
B1	Off-site / 20	Bee Brook Upstream of discharge from basin
B2	Off-site /20	Bee Brook Downstream of discharge from basin
C1	Off-site / 21	Delaware & Raritan Canal (Plainsboro)
D1	On-site / 20	D site Manhole-stormwater sewer
D2	On-site / 20	DSN001 Surface Water Discharge from the basin
E1	On-site / 20	Elizabethtown Water Company - potable water supply
M1	Off-site / 21	Millstone River -Plainsboro & West Windsor boundary- Route 1
P1	Off-site / 21	Plainsboro Surface Water - Millstone River
P2	Off-site / 21	Plainsboro Surface Water - Devils Brook

Biota are also analyzed for tritium in water recovered from fruit and vegetable samples (Table 7). 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 0.082 mrem (0.82 mSv) for CY95 (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[1] were performed and yielded a value of 2.1 person rem (0.021 person-Sievert) out to 80 km (also see Table 2).

4.2 Summary of Non-Radiological Monitoring Program

During CY 95, PPPL operated under the current NJPDES surface water permit, No. NJ0023922, which became effective on March 1, 1994. As stated in the permit conditions, PPPL monitored monthly the discharge of the detention basin, discharge serial number—DSN001 or D2. Once each month, the water quality at DSN001 is assessed by monitoring the 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 additional discharge points continued: DSN002—a storm water and emergency fire protection system discharge (Fig. 19) and DSN003— a filter backwash discharge located at the Delaware and Raritan Canal pump house (Fig. 20).

As a new requirement of the permit, a chronic toxicity characterization study was conducted to test the DSN001 effluent. Quarterly study results were submitted in 1995. Two test species were used, the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). In the first three of five test sequences, the fathead minnow had 100 percent survival; the water flea had 100 percent survival in all tests. Based on those results, the NJDEP eliminated the need to continue the waterflea (*Ceriodaphnia dubia*) testing. Quarterly chronic toxicity testing was conducted with the fathead minnow (*Pimephales promelas*) only. In 1995, the NJDEP proposed a group modification, which included using a statistical test inhibition concentration or IC_{25}, that is a more precise indication of chronic effects upon organisms than the hypothesis tests performed in the past[2]. Based on PPPL and DOE-PG's decision to accept the group modification, the permit limit for the IC_{25} is 100 percent. The

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

[2]The linear interpolation method is used to calculate a point estimate of the effluent concentration causing an effect on the test organisms. The point estimate of the concentrations can be used to evaluate the precision of the test. The hypothesis tests used in the past, however, do not provide the opportunity to calculate a quantitative estimate of the inter- or intra-laboratory variability.

NJDEP determined that the testing frequency be changed to bimonthly instead of quarterly until the results of the toxicity study consistently achieved no observable effect concentration or NOEC of 100 percent.

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. The 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 (separate and distinct from the NJPDES groundwater discharge permit requirements), 10 monitoring wells, located near the former tanks, were monitored for total petroleum hydrocarbons (TPHs) quarterly and annually (August) for volatile organic compounds. Once a month, 30 wells were measured for water elevations with corresponding contour maps 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 [AAC95a, c, d, and e].

Under the NJPDES-required ground-water program, Discharge Permit No. NJ0086029, 7 ground-water monitoring wells were sampled quarterly in 1995 (Exhibit 6-2 and Figs. 19 and 20). Exhibit 4-3 presents the required parameters, wells, frequency, and permit standard. All New Jersey ground-water permits that were due to expire in 1994 were extended two years and will expire on December 31, 1996. 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. The work plan included 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. In May 1995, 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.

In 1995, soil samples were collected at 7 locations originally identified as Areas of Potential Environmental Concern (APEC) in Exhibit 4-4. The soil samples were collected by a Geoprobe®, a direct-push sampling rig, except at the 138 kV and OH yards where a hand auger 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 & total
Former treatment plant sand/sludge drying beds	5	VOCs, BTEX, Chromium hexavalent & total
CAS/RESA buildings	2	VOCs, BTEX
Warehouse building	2	VOCs, BTEX
Northeast of TFTR/Mockup buildings	2	VOCs, BTEX
Radiological Environmental Monitoring Laboratory(REML)	4	BTEX
138 kV switchyard/OH capacitor yard swale	2	PCBs, BNs,VOCs. BTEX,TPH

BNs=base/neutral priority pollutants
BTEX=benzene, toulene, ethylbenzene, 0-xylene and m&p-xylene
PCBs=polychlorinated biphenyls

TPH=total petroleum hydrocarbons
VOCs=volatile organic compounds priority pollutants

Of the seven locations, two locations were identified for soil removal: 1) C site cooling tower former reduction pits (chromium) and 2) 138 kV switchyard/OH capacitor yard swale (BNs).

4.3 Environmental Permits

The environmental permits held by DOE-PG for PPPL are listed in Exhibit 3-3 and are discussed in Section 3.0, "Environmental Compliance Summary" and Section 6.0, "Environmental Non-Radiological Program Information," of this report.

4.4 Environmental Impact Statements and Environmental Assessments

No Environmental Impact Statements were prepared in 1995. One Environmental Assessment, DOE/EA-1108, was prepared for the proposed National Spherical Torus Experiment (NSTX). This EA was approved and a Finding of No Significant Impact (FONSI) was issued by DOE on December 8, 1995.

4.5 Summary of Significant Environmental Activities at PPPL

4.5.1 Clean Air Act Title V

Under the Title V provisions of the Clean Air Act Amendments of 1990, the requirements for an air permit are set forth. In 1995, PPPL and DOE-PG prepared documentation for a negative declaration that was submitted to the NJDEP. This documentation provided the NJDEP with the data that showed PPPL will not exceed the federally enforceable limit of 25 tons of nitrogen oxides (NO_X) emitted from the boilers each year. After a number of discussions with NJDEP representatives, NJDEP granted PPPL and DOE-PG the negative declaration of Title V applicability in 1996. Also, NJDEP granted the non-applicability of the annual air emission survey as a requirement for PPPL.

The PPPL and DOE-PG requested that NJDEP amend the operating certificates for the four boilers to allow a single maximum fuel use quantity. That is, instead of each boiler having a separate limit for the amount of #4 fuel oil and natural gas burned, NJDEP granted that a maximum quantity for each fuel type burned for all boilers be substituted. This fuel use flexibility was significant to the boiler operators who must be able to run each boiler according to boiler availability or for efficiency reasons.

4.5.2 New Jersey Pollutant Discharge Elimination System Ground and Surface Water Permits

During 1995 and in early 1996, PPPL and DOE-PG had the opportunity to meet with DEP representatives to discuss the Surface and Ground-Water NJPDES permits. For the Surface water permit, the main issue was the total suspended solids (TSS) permit limit for DSN002 (the stormwater runoff) that was exceeded on two occasions. An investigation into the source indicated that the natural scouring of the swale was the probable cause for the TSS exceedances. The NJDEP removed the condition to monitor the stormwater runoff at DSN002, effective June 1, 1996.

The NJPDES ground-water permit pre-draft conditions were the subject of a meeting. The potential mixing of surface and ground water occurred within the previously unlined basin and was regulated in the ground-water permit through the required measurements of the basin water quality. This concern of surface and ground-water mixing has been eliminated since the installation of a basin liner in October 1994. The issue of volatile organic compounds present in the ground water is being addressed in the Memorandum of Understanding (MOU) and the subsequent Work Plans. The NJDEP was concerned about the water quality in the basin and the possibility of a breach of the liner causing contamination of the ground water beneath the basin. In 1996, information about those concerns was collected, and a report was drafted.

4.5.3 Waste Minimization Activities and Pollution Prevention Awareness

The PPPL site-wide Waste Minimization/Pollution Prevention Program accomplished the following in 1995. The hazardous waste recycling program continued with approximately 175 tons of contaminated, non-hazardous waste being recycled as asphaltic paving material. In addition, 26 tons of concrete were recycled. The installation of dedicated, low-flow purging and sampling pumps in 35 monitoring wells reduced the quantity of purge water requiring disposal by over 90 percent and saved an estimated $30,000. The PPPL's solid waste stream was reduced by 10 percent in 1995. The proportion of recyclable paper in the trash was reduced by 24 percent. These accomplishments are attributable to the continuation of the Sanitary Waste Evaluation. 235,196 Curies (Ci) of waste tritium was recycled at Savannah River. This represents a diversion of 1,200 cubic feet of low-level waste (LLW) from burial and an associated cost avoidance of $843,600.

4.5.4 Radioactive Waste Facilities

A new Radioactive Waste Storage Building was constructed to replace the trailers that were located in the Boneyard on D site; this new facility temporarily houses 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. The concrete lay-down pad was completed; as the TFTR D&D activities are uncertain, the completion of the building was postponed.

4.5.5 Storm Water Management

The PPPL determined that the proposed second cell detention basin, as part of the site-wide stormwater management plan, was not required. Through discussions with the Princeton Forrestal Center (PFC), the management group for Princeton University's corporate office and research complex, it was learned that PPPL was included in the PFC Stormwater Management Plan. The original phase of this plan was submitted to the Delaware & Raritan Canal Commission (DRCC) in 1980, and a Certificate of Approval was signed on May 20, 1980. The 72-acre parcel that PPPL occupies is included in PFC's stormwater management plan-Phase I. The 72-acre parcel is part of the Bee Brook watershed and therefore includes PPPL in the PFC stormwater plan.

One major concern of the PFC Stormwater Management Plan is the limit of 60 percent impervious cover of developable land. Excluding the stream protection corridor (used as retention capacity for stormwater runoff) and delineated wetlands, PPPL was at 55.5 percent developed as of November 1995; efforts have been taken to lower this percentage by removing temporary trailers that were once used for offices or storage.

In early 1996, PPPL completed the preparation of a site-wide stormwater management plan. It was to include the proposed second cell detention basin Once the PFC plan was accepted as protecting PPPL from stormwater flooding, the need for the second cell detention basin no longer existed, and the project was cancelled. However, PPPL continued with the work on the Site-Wide Stormwater Management Plan and the Stormwater Pollution Prevention Plan.

4.5.6 Environmental Training

In 1995, the 8-hour refresher course for the “Health and Safety for Hazardous Waste Site Investigation Personnel” or OSHA HAZWOPER refresher was taught on site at PPPL by instructors from the Environmental and Occupational Health Sciences Institute (EOHSI). PPPL employees had the opportunity to be trained at this on site course or at EOHSI’s Piscataway, New Jersey facility. EOHSI 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. Through a grant from the Department of Energy, EOHSI provided this training as well as Confined Space Training.

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 Years 1994-1995 (CY94-95). These operations are a potential source of neutron and gamma/x-ray exposure. The Princeton Beta Experiment Modification (PBX-M) did not operate in CY95.

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} for D-D and 1.65×10^{19} for D-T [Ja94]. In 1994, TFTR continued an extensive D-T operations schedule and increased the neutron production to 1.3×10^{19} D-D and 1.85×10^{20} D-T [Ja95]. With the continuence of D-T operations in 1995, the neutron production increased to 2.3×10^{19} D-D and 2.04×10^{20} D-T [Ja96].

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 gamma/χ 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 Fig. 19, locations T1 to T4, RMS-NE and RMS-SE). 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 not 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 and gamma/χ 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 gross beta. All samples for 1995 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). In Table 12, the 1995 total amount of tritium released to the sanitary sewer was 0.496 Curies, about fifty percent of the 1.0 Curie per year allowed by New Jersey regulations.

5.1.3 Radioactive and Mixed Waste

In CY95, low-level radioactive waste (LLW) and mixed waste (LLMW) were stored on-site, either in the D site Boneyard or within a controlled area of TFTR. Three shipments of low-level radioactive waste were made in 1995. The LLW and LLMW shipments made in 1995 consisted of 808.5 cubic feet (ft^3) of LLW material and 0.2 cubic feet of LLMW material, with an activity of 8587 Curies (Ci) and <1 Curie, respectively.

5.1.4 Airborne Emission

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 and at eleven (11) remote environmental sampling locations: 4 TFTR facility boundary trailers (T1 to T4), 6 remote environmental air monitoring stations (REAMS 1 to 6) and one baseline station. In 1995, the baseline location was moved from Montgomery Township to Hopewell Township, NJ. All of the aforementioned sampling is performed continuously.

The projected dose equivalent at the site boundary from emissions of airborne radioactivity (HTO, HT, Ar-41, N-13, N-16, Cl-40, and S-37) was 0.22 mrem (3.1 μSv)(see Table 2),The projected dose equivalent at the nearest off-site business from airborne emissions of these radionuclides was 0.06

mrem (600 nSv). Installed in 1992, the stack sampling system continues to provide tritium emissions data for 1995 (Table 4 and Fig. 32) 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 170 pCi/m^3 of elemental and oxide tritium concentrations (Table 10 and Figs. 22 and 24). Measurements from the off-site monitoring stations are shown in Table 11 and Figures 23 and 25, “Air Tritium (HT)” and “Air Tritium (HTO),” respectively. These measurements were made with the DATS [Gr88b]. Ar-41, N-13, N-16, Cl-40, and S-37 are air activation products from neutrons produced TFTR experiments.

In November 1983, a three-level, 60-meter tower was installed for gathering meteorological data. Data have been collected and recorded for twelve years. The wind-rose data for the twelve years of tower operation are shown in Figures 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 meters per second (m/s) and rise to about 4.1 m/s at 60 m [Ko86].

5.2 Unplanned Releases

There were no unplanned releases in CY95.

5.3 Environmental Monitoring

5.3.1 Waterborne Radioactivity

A. Surface Water

Surface-water samples at eight locations (two on-site, D1 and DSN001, and six off-site, B1, B2, C1, M1, P1, and P2) have been analyzed for tritium (Table 5). Locations C1 (Delaware & Raritan Canal) and the baseline (Rock Brook in Montgomery Township) were replaced by DSN003 (PPPL’s discharge from the pump house on the D&R Canal) in November 1995. 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 Figures 19 (on-site) and 20 and 21 (both are off-site locations).

In August 1995, the method for analyzing tritium in environmental water samples was modified. The electrolysis procedure was eliminated; the tritium analysis included a 5-hour count time, which proved to be a more efficient way to process the samples without losing reliability. A second result was that the method detection limit changed from previously below 100 pCi/L to between 100 and 200 pCi/L.

Tritium analysis by liquid scintillation methods has shown tritium values to be generally less than or comparable to the baseline level (Table 5 and Figs. 28-31), with one exception at Station P2. In October 1995, an off-site location, P2-Devil's Brook, tritium was detected at 1525 pCi/Liter. As an explanation for this data, it is unlikely that the source is tritium from TFTR for the following reasons: 1) at the time of the sample, no increases in tritium oxide in stack effluent or in tritium concentrations in precipitation were also observed and 2) no other surface water locations closer to PPPL exhibited elevated tritium concentrations during this period.

The 1995 rain water samples collected and analyzed ranged from less than 19 to 2561 pCi/liter (see Table 3 and Fig. 26), which varies from the 1994 range of 19 to 1130 pCi/liter (see Table 9). During the weeks of October 25 and November 1, 1995, TFTR released 1.630 and 2.408 Curies (HTO) and 5.431 and 1.393 Curies (HT), respectively; these releases occurred during a maintainance period when equipment was being upgraded or repaired . These releases account for approximately 17.5 percent of the annual 1995 total for tritium released to the atmosphere. The highest level observed in the rain water (2561 pCi/Liter) was collected between October 23 and November 6, 1995 that is, during the same period when elevated atmospheric releases were also observed. Based on this data and the literature [JAERI 88, Mu77, Mu83, Mu90], it is believed that the observed increase in tritium concentrations in rain water is due to washout by precipitation of some of the tritium released from the TFTR stack. Monitoring of the tritium concentrations in rain water will continue.

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; also at 51 (130 cm), 1994 was a wet year. The years 1991, 1992, and 1993 had average amounts of total precipitation: 1991 - 45 inches (114 cm), 1992 - 42 inches (107 cm), and 1993 - 42.7 inches (109 cm) (Table 9 and Fig. 18)[Ch94]. In 1995, the driest year since precipitation was monitored, the annual rainfall was 35.6 inches (90 cm) (Table 3).

B. <u>Ground Water</u>

In 1995, six on-site wells—D-11 and D-12 on C site, and TW-1, TW-2, TW-3, and TW-10 on D site (Fig. 19) were sampled. Since the onset of D-T operations, the ground water results (Table 6 and Fig. 27) were slightly elevated in TW-1; for 1995, TW-1 showed tritium concentrations at 103 pCi/Liter and increasing to 789 pCi/Liter. Beginning in August 1995, more frequent ground water monitoring and sampling different wells began. This increase in scope of ground water monitoring was prompted by the increase in tritium level in well TW-1.

An investigation into the potential sources also began in the fall of 1995. Leak tests and checks of lines and equipment in the area near TW-1 (north side of D site) were performed; none were found to be leaking tritiated water into the ground water. From PPPL's environmental monitoring data and the available scientific literature [JAERI 88, Mu77, Mu83, Mu90], the most likely source of the tritium detected in the on-site ground water samples is from the atmospheric venting of tritium from TFTR operations and the resulting "wash-out' during precipitation. Ground water monitoring of the wells and the foundation sump (dewatering sump for the TFTR and Motor Generator buildings) will continue.

C. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. In April 1984, a sampling point at the input to PPPL was established (E1 location) to provide baseline data for water coming onto the site. Radiological analysis has included gamma spectroscopy and tritium-concentration determination. In 1995, tritium measurements of potable water ranged from 32 to 119 pCi/liter.

5.3.2 Foodstuffs

Foodstuffs collected and analyzed in CY95 during the growing season included zucchini, strawberries, and tomatoes. These fruits and vegetables were collected from area farmers or gardens. The variation shown in detected HTO levels of less than 36 to less than 119 pCi/liter (see Table 7) is consistent with background concentrations of tritium in biota.

5.3.3 Soil 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. 20). 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 samples collected in 1995 from off-site locations, the concentrations ranged from 36 pCi/liter to 790 pCi/liter. The increases observed in the soil samples correlate with the elevated levels in tritium oxide stack releases and precipitation concentrations (see Section 5.3.1).

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 18-20). During CY95, PPPL was within the allowable limits for all testing parameters at DSN001. The last exceedance at DSN001 was reported in November 1993 for the total suspended solids (73 mg/L *vs*. 50 mg/L—the permit limit). One exceedance occurred for DSN003 (filter back wash for the pumps at the Delaware & Raritan Canal) in May when total suspended solid result was 50 mg/L (limit is 20 mg/L).

Stormwater discharge was 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, samples for petroleum hydrocarbons were collected at 15, 30, and 45 minutes after the onset of a discharge (Table 19); all other samples were collected at 15-minute intervals. Exceedances of the total suspended solid limit (50 mg/L) were reported in January (92 mg/L) and March (98 mg/L). The probable cause of the exceedances appears to be the disturbance of sediments at the bottom of the ditch during heavy flow. The DOE-PG and PPPL worked with the DEP's Stormwater Permitting Branch to revise the NJPDES permit; PPPL began the development of a site-wide Stormwater Pollution Prevention Plan. Effective June 1, 1996, DSN002 is no longer monitored to meet the requirements of the permit.

The detention basin inflows or influents are monitored twice each year, in May and August (see Table 17), pursuant to the PPPL NJPDES ground water discharge permit, NJ0086029. Volatile organic compounds were detected at Inflows 1 and 2 in concentrations above the method detection limits for volatile organic compounds—1,2-Dichloroethane (3µg/L,3µg/L), bromodichloromethane (3µg/L, 2µg/L), and chloroform (15 µg/L, 7 µg/L) at Inflow 1 and Inflow 2, respectively. Located on the west side of the detention basin, Inflow 1 receives water from the C site MG, LOB, and CS basement sumps, Evapco cooling tower, C and D site cooling tower and boiler blowdown, and non-contact heat exchanger cooling water, 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 12 months of flow data, greater than 75.4 million gallons of water were discharged from the detention basin in CY95. Modifications to the basin included the installation of a permanent oil boom in the basin and a fence around the perimeter of the basin. The project will be completed with the installation of the continuous-monitoring oil sensors and the outfall flume. Presently, the basin is operated in a flow-through mode.

6.1.2 Chronic Toxicity Characterization Study

In 1995, chronic toxicity testing for DSN001 effluent continued. Of the four quarterly reports submitted to DEP, one report (March 1995) contained the survival results for the two test species, *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow); the other three reports were the test results for *Pimephales promelas* (fathead minnow) only [NJDEP95a]. The DEP chose the fathead minnow as the more sensitive species for the Chronic Toxicity Biomonitoring requirements (Table 18). For all tests but one conducted in 1995, the survival rate, as defined by the NJ Surface Water Quality Standards, was 100 percent no observable effect concentration (NOEC). During the March 1995 test, the fathead minnows survived in the 50 percent dilution, *i.e.*, mortality was observed in the 100 percent effluent test. Chronic toxicity testing continued on a quarterly frequency for the fathead minnow into 1996.

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 the expiration date was extended to December 31, 1996. The DOE-PG 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 [Fi94a].

A. Hydrological Studies from 1989 to 1993

In 1989, DOE-PG 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. 33 and 34) [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 Facilities & Environmental Management Division], 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.

The results of the soil gas survey are summarized below:

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

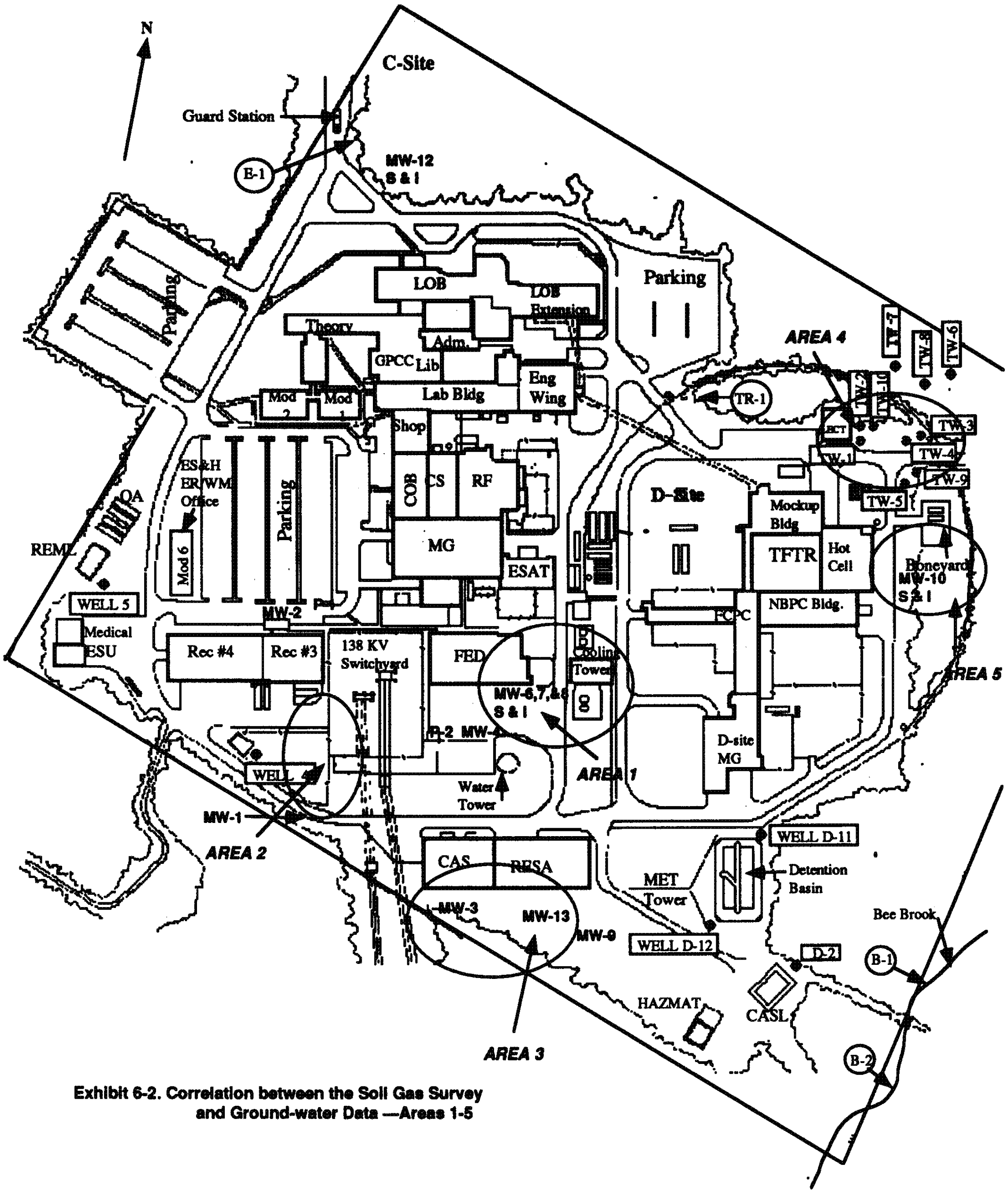

Exhibit 6-2. Correlation between the Soil Gas Survey and Ground-water Data —Areas 1-5

samples and in the soil gas survey. [MP91a,b] [DOE91b,d,e] No correlation between ground-water quality and soil gas survey results were shown for Areas 2 and 5; no ground-water samples were collected in Area 4 and, so no relationship can be drawn.

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 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 significant cone of depression as much as 25 feet deep. Influenced by this cone of depression, the direction of ground water on C and D sites is radially toward the sump pump systems (see Figures 33 and 34). 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 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. (Note: 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 would flow from the basin into the ground water.

In 1991, "(The) 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. The investigation of potential solvent contamination near the CAS/RESA buildings is being conducted as part of PPPL's Remedial Investigation.

B. NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1995

In this section, the NJPDES Quarterly Ground Water Monitoring Program from 1989 to 1995 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 25 and 30). 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; no other parameters were found above the detection limits for the 1995 sampling event. 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-PG 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 1995, all ground water results, except for volatile organic compounds, were below the permit standards (see Tables 26-30). 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 1995, except during the May 1990 event. Of fourteen sampling events, PCE was detected in wells D-11 and/or D-12 twelve times. In well TW-3, PCE was detected in eight of the fourteen sampling events. However, higher concentrations of PCE were found in this well (TW-3) 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 and trichloroethene (TCE) in well D-12. The presence of VOCs in ground water is being investigated as part of PPPL's sitewide Remedial Investigation.

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. These VOCs were not detected in the samples collected during 1995; however, chloroform, bromodichloromethane, and 1,2-dichloroethane were detected in both inflows.

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 March and May 1995, 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. Analyses included volatile organic compounds, total petroleum hydrocarbons, specific conductance, pH, and temperature.

The Regional Ground Water Monitoring Program studies are discussed in Section 6.1.3 A, "Hydrological Studies from 1989 to 1993," of this report. In evaluating the data from those 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 31, the VOC that is most commonly detected and present in the highest concentrations is tetrachloroethene (PCE at 126 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. In 1996, the location of the source will be further investigated through soil sampling and the possible addition of ground water wells in the wetland area south of the CAS/RESA buildings.

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 results from wells TW- 1, -3, and -7 (Table 31). The source of PCE in Area 4 is unknown. No known sources are present in this area, and the data indicate a potential off-site source for these chemicals.

The C and D site sump pump systems (TFTR-S1, 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, March and May 1995 (Table 31). The occurrence of PCE in all the sumps except MG-S5 can be attributed to the PCE present in the ground water.

From August 1991 to December 1995, PPPL has collected ground-water samples from wells located near the former underground storage tanks for annual (August) 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. Once a month, ground-water elevations are measured in a total of thirty ground-water monitoring wells on C and D sites. From these data the ground-water flow contours for the entire PPPL site are mapped at one foot intervals.

In each quarterly report, the results of the analytical data and monthly contour maps are submitted to NJDEP (see Tables 23 and 24) [MP91g,h] [MP92a,c] [RES92a,b][RES93a,b,c] [AAC94a,c,d,e] [AAC95a,b,c,d]. The results of the VOC analyses are discussed above. For sixteen 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 22). Also included are the two detention basin wells, D-11 and D-12, which are located in the southern portion of the site. The average depth to ground water in the upgradient well, MW-1, is at the 88-foot elevation; in years previous to 1995, the next well closest in ground-water elevation was UST-1, at 87 feet. This well was abandoned in 1995 following the removal of the underground storage tank—E-5. The next group of wells—MW-4, P-2, MW-3, and MW-13—are at the 86-foot elevation. The ground-water elevations for all other wells are between 85 and 82 feet.

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 1994, PPPL received the permit amendments to the existing air permits for Boilers #2, #4, and #5; PPPL modified these boilers to burn natural gas and fuel oil, prior to the submittal of the permit applications to NJDEP. After the re-submittal of the Boiler #2 application for correction of a fuel-use error, NJDEP issued a permit amendment for Boiler #2 to burn both fuel types in 1995. In 1995, PPPL submitted a permit amendment for proposed modifications to Boiler #3, which would allow the boiler to burn natural gas and fuel oil as appropriate. Upon receiving approval from the NJDEP, these modifications to Boiler #3 were made.

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.

A permit modification for the Hot Cell degreaser was submitted to NJDEP to allow the venting of the degreaser to the Tokamak Fusion Test Reactor (TFTR) stack. Discussions with NJDEP involved the definition of the word "stack." The TFTR stack is unlike the conventional stack in an industrial setting, and therefore, the uniqueness of the TFTR stack had to be established. The NJDEP agreed that this stack should be regulated under the Environmental Protection Agency's (EPA) National Emissions Standard for Hazardous Air Pollutants (NESHAPs) program, which it is. The permit modification for the Hot Cell degreaser was approved,
and the modifications were completed.

Applications for air permit modifications for the C and D site emergency diesel generators were prepared. PPPL requested that 1) a change in the fuel type from #2 fuel oil to #1 fuel oil and 2) a reduction in the number of operation hours be made in these permits in support of limiting the amount of nitrogen oxides (NO_x) released from these generators.

The PPPL prepared and submitted the 1994 Annual Emission Statement to the NJDEP. Also, the applications for the Operating Permit Negative Declaration and Emission Statement Non-Applicability were prepared and submitted to NJDEP in 1995. The basis for this application is that PPPL's sources in total emit below the threshold of 25 tons of NO_x per year. Other air emissions, *i.e.*, volatile organic compounds, from the above-ground storage tanks, which contain gasoline and diesel fuel were calculated for both the Annual Emission Statement and for the Operating Permit Negative Declaration and Emission Statement Non-Applicability applications, and were found to be minimal.

As requested by NJDEP, PPPL determined the amount of sulfur hexafluoride (SF_6) released annually from TFTR operations. SF_6 is used in the modulator regulators, the ICRF, and the NB high voltage and ion source enclosures.

Five additional air permits are maintained by the PPPL: two permits for two above-ground storage tanks and three permits for three dust collectors. The above-ground storage tank permit No. 114785 was issued on October 25, 1993, and expires on October 25, 1998. The above-ground storage tanks

(25,000 and 15,000 gallon capacities) emit volatile organic compounds that orientate from #4 fuel oil and #1 diesel oil, respectively. The F&EM and CAS dust collector emissions originate from general wood-working operations. The Shop building dust collector emissions originate from metal working operations.

B. Drinking Water

Potable water is supplied by the public utility, Elizabethtown Water Co. The PPPL used approximately 40.69 million gallons in CY95 [JA96]. In 1994, a cross-connection was installed beneath the water tower to provide potable water to the tower for the fire-protection system and other systems. Consequently, the potable water usage showed an increase from 1994 (28.6 million gallons) to 1995 (40.7 million gallons).

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 20). The PPPL used approximately 67.2 million gallons of canal water during CY95 [JA96]. A sampling point (C1) was established to provide baseline data for process water coming on-site. Table 14 indicates results of water quality analysis at the canal.

D. Surface Water

Surface water is monitored for potential non-radioactive pollutants both on-site and at surface-water discharge pathways (upstream and downstream) off-site. Other sampling locations—Bee Brook (B1 & B2), Ditch #5 (D1), Delaware & Raritan Canal (C1), Millstone River (M1), and Plainsboro (P1 &P2) sampling points (See Figs. 20 and 21 and Tables 13-17)—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 FY95, PPPL estimates a total discharge of 9 million gallons of sanitary sewage to the South Brunswick sewerage treatment system [JA96].

In 1994, the Industrial Discharge Permit (22-93-NC) was received and comments were submitted by PPPL and DOE-PG to Stony Brook Regional Sewerage Authority (SBRSA). The SBRSA permit requires the monthly measurement of radioactivity, flow, pH and temperature at the LEC tanks (the designated compliance and sampling location) and the annual sampling for an additional 25 parameters. During 1994 and 1995, PPPL and SBRSA performed split sampling three times for the parameters listed in the permit (see Table 32).

In 1995, PPPL worked to eliminate the photo laboratory waste stream as an industrial flow to the sanitary sewer. Filters were installed to remove silver from the wash and rinse water of the photographic process. By purchasing digital cameras and computer hardware and software, PPPL plans a transition to digital imaging, which is expected to eliminate all photochemical wastes.

F. Spill Prevention Control and Countermeasure

PPPL maintains a Spill Prevention Control and Countermeasure Plan (SPCC), which was revised in 1995 [VNH96]. The SPCC Plan is incorporated as a supplement to the PPPL Emergency Preparedness Plan.

G. Herbicides and Fertilizers

During CY95, the use of herbicides 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 21 lists the quantities applied during CY95. No herbicides or fertilizers are stored on site; therefore, no disposal of these types of regulated chemicals is required by PPPL.

H. Polychlorinated Biphenyls (PCBs)

At the end of 1995, PPPL's inventory of equipment containing polychlorinated biphenyls (PCBs) was 653 large, regulated capacitors. No PCB capacitors were removed in 1995. However, as they are taken out of service, the disposal records are listed in the Annual Hazardous Waste Generators Report [PPPL96b].

I. Hazardous Wastes

The Hazardous Waste Generator Annual Report (EPA ID No. NJ1960011152) has been submitted for 1995 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 re-reviewed the data as of the Remedial Investigation/Remedial Alternative Assessment Program and required further soil sampling around the C site cooling tower for chromium contamination. Soil sampling was conducted and detected low levels of chromium in the soil next to the former chromium reduction pits. This soil was scheduled for removal in CY96.

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

Three releases were reported to the NJDEP Hotline, and confirmation reports submitted in CY95 (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.

In April 1994, a chlorofluorocarbon (CFC) release from one chiller occurred when a discharge of Freon® 12 or dichlorodifluoromethane (CFC 12) vented from the chiller located in the boiler room to the atmosphere. It is estimated that 1600 pounds of Freon® 12 was released at this time. In addition to notifying the NJDEP Bureau of Discharge Prevention, the NJDEP Air Enforcement Program—Central Regional Office was also notified of the discharge. The chiller was repaired and returned to service. On another occasion, from November 1994 to April 1995, the same chiller system was under investigation. Faulty leak detection equipment was cited for the difficulty in determining if leaks were actually occurring. The leak detection equipment was repaired, and all the leaks were found and also repaired. It was calculated that a total of 900 pounds of CFC 12 was released over the five month period. In April 1995, NJDEP was notified of the release, and the release confirmation report was prepared and submitted to NJDEP.

Of the other two reported releases, one release involved a transmission fluid leak from an employee's vehicle in an amount between 1 pint to 1 quart spilled onto an unpaved surface [Fi95a]. This incident was cleaned up immediately upon being reported. The other incident was the release of mineral oil from a tank truck onto gravel. The tank truck held the remainder of the transformer oil while the capacitor was being removed[Fi95c]. Soil sampling was conducted and approximately 30 cubic yards of oil-contaminated soil was removed.

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 1995 SARA Title III report to NJDEP in February 1996 [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 1995, and submitted these documents to DOE.

The SARA Title III report included information about twelve compounds used at PPPL. Of the twelve, six compounds are in their gaseous form and are therefore classified as sudden release of pressure hazards; three gaseous compounds are also classified as acute health hazards: carbon dioxide, chlorodifluoromethane, and dichlorodifluoromethane (CFC-12). There are seven liquid compounds; nitrogen is used in both gaseous and liquid forms. Fuel oil, gasoline, and petroleum oil are flammables; trichlorotrifluoroethane (CFC-113) and sulfuric acid are the liquid compounds that are classified as acute health hazards; sulfuric acid is also reactive. 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 (Figure 19). 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 (Tables 23, 24, and 28-30). These VOCs are commonly used or contained in solvents or metal degreasing agents, all of which have been used or are currently 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 of the ground water (Tables 23 and 24). In *Area 3*, south of the Coil Storage and Assembly (CAS) building and the Research Equipment Storage and Assembly (RESA) building, ground water was found to be 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 detected in ground-water samples.

The foundation dewatering sumps located on D site largely influence the ground-water gradient. The sumps create a significant cone of depression drawing the ground water toward them (Figures 33 and 34). Under natural conditions, the ground-water flow is 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.

The regional ground water quality investigation has continued as part of PPPL's sitewide Remedial Investigation under the conditions of the MOU. In March and May 1995, ground-water sampling was conducted in accordance with the work plan "conditionally" approved by NJDEP. The results of those ground-water samples confirmed the presence of VOCs in several wells as indicated from the results of previous studies. The highest concentrations of tetrachloroethene or PCE were detected in the wells nearest the CAS/RESA building, MW-3, MW-9, and MW-13. Based on these results, the recommendations were for the installation of two additional wells: 1) a double-cased wells near MW-13 that cases off the top 10 feet of the water table and 2) a background well to monitor the water table located between 50 to 100 feet south of MW-13. The latter well would require a wetlands permit from NJDEP for its installation (see Exhibit 3.4). Sampling for volatile organic compounds would follow. In early 1996, PPPL and DOE-PG proposed to NJDEP that additional wells be installed to delineate the extent of contamination and evaluate the potential for an off-site source fo these contaminants..

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. A NJDEP site inspection of the REML by the Office of Quality Assurance was conducted in 1995 for pH and temperature certification. Equipment calibration record keeping needed improvement. PPPL complied with the recommended for improved calibration record keeping.

In 1995, PPPL followed its internal procedures, EN-OP-001—"Surface Water Sampling Procedure," EN-OP-002—"Ground Water Sampling Procedures," and EN-OP-008—"Stormwater Sampling Procedures." These procedures provide in detail the 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 are certified by New Jersey DEP and participate in the state's QA program; the subcontractor laboratories must also follow their own internal quality assurance plans [EMSL].

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11.0 TABLES

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

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

P = Probability of occurrence in a year.

[a] All operations must be planned to incorporate 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 1995 Emissions and Doses From TFTR

Radiolnuclide & Pathway	Quantity Released in 1995[1]	EDE at Site Boundary	EDE at Nearest Business[2]	Population Dose within 80 km[3]
Tritium (air)	37.03 Ci HTO[4], 24.87 Ci HT	9.7×10^{-2} mrem[5]	2.7×10^{-2} mrem[6]	2.0 person-rem[7]
Ar-41 (air)	16.66 Ci[4]	6.7×10^{-2} mrem[8]	1.9×10^{-2} mrem[6]	9.7×10^{-2}person-rem[9]
N-13 (air)	10.81 Ci[4]	3.0×10^{-2} mrem[8]	8.4×10^{-3} mrem[6]	3.7×10^{-3} person-rem[9]
N-16 (air)	0.83 Ci [4]	5.6×10^{-5} mrem[8]	1.6×10^{-5} mrem[6]	Negligible
Cl-40 (air)	1.34 Ci [4]	1.1×10^{-2} mrem[8]	3.1×10^{-3} mrem[6]	Negligible
S-37 (air)	1.35Ci [4]	$1.5. \times 10^{-2}$ mrem[8]	4.2×10^{-3} mrem[6]	Negligible
Direct/Scattered n/γ Radiation	----------------------------	7.8×10^{-2} mrem[8]	2.0×10^{-2} mrem[11]	Negligible
Tritium (HTO) (water)	4.96×10^{-1} Ci[12]	9.9×10^{-3} mrem[13]	--------------------------	1.4×10^{-2} person-rem[14]
Total	----------------------------	3.1×10^{-1} mrem	8.2×10^{-2} mrem	2.1 person-rem
Background	----------------------------	600 mrem[15]	600 mrem[15]	1.6×10^{6} person-rem[9]

[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 2.3 E19 D-D neutrons and 2.04 E20 D-T neutrons in 1995, using methodlogy of JL-542, Rev. 1, 2/5/93 for release during D-T operations.

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

[3]Based on year 1995 population figures as utilizx\ed 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, 1/22/96 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); (37.73 Cix 2.6 E-03 mrem/Ci) + (0.2442 Ci x 2.6 E-03 mrem/Ci) + (24.1758 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, PPPL calculates (62.15 Ci/500 Ci) x 16.2 person-rem = 2.0 person-rem.

[8]Based on NOAA X/Q [Start, 1989] and JL-457, 7/2/92, Table 1; Ar-41: 16.66 Ci x 4.0 E-03 mrem/Ci. N-13: 10.81 Ci x 2.8 E-03 mrem/Ci. N-16: 0.83 Ci x 6.71 E-05 mrem/Ci. Cl-40: 1.34 Ci x 8.2 E-03 mrem/Ci. S-37: 1.35 Ci x 1.08 E-02 mrem/Ci.

[9]Scaling from values used for the TFTR D-T EA, PPPL calculate for Ar-41: (16.66 Ci/115 Ci) x 0.67 person-rem = 9.7 E-02 person rem; for N-13: (10.81 Ci/434 Ci) x 0.149 person-rem = 3.7 E-03 person-rem.

[10]Based on 1995 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 1995 would be [(4.96 E-01 Ci/yr)(/1 E10 l/yr)] x [(4 mrem)/(2 E-08 Ci/l)] = 9.9 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 radon concentration in Plainsboro homes (Memo, J. Greco to J. Levine, 11/13/90, "Radon Dose Equivalent," JMG-160).

Table 3. Precipitation and Tritium in Precipitation at PPPL for 1995

START DATE	WEEK	INCH	INCH/ MONTH	MONTH	ACCUMU- LATION	Tritium Conc. pCi/L
2-Jan	1	1.550			1.550	
9-Jan	2	0.100			1.650	
16-Jan	3	1.300			2.950	
23-Jan	4	0.000			2.950	312
30-Jan	5	0.600*	3.550	January	3.550	
6-Feb	6	0.000			3.550	123
13-Feb	7	0.400			3.950	
20-Feb	8	0.200			4.150	
27-Feb	9	1.050	1.650	February	5.200	154
6-Mar	10	1.500			6.700	
13-Mar	11	0.000			6.700	<19
20-Mar	12	0.350			7.050	
27-Mar	13	0.000	1.850	March	7.050	
3-Apr	14	0.675			7.725	
10-Apr	15	0.750			8.475	122
17-Apr	16	0.000			8.475	27
24-Apr	17	0.800	2.225	April	9.275	
1-May	18	0.150			9.425	132
8-May	19	0.600			10.025	
15-May	20	0.350			10.375	120
22-May	21	0.550			10.925	
29-May	22	0.475	2.125	May	11.400	130
5-Jun	23	0.100			11.500	77
12-Jun	24	0.400			11.900	82
19-Jun	25	0.350			12.250	
26-Jun	26	0.450	1.300	June	12.700	254
3-Jul	27	0.750			13.450	
10-Jul	28	1.000			14.450	77 (57)
17-Jul	29	1.750			16.200	48
24-Jul	30	0.950	4.450	July	17.150	
31-Jul	31	1.500			18.650	
7-Aug	32	0.000			18.650	
14-Aug	33	0.350			19.000	
21-Aug	34	0.000			19.000	
28-Aug	35	0.000	1.850	August	19.000	
4-Sep	36	0.150			19.150	
11-Sep	37	2.250			21.400	
18-Sep	38	0.650			22.050	<119
25-Sep	39	1.450	4.500	September	23.500	<119 (<119)
2-Oct	40	1.675			25.175	
9-Oct	41	0.950			26.125	<119 (<119)
16-Oct	42	1.300			27.425	
23-Oct	43	1.225	5.150	October	28.650	<119
30-Oct	44	0.700			29.350	
6-Nov	45	2.350			31.700	2561
13-Nov	46	1.400			33.100	<119
20-Nov	47	0.250			33.350	
27-Nov	48	0.350	5.050	November	33.700	
4-Dec	49	0.700			34.400	
11-Dec	50	0.625			35.025	
18-Dec	51	0.275			35.300	
25-Dec	52	0.325	1.925	December	35.625	

* Snow storm about 14"

Tritium concentration measured in pCi/l or picoCuries per Liter.
See Figure 26.
( ) indicates duplicate analyses.

Table 4. Tritium Released from the TFTR Stack for 1995

Week Ending	HTO (Ci)	HT (Ci)	Weekly Total (Ci)	Annual Total (Ci)	Week Ending	HTO (Ci)	HT (Ci)	Weekly Total (Ci)	Annual Total (Ci)
1/9	0.228	0.043	0.271	0.271	7/3	0.650	0.040	0.690	21.830
1/16	0.194	0.111	0.305	0.576	7/10	0.504	0.026	0.530	22.360
1/23	0.292	0.099	0.391	0.967	7/17	0.736	0.231	0.967	23.327
1/30	0.603	0.180	0.783	1.750					
2/6	0.403	0.163	0.566	2.316	8/7	1.008	0.295	1.303	24.630
2/13	0.120	0.080	0.200	2.516	8/15	1.104	0.864	1.968	26.598
2/20	0.215	0.221	0.436	2.952	8/21	0.582	0.196	0.778	27.376
2/27	0.327	0.677	1.004	3.956	8/28	0.469	0.197	0.666	28.042
3/6	0.331	0.178	0.509	4.465	9/5	0.479	0.868	1.347	29.389
3/13	1.632	0.214	1.846	6.311	9/11	0.678	0.422	1.100	30.489
3/20	0.423	0.190	0.613	6.924	9/18	0.778	0.506	1.284	31.773
3/27	0.345	0.276	0.621	7.545	9/25	0.711	0.790	1.501	33.274
4/3	0.195	0.183	0.378	7.923	10/5	0.869	0.765	1.634	34.908
4/10	0.208	0.284	0.492	8.415	10/11	0.883	0.187	1.070	35.978
4/17	1.266	0.232	1.498	9.913	10/18	0.832	0.283	1.115	37.093
4/24	0.169	0.032	0.201	10.114	10/25	1.630	5.431	7.061	44.154
5/1	0.270	0.321	0.591	10.705	11/1	2.408	1.393	3.801	47.955
5/8	0.419	0.300	0.719	11.424	11/8	0.891	0.176	1.067	49.022
5/15	0.402	0.102	0.504	11.928	11/15	1.223	0.593	1.816	50.838
5/22	2.880	1.100	3.980	15.908	11/22	1.213	1.624	2.837	53.675
5/29	1.200	0.170	1.370	17.278	11/29	0.671	1.038	1.709	55.384
6/5	0.478	0.174	0.652	17.930	12/6	0.711	0.189	0.900	56.284
6/12	1.130	0.150	1.280	19.210	12/13	0.731	1.924	2.655	58.939
6/19	1.180	0.060	1.240	20.450	12/20	0.769	0.283	1.052	59.991
6/26	0.660	0.030	0.690	21.140	12/20 - 1/3/96	0.931	0.979	1.910	61.901

See Figure 32.

Table 5. Tritium Concentrations in Surface Water for 1995

Sample Date	B1	B2	C1	D1	DSN001 (D2)	Baseline
1/24/95	68 (84)	71	64	49	114	44
2/10/95	66	108 (106)	47	76	126	33
3/8/95	94	84	27 (31)	50	79	22
3/24/95	72	92	46	58 (66)	163	53
4/19/95	65	77	46	63	117 (97)	41
4/26/95	72	82	40	48	116	78
5/23/95	101	122	66	75	152	64
6/16/95	123	144	87	118	130	42
7/14/95	82	198	58	58	175	47
8/16/95	47 (69)	93	37	48	75	
		Change in	method	detection limit		
8/29/95						<119
9/13/95	<119	<119	<119 (<119)	<119	<119	<119
10/3/95	<186		<116	<186	<116	<116
11/14/95					<186	
12/7/95					<116	

Sample Date	DSN003	E1	P1	P2	M1	Baseline
1/24/95		32	52	42	50	44
2/10/95		44		45		33
3/8/95		22	28	41	24	22
3/24/95		67	73	51	50	53
4/19/95		45	42	54	53	41
4/26/95		54 (66)	61	75	62	78
5/23/95		57	99	84	78 (71)	64
6/16/95		49	<36 (36)	61	<36	42
7/14/95		39	60	55 (42)	43	47
8/16/95		40			<36	
		Change in	method	detection limit		
8/29/95		<119	<119	<119	<119	<119
9/13/95		<119	<119	<119	<119	<119
10/3/95		<186	<116	1525	<116	
11/14/95	<186					
12/7/95	<116					

( ) indicates duplicate samples and analysis.
All measurement values are in pCi/Liter.
Blank indicates no measurement.

Key:
B1 = Bee Brook (upstream)
B2 = Bee Brook (downstream)
Baseline= Rock Brook on Spring Hill Road (Montgomery Township)
C1 = Delaware & Raritan Canal (non-potable water supply) after 8/16/95 replaced by DSN003 sample
D1 = D site (upstream of discharge)
DSN001 = downstream of basin discharge, sometimes referred to as D2
DSN003 = PPPL pump house discharge on Delaware & Raritan Canal (non-potable water supply)
E1 = Elizabethtown Water Company (potable water supply)
M1 = Millstone River (downstream)
P1 = Cranbury Brook (upstream)
P2 = Devil's Brook(upsteam)

See Figures 28, 29, 30, and 31

Table 6. Tritium Concentrations in Ground Water (Wells and Sump) for 1995

Collection Date	TW-1	TW-2	TW-3	TW-5	TW-10	D-12	TFTR Sump	MW-10I	MW-12S
2/2/95	103				37				
5/8/95	152				83				
8/3/95			72			104			
8/4/95	789				81				
9/21/95	350	129		153	<119		328	344	
10/23/95	345								
10/24/95	431						<119		
10/25/95							151		
10/26/95							<119		
10/27/95							172		
11/13/95	452				<119				
11/21/95	<186	<186		<186		<186	<186		<186
12/7/95							435		

See Figure 27.

Table 7. Tritium Concentrations in Biota Moisture for 1995

Sample Type	Stultz Farm	Stultz Farm Dup.	Control
Strawberries	73	51	
Tomatoes	<119	<119	
Zucchini	<36	<36	<36

Table 8. Tritium Concentrations in Soil for 1995

Sample Location/Type	3/29/95	7/5/95
REAM1	86	101
REAM1 duplicate	78	
REAM1 duplicate spike	555	
REAM 2	71	51
REAM2 duplicate		49
REAM2 duplicate spike		790
REAM3	90	214
REAM4	76	81
REAM 5	95	63
REAM6	77	36
Baseline	46	51

Table 9. Annual Range of Tritium Concentration in Precipitation from 1985 to 1995

Year	Tritium Range	Precipitation (in)
1985	45 to 160	
1986	40 to 140	
1987	26 to 144	
1988	34 to 105	
1989	7 to 90	55.345
1990	14 to 94	50.332
1991	10 to 154	45.075
1992	10 to 83.8	41.86
1993	24.5 to 145	42.731
1994	32.2 to 1130.4	51.26
1995	<19 to 2561	35.625

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

See Figure 18.

Table 10. Tritium in Air (TR 1-4 and Baseline) for 1995

Month	TR1 HTO	TR2 HTO	TR3 HTO	TR4 HTO	Baseline HTO
January	2.357	2.517	9.347	3.689	1.907
February	1.052	1.044	7.500	1.679	2.092
March	10.136	14.595	17.063	3.513	2.282
April	8.980	4.531	11.711	12.625	1.981
May	16.967	36.456	70.266	9.363	1.927
June	17.959	21.288	34.713	14.380	1.718
July	10.288	13.971	12.157	3.812	1.894
August	39.009	39.797	45.477	38.503	1.958
September	14.222	21.469	36.728	9.150	2.461
October	45.060	44.246	25.001	44.761	1.932
November	6.711	15.867	29.920	5.741	2.383
December	48.898	45.671	63.149	46.775	1.867

Month	TR1 HT	TR2 HT	TR3 HT	TR4 HT	Baseline HT
January	1.992	2.834	8.342	4.098	1.907
February	3.228	3.804	10.449	5.982	2.295
March	2.740	5.521	12.942	3.101	2.338
April	2.438	7.058	10.902	3.764	2.351
May	5.779	3.494	32.056	6.013	2.883
June	3.520	6.157	13.425	3.361	1.718
July	4.251	3.647	3.992	1.697	2.263
August	6.579	7.513	14.450	2.924	2.458
September	6.286	15.748	27.342	10.585	2.872
October	4.315	8.385	4.609	11.427	2.267
November	2.581	2.839	19.652	3.896	2.351
December	1.965	2.021	9.264	1.952	2.153

All measurement values are in picoCuries/Cubic meter.

TR1-4 are located on D site.
Baseline is located in Montgomery Township, NJ - 1/95 to 7/95; in Hopewell Township, NJ - 7/95 to 12/95.

HTO is tritium oxide.
HT is elemental tritium.

See Figures 22 and 24.

Table 11. Tritium in Air (REAM 1-6 and Baseline) for 1995

Month	REAM1 HTO	REAM2 HTO	REAM3 HTO	REAM4 HTO	REAM5 HTO	REAM6 HTO	Baseline HTO
January	2.100	2.583	2.329	2.281	2.309	2.121	1.907
February	2.582	1.813	1.900	2.058	2.094	2.092	2.092
March	1.977	2.154	2.697	2.667	2.354	2.773	2.282
April	2.258	2.136	2.174	2.628	2.623	1.978	1.981
May	3.430	1.913	5.742	3.187	3.941	3.671	1.927
June	2.136	2.767	1.704	2.207	1.901	1.633	1.718
July	1.908	1.673	2.416	2.774	1.862	4.173	1.894
August	2.256	2.027	3.610	1.725	3.899	1.812	1.958
September	3.029	2.343	4.227	3.513	3.536	6.448	2.461
October	1.930	2.639	8.365	4.115	2.581	3.088	1.932
November	1.949	2.314	3.040	3.968	2.805	2.497	2.383
December	2.119	2.427	2.037	3.337	3.611	2.641	1.867

Month	REAM1 HT	REAM2 HT	REAM3 HT	REAM4 HT	REAM5 HT	REAM6 HT	Baseline HT
January	3.061	3.394	2.329	3.153	3.723	13.009	1.907
February	5.981	2.764	2.272	3.294	2.748	4.612	2.295
March	2.345	2.640	2.401	3.083	2.378	3.595	2.338
April	2.002	3.568	2.544	2.506	2.732	1.997	2.351
May	1.905	2.700	3.244	2.213	3.081	3.370	2.883
June	2.628	2.080	2.823	1.996	2.130	1.633	1.718
July	2.284	1.584	3.636	1.817	2.206	2.285	2.263
August	2.359	2.068	2.877	1.867	4.196	2.449	2.458
September	2.987	2.280	3.697	2.918	4.459	4.635	2.872
October	2.694	2.878	3.923	2.706	2.532	3.733	2.267
November	2.202	2.471	2.975	6.899	2.460	2.530	2.351
December	2.119	2.418	1.832	4.170	3.054	2.314	2.153

All measurement values are in picoCuries/Cubic meter.

REAM 1-6 are located off- site, within a radius of 0.5 miles from PPPL .
Baseline is located in Montogmergy Township, NJ - 1/95 to 7/95; in Hopewell Township, NJ - 7/95 to 12/95.

HTO is tritium oxide.
HT is elemental tritium.

See Figures 23 and 25.

Table 12. Tritium Released from Liquid Effluent Collection (LEC) Tanks in 1995

Sample Date	Tank Number	Tank Volume (gal)	Tritium Low Limit of Detection Activity (Ci)	Tritium Tank Activity (Ci)	Tritium Total Activity (Ci)
1/9/95	1	6450	0.00000844	0.00698	0.00698
2/1/95	3	6600	0.00000889	0.00711	0.0141
3/7/95	3	6600	0.00000836	0.00174	0.0158
4/4/95	3	6000	0.00000823	0.00194	0.0178
5/18/95	3	12000	0.000015	0.00718	0.0249
6/6/95	3	9750	0.0000126	0.0185	0.0434
6/14/95	3	12750	0.0000158	0.015	0.0585
6/21/95	3	6900	0.00000873	0.0132	0.0717
6/28/95	3	12300	0.0000158	0.0361	0.108
7/6/95	3	8250	0.000011	0.00974	0.117
7/13/95	3	13200	0.0000172	0.0246	0.142
7/18/95	3	13500	0.0000177	0.013	0.155
7/26/95	3	12000	0.0000155	0.014	0.169
7/28/95	3	12750	0.0000177	0.00902	0.178
8/1/95	3	13050	0.0000177	0.00959	0.188
8/7/95	3	12750	0.0000159	0.00863	0.196
8/15/95	3	12450	0.0000173	0.00924	0.205
8/18/95	3	12000	0.0000173	0.00706	0.213
8/30/95	3	11475	0.0000161	0.00969	0.222
9/7/95	3	8700	0.0000129	0.00891	0.231
9/18/95	3	11805	0.0000168	0.0129	0.244
10/4/95	3	11400	0.0000158	0.013	0.257
10/17/95	3	12750	0.0000192	0.0484	0.305
11/14/95	2	3500	0.00000379	0.0159	0.321
11/15/95	2	12000	0.0000129	0.0404	0.362
11/16/95	2	12000	0.0000144	0.0412	0.403
11/17/95	2	12000	0.0000193	0.0455	0.448
11/17/95	3	9000	0.0000134	0.0266	0.475
11/21/95	3	9000	0.0000151	0.0126	0.488
12/17/95	2	6000	0.0000151	0.00814	0.496
Total gals.		308,930			

Table 13. Surface Water Analysis for Bee Brook, Locations B1 and B2 for 1995

Parameters, Units	***B1 5/9/95***	***B1 8/1/95***	***B2 5/9/95***	***B2 8/1/95***
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
pH, units	7.39	7.17	7.66	7.42
Phenolics as phenol, mg/L	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/L	6.3	8.5	5.8	<5.0
Biochemical Oxygen Demand, 5-day total, mg/L	<2	9.2[1]	<2	8.2[2]
Temperature, °C	11.8	22.5	14.8	25.3
Petroleum Hydrocarbons by IR, mg/L	<1.0	<1.0	<1.0	<1.0
Ammonia-N, mg/L	<0.5	<0.5	<0.5	<0.5
Total Suspended Solids, mg/L	1.0	<5.0	2.0	<5.0
Total Dissolved Solids, mg/L	100	260	220	190
Flow, Approximate GPM	Not Measured	Not Measured	252	Not Measured

[1]The sample for BOD was collected on 8/7/95.

[2]The sample for BOD was collected on 8/7/95.

Table 14. Surface Water Analysis for D&R Canal, C1, and Ditch #5, D1 for 1995

Parameters, Units	***C1 5/9/95***	***C1 8/1/95***	***D1 5/9/95***	***D1 8/7/95***
Chromium, mg/L			<0.05	<0.005
pH, units	7.42	7.65	7.35	7.45
Phenolics as phenol, mg/L	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/L	9.2	<5.0	<5	8.5
Biochemical Oxygen Demand, 5-day total, mg/L	<2	8.2[1]	<2	8.1
Temperature, °C	17.2	29.2	16	26.1
Petroleum Hydrocarbons by IR, mg/L	<1.0	<1.0	<1.0	<1.0
Ammonia-N, mg/L	<0.5	<0.5	<0.5	<0.5
Total Suspended Solids, mg/L	6.0	<5.0	6.0	<5.0[2]
Total Dissolved Solids, mg/L	140.0	110	220.0	110[2]
Flow, Approximate GPM			1301.61	

[1]The sample for BOD was collected on 8/7/95.

[2]The hold time for these parameters was exceeded.

Blank indicates no measurement.

Table 15. Surface Water Analysis for the Millstone River M1 for1995

Parameters, Units	***M1*** *5/9/95*	***M1*** *8/1/95*
pH, units	7.28	7.12
Phenolics as phenol, mg/L	<0.05	<0.05
Chemical Oxygen Demand, mg/L	14.0	14.0
Biochemical Oxygen Demand, 5-day total, mg/L	<2.0	13.0[1]
Temperature, °C	17.7	28.3
Petroleum Hydrocarbons by IR, mg/L	<1.0	<1.0
Ammonia-N, mg/L	<0.5	<0.5
Total Suspended Solids, mg/L	5.0	8.0
Total Dissolved Solids, mg/L	160.0	130.0

[1]The sample for BOD was collected on 8/7/95.

Table 16. Surface Water Analysis for Plainsboro, Locations P1 and P2, for 1995

Parameters, Units	***P1*** *5/9/95*	***P1*** *8/1/95*	***P2*** *5/9/95*	***P2*** *8/1/95*
pH, units	7.13	6.65	6.75	7.38
Phenolics as phenol, mg/L	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/L	12.0	15.0	8.7	5.7
Biochemical Oxygen Demand, 5-day total, mg/L	3.8	16.0[1]	<2.0	15.0[2]
Temperature, °C	19.3	29.9	14.3	20.9
Petroleum Hydrocarbons by IR, mg/L	<1.0	<1.0	<1.0	<1.0
Ammonia-N, mg/L	<0.5	<0.5	<0.5	<0.5
Total Suspended Solids, mg/L	24.0	8.0	4.0	<5.0
Total Dissolved Solids, mg/L	98.0	91.0	120.0	98.0

[1]The sample for BOD was collected on 8/7/95.

[2]The sample for BOD was collected on 8/7/95.

Table 17. Detention Basin Influents Analysis (NJDPES NJ0086029) for 1995

Parameters, Units	***Inflow 1*** *5/9/95*	***Inflow 1*** *8/1/95*	***Inflow 2*** *5/9/95*	***Inflow 2*** *8/1/95*
pH, units	7.93	7.75	7.53	7.15
Phenolics as phenol, mg/L	<0.05	<0.05	<0.05	<0.05
Chemical Oxygen Demand, mg/L	<5.0	<5.0	<5.0	<5.0
Biochemical Oxygen Demand, 5-day total, mg/L	2.0	9.1	<2.0	6.0
Petroleum Hydrocarbons by IR, mg/L	<1.0		<1.0	
Ammonia-N, mg/L	<0.50	<0.50	<0.50	<0.50
Settleable Solids, %	<0.4	<0.50	<0.4	<0.50
Total Dissolved Solids, mg/L	190.0	140.0	230.0	220.0
Chromium, mg/L	<0.05	<0.05	<0.05	<0.05
Total Volatile Organics (GC/MS) µg/l				
Methylene Chloride		5.0		5.0
1,2-Dichloroethane		3.0		3.0
Chloroform		15.0		7.0
Bromodichloromethane		3.0		2.0

Blank indicates no measurement.

Table 18. Monthly Surface Water Analysis for NJPDES NJ0023922— DSN001 (Ditch #5-D2) for 1995

Permit Limit	*Parameters, Units*	*1/3*	*2/3*	*3/7*	*4/4*	*5/9*	*6/6*
NA	Chromium total,mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6.0 - 9.0	pH, units	6.66	7.15	7.58	7.49	7.50	7.46
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	11.0	<5.0	10.0	7.5	<5.0	9.9
NA	Biochemical Oxygen Demand, 5-day total, mg/L	<1.0	<2.0		<1.0	<2.0	<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		0.020		0.14		
NA	Chronic Toxicity NOEC (% effluent), P. promelas			50			100
NA	Ammonia-N, mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
50 mg/L	Total Suspended Solids, mg/L	<2.0	<1.0	2.0	10.0	1.0	2.0
NA	Total Dissolved Solids, mg/L	300.0	260.0	200.0	81.0	250.0	200.0
30°C max.	Temperature°C	8.3	7.5	3.8	12.8	15.7	19.4
NA	Flow, GPM	<27.56 [1]	<27.56 [1]	<33.93 [1]	<35.59 [1]	<49.17 [1]	<35.58 [1]

[1]Flow was less than the detection limit (0.1 ft./sec.) on the flow meter. Calculations are based on the flow being less than the flow meter detection limit or 0.1 ft./sec.

Permit Limit	*Parameters, Units*	*7/6*	*8/1*	*9/7*	*10/3*	*11/14*	*12/4*
NA	Chromium total,mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6.0 - 9.0	pH, units	8.02	7.74	7.59	7.21	7.52	7.76
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	10.0	<5.0	13.0	17.0	16.0	10.0
NA	Biochemical Oxygen Demand, 5-day total, mg/L	<2.0	8.3[2]	<2.0	<2.0	<2.0	<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			0.00[3]	
NA	Chronic Toxicity NOEC (% effluent), P. promelas			100			100
NA	Ammonia-N, mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
50 mg/L	Total Suspended Solids, mg/L	5.0	5.0	<5.0	29.0	<5.0	<5.0
NA	Total Dissolved Solids, mg/L	140.0	180.0	160.0	250.0	180.0	140.0
30°C max.	Temperature°C	24.0	23.9	22.7	19.8	11.9	9.30
NA	Flow, GPM	<35.58 [1]	<33.93 [1]	<42.28 [1]	161.58	353.23	870.73

[1]Flow was less than the detection limit (0.1 ft./sec.) on the flow meter. Calculations are based on the flow being less than the flow meter detection limit or 0.1 ft./sec.

[2]BOD samples collected on 8/7/95.

[3]CPO was measured using a LaMotte DC1100 Colorimeter with a range of 0 to 4.0 mg/L chlorine and resolution of 0.05 mg/L.

Blank indicates no sample obtained for the monitoring period.

Table 19. Monthly Surface Water Analysis for Stormwater — DSN002 (NJPDES NJ0023922) for 1995

Permit Limit	Parameters, Units	1/16	3/21	6/12	7/7	9/22	11/1
50 mg/L	Total Suspended Solids, mg/L	**92.0**	98.0	**26.0**	32.0	22.0	8.0
15 mg/L	Petroleum Hydrocarbons-15 min., mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15 mg/L	Petroleum Hydrocarbons-30 min., mg/L	<1.0	<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	7.45	6.90	7.33	6.84	7.11	7.28
100 mg/L	Chemical Oxygen Demand, mg/L	63.0	80.0	33.0	18.0	24.0	25.0
NA	Temperature °C	11.6	10.6	20.8	23.5	21.7	14.1
NA	Phenolics, as phenol, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
NA	Ammonia-N, mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
NA	Total Dissolved Solids, mg/L	110.0	170.0	83.0	35.0	65.0	44.0
NA	Biochemical Oxygen Demand,mg/L	1.7	12.0	1600	<70.0[1]		<18.0
NA	Chromium, mg/L	<0.05	<0.05	1.7	<0.05	<0.05	<0.05

[1] Analytical laboratory misdiagnosed the dilutions used in the analysis. Dilutions were incorrectly prepared. causing the method detection limit ito be70.0 mg/L.
No rain events occurred during Feb., Apr., May, Aug., Oct., and Dec. 1994 to cause flow at DSN002.

Table 20. Monthly Surface Water Analysis for the Canal Pump House — DSN003 (NJPDES NJ0023922) for 1995

Permit Limit								
Monthly Average	Daily Max.	Parameters, Units	1/16	2/3	3/7	4/4	5/17	6/6
NL	NL	Chlorine Produced Oxidants, mg/L	<1.0	1.9		3.1	0.83	
20 mg/L	60 mg/L	Total Suspended Solids, mg/L	14.0	<1.0	9.0	17.0	**50.0**	13.0
10 mg/L	15 mg/L	Petroleum Hydrocarbons, mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NA	6.0 - 9.0	pH, units	7.05	7.51	7.84	8.24	7.31	7.25
NA	NA	Chemical Oxygen Demand, mg/L						
NA	NA	Temperature °C	7.50	1.7	<1.0	10.4	18.6	20.0
NA	NA	Phenolics, as phenol, mg/L	<0.05	<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	<0.5
NA	NA	Total Dissolved Solids, mg/L	96.0	140.0	150.0	120.0	<5.0	120.0
NA	NA	Biochemical Oxygen Demand,mg/L	<1.0	<2.0	<1.0	<1.0	<2.0	<2.0
NA	NA	Chromium, mg/L	0.067	<0.05	<0.05	<0.05		<0.05

Permit Limit								
Monthly Average	Daily Max.	Parameters, Units	7/6	8/1	9/7	10/3	11/14	12/7
NL	NL	Chlorine Produced Oxidants, mg/L		1.2			0.01	
20 mg/L	60 mg/L	Total Suspended Solids, mg/L	10.0	12.0	6.0	10.0	6.0	<5.0
10 mg/L	15 mg/L	Petroleum Hydrocarbons, mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NA	6.0 - 9.0	pH, units	7.53	7.54	7.21	7.27	7.11	7.48
NA	NA	Chemical Oxygen Demand, mg/L			8.6			
NA	NA	Temperature °C	25.0	28.8	24.6	17.9	6.9	4.80
NA	NA	Phenolics, as phenol, mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
NA	NA	Ammonia-N, mg/L	<0.5	0.83	<0.5	<0.5	<0.5	<0.5
NA	NA	Total Dissolved Solids, mg/L	140.0	110.0	120.0	140.0	150.0	120.0
NA	NA	Biochemical Oxygen Demand,mg/L	<2.0		<2.0	<2.0	<2.0	<2.0
NA	NA	Chromium, mg/L	<0.05	<0.05	<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; NA - Not Applicable

Table 21. Application of Herbicides and Fertilizers in 1995

Herbicides and Fertilizers	Amounts Used
Princep	0.25 gallons
Roundup	4.7gallons
Lime	2,100 pounds

Table 22. Average Ground Water Elevation by Well Group for 1995 (in Feet Above MSL)

88	86	85	84	83	82
MW-1	MW-4	MW-2	MW-8I	MW-8S	MW-5S
	P-2	P-1	MW-6S	MW-5I	MW-7I
	MW-3	MW-9	MW-6I		D-12
	MW-13	MW-7S			

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

Table 23. Total Petroleum Hydrocarbons Results from Quarterly Ground Water Monitoring Program for 1995 (in mg/L)

Well Number	2/16/95	5/95	8/95	11/95
P-2	0.57U	0.50U	0.50U	0.55U
MW-4	0.57U	0.57U	0.57U	0.54U
MW-5S	0.60U	0.56U	0.56U	0.55U
MW-5I	**3.7**	0.60U	0.58U	0.55U
MW-6S	0.71U	0.52U	0.59U	0.56U
MW-6I	0.58U	0.58U	0.57U	0.56U
MW-7S	0.59U	0.60U	0.57U	0.56U
MW-7I	0.60U	0.61U	0.56U	0.54U
MW-8S	0.71 U	**0.92**	0.60U	0.56U
MW-8I	0.65U	0.60U	**0.71**	0.55U

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.

Table 24. Ground Water Monitoring Program Results
Volatile Organic Compounds — August 1995 (in µg/l)

Parameter	P-2 8/23/95	MW-4 08/23/95	MW-5I 8/23/95	MW-6S 8/23/95	MW-6I 8/23/95	MW-7S 8/23/95
Target VOC						
1,1-Dichloroethene	2U	2U	2U	**3**	2U	**3**
1,1-Dichloroethane	1U	1U	**2**	**13**	1U	**17**
1,1,1-Trichloroethane	0.5U	0.5U	1U	**15**	0.5U	**14**
Trichloroethene	0.6U	0.6U	**10**	**21**	0.6U	**4**
Tetrachloroethene	0.7U	0.7U	0.7U	**73**	0.7U	**21**
Toluene	0.8U	0.8U	0.8U	**1**	0.8U	0.8U
Xylenes	0.9U	0.9U	0.9U	**2**	0.9U	0.9U
Total Target VOC	0	0	**12**	**128**	0	**59**
Non-Target Semi-VOCs	**13**	**8**	0	**5**	**0**	**280**
Non-Target VOC	0	0	**3**	**10**	**6**	**0**

Parameter	MW-7I 8/23/95	MW-8S 8/23/95	MW-8I 8/23/95	Trip Blank 8/23/95*	Field Blank 8/23/95
Target VOC					
1,1-Dichloroethene	2U	2U	2U		2U
1,1-Dichloroethane	**5**	**1J**	1U		1U
1,1,1-Trichloroethane	0.5U	0.5U	0.5U		0.5U
Trichloroethene	**4**	**2**	0.6U		0.6U
Tetrachloroethene	**3**	**12**	0.7U		0.7U
Toluene	**2**	0.8U	0.8U		0.8U
Xylenes	0.9U	0.9U	0.9U		0.9U
Total Target VOC	**14**	**14**	0		0
Non-Target Semi-VOCs	**36**	0	**408**		0
Non-Target VOC	**9**	0	0		0

No sample collected from MW-5S as it did not yield enough water.
**No Trip Blank collected*
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 analyzed but not detected. For results marked "U," the numerical value is the compound detection limit.

Table 25. Ground Water Analysis for Wells MW-14, MW-15, and MW-16 for 1995

Parameters Units	*NJPDES Permit Standard*	*MW-14 2/2*	*MW-14 5/8*	*MW-14 8/3*	*MW-14 11/4*
Chromium, mg/L	*0.05*			<0.025	<0.025
Lead, dissolved, mg/L	*0.05*			0.0025	<0.005
pH, units		5.61	5.42	5.62	5.27
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			1.5	1.5
Total Organic Carbon, mg/1				<1	
Total Organic Halides, mg/L				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			<3.0	<3.0
Total Dissolved Solids, mg/1	*500*	120	87	71	120
Sulfate, mg/1	*250*	13	12	18	13
Conductivity, mmhos/cm^2		91.3	94.8	91.2	100

Parameters Units	*NJPDES Permit Standard*	*MW-15 2/2*	*MW-15 5/8*	*MW-15 8/3*	*MW-15 11//3*
Chromium, mg/L	*0.05*			<0.025	<0.025
Lead, dissolved, mg/L	*0.05*			0.0037	<0.003
pH, units		5.69	5.36	5.64	5.45
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			0.86	1.2
Total Organic Carbon, mg/1				<1.0	
Total Organic Halides, mg/L				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			4.7	<3.0
Total Dissolved Solids, mg/1	*500*	140	7.4	81	86
Sulfate, mg/1	*250*	5	69	12	7.9
Conductivity, mmhos/cm^2		78.4	68.1	125	87.7

Parameters Units	*NJPDES Permit Standard*	*MW-16 2/2*	*MW-16 5/9*	*MW-16 8/4*	*MW-16 11//3*
Chromium, mg/L	*0.05*			<0.025	<0.025
Lead, dissolved, mg/L	*0.05*			<0.0025	0.003
pH, units		6.52	6.20	6.17	6.56
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			<0.05	6.6
Total Organic Carbon, mg/1				3.0	
Total Organic Halides, mg/L				<0.043	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			7.5	13
Total Dissolved Solids, mg/1	*500*	330	270	330	**530**
Sulfate, mg/1	*250*	46	40	66	150
Conductivity, mmhos/cm^2		547	445	445	771

Blank indicates no measurement.

Table 26. Ground Water Analysis for Well D-12 for 1995

Parameters Units	*NJPDES Permit Standard*	*D-12 2/15*	*D-12 5/8*	*D-12 8/3*	*D-12 11/13*
Chromium, mg/L	*0.05*			<0.025	<0.025
Lead, dissolved, mg/L	*0.05*			<0.0025	0.027
pH, units		6.20	5.44	5.43	5.11
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				1.2	
Total Organic Halides, mg/L				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			21	21
Total Dissolved Solids, mg/1	*500*	270	120	130	94
Sulfate, mg/1	*250*	32	34	23	30
Conductivity, mmhos/cm^2		230	219	220	177
Tritium, pCi/L	**			104	

Note: D-11 not sampled due to insufficient water for samples; since Oct.1994, under drain system was in operation, ca using a lowering of the ground water level.
Blank indicates no measurement.
*** The lower limit of detection (LLD) is 33.5 p Ci/L.*

Table 27. Ground Water Analysis for Wells TW-2 and TW-3 for 1995

Parameters Units	*NJPDES Permit Standards*	*TW-2 2/2*	*TW-2 5/8*	*TW-2 8/4*	*TW-2 11/913*
Chromium, mg/L	*0.05*				
Lead, dissolved, mg/L	*0.05*			0.024	0.003
pH, units		7.32	6.87	7.22	7.38
Phenolics as phenol, mg/1	*0.3*			<0.05	<0.05
Nitrate-Nitrogen, mg/1	*10*			0.4	<0.05
Total Organic Carbon, mg/1				<1.0	
Total Organic Halides, mg/L				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			44	27
Total Dissolved Solids, mg/1	*500*	270	230	310	260
Sulfate, mg/1	*250*	18	20	27	16
Conductivity, mmhos/cm^2		383	392	474	417

Parameters Units	*NJPDES Permit Standards*	*TW-3 2/2*	*TW-3 5/8*	*TW-3 8/3*	*TW-3 11/14*
Chromium, mg/L	*0.05*				
Lead, dissolved, mg/L	*0.05*			<0.0025	<0.005
pH, units		7.34	7.00	7.05	6.94
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				1.1	
Total Organic Halides, mg/L				<0.01	
Petroleum Hydrocarbon by IR, mg/1				<1	
Ammonia-Nitrogen, mg/1	*0.5*		<0.5	<0.5	<0.5
Chloride, mg/1	*250*			11	13
Total Dissolved Solids, mg/1	*500*	320	220	220	220
Sulfate, mg/1	*250*	18	22	18	2.5
Conductivity, mmhos/cm^2		457	386	380	540
Tritium, pCi/L				72*	

Blank indicates no measurement.

** The lower limit of detection (LLD) is 33.5 p Ci/L.*

Table 28. Ground Water Volatile Organics Analytical Results from Wells D-12 and TW-3 — May 1995 (in µg/l)

Parameter	*DEP GW Quallity Criteria*	*D-12 5/8*	*TW-3 5/8*	*Trip Blank*	*Field Blank*
Methyl Chloride (Chloromethane)	*30*	<2	<2	<2	<2
Methyl Bromide (Bromomethane)	*10*	<6	<6	<6	<6
Vinyl Chloride	*0.08*	<3	<3	<3	<3
Chloroethane	*NL*	<5	<5	<5	<5
Methylene Chloride	*400*	**10 TB**	**10 TB**	**10 TB**	**11 TB**
Acrolein	*NA*	<100	<100	<100	<100
Acrylonitrile	*0.06*	<50	<50	<50	<50
1,1-Dichloroethane	*70*	**3**	<2	<2	<2
1,2-Dichloroethane	*0.3*	<2	<2	<2	<2
1,1-Dichloroethene	*1*	<2	<2	<2	<2
1,2-trans-Dichloroethene	*100*	<1	<1	<1	<1
1,2-Dichloropropane	*0.5*	<2	<2	<2	<2
1,3-cis-Dichloropropene		<2	<2	<2	<2
1,3-trans-Dichloropropene	*0.2*	<2	<2	<2	<2
Chloroform	*6*	<1	<1	<1	<1
1,1,1-Trichloroethane	*30*	<1	<1	<1	<1
1,1,2-Trichloroethane	*3*	<1	<1	<1	<1
Trichloroethene	*1*	**4**	<1	<1	<1
Carbon Tetrachloride	*0.4*	<1	<1	<1	<1
Bromodichloromethane	*0.3*	<2	<2	<2	<2
Chlorodibromomethane	*10*	<1	<1	<1	<1
Benzene	*0.2*	<1	<1	<1	<1
2-Chloroethyl Vinyl Ether	*NL*	<50	<50	<50	<50
Bromoform	*4*	<3	<3	<3	<3
Tetrachloroethene	*0.4*	**9**	<2	<2	<2
1,1,2,2-Tetrachloroethane	*2*	<2	<2	<2	<2
Toluene	*1,000*	<5	<5	<5	<5
Chlorobenzene	*4*	<1	<1	<1	<1
Ethylbenzene	*700*	<1	<1	<1	<1
Trichlorofluoromethane	*NL*	<1	<1	<1	<1
Xylene (para & meta)	*NA*	<2	<2	<2	<2
Xylene (ortho)	*NA*	<2	<2	<2	<2
1,2-Dichlorobenzene	*600*	<1	<1	<1	<1
1,3-Dichlorobenzene	*600*	<1	<1	<1	<1
1,4-Dichlorobenzene	*75*	<1	<1	<1	<1

TB Found in the trip blank.
**Note: D-11 was no sampled due to insufficient water for sample collection; since Oct. 1994, underdrain system in operation, which lowered ground water levels.*

Table 29. Volatile Organics Analytical Results from Wells TW-3 and D-12 and Detention Basin Inflows 1 and 2— August 1995 (in µg/l)

Parameter	*DEP GW Qual. Criteria*	*TW-3 8/3*	*D-12 8/3*	*Inflow 1 8/1*	*Inflow 2 8/1*	*Trip Blank 8/3*	*Field Blank 8/3*
Methyl Chloride (Chloromethane)	*30*	<2	<2	<2	<2	<2	<2
Methyl Bromide (Bromomethane)	*10*	<6	<6	<6	<6	<6	<6
Vinyl Chloride	*0.08*	<3	<3	<3	<3	<3	<3
Chloroethane	*NL*	<5	<5	<5	<5	<5	<5
Methylene Chloride	*400*	**7 TB**	**8 TB**	**5 TB**	**5 TB**	**9**	**9 TB**
Acrolein	*NA*	<100	<100	<100	<100	<100	<100
Acrylonitrile	*0.06*	<50	<50	<50	<50	<50	<50
1,1-Dichloroethane	*70*	<2	**3**	<2	<2	<2	<2
1,2-Dichloroethane	*0.3*	<2	<2	**3**	**3**	<2	<2
1,1-Dichloroethene	*1*	<2	<2	<2	<2	<2	<2
1,2-trans-Dichloroethene	*100*	<1	<1	<1	<1	<1	<1
1,2-Dichloropropane	*0.5*	<2	<2	<2	<2	<2	<2
1,3-trans-Dichloropropene	*0.2*	<2	<2	<2	<2	<2	<2
Chloroform	*6*	<2	<2	**15**	**7**	<2	<2
1,1,1-Trichloroethane	*30*	<1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	*3*	<1	<1	<1	<1	<1	<1
Trichloroethene	*1*	**1**	**4**	<1	<1	<1	<1
Carbon Tetrachloride	*0.4*	<1	<1	<1	<1	<1	<1
Chlorodibromomethane	*0.3*	<1	<1	<1	<1	<1	<1
Bromodichloromethane		<2	<2	**3**	**2**	<2	<2
Benzene	*0.2*	<1	<1	<1	<1	<1	<1
2-Chloroethyl Vinyl Ether	*NL*	<50	<50	<50	<50	<50	<50
Bromoform	*4*	<3	<3	<3	<3	<3	<3
Tetrachloroethene	*0.4*	<2	**10**	<2	<2	<2	<2
1,1,2,2-Tetrachloroethane	*2*	<2	<2	<2	<2	<2	<2
Toluene	*1,000*	<5	<5	<5	<5	<5	<5
Chlorobenzene	*4*	<1	<1	<1	<1	<1	<1
Ethylbenzene	*700*	<1	<1	<1	<1	<1	<1
Trichlorofluoromethane		<1	<1	<1	<1	<1	<1
cis-1,3-Dichloropropene	*0.2*	<2	<2	<2	<2	<2	<2
Xylene (para&meta)	*NA*	<2	<2	<2	<2	<2	<2
Xylene (ortho)	*NA*	<2	<2	<2	<2	<2	<2
1,2-Dichlorobenzene	*600*	<1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	*600*	<1	<1	<1	<1	<1	<1
1,4-Dichlorobenzene	*75*	<1	<1	<1	<1	<1	<1

TB Found in the trip blank.
**Note: D-11 was no sampled due to insufficient water for sample collection; since Oct. 1994, underdrain system in operation, which lowered ground water levels.*

Table 30. Ground Water Base Neutrals Analytical Results — August 1995 (in µg/l)

Parameter	***D-12 8/3***	***MW-14 8/3***	***MW-15 8/3***	***TW-3 8/3***	***Field Blank 8/3***	***MW-16 8/4***	***TW-2 8/4***	***Field Blank 8/4***
Acenaphthene	<3	<3	<3	<3	<3	<3	<3	<3
Acenaphthylene	<5	<5	<5	<5	<5	<5	<5	<5
Anthracene	<2	<2	<2	<2	<2	<2	<2	<2
Benzidine	<1	<1	<1	<1	<1	<1	<1	<1
Benzo (a)anthracene	<2	<2	<2	<2	<2	<2	<2	<2
Benzo (a)pyrene	<2	<2	<2	<2	<2	<2	<2	<2
Benzo (b)fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1
Benzo (k)fluoranthene	<2	<2	<2	<2	<2	<2	<2	<2
Benzo (g,h,i)perylene	<2	<2	<2	<2	<2	<2	<2	<2
bis(2-Chloroethoxy)methane	<3	<3	<3	<3	<3	<3	<3	<3
bis(2-Chloroethyl)ether	<1	<1	<1	<1	<1	<1	<1	<1
bis(2-Chloroisopropyl)ether	<5	<5	<5	<5	<5	<5	<5	<5
Bis(2-Ethylhexyl)phthalate	<4	<4	<4	<4	**7**	<4	<4	<4
4-Bromophenyl-phenylether	<2	<2	<2	<2	<2	<2	<2	<2
Butylbenzlphthalate	<9	<9	<9	<9	<9	<9	<9	<9
2-Chloronaphthalene	<1	<1	<1	<1	<1	<1	<1	<1
2-Chlorophenol	<2	<2	<2	<2	<2	<2	<2	<2
4-Chlorophenyl-phenylether	<3	<3	<3	<3	<3	<3	<3	<3
4-Chloro-3-methylphenol	<3	<3	<3	<3	<3	<3	<3	<3
Chrysene	<2	<2	<2	<2	<2	<2	<2	<2
Dibenz[a,h]anthracene	<3	<3	<3	<3	<3	<3	<3	<3
1,2-Dichlorobenzene	<2	<2	<2	<2	<2	<2	<2	<2
1,3-Dichlorobenzene	<2	<2	<2	<2	<2	<2	<2	<2
1,4-Dichlorobenzene	<1	<1	<1	<1	<1	<1	<1	<1
3,3-Dichlorobenzidine	<15	<15	<15	<15	<15	<15	<15	<15
2,4-Dichlorophenol	<3	<3	<3	<3	<3	<3	<3	<3
Diethylphthalate	<1	<1	<1	<1	<1	<1	<1	<1
Dimethylphthalate	<1	<1	<1	<1	<1	<1	<1	<1
2,4-Dimethylphenol	<3	<3	<3	<3	<3	<3	<3	<3
Di-n-butylphthalate	<5	<5	<5	<5	<5	<5	<5	<5
2,4-Dintor-2-methylphenol	<3	<3	<3	<3	<3	<3	<3	<3
2,4-Dinitrophenol	<24	<24	<24	<24	<24	<24	<24	<24
2,4-Dinitrotoluene	<3	<3	<3	<3	<3	<3	<3	<3
2,6-Dinitrotoluene	<2	<2	<2	<2	<2	<2	<2	<2
Di-n-octylphthalate	<2	<2	<2	<2	<2	<2	<2	<2
1,2-Diphenylhydrazine	<6	<6	<6	<6	<6	<6	<6	<6
Fluoranthene	<1	<1	<1	<1	<1	<1	<1	<1
Fluorene	<3	<3	<3	<3	<3	<3	<3	<3
Hexachlorobenzene	<2	<2	<2	<2	<2	<2	<2	<2
Hexachlorobutadiene	<2	<2	<2	<2	<2	<2	<2	<2
Hexachlorocyclopentadiene	<12	<12	<12	<12	<12	<12	<12	<12
Hexachloroethane	<1	<1	<1	<1	<1	<1	<1	<1
Indeno (1,2,3-cd)pyrene	<2	<2	<2	<2	<2	<2	<2	<2
Isophorone	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	<2	<2	<2	<2	<2	<2	<2	<2
Nitrobenzene	<2	<2	<2	<2	<2	<2	<2	<2
2-Nitrophenol	<3	<3	<3	<3	<3	<3	<3	<3
4-Nitrophenol	<21	<21	<21	<21	<21	<21	<21	<21
N-nitrosodimethylamine	<2	<2	<2	<2	<2	<2	<2	<2
N-Nitroso-Di-n-propylamine	<2	<2	<2	<2	<2	<2	<2	<2
N-Nitrosodiphenylamine	<6	<6	<6	<6	<6	<6	<6	<6
Pentachlorophenol	<5	<5	<5	<5	<5	<5	<5	<5
Phenathrene	<2	<2	<2	<2	<2	<2	<2	<2
Phenol	<2	<2	<2	<2	<2	<2	<2	<2
Pyrene	<2	<2	<2	<2	<2	<2	<2	<2
1,2,4-Trichlorobenzene	<2	<2	<2	<2	<2	<2	<2	<2
2,4,6-Trichlorophenol	<3	<3	<3	<3	<3	<3	<3	<3

Note: D-11 did not yield sufficient water for sample collection due to basin underdrain system in operation.
Two field blanks collected as sampling was performed on 8/3 and 8/4.

Table 31. Volatile Organic Compounds Exceeding NJDEP Groundwater Quality Standard for Class II-A Aquifers — June 1994, March 1995 and May 1995

Well or Sump Number		PCE (µg/L)			TCE (µg/L)			Ben-zene (µg/L)	
Date Sampled	***6/94***	***3/95***	***5/95***	***6/94***	***3/95***	***5/95***	***6/94***	***3/95***	***5/95***
Standard	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
D-11	**1.9**	**4.62**	**1.35**	<1	<1	<1	<1	<1	<1
D-12	**11**	**9.87**	**10.6**	**1.7**	**5.16**	**5.43**	<1	<1	<1
TFTR-S1	**3**	**5.37**	**4.16**	<1	<1	<1	<1	<1	<1
MG-S2	**30**	**39.3**	**58.7**	**2.1**	**4.96**	<10	<1	<1	<1
LOB-S3	**2.3**	**2.14**	**2.01**	<1	<1	<1	<1	<1	<1
MG-S4	**2.3**	**9.5**	**4.44**	**2.1**	**1.08**	**4.89**	<1	<1	<1
MG-S5	<1	<1	<1	<1	<1	<1	<1	<1	<1
MG-S6	**11**	**20.9**	**8.66**	<1	**1.8**	<1	<1	<1	<1
MW-1	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW-2	<1	<1	<1	<1	<1	<1	<1	<1	<1
MW-3	**25**	**14.7**	**15.4**	<1	<1	<1	<1	<1	<1
MW-5I	**3.6**	**5.53**	<1	**5.2**	**8.1**	**5.8**	<1	<1	<1
MW-6S	**2.8**	NC	**13.1**	<1	**8.15**	**25.1**	<1	<1	<1
MW-7I	**7.4**	**6.87**	**2.79**	**3**	**4.13**	**2.21**	0.8 T	**1.03**	<1
MW-7S	**12**	**13.8**	**17.2**	**2**	**3.48**	**4.5**	<1	<1	<1
MW-8S	**14**	**9.23**	**7.48**	**1.6**	**1.62**	**1.38**	<1	<1	<1
MW-9	**78**	**89.9**	**79.8**	**1.7**	<5	<10	<1	<1	<1
MW-13	**120**	**126**	**111**	**1.8**	<10	<10	<1	<1	<1
TW-1	**1.7**	<1	**1.57**	<1	<1	<1	<1	<1	<1
TW-2	**2.2**	<1	<1	<1	<1	<1	<1	<1	<1
TW-3	**14**	<1	**5.15**	<1	<1	<1	<1	<1	<1
TW-4	<1	<1	<1	<1	**1.07**	**1.12**	<1	<1	<1
TW-6	<1	<1	<1	<1	<1	<1	<1	<1	<1
TW-7	**30**	**3.75**	**21.7**	**1.3**	<1	<2.5	<1	<1	<1
TW-10	<1	**1.34**	<1	<1	<1	<1	<1	<1	<1

PCE = Perchloroethene, tetrachloroethene, or tetrachloroethylene
TCE = 1,1,1-Trichloethene or 1,1,1-Trichloroethylene
NC = Not collected
T = Value reported is less than criteria detection

Table 32. Sanitary Sewer Sampling and Analytical Results for 1995

PARAMETER	January 1995 Manhole #11	February 1995 Manhole #11	February 1995 Manhole #11	March 1995 LEC #3
BOD, 5 day total, mg/L		123		12
COD, mg/L		260		46
Color, pt/co unit		100		30
Nitrogen, Ammonia, mg/L		11		<0.5
pH	8.18	7.26 - min. 7.40 - max.	7.86	7.19
Oil & Grease, mg/L		7		<5
Phosphorus, Total, mg/L		5.2		0.69
Phenolics as phenols, mg/L		<0.05		<0.05
Temperature, ^{o}C	12	14	9	13.4
Sulfide, mg/L[1]	<1	1.8	0.47	
Sulfide, mg/L[2]		0.19		0.093
Total Cyanide, mg/L		<0.01		<0.01
TSS, mg/L		80		4
Specific Conductivity, umhos/cm	412		601	
Silver, mg/L		<0.05		<0.05
Arsenic, mg/L		<0.005		<0.0025
Barium, mg/L		0.056		<0.05
Cadmium, mg/L		<0.02		<0.02
Chromium, mg/L		<0.05		<0.05
Copper, mg/L		0.088		0.063
Iron, mg/L		0.45		0.94
Mercury, mg/L		<0.001		<0.001
Nickel, mg/L		<0.05		<0.05
Lead, mg/L		<0.1		<0.1
Selenium, mg/L		<0.005		<0.005
Zinc, mg/L		0.16		0.088

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

Table 33. Quality Assurance Data for Radiological Samples for 1995

QA Sample & Date	PPPL Result	True Value	Control Range
USEPA 3/95	7510.33 avg.	7435.0	6144.2 to 8725.8
Inter-DOE 3/95 test: Environmental Measurements Laboratory	55.10, 56.40	60.30	Acceptable

Results in picoCuries/Liter

12.0 FIGURES

13.0 REPORT DISTRIBUTION LIST

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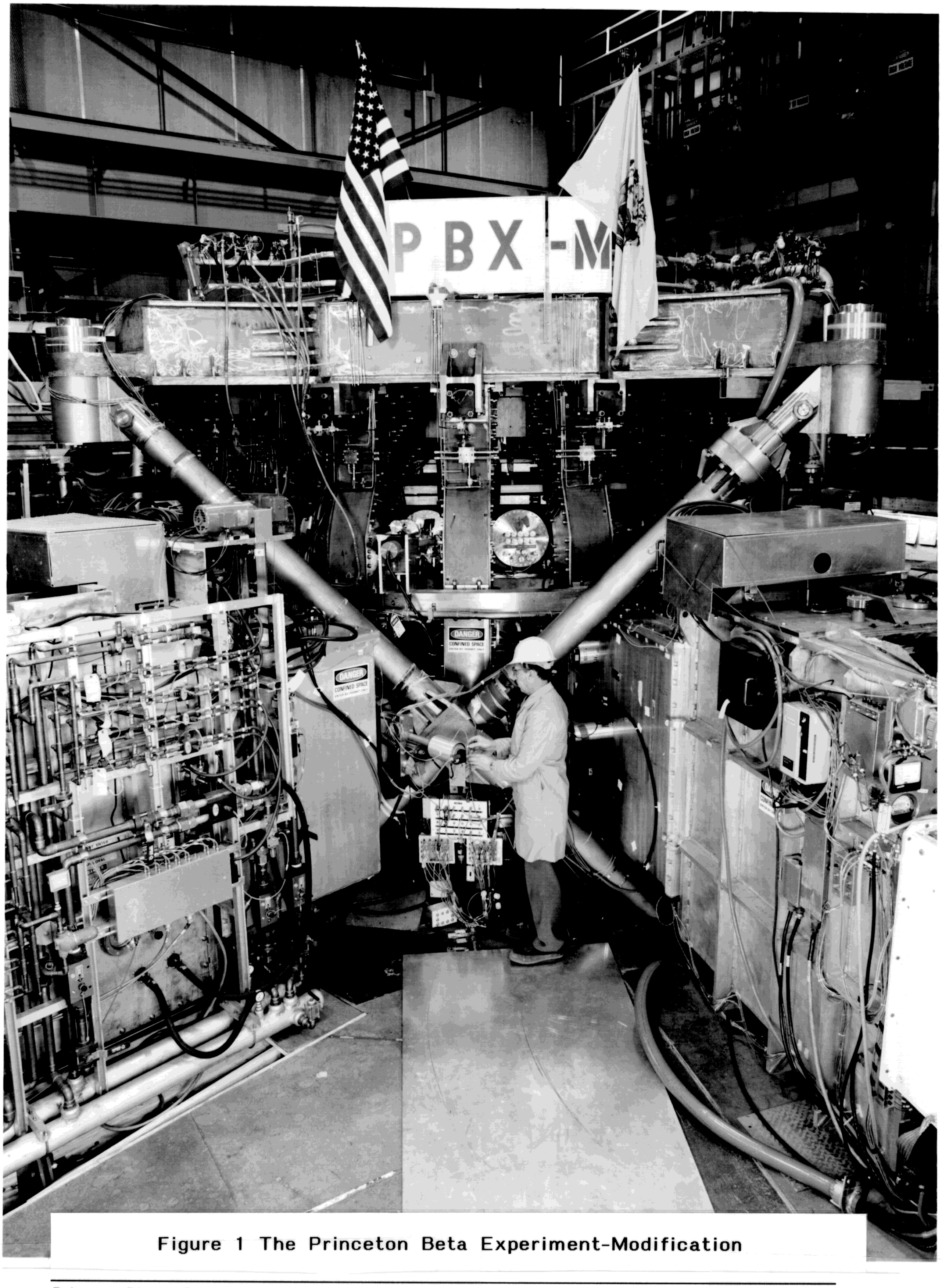


Figure 1 The Princeton Beta Experiment-Modification

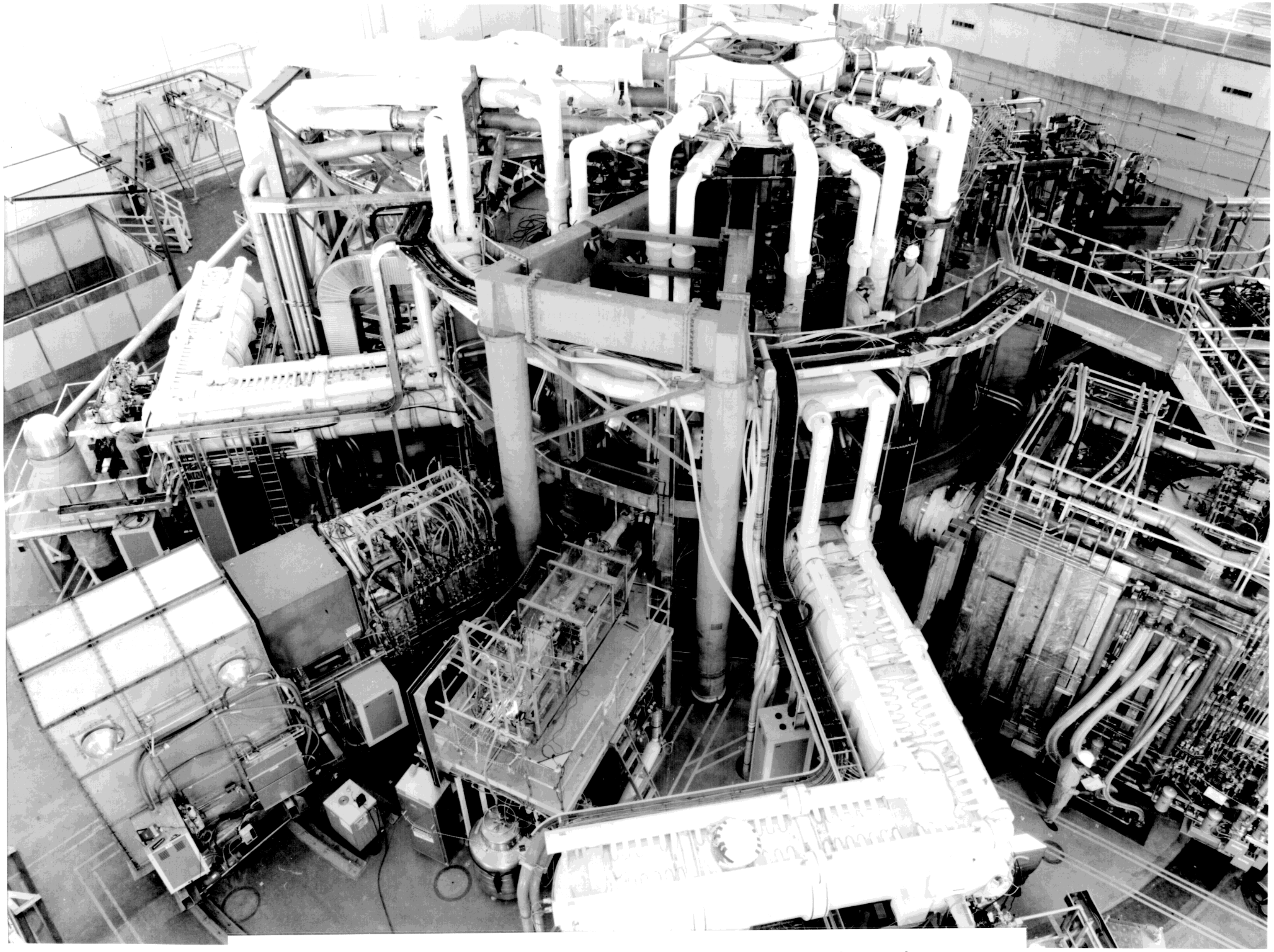


Figure 2 The Tokamak Fusion Test Reactor (TFTR)

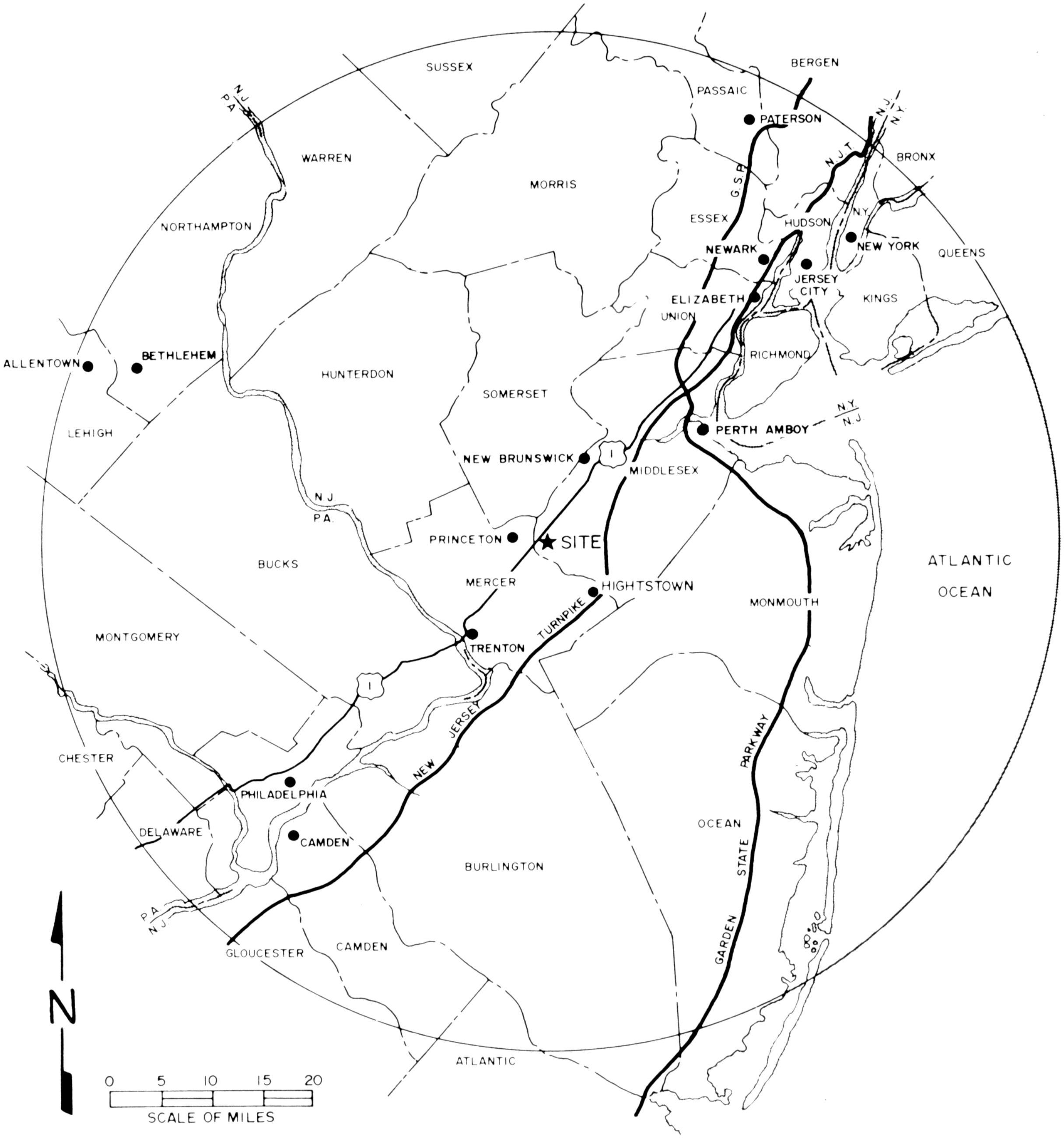


Figure 3

Region Surrounding the TFTR Site
(50 Mile Radius Shown)

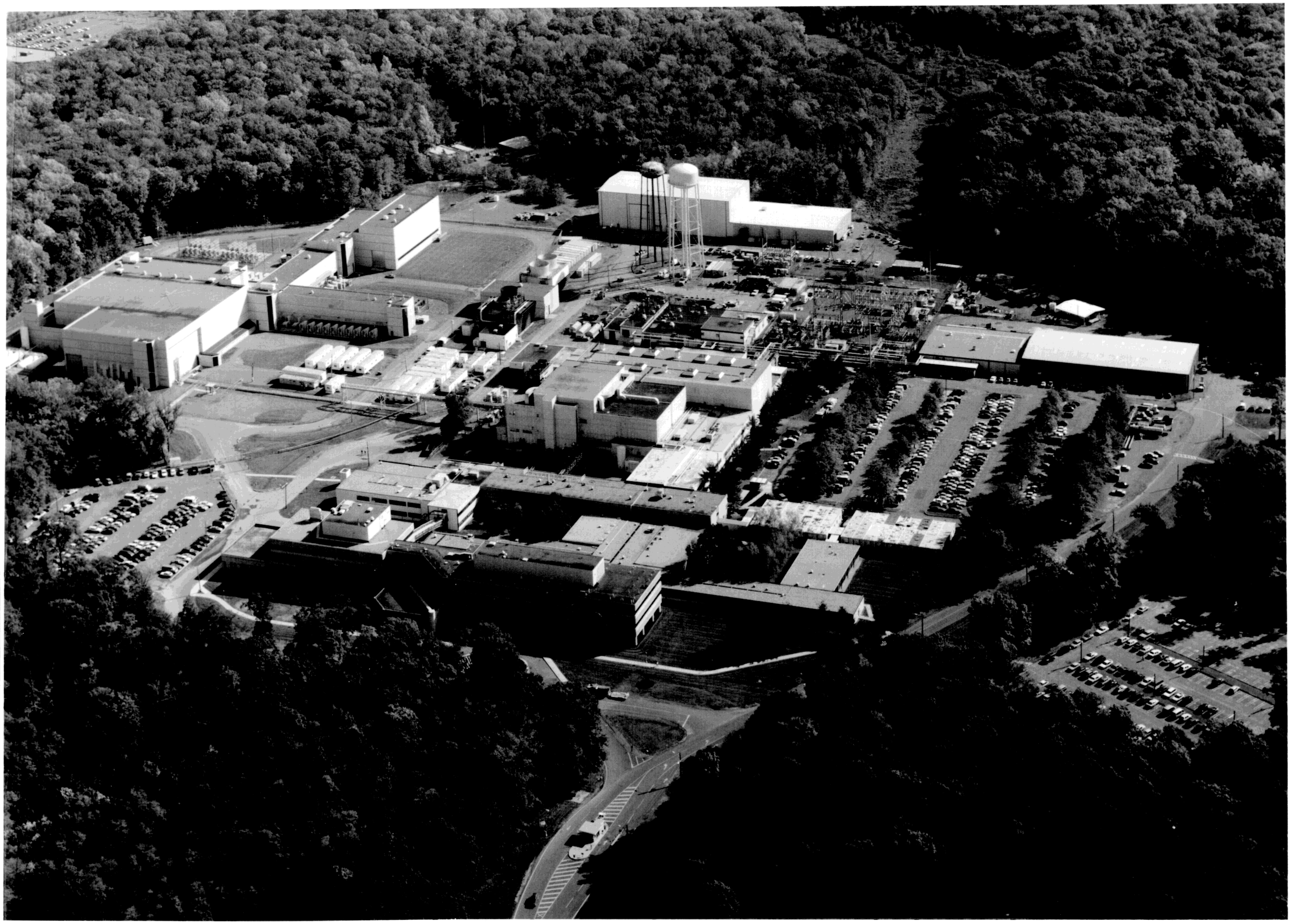
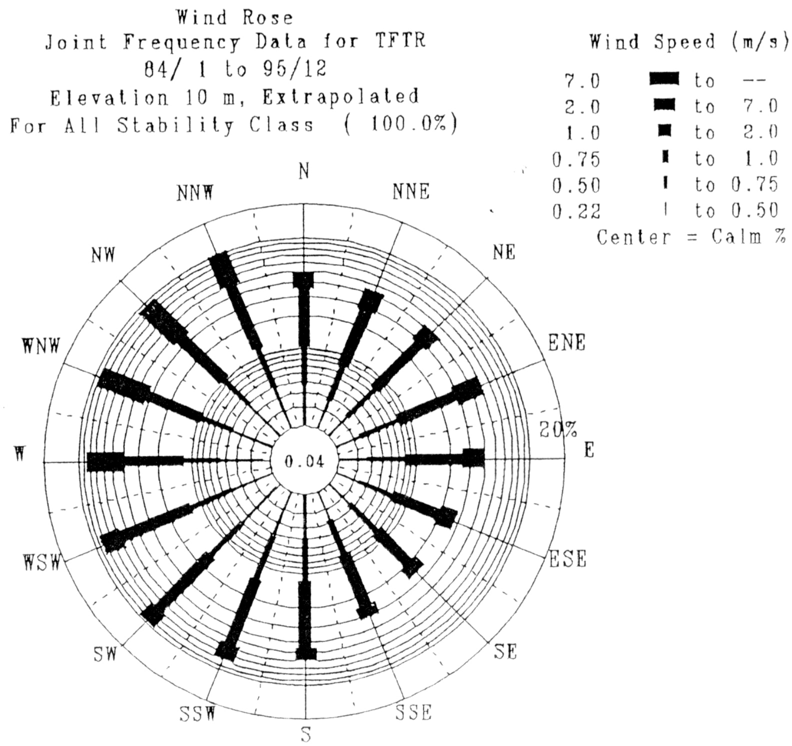


Figure 4 PPPL C and D Sites of James Forrestal Campus

Figure 5



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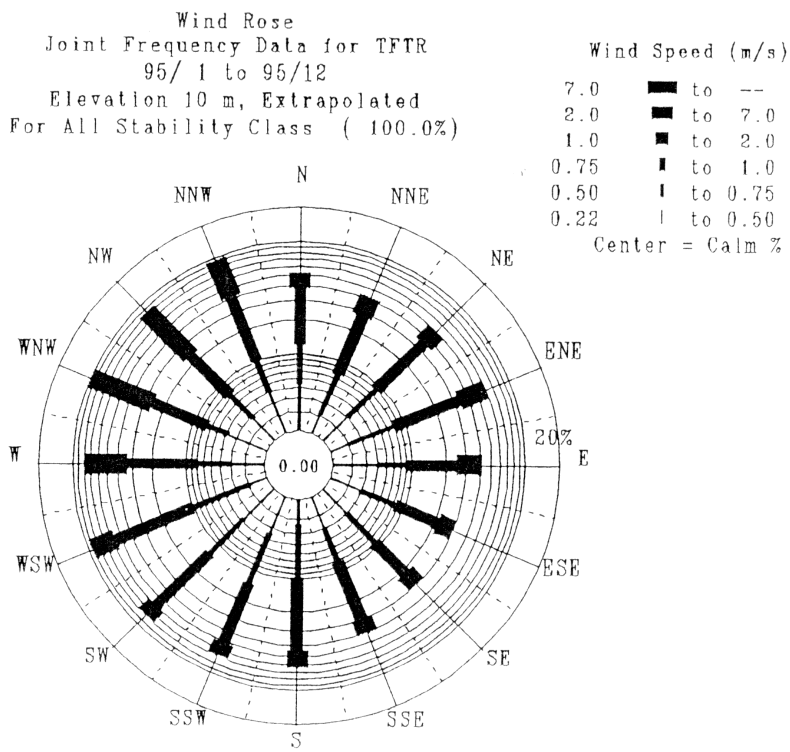

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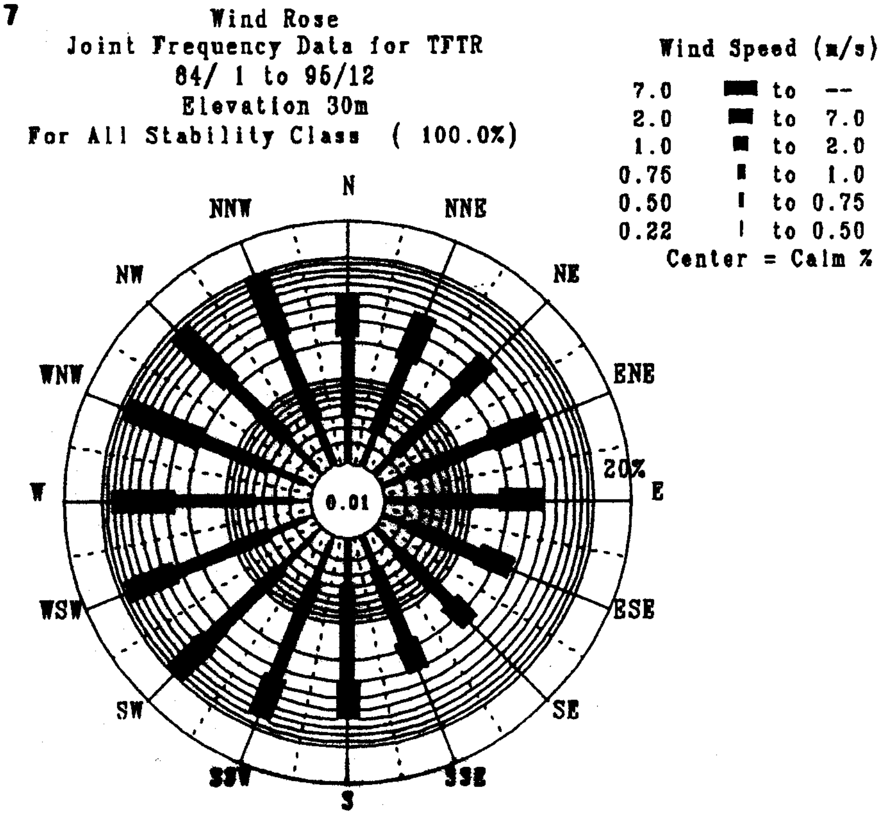

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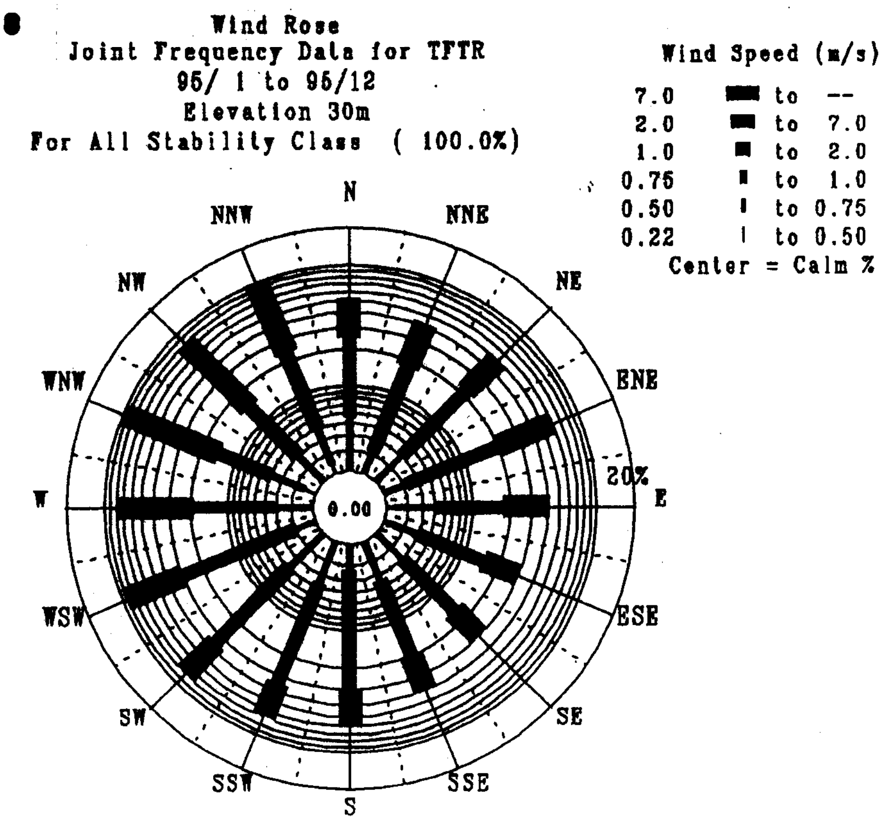

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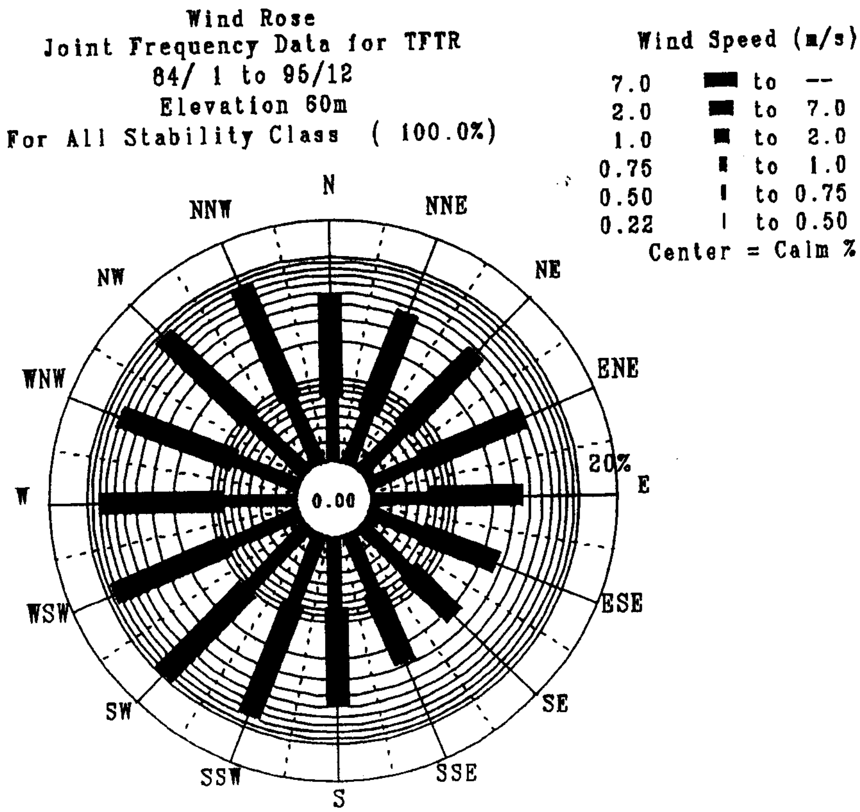

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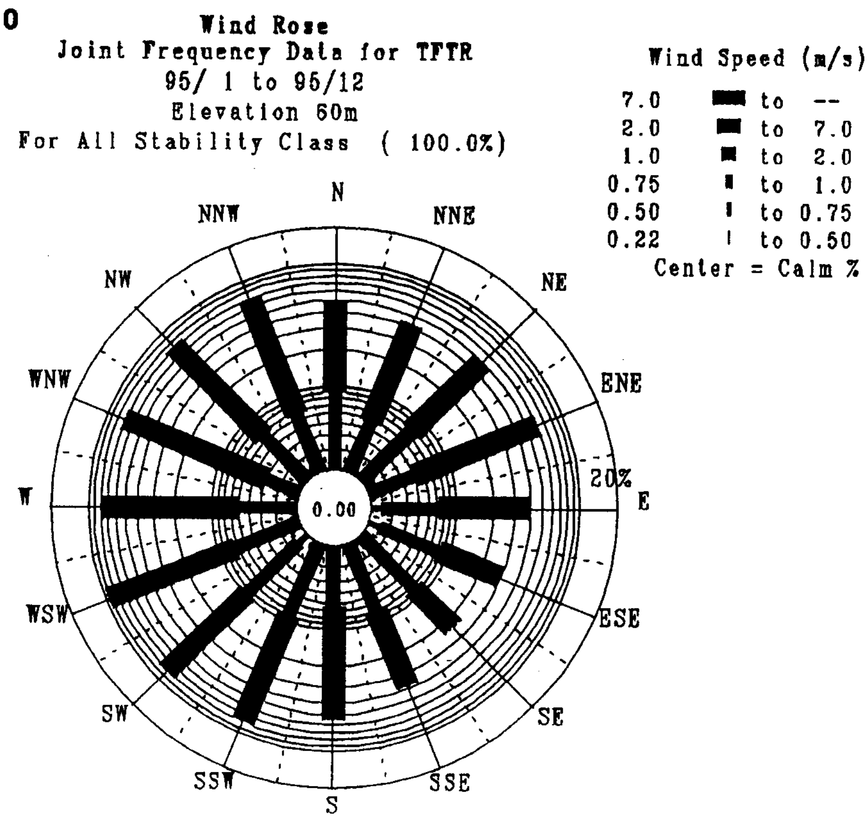


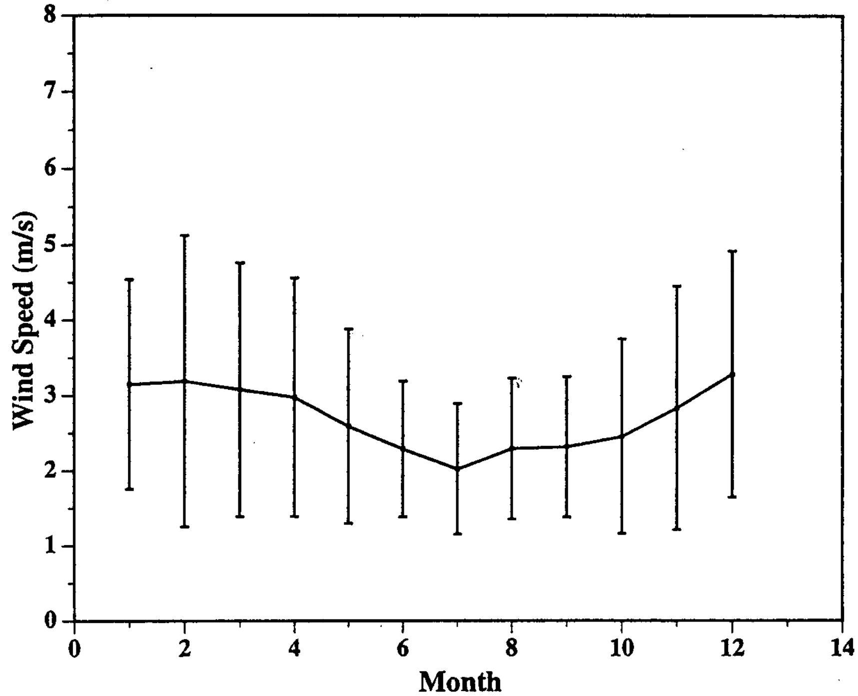


Figure 11 Monthly average wind speed at 30 m for 1995

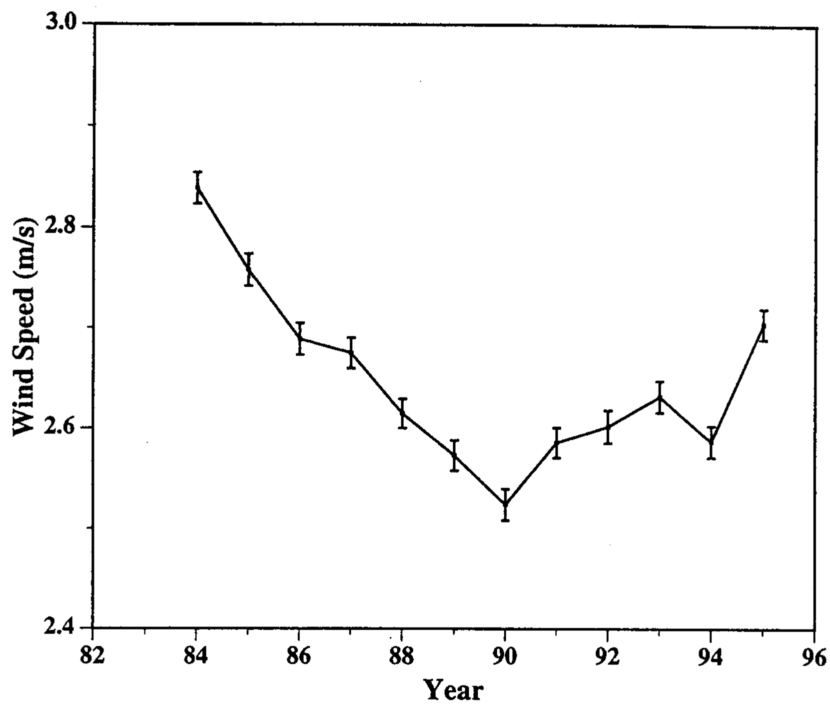


Figure 12 Annual average wind speed at 30 m elevation from 1984 to 1995.

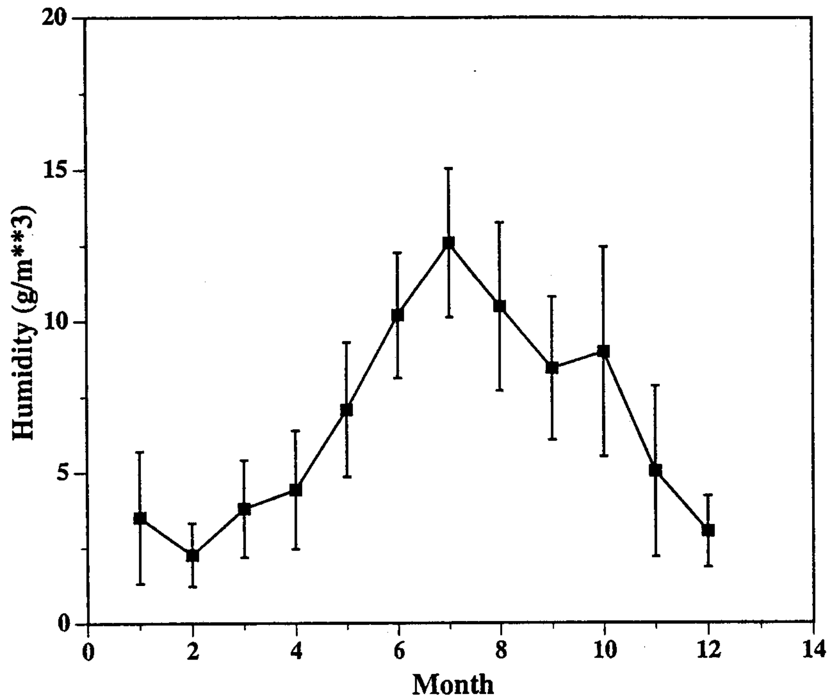


Figure 13 Monthly average absolute humidity for 1995

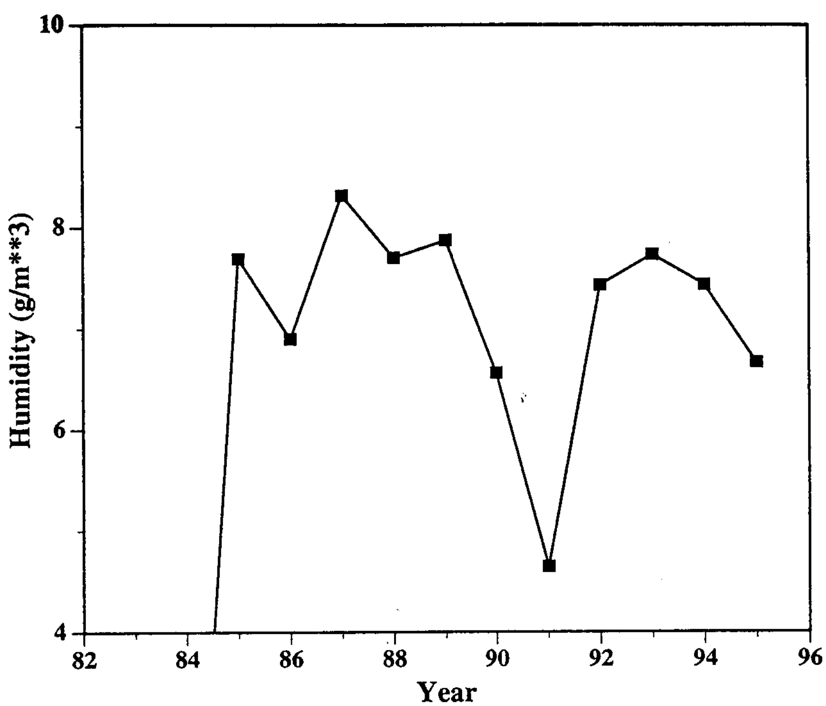


Figure 14 Annual average absolute humidity from 1984 to 1995.

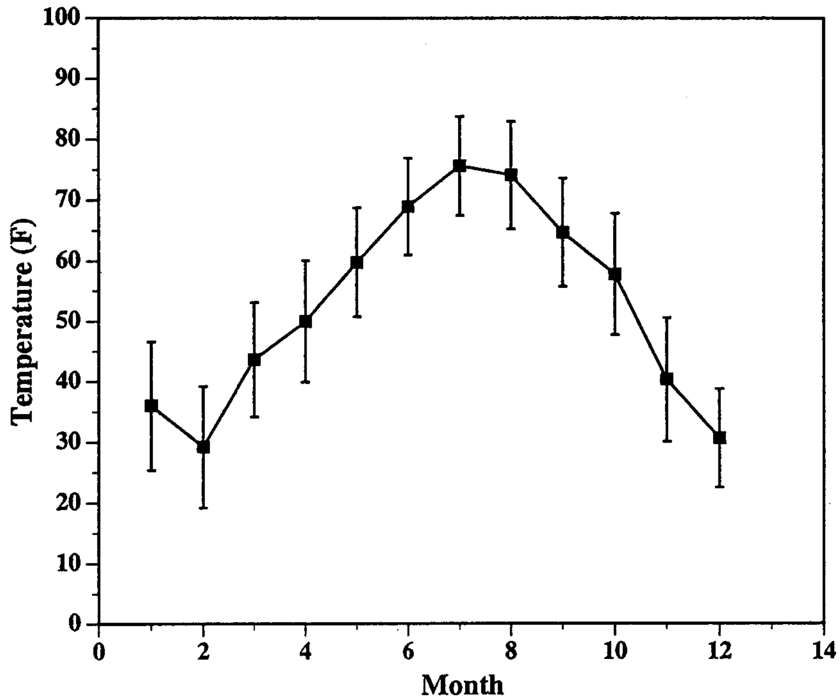


Figure 15 **Monthly average temperature at 10 m for 1995**

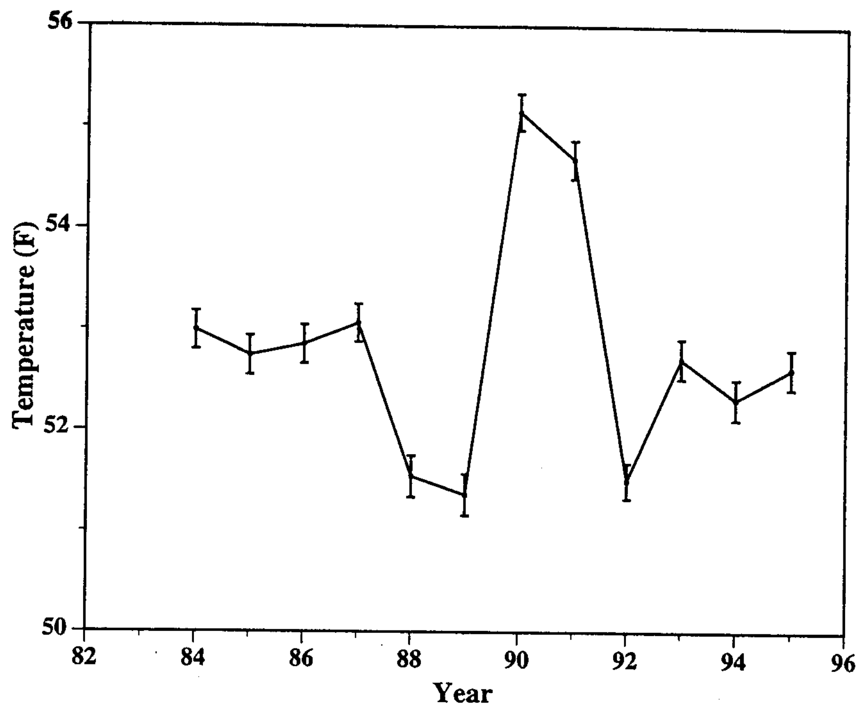


Figure 16 **Annual average temperature at 10 m elevation from 1984 to 1995.**

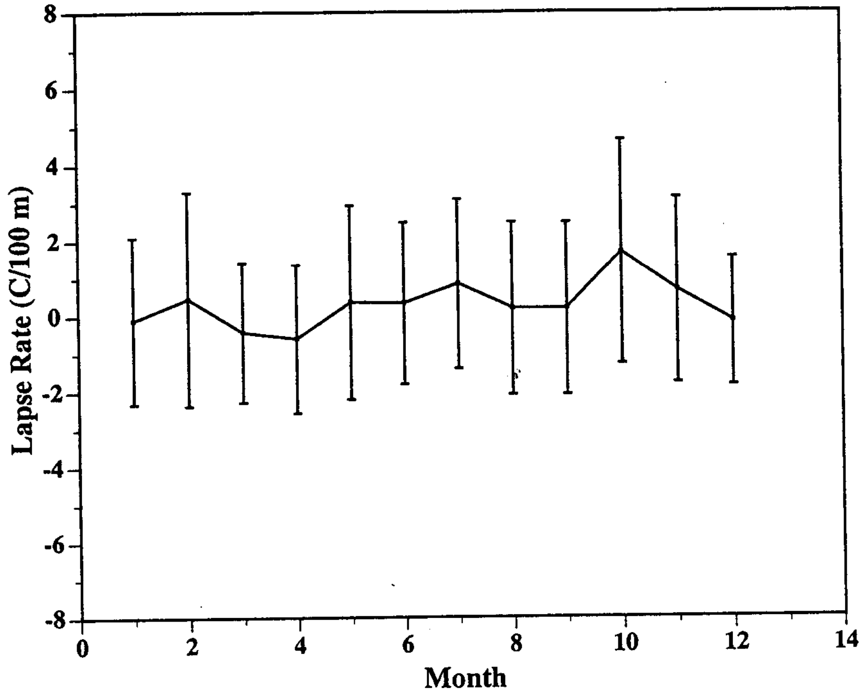
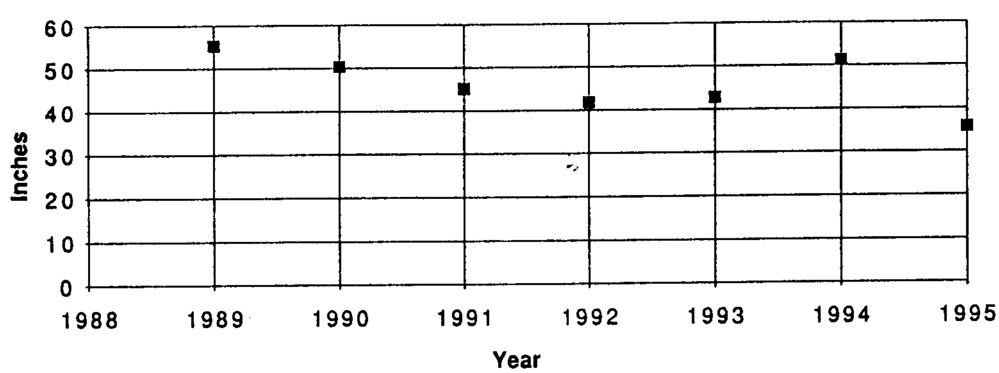


Figure 17 Monthly average vertical lapse rate for 1995

Figure 18. Annual Total Precipitation from 1989 to 1995



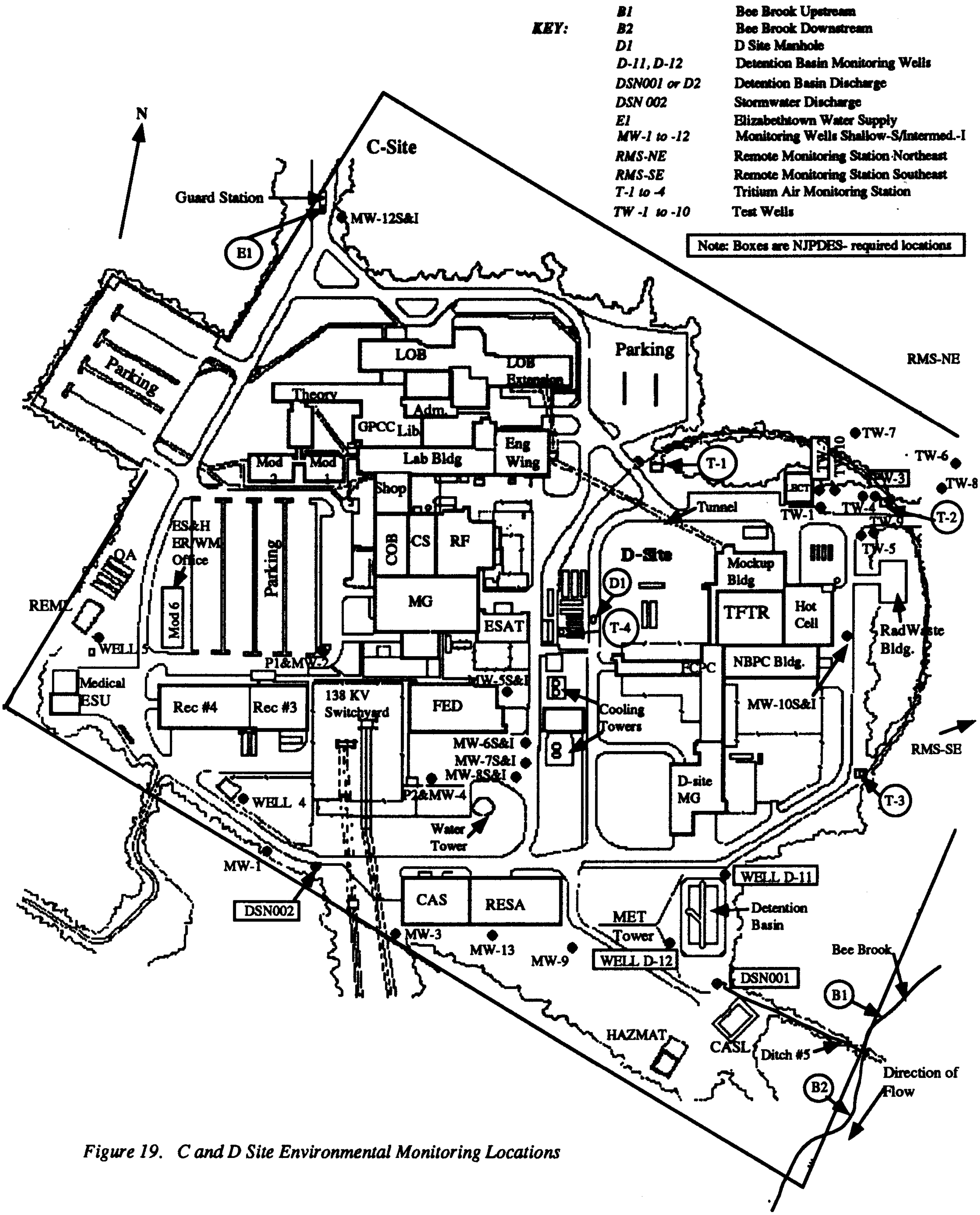
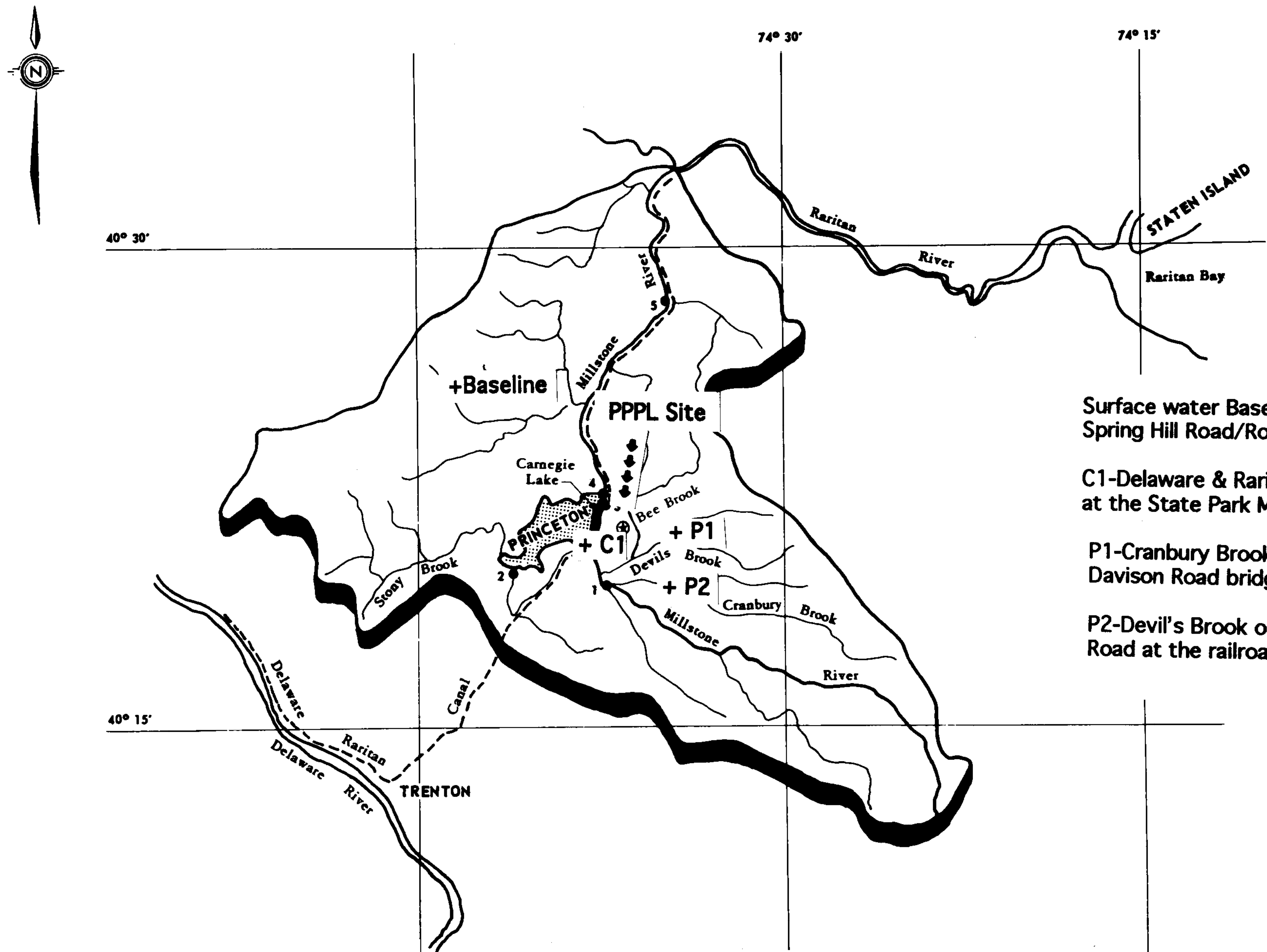


Figure 19. C and D Site Environmental Monitoring Locations

Key: Off-site Monitoring Locations
* DSN003 D&R Canal Pump House
+ M1 Millstone River
◊ Wells MW-14, 15, & 16
Δ REAM 1-6 Tritium Air & Soil Monitoring Stations
PPPL SITE
Δ REAM 1
Δ REAM 2
Δ REAM 3
Δ REAM 4
Δ REAM 5
Δ REAM 6
◊ MW-14
◊ MW-15
◊ MW-16
* DSN003
+ M1
N
Approximate Scale in
0 1000 2000



Surface water Baseline - Spring Hill Road/Rock Brook

C1-Delaware & Raritan Canal at the State Park Mapleton Rd.

P1-Cranbury Brook at Davison Road bridge

P2-Devil's Brook off Schalks Road at the railroad bridge

Figure 21 Millstone River Basin Monitoring Locations

Figure 22 **DATS Environmental Tritium Monitors (HT)**
Trailer Locations T1 - T4 Annual Summary - 1995

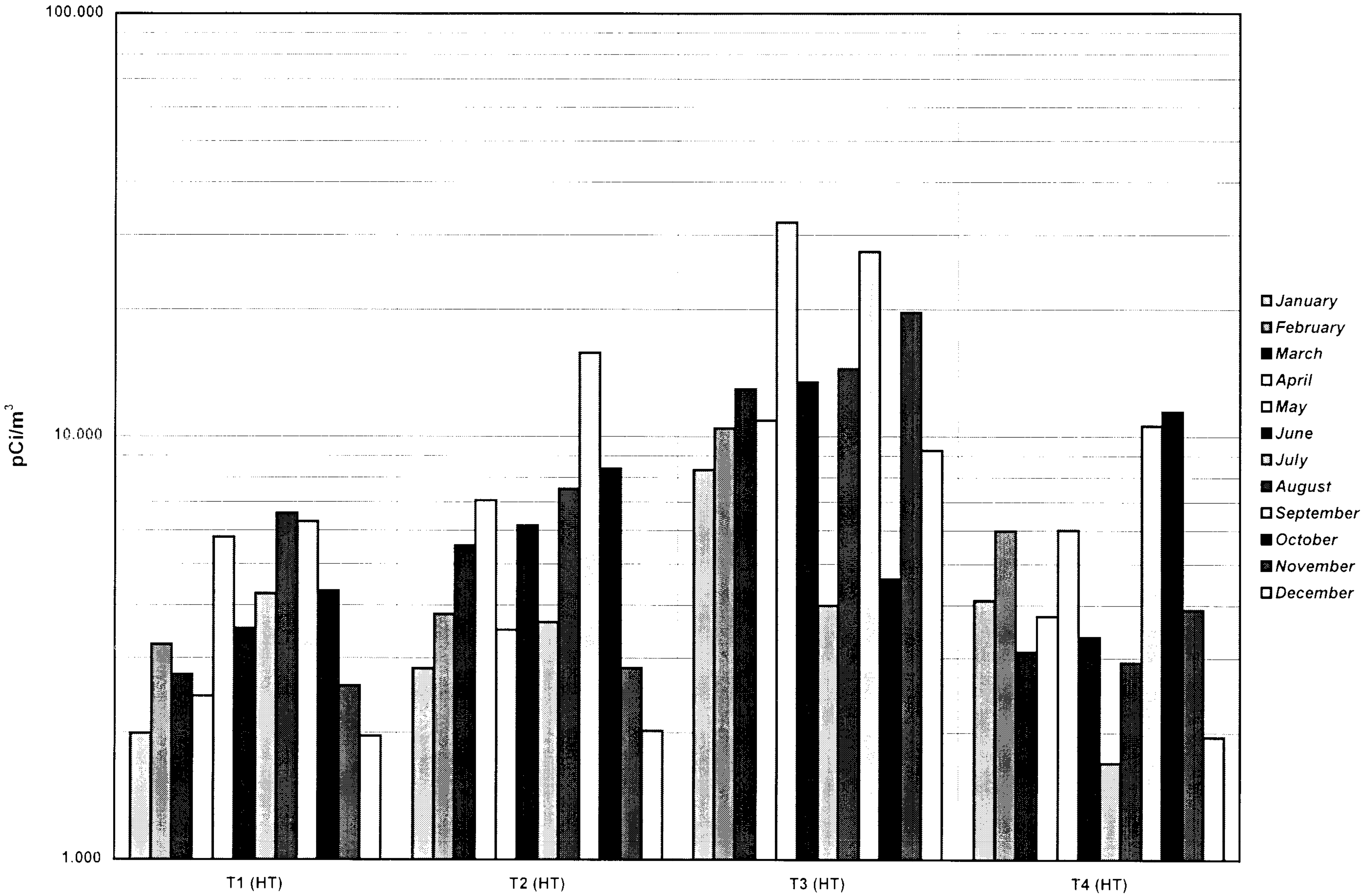


Figure 23 **DATS Environmental Tritium Monitors (HT)**
Trailer Locations R1-R6 Annual Summary - 1995

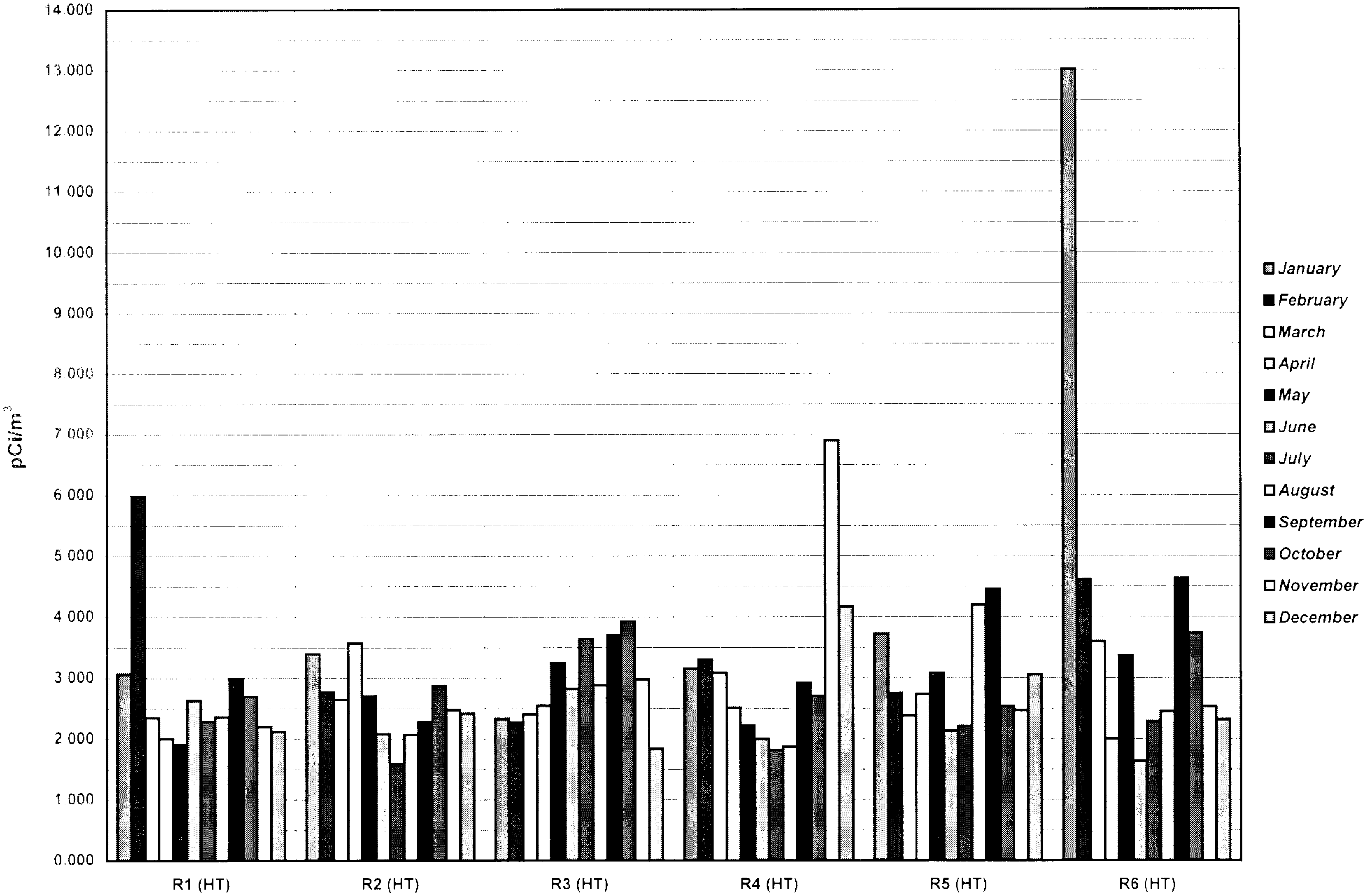


Figure 24 DATS Environmental Tritium Monitors (HTO)
Trailer Locations T1 - T4 Annual Summary - 1995

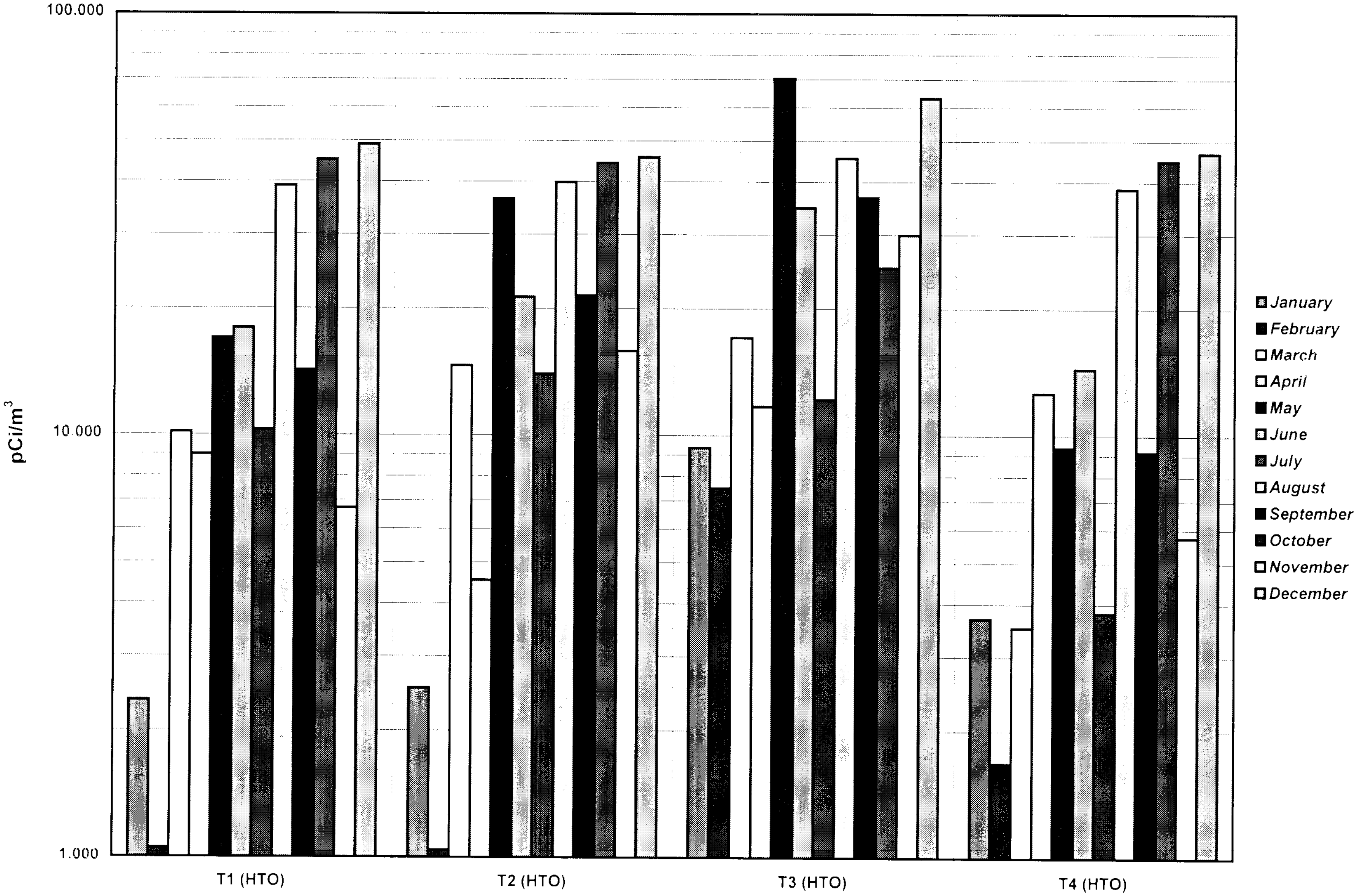


Figure 25 **DATS Environmental Tritium Monitors (HTO)**
Trailer Locations R1-R6 Annual Summary - 1995

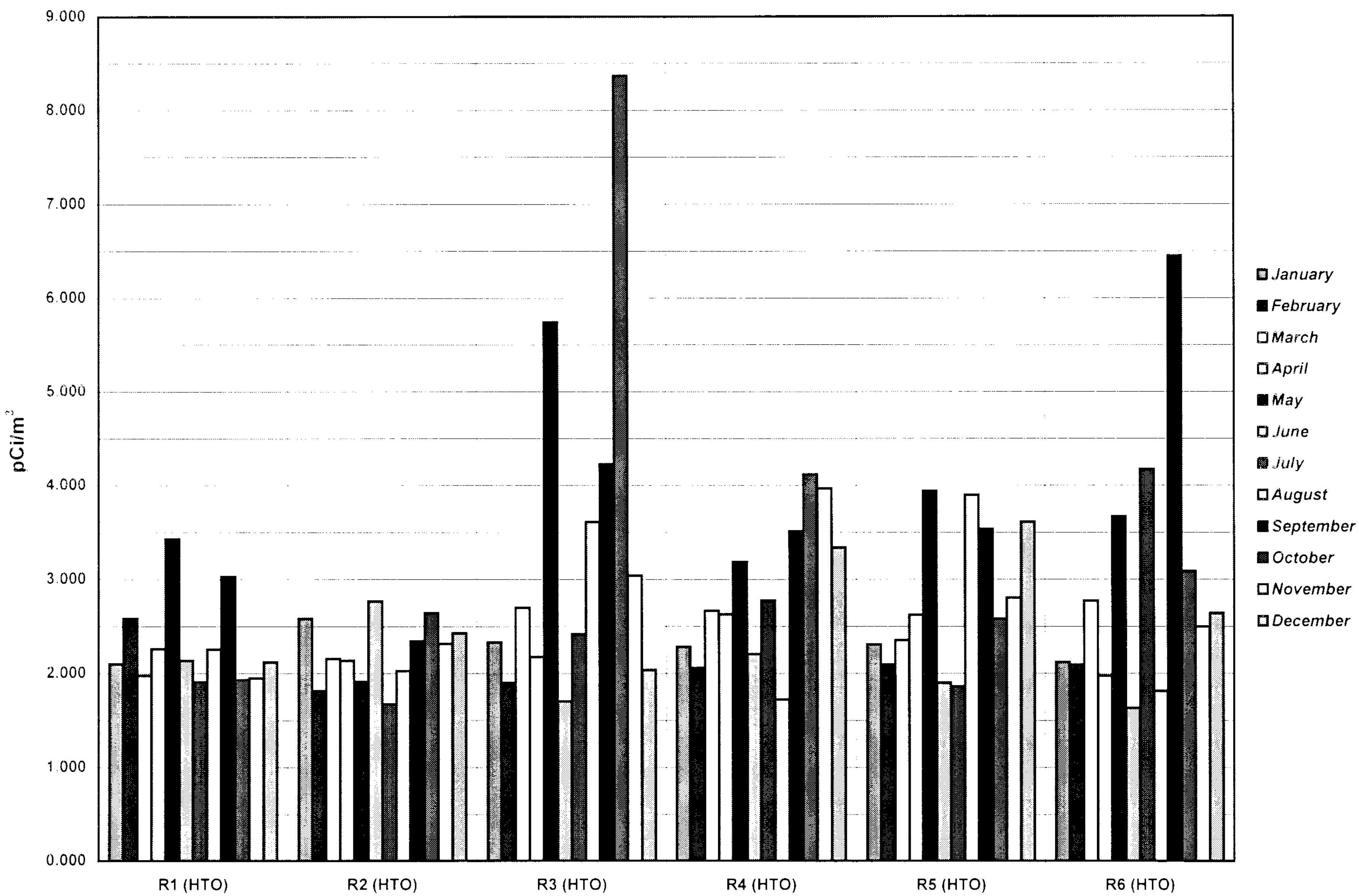


Figure 26. 1995 Tritium (HTO) in Rain Water

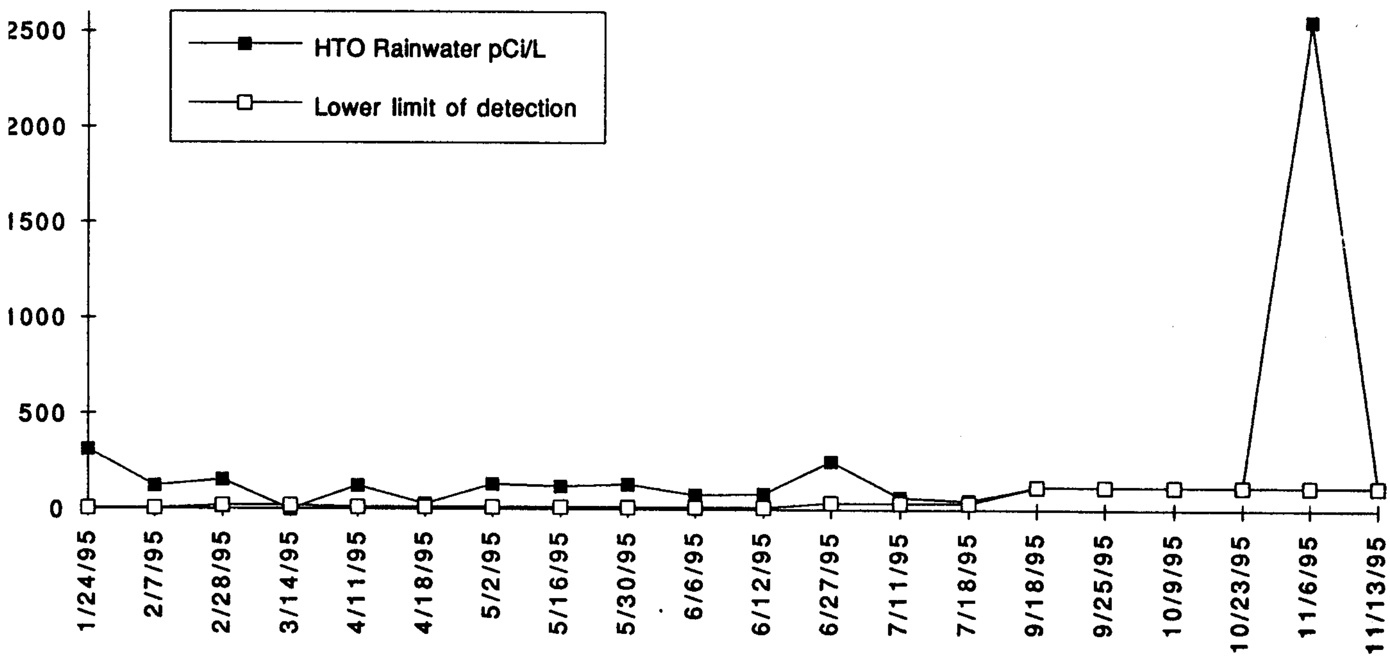


Figure 27. 1995 Tritium (HTO) Concentrations in Ground Water

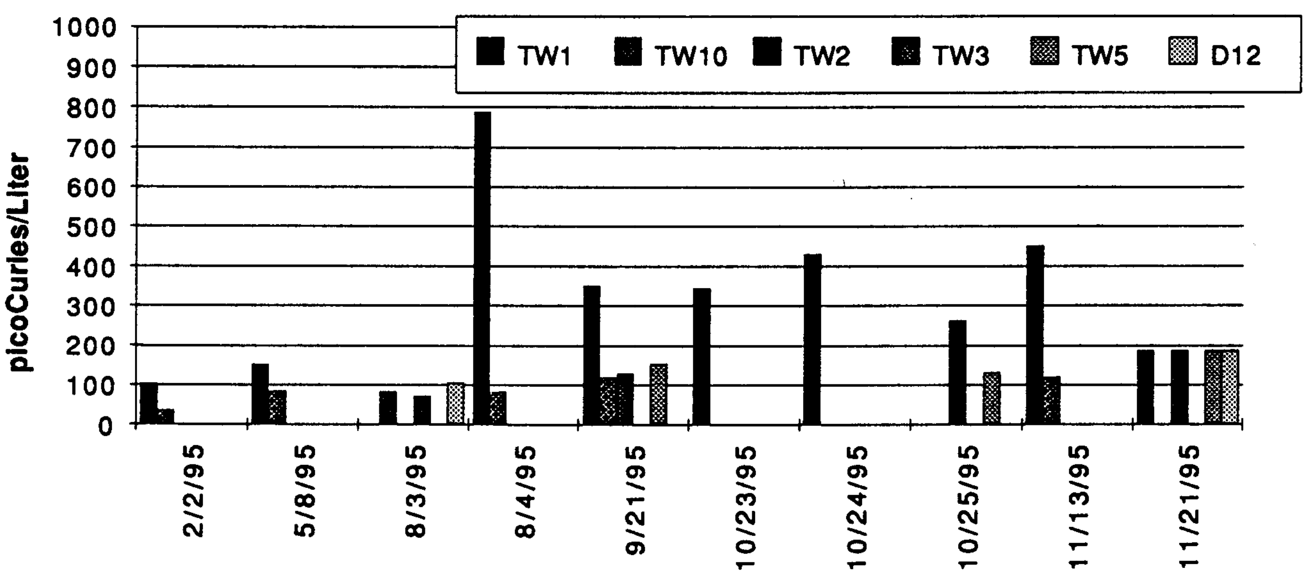


Figure 28. 1995 Tritium (HTO) Results for PPPL Discharge

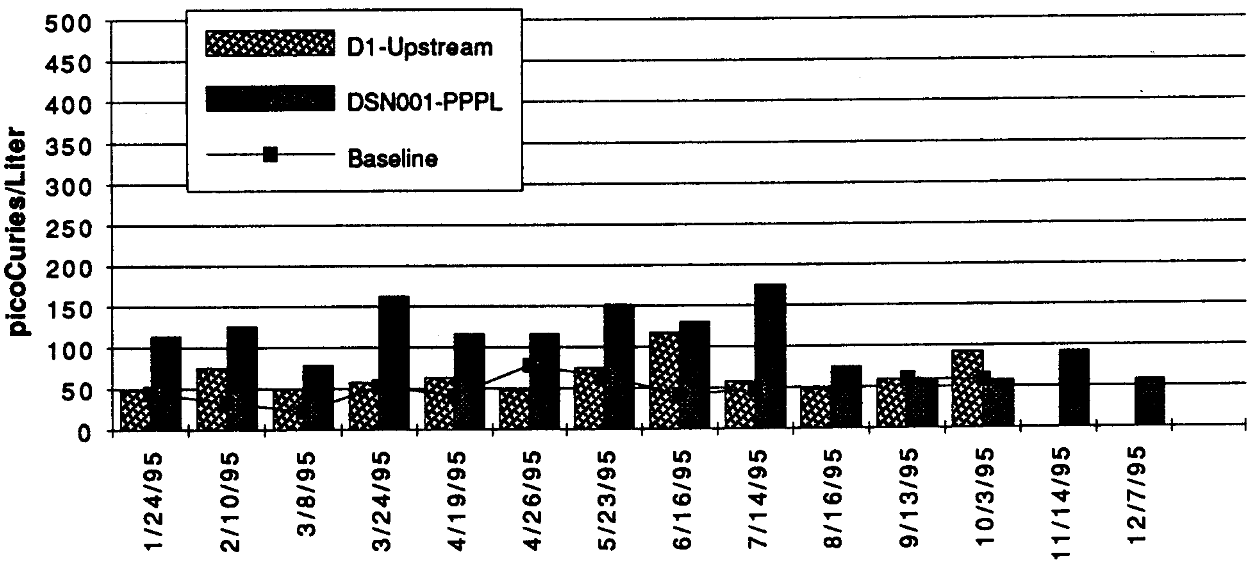


Figure 29. 1995 Tritium (HTO) Concentrations in Bee Brook

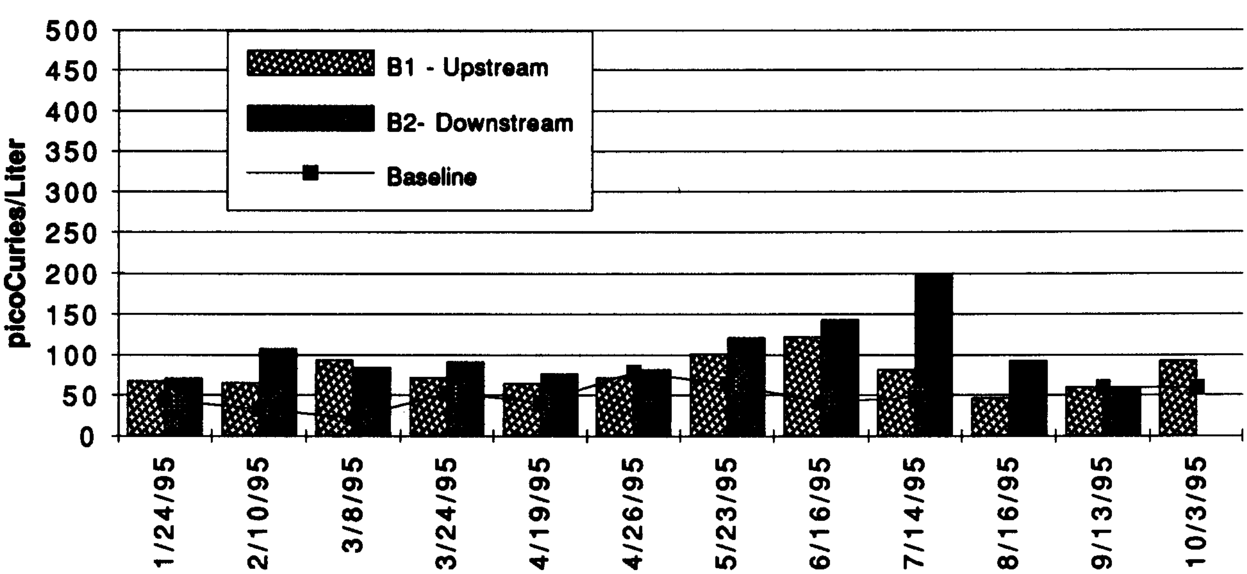


Figure 30. 1995 Tritium (HTO) Concentrations for Non-Contact Process (C1) and Potable (E1) Water

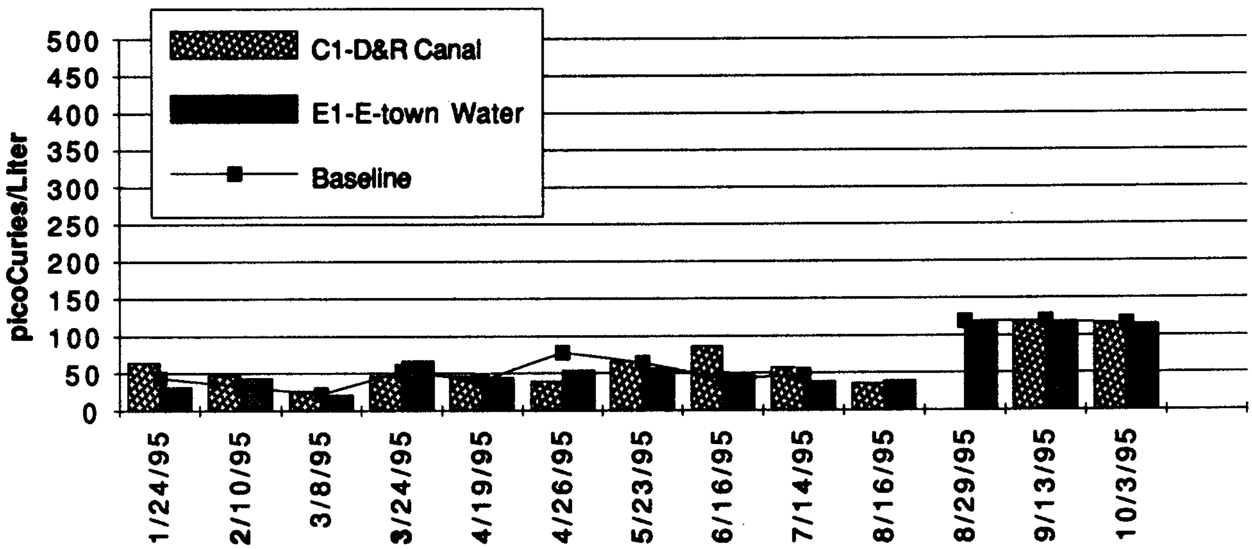


Figure 31. 1995 Tritium (HTO) Concentrations in Millstone River Tributaries

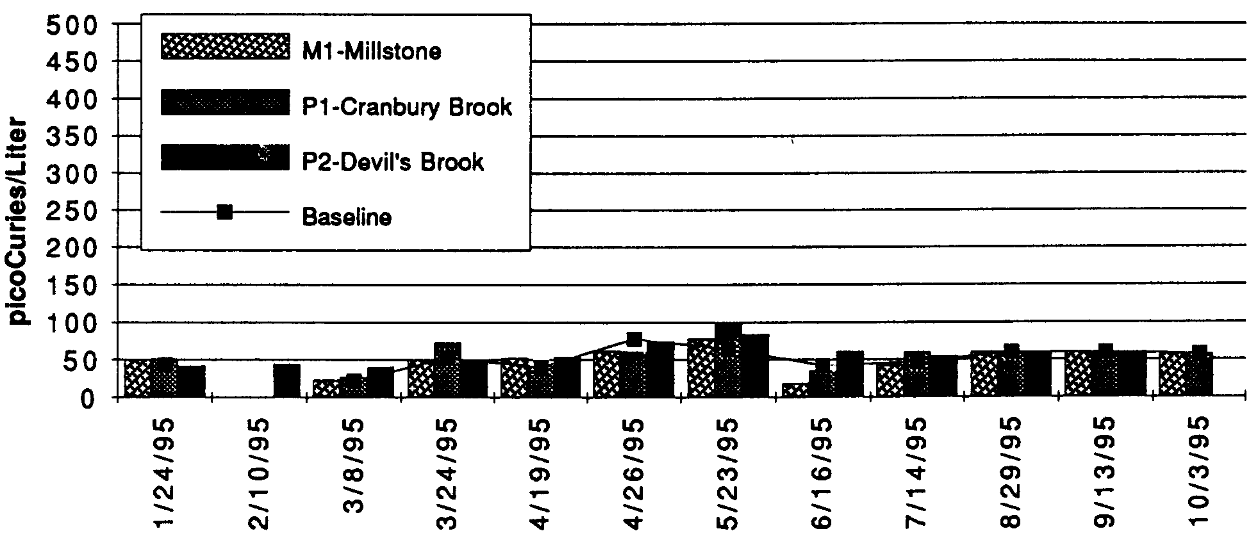
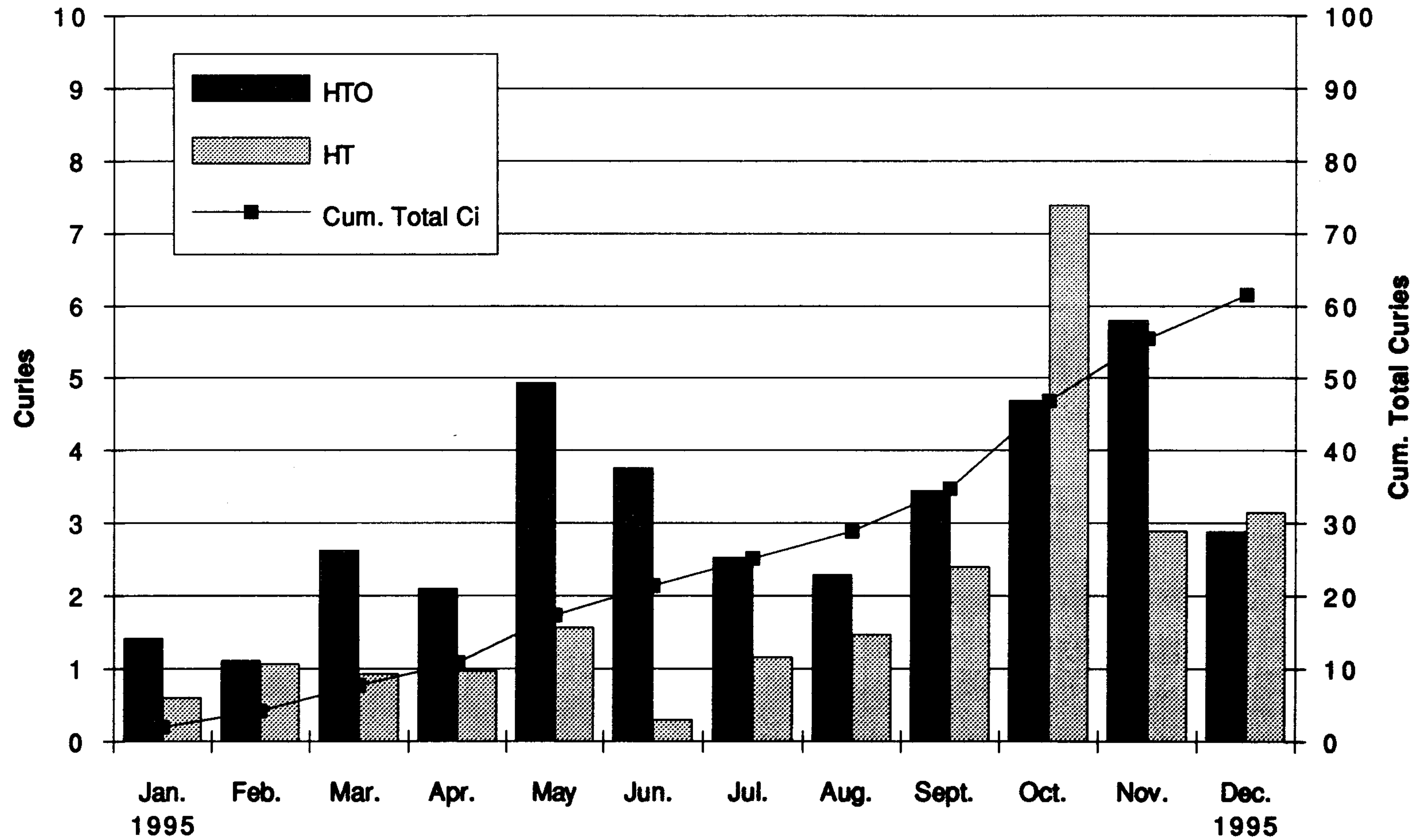


Figure 32. TFTR Total Stack Tritium (HT/HTO) Released in Air for 1995 Activities



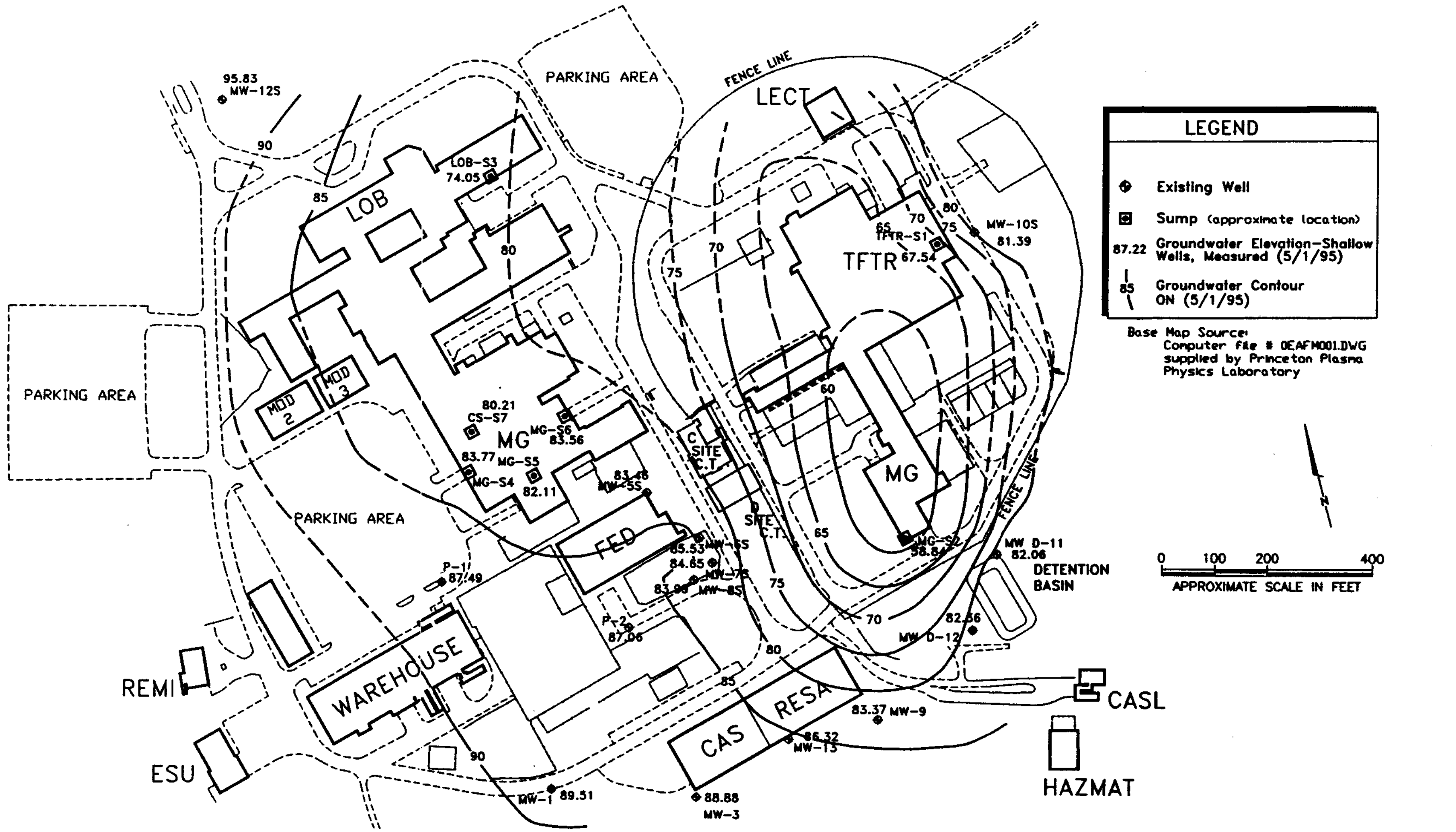


Figure 33

SHALLOW GROUNDWATER ELEVATIONS CONTOUR MAP – May 1, 1995
PRINCETON PLASMA PHYSICS LABORATORY
Plainsboro, New Jersey

APPROVED	DRAWING NUMBER	DATE
	ppp-site	8/2/95

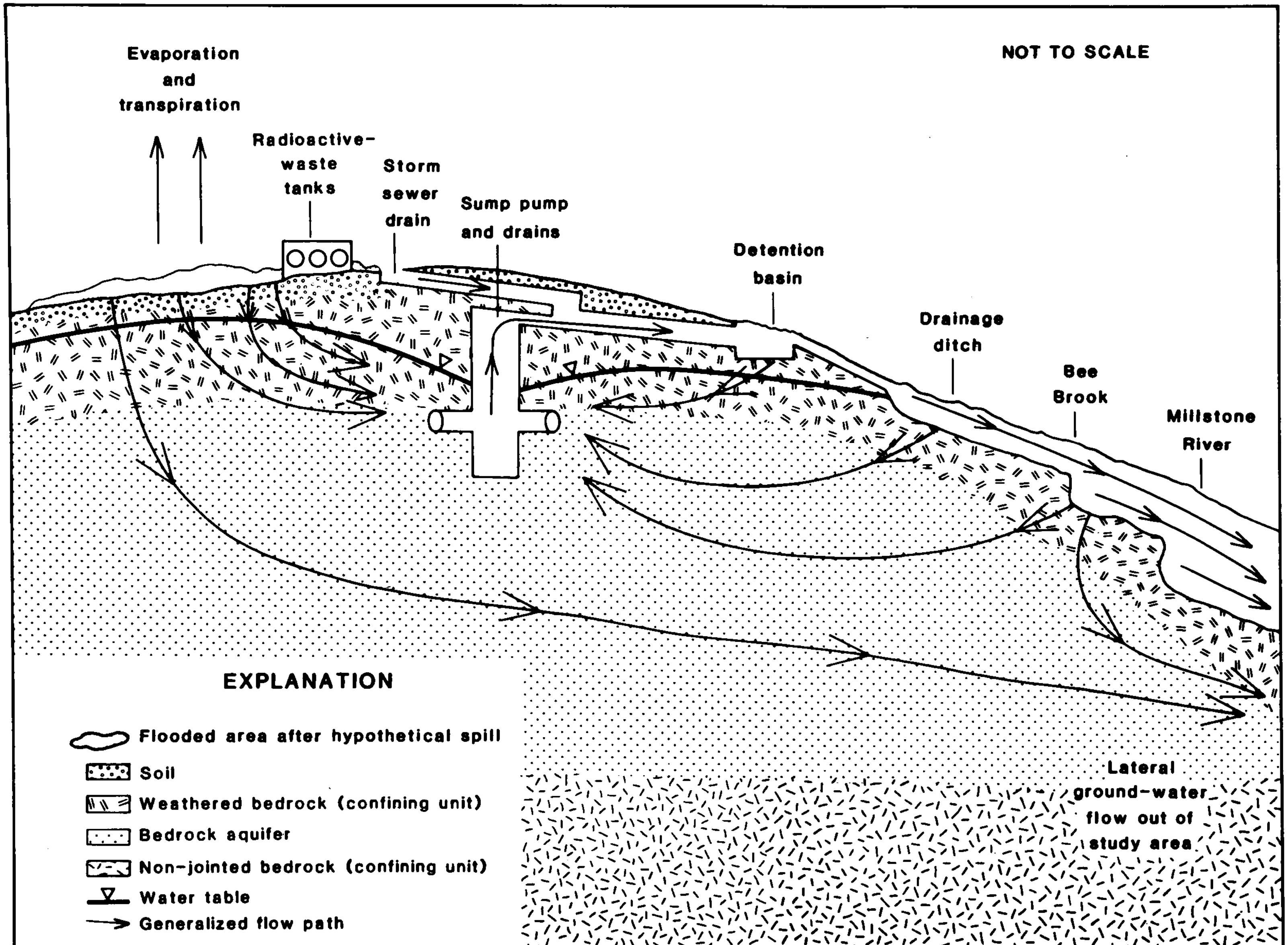
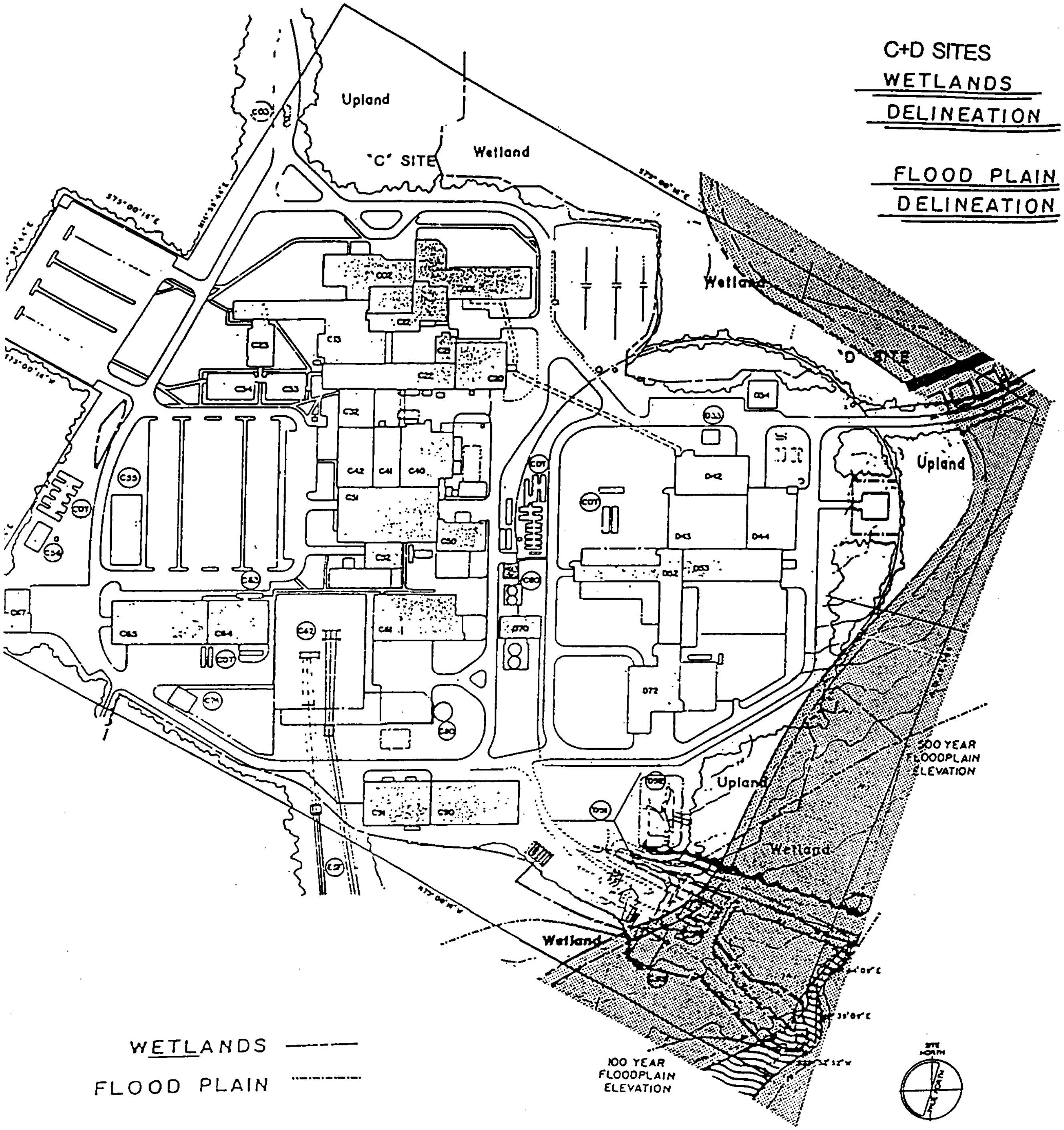


Figure 34 Schematic representation of hydrogeologic framework and potential flow paths of spilled water.

See reference Le87



SHADE INDICATES STREAM PROTECTION CORRIDOR PER PRINCETON FORRESTAL CENTER STORMWATER MANAGEMENT PLAN, 1980

0 100 300 600 FT

SITE PLAN
PRINCETON UNIVERSITY
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Figure 35 PPPL Flood Plain and Wetland Boundary

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