JL

Department of Energy
Brookhaven Group
Building 464
P.O. Box 5000
Upton, New York 11973

MAY 13 1997

Mr. James Lister, P.E.
New York State Department of
Environmental Conservation
Division of Hazardous Waste Remediation
50 Wolf Road, Suite 210
Albany, New York 12233-7010

Ms. Mary Logan
Federal Facilities Section
Emergency and Remedial Response Division
U.S. EPA - Region II
290 Broadway - 18th Floor
New York, New York 10007-1866

Dear Mr. Lister and Ms. Logan:

SUBJECT: BROOKHAVEN NATIONAL LABORATORY (BNL): TRITIUM GROUNDWATER REMOVAL ACTION

Attached is the final Action Memorandum for the above referenced project. This document will be entered into the BNL Administrative Record and public notices of availability will be published in Newsday and Suffolk Life later this week.

If you should have any questions, please call Angela Harvey or Gail Penny of my staff at (516)344-5345 and (516) 344-3429, respectively.

Sincerely,

Carson L. Nealy
Brookhaven Group Manager

Enclosure:
As stated

cc: R. Cowen, NYSDEC, w/encl.
T. Vickerson, NYSDOH, w/encl.
J. Pim, SCDHS, w/encl.
J. Pavacic, Town of Brookhaven, w/encl.
D. Lynch, Town of Brookhaven, w/encl.
M. Stahr, EM-441, GTN, w/encl.
A. Harvey, BHG, w/encl.
G. Penny, BHG, w/o encl.
M. S. Davis, BNL, w/encl.
W. Gunther, BNL, w/encl.
M. Hauptmann, BNL, w/encl.

FINAL
ACTION MEMORANDUM
OPERABLE UNIT III TRITIUM REMOVAL ACTION

May 9, 1997

Prepared by:
Brookhaven National Laboratory
Office of Environmental Restoration
Upton, New York 11973-5000

and

U.S. Department of Energy
Brookhaven Group
Upton, New York 11973-5000

Prepared for:

U.S. Department of Energy
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ACTION MEMORANDUM
OPERABLE UNIT III TRITIUM REMOVAL ACTION

TABLE OF CONTENTS

ACTION MEMORANDUM

I. PURPOSE

The purpose of this Action Memorandum is to document the decision by the U.S. Department of Energy (DOE) to conduct a removal action to address a plume of tritium contaminated groundwater located south of the High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory (BNL). The action involves pumping groundwater from the leading edge of the tritium plume as defined by the drinking water standard and recharging it further north on the BNL property at an existing recharge basin. This will reduce the migration of the tritium contamination located at Princeton Avenue, move contaminated groundwater further away from the site boundary, and allow additional time for radiological decay of the tritium. Carbon filtration of the groundwater is also being performed to remove Volatile Organic Compounds (VOCs) that are also present in the groundwater.

The likely source of the tritium in the groundwater is the spent fuel pool associated with the HFBR. All spent fuel and other radioative materials in the pool will be shipped off-site in accordance with federal requirements. The water in the pool, which contains tritium, will be managed in accordance with current DOE and BNL radioactive waste management procedures. The pool will be upgraded with a stainless steel liner prior to reuse.

These actions are not the final remedial action for the tritium plume. The purpose of the current actions are to:

Assure that tritium in excess of the drinking water standard of 20,000 pCi/l does not leave the BNL site boundary.

Respond to commitments made by DOE to the public and elected officials concerned about the tritium plume.

Provide additional time to thoroughly study the most effective way to manage and remediate the plume.

These actions are being undertaken as a short term removal action in accordance with the Interagency Agreement among DOE, the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC). The final remedial action will be determined through the Operable Unit III Remedial Investigation/Feasibility Study process and will be based on additional data collected, groundwater modeling and evaluations of various remediation options including the current system.

Work will be conducted in accordance with the National Contingency Plan (NCP, 40 CFR 300).

II. SITE CONDITIONS AND BACKGROUND

A. SITE DESCRIPTION

1. Removal Site Evaluation

This removal action concerns elevated levels of tritium that were found during routine groundwater monitoring in the vicinity of the HFBR. Figure 1 shows BNL, the location of the HFBR and the surrounding communities. Table 1 contains background information on tritium. The plume was initially discovered after a series of permanent groundwater monitoring wells installed in August 1996 were sampled. Sampling data from October 1996 revealed tritium concentration at 2,520 picoCuries per liter (pCi/l), which is above background levels but well below the drinking water standard of 20,000 pCi/l. Follow-up sampling in December 1996 revealed concentrations in one monitoring well at 44,700 pCi/l.

The discovery of concentrations above the drinking water standard initiated a comprehensive groundwater investigation to delineate the vertical and horizontal extent of this groundwater contamination. To date, the investigation has determined that groundwater with concentrations above drinking water standards extends approximately 2,200 feet south to between Rowland Street and Weaver Drive, with the highest concentration of approximately 660,000 pCi/l found immediately south of the HFBR. Figure 3 shows an areal depiction of the tritium groundwater plume with contour intervals.

The plume likely originates from a 68,000 gallon pool inside the reactor building that is used to store spent fuel rods. The high concentration plume is confined to very discrete depth intervals in the aquifer. Immediately south of the reactor, the high concentrations (i.e. greater then 20,000 pCi/l) are confined to approximately the upper 20 feet of the upper glacial aquifer and then move progressively deeper reaching a depth of approximately 175 feet below land surface into the upper glacial aquifer about approximately 2,200 feet south of the reactor. The width of the plume widens gradually from approximately 100 feet at the HFBR to approximately 200 feet on Rowland Street.

In addition to the tritium plume, a plume of Volatile Organic Compounds (VOCs) starts in an area north of Rowland Street. This plume of VOCs is in the vicinity of the tritium plume and will likely be impacted by any pumping scenario that is implemented south of Rowland Street. This VOC plume is described in the Operable Unit III Groundwater Removal Action Memorandum and Pre-Design Report. A more detailed description will be provided in the Operable Unit III Remedial Investigation Report.

2. Physical Location

BNL is located in the geographical center of Suffolk County on Long Island, New York, in the Town of Brookhaven. The site contains 5,300 acres, of which 75 percent are wooded as shown in Figure 1. The remainder is developed and contains office buildings, various large research facilities and parking lots. Residential neighborhoods located downgradient, i.e. south of BNL.

The BNL site, formerly occupied by the U.S. Army as Camp Upton during World Wars I and II, was transferred to the Atomic Energy Commission in 1947, to the Energy Research and Development Administration in 1975 and to the DOE in 1977. It has been used as a national laboratory since 1947. The BNL site is owned by the DOE and is operated by Associated Universities, Incorporated.

BNL carries out basic and applied research in the fields of high-energy nuclear and solid state physics; fundamental material and structure properties and the interaction of matter; nuclear medicine; biomedical and environmental sciences; and selected energy technologies. Major operating facilities include the High Flux Beam Reactor, the Brookhaven Medical Research Reactor, the National Synchrotron Light Source, and the Alternating Gradient Synchrotron.

3. Release or Threatened Release into the Environment of a Hazardous Substance, Pollutant or Contaminant

The major threat to public health or welfare and the environment from the site consists of potential off-site migration in the groundwater of the radionuclide tritium above the drinking water standard. This aquifer is designated as a "sole source aquifer" under the Federal Safe Drinking Water Act. The basis for this removal action is to prevent further migration, potentially into residential areas, of tritium in groundwater at levels above the drinking water standard. Migration will be prevented by hydraulic control.

B. OTHER ACTIONS TO DATE

1. Previous Actions

Monitoring wells were installed in August 1996 and were subsequently sampled in October 1996. The initial sample results detected tritium at 2,520 pCi/l, which is above background levels but well below the drinking water standard of 20,000 pCi/l. The wells were subsequently re-sampled in December 1996 and one well showed concentrations at 44,700 pCi/l which is about twice the drinking water standard. This finding initiated the groundwater investigation to determine the extent of the tritium plume through groundwater sampling and modeling.

In addition, DOE has provided public water to the area south and southeast of BNL which is bounded by River Road on the west; Sunrise Highway to the south and Wading River Road to the east.

2. Current Actions

Additional characterization work and groundwater modeling is currently being performed to further delineate the extent of this tritium plume. Additional Vertical Profile Borings (VPBs) and permanent monitoring wells are being installed to the south of the HFBR to better define the western edge of the plume and the southern extent of concentrations above the drinking water standard. All existing monitoring wells located in the projected path of this plume, off-site and at the southern BNL boundary were sampled in February 1997. The results indicate that these areas have not been impacted by this plume at concentrations above the drinking water standard.

The HFBR and the associated groundwater plume of tritium has been added to the Interagency Agreement as Area of Concern 29.

The pump-and-treat system planned for the southern boundary of Operable Unit III is in the projected path of this plume and would intercept any potential low level tritium contamination from the HFBR prior to its moving off-site. This system is currently under construction and a June 1997 start up is planned. Treatment of the higher concentrations near the HFBR will be evaluated as part of the Operable Unit III Remedial Investigation/Feasibility Study.

C. NATIONAL PRIORITIES LIST STATUS

BNL was added to the National Priorities List in 1989. An Interagency Agreement under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA) and applicable New York State regulations was negotiated between DOE, EPA and NYSDEC. The Interagency Agreement became effective in May 1992 and governs the environmental restoration program at BNL.

III. THREATS TO PUBLIC HEALTH OR WELFARE AND THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

A. THREATS TO PUBLIC HEALTH OR WELFARE

The BNL site is located above a sole source aquifer as designated by the EPA under the Safe Drinking Water Act, and groundwater is the primary source of drinking water in the area. The groundwater is also classified by New York State as Class GA under 6 NYCRR Part 703.

The best usage of Class GA groundwater is a source of potable water supply. The currently available data indicates that no tritium concentrations at or above drinking water standards have migrated to the site boundary. However, the potential exists for this plume to migrate to the site boundary and beyond and local residents and elected officials are extremely concerned. Therefore this hydraulic containment removal action is being undertaken as a time-critical removal, but with no imminent health threat.

The appropriateness of a removal action is based on two of the eight factors that are listed in 40 CFR 300.415(b)(2) of the regulations implementing the National Contingency Plan:

1. Actual or potential exposure to nearby populations, animals or food chain from hazardous substances, pollutants or contaminants; and

2. Actual or potential contamination of drinking water supplies or sensitive ecosystems.

B. THREATS TO THE ENVIRONMENT

The major threat to the environment is the potential for continued migration of the plume and the additional contamination of groundwater resources. As stated earlier, the BNL site is located above an EPA-designated sole source aquifer. As such the continued migration of contaminated groundwater is a potential threat to potable water supplies.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of pollutants and contaminants from this site, if not addressed by implementing the response action selected in this Action Memorandum, may present an imminent and substantial endangerment to the "sole source" aquifer.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed Action Description

The action involves the installation of a pump and recharge system with pumping wells located along Princeton Avenue. The location of the pumping wells on Princeton Avenue is based upon the currently available information and may be modified when additional investigation data becomes available. This action is being undertaken on an accelerated schedule in order to

prevent additional migration of tritium contaminated groundwater above the drinking water standard of 20,000 pCi/l.

The tritium present in the groundwater will be addressed through hydraulic containment, half-life decay and dilution. Figure 4 shows a schematic layout of this system. The design objective for the pump and recharge system on Princeton Avenue is the containment of groundwater containing tritium above 20,000 pCi/l along Princeton Avenue. Tritium concentrations below the drinking water standard will be recharged to the aquifer in the existing basin for Removal Action V; these concentrations will decay and disperse to even lower concentrations prior to leaving the site boundary. Recirculation from the site boundary to the recharge basin is an available option, if necessary to further reduce contaminant concentrations. Additional groundwater monitoring, including additional well installations, will be performed within the plume area and in the vicinity of the recharge basin. Public water has already been provided to residences south of BNL as a precautionary measure.

The rationale for the proposed action is to prevent groundwater with elevated (i.e. greater than 20,000 pCi/l) concentrations of tritium from migrating farther south beyond the site boundary. Once this system becomes operational, it will prevent the tritium contaminated groundwater from migrating beyond Princeton Avenue and thus eliminate the potential for off-site migration. Concentrations of less then 20,000 pCi/l that may be beyond Princeton Avenue will be intercepted by the planned Operable Unit III pump and treat system located at the south boundary. This system is scheduled to be operational in the Spring of 1997.

Groundwater modeling is being performed to determine the most efficient configuration of well locations, the number of wells, required pumping rates and to further evaluate the impact to groundwater flow in the vicinity of the recharge basin. The groundwater modeling will also be used to evaluate options for the final remedial action in the Operable Unit III Feasibility Study. The groundwater modeling indicates that three pumping wells strategically located along Princeton Avenue with a combined flow rate of 120 gallons per minute (GPM) will achieve the goal of hydraulic containment on-site of tritium contaminated groundwater with concentrations greater than 20,000 pCi/l. Discharge of groundwater will be to an existing recharge basin on the BNL site associated with Removal Action V. Modeling will be used periodically with additional data to evaluate the impacts of recharge. Groundwater will be treated via carbon adsorption units located in the vicinity of the recharge basin. Carbon adsorption will be used to remove VOCs which are present in the vicinity of the pumping wells. No changes to the treatment system for the removal of VOCs will be made without the review and approval of the EPA and the NYSDEC.

Carbon treatment was determined to be the most feasible and reliable treatment option for VOCs at this time. Disposal or regeneration of the spent carbon, which is a major portion of the operation and maintenance costs of this project, has been evaluated. Preliminary evaluation of disposal of the spent carbon indicates that it will not be contaminated with tritium and may

be regenerated or incinerated. Once the system is in operation and VOC contaminant loading is established and additional characterization data available, the feasibility and cost-effectiveness of alternative treatment options for the VOCs, will be evaluated in the Operable Unit III Remedial Investigation/Feasibility Study.

Off-Site Groundwater

No tritium has been found off-site, to date, in concentrations at or near the drinking water standards. The implementation of the proposed action would eliminate this potential impact to the environment off-site.

Additional Needed Information

Further information is needed after initial operation to monitor system performance, optimize the components of the selected system and obtain additional information needed for the Remedial Investigation/Feasibility Study. The additional information will be generated during the operation of the groundwater treatment system. Additional groundwater studies of the extent of the tritium plume, alternative treatment options will be conducted during the operation of the system and during the Operable Unit III Feasibility Study. If the additional monitoring and studies indicates that the system is causing unacceptable damage to the environment, the system will be turned off.

However the system will not be shut down (outside of routine maintenance and repairs), without the review and approval of the EPA and NYSDEC.

Source Control Actions:

The likely source of the tritium in the groundwater is the spent fuel pool associated with the HFBR. All spent fuel and other radioactive materials in the pool will be shipped off-site in accordance with federal requirements. The water in the pool, which contains tritium, will be managed in accordance with current DOE and BNL radioactive waste management procedures. The pool will be upgraded with a stainless steel liner prior to reuse.

Compliance with Off-site Policy

Off-site disposal of spent carbon will be required and will be performed within all relevant and appropriate requirements governing the disposal/regeneration of spent carbon.

2. Contribution to Remedial Performance

Implementation of the removal action is consistent with the overall remedial action for Operable Unit III because it initiates the remediation of contaminated groundwater migrating

on-site that may impact public or private supply wells. This removal action will be integrated into the overall remedial approach for Operable Unit III during the Feasibility Study. The implementation of this action will also reduce the levels of VOCs which are migrating to the southern boundary of BNL and may reduce the duration of pumping for the Operable Unit III interim action at the southern site boundary.

Recharge of up to 1550 gallons per minute to the Removal Action V recharge basin was evaluated in the Removal Action V 30% Design Report (CDM-Federal, 1996). This recharge was predicted not to interfere with other remedial activities. The Operable Unit IV air sparging/vapor extraction system will receive some impact which is manageable through design modifications. The basin is currently receiving approximately 700 gallons per minute from the Removal Action V project. The tritium pump and recharge will add 120 gpm to the current 700 gpm.

3. Description of Alternative Technologies

Alternatives to the use of hydraulic containment with decay and dispersion of this plume that were considered for this action were pumping with off-site disposal or on-site treatment of contaminated water; subsurface barrier wall technologies; thermal control (freezing) of the source area; and natural attenuation, radiological decay and groundwater monitoring. The other technologies were considered infeasible due to the implementation time frame and the unproven applicability to tritium environmental restoration. Alternative technologies that may enhance, modify or terminate the selected approach will be evaluated as part of the Operable Unit III Remedial Investigation/Feasibility Study.

Alternative pumping scenarios that were evaluated for use with the hydraulic containment option were pumping to the Operable Unit III recharge basin and pumping and reinjection north or south of the HFBR. There is presently no proven treatment technology for the removal of tritium in groundwater. Tritium cannot be chemically treated to render it nonradioactive. Therefore, isotope separation techniques to concentrate the tritium into a small volume are the only methods available for treating tritium-bearing water. These technologies have been previously evaluated and deemed experimental or otherwise impractical for ground water treatment applications and all were considered inappropriate due to potential interference with other remedial activities, unproven applicability of technologies, the potential for creating additional exposure pathways or failure to prevent further migration of the tritium above drinking water standards.

Various alternatives were also considered for treatment of the VOCs incidently captured by the tritium remediation. These included Granular Activated Carbon, treatment of VOCs at the Removal Action V air stripper, treatment of VOCs using the planned Operable Unit III air stripper, treatment of VOCs with UV peroxide at the Removal Action V basin and in-situ treatment of VOCs with air sparging. Other than Granular Activated Carbon treatment

technologies were considered infeasible for the 60 day implementation time frame due to unproven applicability, the need to obtain air discharge equivalency permits or the potential to create additional exposure pathways.

4. Applicable or Relevant and Appropriate Requirements (ARARs)

Federal and State drinking water standards and New York State Class GA groundwater quality standards were compiled to establish treatment standards for discharge of the extracted water. Discharge limits and monitoring requirements for chemical contaminants have been provided by NYSDEC as part of the State Pollutant Discharge Elimination System (SPDES) permit equivalency review. The discharge limits for VOCs will meet the Class GA water standards for VOCs and the drinking water standard for tritium. Compliance sampling to confirm effluent water is within permitted levels will be performed at specified intervals.

Treatment of VOCs will be through a carbon adsorption system and no air emissions of VOCs are expected for this action. Potential emissions from the evaporation of tritium in the recharge basin were evaluated in Appendix C. This evaluation confirmed emissions will be well within federal air emission standards at 40 CFR 61 Subpart H. This analysis was reviewed and concurred on by the USEPA (USEPA, April 1997).

The final set of ARARs will be determined through the Operable Unit III Remedial Investigation/Feasibility Study.

5. Project Schedule

This project is being undertaken under an accelerated schedule. The infrastructure (access roads, electric distribution and water piping) is being installed concurrently with the design phase of the project. The installation of the wells and the treatment system was started in March and completed in April 1997. Completion of the pump and recharge system will be followed by a four to eight week period of start-up testing in early May and then the initiation of routine operation and maintenance.

B. ESTIMATED COSTS

The estimated design and construction cost is $850,000. Annual operation and maintenance costs are estimated to be $205,000.

VI. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

A delayed action or no action will increase the potential for contaminant migration on-site and increase the potential for off-site groundwater contamination. Delayed action will potentially increase the scope and cost of the project as larger volumes of the aquifer are impacted.

VII. PUBLIC PARTICIPATION

Activities to date:

- Presentations/updates given by project staff and management at approximately 25 civic association and other community-based group meetings.
- Community relations staff addressed community's concerns about tritium in groundwater during neighborhood canvassing regarding installation of monitoring wells not associated with tritium.
- Two letters were sent to the BNL Office of Environmental Restoration mailing list informing the community of four tritium-related workshops. Also sent to the mailing list was a compilation of tritium-related questions and answers reflecting those most frequently asked by the community.
- Informational workshops/poster sessions focusing on tritium remediation plans were held at four off-site locations. Copies of the posters were used as handouts at these and other community meetings.
- U.S. Department of Energy press releases were issued on a regular basis to keep the community informed of developments in the tritium project.
- BNL Human Resources organized, and BNL Office of Environmental Restoration participated in, tritium/HFBR question-and-answer sessions for employees held daily during April.
- WorldWideWeb pages (BNL Home Page, plus Office of Environmental Restoration and Public Affairs Office) provided the community with access to information on the tritium investigation and remediation process.

Future activities:

- Continue updates and presentations to civic groups and others.
- Issue a public notice and summary sheet regarding the availability of the Action Memorandum.
- Issue a press release regarding the start-up of the tritium pump and recharge system.
- Send a letter, copy of the public notice, and a copy of the Action Memorandum summary sheet to the Office of Environmental Restoration mailing list.
- Place updates on the WorldWideWeb.
- Include the tritium plume remediation project in the Operable Unit III remedial investigation and feasibility study, subject to full public participation before issuing a Record of Decision.

VIII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues at this time. The final remedial action will be determined through the Operable Unit III Feasibility Study and that this action may be changed or modified depending upon the final remedy selected.

IX. ENFORCEMENT

The site is owned by DOE and is operated by Associated Universities, Incorporated. The funding for source control and groundwater remediation will be provided entirely by DOE.

The removal action will be conducted in accordance with CERCLA and National Contingency Plan requirements, the Interagency Agreement, Executive Order 12580, and applicable New York State regulations.

X. RECOMMENDATION

This decision document represents part of the selected removal action for groundwater associated with Operable Unit III at the Brookhaven National Laboratory in Upton, New York, developed in accordance with CERCLA as amended, and is consistent with the National Contingency Plan.

XI. REFERENCES

1) [BNL, 1996]. Final Action Memorandum for Operable Unit I Groundwater Removal Action and Operable Unit I/III Public Water Hookups.

2) [BNL, 1997]. Final Action Memorandum for Operable Unit III Groundwater Removal Action

3) [I.T. Corp., 1997] Operable Unit III, Final Pre-Design Investigation Report for Groundwater Removal Action.

4) [U.S.EPA, September 1990] OSWER Directive 9360.3-01. Superfund Removal Procedures - Action Memorandum Guidance.

5) [U.S.EPA, April 1997] Letter Paul Giardina -U.S.EPA to Carson Nealy- DOE. Concurrence on NESHAPS evaluation.

Table 1: Background Information on Tritium	
What is Tritium?	Tritium is the only radioactive isotope of hydrogen. It contains two neutrons in the nucleus, in addition to one proton that all hydrogen isotopes share. Due to radioactive decay, tritium has a physical half-life of 12.3 years.
How is Tritium measured?	Tritium concentrations are expressed in units of activity, or activity-fractions of a Curie (Ci) per unit volume. A Ci equals 3.7×10^{10} radionuclide disintegrations per second.
How is Tritium made?	Tritium is created in nuclear fission and fusion reactors. It is also created through natural process's in the atmosphere. (Crowson, 1974).
What is Tritium used for?	Tritium is used in chemical and biological tracer studies, fusion reactor prototypes, nuclear weapons, luminous watch dials and signs, and other industrial applications. A luminescent watch dial may contain 0.002 Ci of tritium; a highway exit sign may contain 25 Ci of tritium.
What is the drinking water standard for Tritium?	20,000 pCi/l

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
BNL	Brookhaven National Laboratory
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GA	State groundwater class, suitable for potable use
HFBR	High Flux Beam Reactor
IT	IT Corporation
NCP	National Contingency Plan
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
RCRA	Resource Conservation and Recovery Act
pCi/l	picoCuries per liter
SPDES	State Pollution Discharge Elimination System permit
TVOCs	total volatile organic compounds
ug/l	microgram per liter
VOCs	volatile organic compounds
VPBs	vertical profile borings

FIGURES

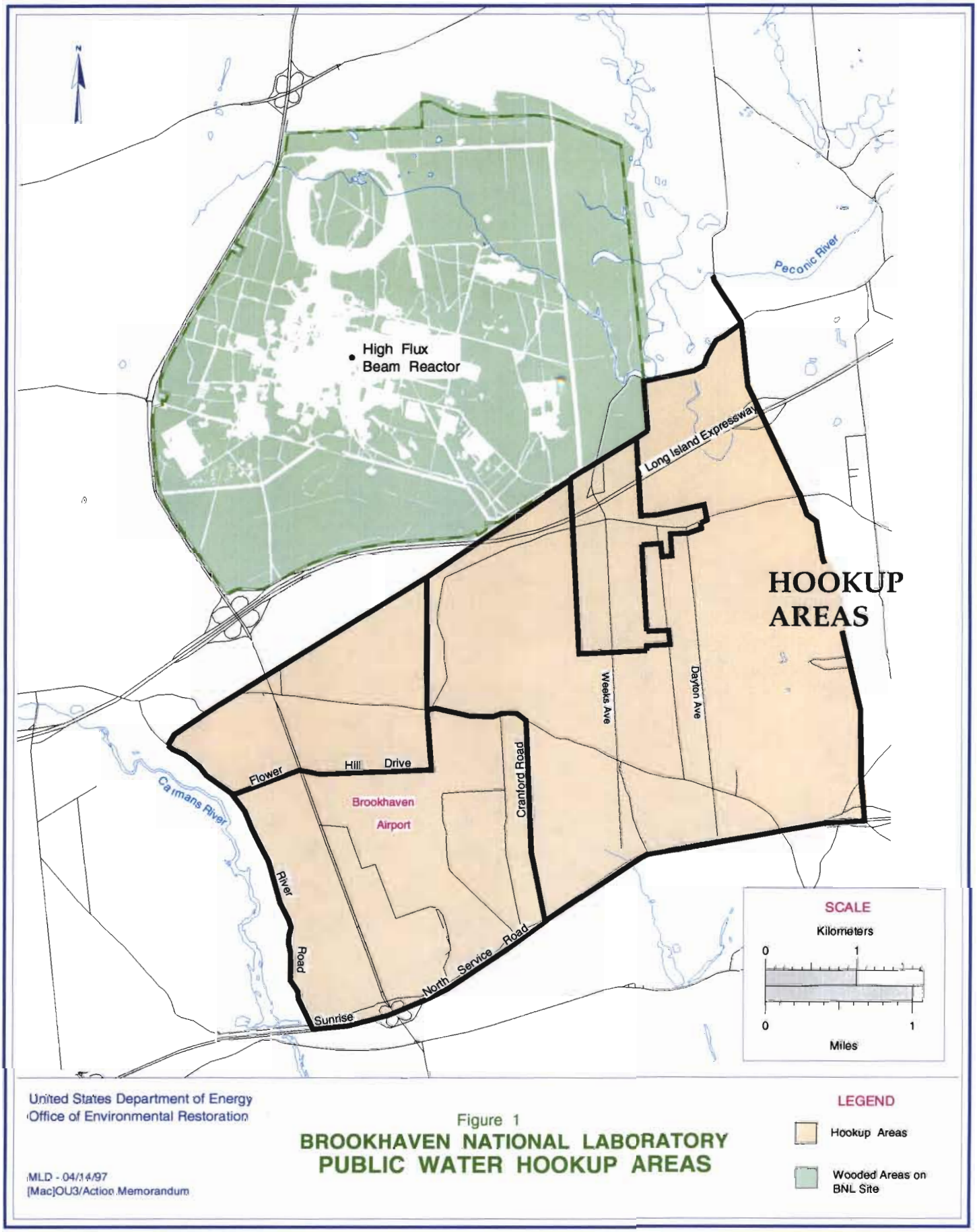
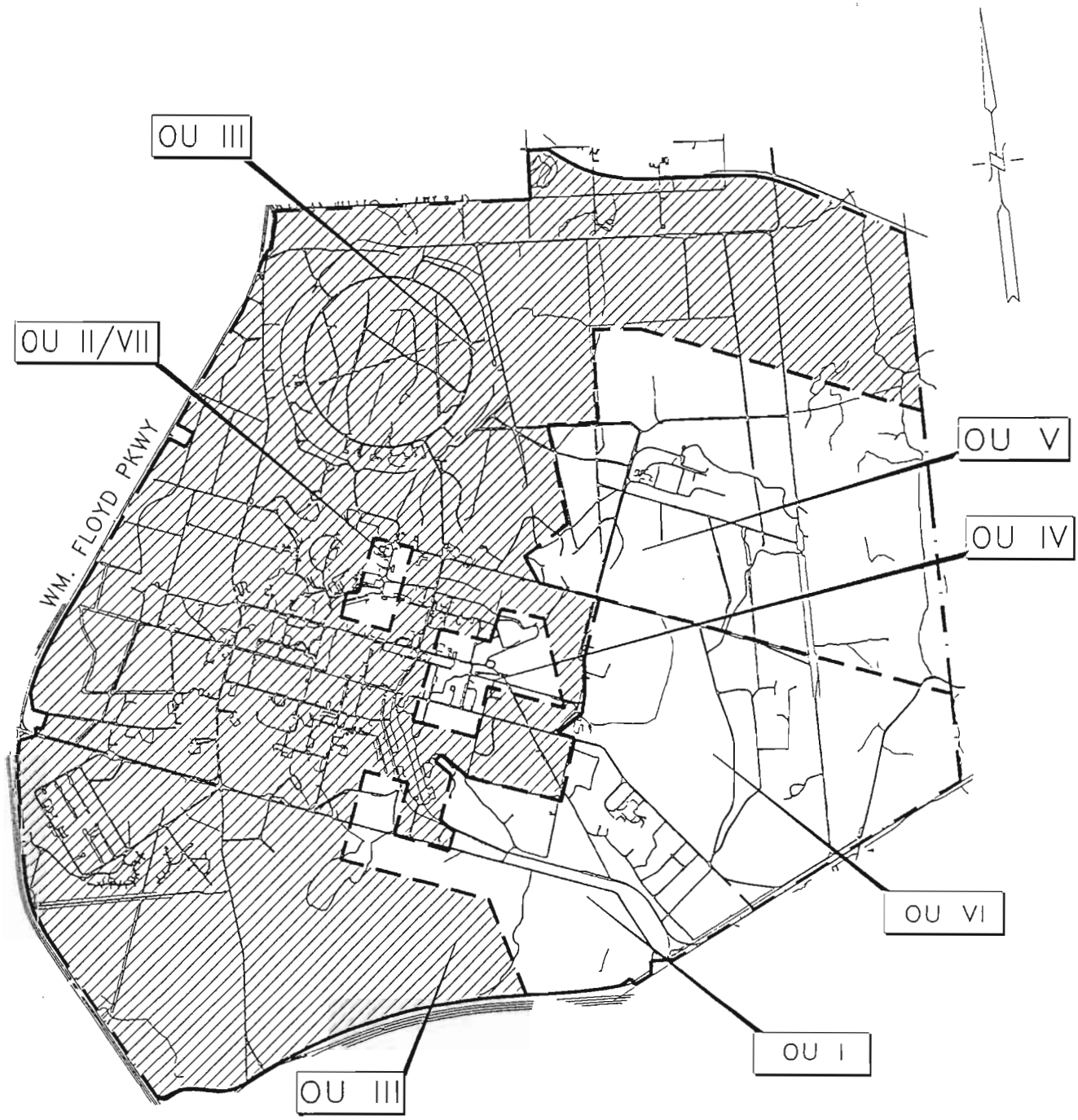


Figure 1

BROOKHAVEN NATIONAL LABORATORY
PUBLIC WATER HOOKUP AREAS

MLD - 04/14/97
[Mac]OU3/Action Memorandum



LEGEND:

STUDY AREA

OPERABLE UNIT AREAS

BNL BOUNDARY

0 1500 3000

SCALE OF FEET

Prepared By:

P.W. GROSSER CONSULTING
ENGINEER & HYDROGEOLOGIST, P.C.

100 South Main Street, Suite 202 Phone (516) 689-0363 Fax (516) 689-8705 Baldwin, N.Y. 11782

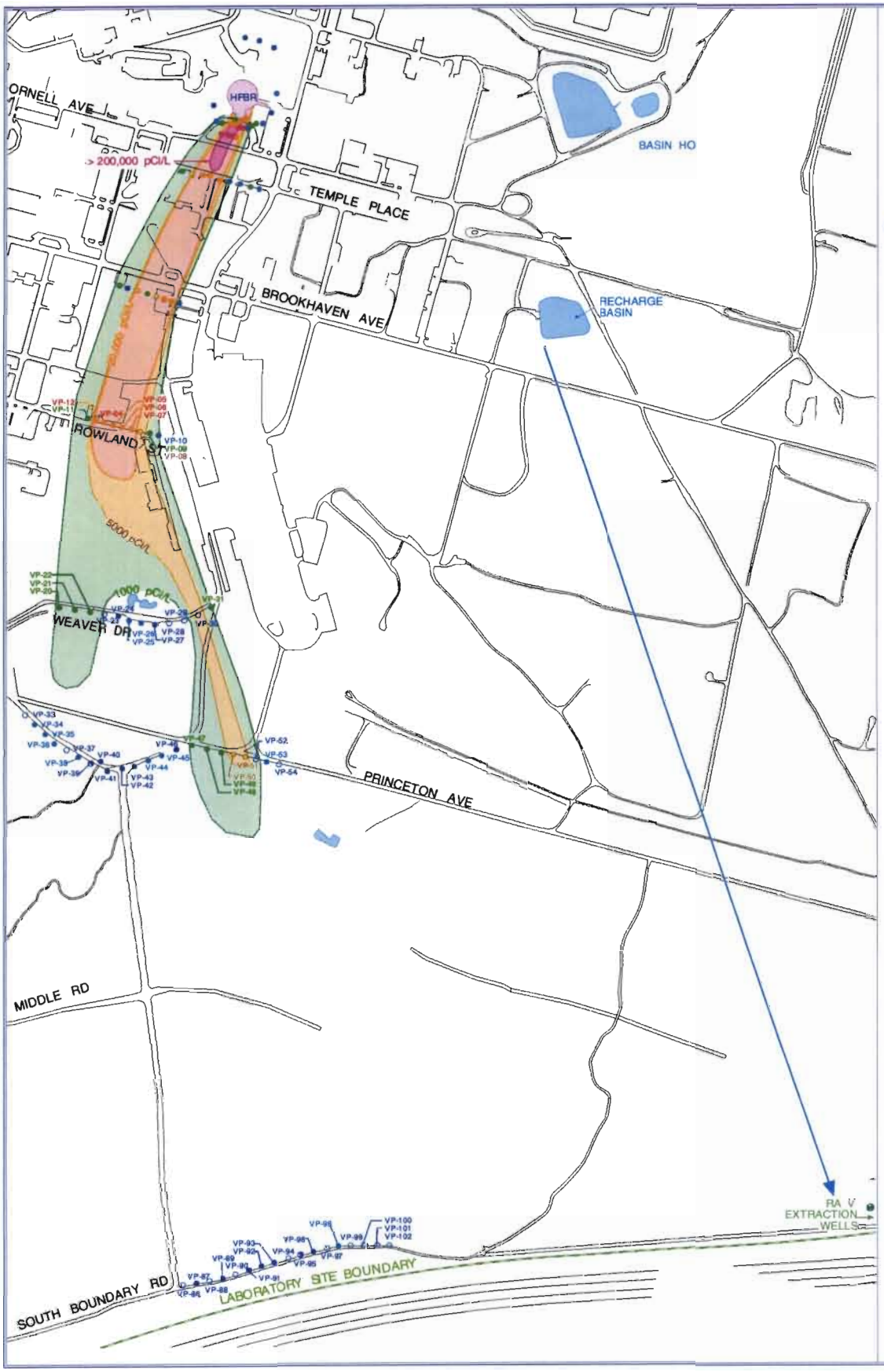
Adapted from data prepared by:
INTERNATIONAL TECHNOLOGY CORPORATION

Prepared For:

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC. UPTON, LONG ISLAND, NEW YORK 11973
UNDER CONTRACT WITH THE
UNITED STATES DEPARTMENT OF ENERGY

FIGURE. 2
OPERABLE UNITS

JOB No.	BNL9603
DATE	10/24/96
SCALE	AS SHOWN
DRAWING No.	963_2-3



BROOKHAVEN NATIONAL LABORATORY
OFFICE OF ENVIRONMENTAL RESTORATION

FIGURE 3

HFBR TRITIUM PLUME CHARACTERIZATION

STATUS OF DRILLING SAMPLING AND ANALYSIS

APRIL 3, 1997

LEGEND

- Samples being analyzed
- Results in, undergoing validation
- Nondetect
- Detect - 1,000 pCi/L
- 1,000 - 5,000 pCi/L
- 5,000 - 20,000 pCi/L
- 20,000 - 200,000 pCi/L
- > 200,000 pCi/L
- 1,000 pCi/l
- 5,000 pCi/L
- 20,000 pCi/l
- 200,000 pCi/l

General direction of groundwater flow

SCALE

Meters

0 100 200 300

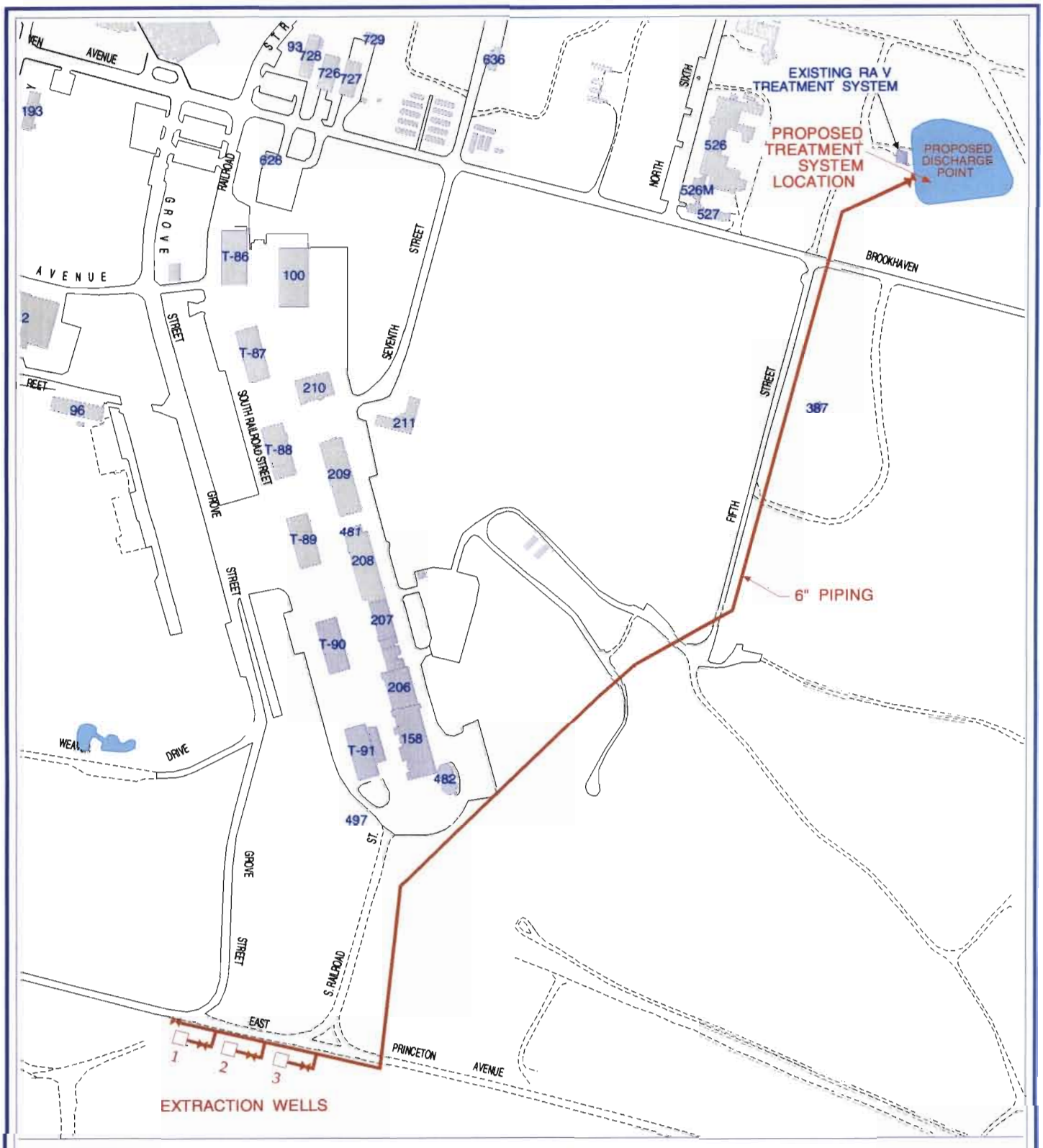
0 1000

Feet

OER Map Index No. 2010-r7

MLD - 04/09/97

{mygis}/ou3/trit/map2010.aml



SCALE
Meters
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Feet

Brookhaven National Laboratory
Office of Environmental Restoration

Figure 4

Flow Schematic

MLD - 04/09/97
[mygis]/ou3/trit/
treatment_sys-n1.map

APPENDIX A

Tritium Treatment Options Evaluation Summary - 3/26/97

1.0 Description

A tritium plume has been detected in the groundwater at varying concentrations and depths depending on its distance from the High Flux Beam Reactor (HFBR), its source. A commitment has been made by the DOE to stop the migration of the tritiated groundwater by installing a pumping system. The purpose of the pumping system is to minimize the migration of tritiated water off-site. The goal is to determine the leading edge of the plume, design and construct a pumping system, and operate it by April 20, 1997.

2.0 Assumptions

- The 60-day commitment to pump at the leading edge of the plume (as defined by 20,000 pCi/L) will be met.

3.0 Options

Pump at the leading edge of the plume to an upgradient recharge basin - This alternative would pump water at or below 20,000 pCi/L from the leading edge to an existing recharge basin presently being used for the recharge of water from a pump and treat system used in the environmental restoration program (removal action 5) through the process identified below:

a. Determine the leading edge of the plume by drilling vertical profile wells. Present data indicates that it will be at or near Princeton Ave.

b. Design and construct a pumping system which will prevent the plume from traveling further south than the leading edge. Determine:

1. Local concentrations of tritium and VOCs
2. Pumping rate needed to capture plume
3. Dilution factors expected so that 20,000 pCi/L is not exceeded in the recharge basin (average over time)
4. Carbon filter capacity needed for VOCs
5. Projected plume path and concentration changes from modeling and empirical data
6. Additional monitoring well locations to assure the proper operation of the system; includes permanent wells around the extraction wells and the recharge basin.

c. Pump tritiated water to an existing CERCLA recharge basin at less than the drinking water standard. This flow (< 500 gpm) will be combined with flow from the south boundary (700 gpm).

d. Monitoring wells will be installed in the projected plume path and downgradient of the recharge basin to monitor the levels of tritium in groundwater. If elevated levels of tritium are measured at the recharge basin, additional recirculation pumping can be installed downgradient.

e. Pumping rates and duration would be based on data from the wells and modeling projections.

f. Install an activated carbon treatment system at the recharge basin to treat volatile organic compounds at up to 3 ppm. The VOCs are located in the same vicinity as the tritium and would be captured by the pumpage.

The design, installation, and construction of this system is being coordinated with other remediation activities so that integration of the goals of each are evaluated. Specifically, this includes the Operable Unit 1 pump and treat system presently in operation and the Operable Unit 3 pump and treat system which is being constructed and will be operational in June. Both systems prevent contaminated groundwater from migrating off the site property.

Advantages

- The rationale for the proposed action is to prevent groundwater with elevated concentrations of tritium from migrating beyond the site boundary. Once this system becomes operational it will prevent migration of the tritium plume beyond Princeton Avenue. Monitoring wells will provide future data to verify the performance of the system.

- The pump and treat system under construction for the south boundary is in the projected path of this plume. Concentrations of tritium below 20,000 pCi/L beyond Princeton Avenue will be intercepted by the OU III pump and treat system located at the south boundary. This system is scheduled for operation in June, 1997.

- Additional remedial actions for source areas and groundwater remediation in Operable Unit III will be evaluated in the Feasibility Study or can be completed as a separate Focused Feasibility Study.

- Treatment of VOCs located at and north of Princeton Avenue may help to accelerate the cleanup process for OU III.

- Recharge at the OU I basin will not significantly interfere with other remedial activity and will not mobilize other contaminants.

Disadvantages

The negative aspect of this system is that tritiated water is being pumped to a relatively clean area of the site. Although some tritium is detected in the discharge from the Operable Unit I pump and treat system.

A second disadvantage is the carbon useage costs will be high at the highest projected VOC concentrations. This may be mitigated by the design and operation of the extraction wells to capture as little of the VOCs as possible.

Another disadvantage is that tritium will evaporate from the recharge basin when there is standing water present. This will be controlled by adding a floating cover or by injecting the tritiated water below the bottom of the recharge basin.

The potential disadvantage of the spent carbon being a radioactive waste is unlikely if the tritium is flushed out of the carbon with potable water. Any VOCs in the flush water will be adsorbed in the lag carbon vessel.

No Action - This alternative includes monitoring of the tritium concentrations until decay and dispersion in the aquifer reduce the levels to less than drinking water standards. Preliminary groundwater modeling indicated that even the highest concentrations near the HFBR would be at or below drinking water standards upon reaching the site boundary. On the other hand, half-life analysis indicated that concentrations could be as high as 150,000 pCi/L when the site boundary was reached. In the absence of sufficient data and a calibrated model to perform an evaluation this alternative was rejected in order to be protective of the public health and the environment.

Pumping from Princeton Avenue to the OU III Recharge Basin - New wells would be installed to capture the >20,000 pCi/L leading edge of the plume and recharged to the OU III basin. After additional migration south of the OU III basin, the recharged concentrations would be well below drinking water standards at the site boundary. This alternative was considered inappropriate because it would introduce radioactive contaminants to a relatively pristine area of the site where radionuclides are not known to be present.

Pumping from the Site Boundary to the OU III Recharge Basin - Existing wells being installed at the southern site boundary as part of the OU III remedial action would pump low levels of tritium to the OU III recharge basin. Additional decay would result in non-detectable concentrations

when the recharged water reached the site boundary. This alternative was rejected because it does not address the design goal of capturing the >20,000 pCi/L leading edge of the plume.

Recirculation North or South of the HFBR - Extraction wells at the >20,000 pCi/L leading edge of the plume would recharge groundwater north of the HFBR or at another location between the HFBR and the extraction wells. A recirculation cell would be established in which the tritium would decay naturally to less than the drinking water standard before it would be allowed to migrate beyond the site boundary. This alternative was rejected due to potential contamination of BNL public supply wells and/or mobilization of high levels of tritium from beneath the HFBR. If recharge occurred to the south of the HFBR, the potential exists for increasing the tritium migration rate or interfering with the treatment of the highest levels of tritium currently beneath and just south of the HFBR.

Extraction and Treatment by Evaporation - This alternative would have evaporated the tritium captured at the leading edge of the plume in the existing HFBR evaporator within the parameters of the <existing discharge permit?>. It was considered infeasible to obtain regulatory approval of this transfer of tritium to another environmental medium.

Extraction and Treatment by Electrolysis and Catalytic Exchange - Systems have been developed in the nuclear industry to concentrate tritium and reduce volume to manageable quantities. One method is combined electrolysis and catalytic exchange which has been successfully applied elsewhere. However the processing rate of 10 gallons per hour and the high capital and energy cost make this process inappropriate for dilute environmental tritium contamination such as the leading edge of the HFBR plume.

Extraction and Treatment by Reverse Osmosis - This promising technology is in the development stage and was considered too innovative to obtain regulatory approval within the 60 day time frame.

4.0 Recommendation

Extraction with carbon treatment for VOCs, and recharge to the OU I basin is recommended. It is feasible within the 60-day schedule, and is expected to receive favorable response from the regulatory community. It also has the minimum cost and minimizes impacts to the central area of the site.

APPENDIX B

EVALUATION OF ALTERNATIVES TO TREAT VOLATILE ORGANIC COMPOUNDS

As part of the design process for interim treatment of the leading edge of the HFBR tritium plume, a technology is needed to remove volatile organic compounds that will be incidently captured with the tritium. A preliminary evaluation of options was performed in order to meet the 60-day implementation schedule. The following is a summary of the evaluations:

Treatment of Volatiles with Activated Carbon Adsorption at the OU I Recharge Basin - VOCs (2-3 ppm) entrained in the capture of the tritium plume would be removed to below drinking water standards with granular activated carbon adsorption units installed at the OU I recharge basin. This option is preferred because it consists of well-established, proven technology; removes all VOCs from the recharged water when applied in a lead/lag configuration; and should be the easiest to be approved by the regulatory agencies and the public so that the 60-day time frame can be met. Other options discussed below require permit equivalency applications or atmospheric dispersion modeling or pilot scale testing, or additional VOC characterization to determine loading rates, or extensive groundwater modeling prior to implementation. It was not considered feasible to obtain regulatory or public approval within the 60-day time frame for these other options. Pumpage from the tritium recovery wells can be optimized to capture a minimum amount of the VOCs which are deeper in the aquifer than the tritium, and yet capture sufficient quantities of the tritium. This operation may result in lower costs than were originally estimated assuming that less than the entire VOC loading would need to be treated.

Mixed Waste Issue - The carbon vessels will be exposed to tritiated water as the VOCs are removed. Discussions with vendors (Calgon Carbon Corporation and Carbon Services Company) indicate that tritium is not known to adsorb to activated carbon and should therefore be easily removed to essentially non-detectable amounts by flushing the lead carbon vessel with 10 volumes of potable water before being sent offsite for regeneration. The lag carbon vessel will capture any VOCs that are mobilized by this procedure.

A laboratory test is being conducted at BNL to determine the degree to which the tritium is entrained in activated carbon after a 10 volume rinse. After completing the rinse, samples of the final rinsate as well as the carbon itself will be tested for the presence of tritium.

In addition, calculations are being performed and vendors are being contacted to determine whether short-term air stripping or UV-oxidation may be substituted for the carbon treatment if necessary.

Treatment of Volatiles with Air Stripping at the OU I Recharge Basin - VOCs would be stripped from the extracted water containing tritium at the RA V recharge basin and released directly to the atmosphere. Release to the atmosphere was not considered feasible in the 60-day time frame due to the need to establish NYS air discharge permit equivalency. Based on experience with similar VOC concentrations at the OU III treatment system, this would require running an air dispersion model, and state acceptance could not be guaranteed within the short time frame. Therefore, this option was selected as a back up for the short term and will be further evaluated

so that it may be substituted on an emergency discharge basis if the carbon test results in a potential mixed waste.

Treatment with Air Stripping and Carbon Adsorption - VOCs would be stripped from the extracted water containing tritium at the RA V recharge basin and the air stream would be treated with activated carbon. This option would require construction of an air stripper plus a vapor phase carbon unit. Based on experience with RA V the air stripper would be a long lead item and not considered feasible for the short implementation schedule. Treatment with vapor phase carbon would probably not result in significant cost savings compared to treatment of the liquid phase with carbon and, therefore, this option will not be further evaluated. Only in the event that tritium cannot be satisfactorily removed from the liquid phase carbon units will this option be further evaluated.

Treatment with Air Stripping and Catalytic Oxidation - VOCs would be stripped from the extracted water containing tritium at the recharge basin and the air stream would be treated with catalytic thermal oxidation. The addition of a catalyst accelerates the rate of oxidation and allows the reaction to occur at much lower temperatures than conventional thermal oxidation. Catalyst systems typically use metal oxides such as nickel oxide, copper oxide, manganese oxide, or chromium oxide although platinum and palladium may also be used. This treatment process results in air emissions which would require NYS air discharge permit equivalency. The technology is also complicated to implement, as it requires an external fuel source. Because of the permitting process and the complexity of the technology it was not considered feasible for the short term. For the long term this technology will be evaluated further.

Treatment of VOCs with UV-Peroxide at the RA V Recharge Basin - This treatment would apply ultraviolet light in the presence of hydrogen peroxide to destroy halogenated carbon compounds in the extracted ground water. The system was not considered appropriate because it has not been demonstrated to be cost effective at the high flow rates anticipated for the tritium remediation. A pilot study would need to be performed to determine operation costs. In addition, it was not considered feasible to obtain regulatory approval of this innovative technology in time to complete construction within the 60 day time frame. However, this technology will be further evaluated as a substitute for carbon treatment, if necessary, and for the long term.

In Situ Treatment of Volatile Organic Compounds With Air Sparging - This treatment would strip VOCs from the groundwater up gradient of the tritium extraction wells so that the water recharged to the OU I basin would not contain VOCs. This alternative was rejected because there was not enough data available to support an accurate design of the sparge well system and because the air emissions from the in situ stripping process would require an air discharge permit equivalency evaluation and possibly air treatment. Also, tritium vapor would need to be managed as an air emission because it will be present in the water vapor emitted from the sparge well(s). It was not considered feasible to obtain regulatory approval of this innovative technology within the 60 day time frame. However, this technology will be further evaluated for the long term tritium plume remediation.

APPENDIX C

BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

DATE: March 12, 1997

TO: M. Hauptmann

FROM: G. Schroeder GS

SUBJECT: Recharge Basin Air Evaluation

As per your request, this memo evaluates the potential radiological dose impact from the use of a recharge basin in receiving water from the tritium plume remediation project. Three assumptions which you supplied were included in the evaluation:

1. Area of the basin = 1 acre (43,560 ft^3)
2. Evaporation rate = 30 in./year
3. Tritium concentration in water = 20,000 pCi/L

Assuming a circular area for the basin, the evaporative volume of a 30 inch deep cylinder with a radius of 117 feet is 107,513 ft^3 (3,045 m^3). When multiplied by the concentration of tritium in the water, this results in a total annually released source term of 0.06 Ci (compare this to the approximately 90 to 100 Ci released by the HFBR annually).

The dose evaluation was performed using the CAP88-PC computer model. Dose assessments were made for individuals residing on-site, full-time at a distance of 500 and 1,000 meters. The basin was modeled as an area source with a plume rise of zero for each of the seven Pasquill atmospheric stability categories. The projected maximum effective dose equivalent (EDE) of 3E-5 mrem occurs 500 meters to the northeast, which is unoccupied land. Directly south at 500 meters, the projected EDE is 2E-5 mrem. Doses to the northeast and south at 1,000 meters are calculated as 8E-6 and 5E-6 mrem, respectively. These estimates are conservative since it assumes full-time occupancy in these areas. The annual dose limit specified for members of the public under 40 CFR 61, Subpart H is 10 mrem/yr. Please contact me at x7045 if you have any questions.

GS/rt
Attachment: Selected printouts from the CAP88 program

cc: W. Gunther
R. McNair
D. Paquette
B. Royce
O. White
EC5220.97

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Mar 12, 1997 10:13 am

Facility: Recharge basin accepting plume water
Address: Brookhaven National Laboratory
City: Upton
State: NY Zip: 11973-5000

Effective Dose Equivalent
(mrem/year)

3.18E-05

At This Location: 500 Meters Northeast
Source Category: area, diffuse
Source Type: Area
Emission Year: 1997

Comments: Evaluation of airborne tritium emissions due to evaporative losses from recharge basin.

Dataset Name: plume pond
Dataset Date: Mar 12, 1997 10:13 am
Wind File: WNDFILES\BNL8089A.WND

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

APR 0 2 1997

Dr. Carson L. Nealy
Brookhaven Group Manager
Department of Energy
Building 464
POB 5000
Upton, New York 11973

Dear Dr. Nealy:

The purpose of this letter is to acknowledge receipt of your letter, dated March 26, 1997, concerning the radionuclide NESHAPs evaluation for potential tritium emissions from the recharge basin proposed for use as part of the Tritium Plume Removal Action. Our understanding is that you are seeking concurrence and not approval.

Your analysis/calculation show a dose of 3.18E-05 mRem/year 500 meters Northeast of the recharge basin. We concur with your analysis/calculation and agree that this dose is substantially lower than the annual dose limit specified for members of the general public under 40 CFR 61, Subpart H of 10 mRem/year.

If you or your staff has any questions, please contact George Brozowski at (212) 637-4007.

Sincerely,

Paul A. Giardina, Chief
Radiation and Indoor Air Branch

cc: G. Brozowski - RIAB
M. Logan - ERRD