

**MATERIALS LICENSE
SUPPLEMENTARY SHEET**

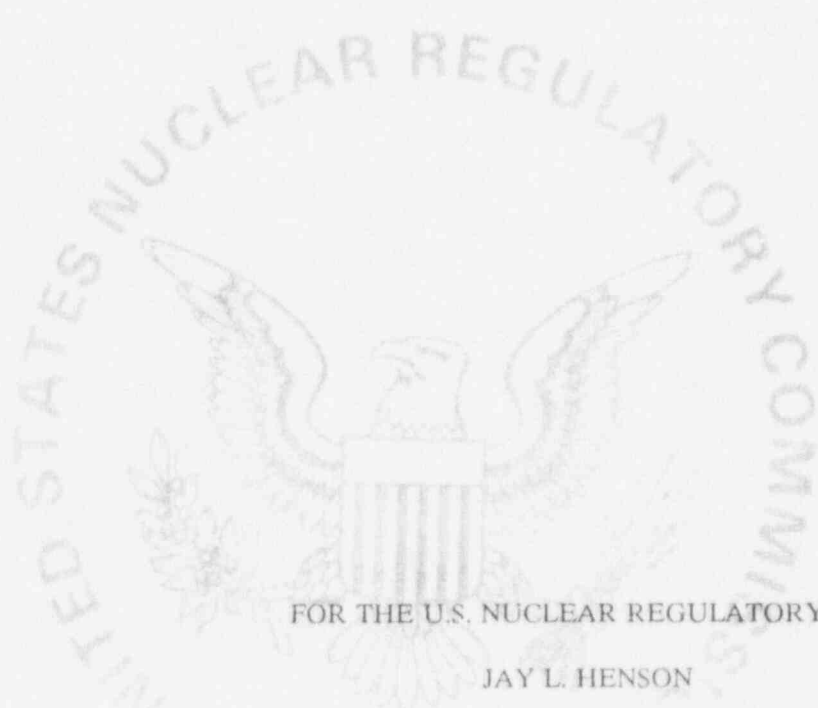
License Number 41-25047-02

Docket or Reference Number 90-33606

Amendment No. 1

Tennessee Valley Authority
River Basin Operations,
Systems Engineering
Engineering Laboratories
129 Pine Road
Norris, Tennessee 37828

In accordance with the letter dated March 27, 1996, and the NRC Form 314, Certificate of Disposition of Materials dated March 27, 1996, and attachments thereto, License Number 41-25047-02 is hereby terminated.



FOR THE U.S. NUCLEAR REGULATORY COMMISSION

JAY L. HENSON

Date OCT 02 1996

By Jay L. Henson
Region II, Division of Nuclear Materials Safety
101 Marietta Street, Suite 2900
Atlanta, GA 30323

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FOR THE U.S. NUCLEAR REGULATORY COMMISSION

JAY L. HENSON

Date OCT 02 1996

J 10/3/96

By *Jay L. Henson*
Region II, Division of Nuclear Materials Safety
101 Marietta Street, Suite 2900
Atlanta, GA 30323

N:MLICENSE\41-25047.T01

ML 20



UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

September 23, 1996

MEMORANDUM TO: John P. Potter, Chief
Materials Licensing/Inspection Branch, RII

FROM: Michael F. Weber, Chief *M. F. Weber*
Low-Level Waste and Decommissioning Projects Branch
Division of Waste Management, NMSS

SUBJECT: RESPONSE TO TECHNICAL ASSISTANCE REQUEST FOR REVIEW OF
TENNESSEE VALLEY AUTHORITY REQUEST FOR TERMINATION OF BY-
PRODUCT LICENSE 41-25047-02

This memorandum responds to your Technical Assistance Request (TAR), dated August 8, 1996, for review of Tennessee Valley Authority's (TVA) request for termination of by-product license 41-25047-02. NRC's Division of Industrial and Medical Nuclear Safety forwarded your TAR to the Division of Waste Management (DWM) for review on August 23, 1996.

DWM staff has reviewed the information submitted by TVA in support of its request to terminate by-product license 41-25047-02 and release the site for unrestricted use. Under this license, small amounts of H-3 and C-14 were introduced as part of a natural-gradient groundwater tracer test. TVA estimated total annual doses from consumption of groundwater based on occupational dose limits. We made independent calculations based on the more stringent dose limits for individual members of the public. We find that the highest reported groundwater concentrations for H-3 and C-14 down-gradient from the test site yield internal doses less than 0.6 mrem/yr and 6 mrem/yr respectively, which are small fractions of the applicable standard of 100 mrem/yr (10 CFR Part 20.1301).

Therefore, we agree with your assessment that based on the information presented, the amount of tritium and C-14 remaining in the ground at the site will not pose a significant radiological risk to members of the public. The potential doses are well below NRC's public dose limit in 10 CFR 20.1301. Therefore, we concur with your recommendation to terminate the license and release the site for unrestricted use.

License No. 41-25047-02

Contacts: John Buckley
301-415-6607

Tim Johnson
301-415-7299

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

: (FOR LFMS USE)
: INFORMATION FROM LTS
: -----
: Program Code: 03113
: Status Code: 0
: Fee Category: EX 3M
: Exp. Date: 20040731
: Fee Comments: NOT REACTOR RELATED/3
: Decom Fin Assur Req'd: Y
: ::::::::::::::::::::::::::::

LICENSE FEE TRANSMITTAL

A. REGION II

1. APPLICATION ATTACHED

Applicant/Licensee: TENNESSEE VALLEY AUTHORITY
Received Date: 960326
Docket No: 3033606
Control No.: 257000
License No.: 41-25047-02
Action Type: Termination

2. FEE ATTACHED

Amount: _____
Check No.: _____

3. COMMENTS

Signed _____
Date 4/26/96

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered ☒)

1. Fee Category and Amount: EX 3M

FEE EXEMPT

2. Correct Fee Paid. Application may be processed for:

Amendment ☒
Renewal _____
License _____

3. OTHER _____

Signed _____
Date 4/11/96

RECEIVED BY LFMS	
Date	<u>4/1/96</u>
Log	<u>April II</u>
By	<u>Ken</u>
Date Completed	<u>4/1/96</u>



Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902

March 27, 1996

Ms. Diane Heim
Materials Licensing Section
U.S. Nuclear Regulatory Commission
101 Marietta Street, Northwest
Atlanta, Georgia 30323

Dear Ms. Heim:

REQUEST FOR TERMINATION OF BY-PRODUCT LICENSE 41-25047-02

This is a request to terminate by-product license 41-25047-02.

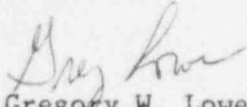
This license authorized the use of tritium and carbon-14 in a groundwater tracer experiment. The material was injected into the ground during June 1990. Studies of the dispersion and transport of this material have concluded. We wish to terminate this license because the trivial hazard represented by the remaining radioactive material does not justify the continuing expense of a radiation safety program and the annual license fees. These expenses represent a substantial portion of our limited research budget.

Enclosed is a Nuclear Regulatory Commission Form 314 (Certificate of Disposition of Materials), a description of the experiment in which the material was injected into the ground, a description of the remaining radioactive material, and an estimate of the health hazard that it represents.

We would appreciate it if you would expedite this request for the termination of this license and release of the land for unrestricted use.

If you have any questions regarding this, please write to me or call J. Markus Boggs at (423) 632-1894 or Jesse Coleman at (205) 386-2993.

Sincerely,


Gregory W. Lowe, Manager
River Systems Operations

Enclosure

257000

CERTIFICATE OF DISPOSITION OF MATERIALS

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 30 MIN. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB-7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (150-0028), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

INSTRUCTIONS: SEND THE COMPLETED CERTIFICATE TO THE NRC OFFICE SPECIFIED ON THE REVERSE.

(All items MUST be completed—
print or type)

LICENSEE NAME AND ADDRESS

Tennessee Valley Authority, River Basin Operations, Systems
Engineering
Engineering Laboratories
129 Pine Road
Norris, TN 37828

LICENSE NUMBER

41-25047-02

LICENSE EXPIRATION DATE

July 31, 1999

THE LICENSEE OR ANY INDIVIDUAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE LICENSEE CERTIFIES THAT:

(Check and/or complete the appropriate item(s) below.)

A. MATERIALS DATA (Check one and complete as necessary)

- ☐ 1. NO MATERIALS HAVE EVER BEEN PROCURED OR POSSESSED BY THE LICENSEE UNDER THIS LICENSE.
- OR
- ☐ 2. ALL MATERIALS PROCURED AND/OR POSSESSED BY THE LICENSEE UNDER THE LICENSE NUMBER CITED ABOVE HAVE BEEN DISPOSED OF IN THE FOLLOWING MANNER. (If additional space is needed, use the reverse side or provide attachments.)

Describe specific material transfer actions and, if there were radioactive wastes generated in terminating this license, the disposal actions, including the disposition of low-level radioactive waste, mixed waste, Greater-than-Class-C waste, and sealed sources, if applicable.

For transfers, specify the date of the transfer, the name of the licensed recipient, and the recipient's NRC license number or Agreement State name and license number.

If materials were disposed of directly by the licensee rather than transferred to another licensee, licensed disposal site or waste contractor, describe the specific disposal procedures (e.g., decay in storage).

See attached materials.

B. OTHER DATA

- ☒ 1. OUR LICENSE HAS NOT YET EXPIRED; PLEASE TERMINATE IT.
2. WAS A RADIATION SURVEY CONDUCTED TO CONFIRM THE ABSENCE OF LICENSED RADIOACTIVE MATERIALS AND TO DETERMINE WHETHER ANY CONTAMINATION REMAINS ON THE PREMISES COVERED BY THE LICENSE? (Check one)
- ☐ NO (Attach explanation)
- ☒ YES, THE RESULTS (Check one)
- ☒ ARE ATTACHED, or
- ☐ WERE FORWARDED TO NRC ON (Date)

3. THE PERSON TO BE CONTACTED REGARDING THE INFORMATION PROVIDED ON THIS FORM

NAME

J. Markus Boggs

TELEPHONE NUMBER

(423) 632-1894

4. MAIL ALL FUTURE CORRESPONDENCE REGARDING THIS LICENSE TO

J. Markus Boggs
Tennessee Valley Authority - LAB 1A-N
129 Pine Road
Norris, TN 37828

CERTIFYING OFFICIAL

I CERTIFY UNDER PENALTY OF PERJURY THAT THE FOREGOING IS TRUE AND CORRECT.

SIGNATURE

Gregory W. Lowe

DATE

March 27, 1996

PRINTED NAME AND TITLE

Gregory W. Lowe, Manager, River Systems Operations

WARNING: FALSE STATEMENTS IN THIS CERTIFICATE MAY BE SUBJECT TO CIVIL AND/OR CRIMINAL PENALTIES. NRC REGULATIONS REQUIRE THAT SUBMISSIONS TO THE NRC BE COMPLETE AND ACCURATE IN ALL MATERIAL RESPECTS. 18 U.S.C. SECTION 1001 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

FILE CERTIFICATES AS FOLLOWS

IF YOU ARE A DISTRIBUTOR OF EXEMPT PRODUCTS, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION
DIVISION OF INDUSTRIAL AND MEDICAL NUCLEAR SAFETY, NMSS
WASHINGTON, DC 20555

ALL OTHERS, IF YOU ARE LOCATED IN:

CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, MAINE, MARYLAND,
MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, PENNSYLVANIA,
RHODE ISLAND, OR VERMONT, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION I
NUCLEAR MATERIALS SAFETY SECTION B
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406

ALABAMA, FLORIDA, GEORGIA, KENTUCKY, MISSISSIPPI, NORTH CAROLINA,
PUERTO RICO, SOUTH CAROLINA, TENNESSEE, VIRGINIA, VIRGIN ISLANDS, OR
WEST VIRGINIA, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION II
NUCLEAR MATERIALS SAFETY SECTION
101 MARIETTA STREET, SUITE 2900
ATLANTA, GA 30323

IF YOU ARE LOCATED IN:

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR
WISCONSIN, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION III
MATERIALS LICENSING SECTION
799 ROOSEVELT ROAD
GLEN ELLYN, IL 60137

ARKANSAS, COLORADO, IDAHO, KANSAS, LOUISIANA, MONTANA, NEBRASKA,
NEW MEXICO, NORTH DAKOTA, OKLAHOMA, SOUTH DAKOTA, TEXAS, UTAH,
OR WYOMING, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION IV
MATERIAL RADIATION PROTECTION SECTION
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TX 76011

ALASKA, ARIZONA, CALIFORNIA, HAWAII, NEVADA, OREGON, WASHINGTON,
AND U.S. TERRITORIES AND POSSESSIONS IN THE PACIFIC, SEND TO:

U.S. NUCLEAR REGULATORY COMMISSION, REGION V
NUCLEAR MATERIALS SAFETY SECTION
1450 MARIA LANE, SUITE 210
WALNUT CREEK, CA 94596

REGIONAL TECHNICAL ASSISTANCE REQUEST FORM

Date: August 8, 1996

Mail or E-Mail to: Donald A. Cool (DAC), Mail Stop: T-8 F5, If E-mail, cc: CLE
Division of Industrial and Medical Nuclear Safety, NMSS

From: John P. Potter (Name and E-mail initials) Region II
Chief, Materials Licensing/Inspection, Branch 2

Licensee: Tennessee Valley Authority License No.: 41-25047-02

☐ Control No. 257000 (if applicable)

☐ Letter dated: March 27, 1996 (if applicable)

☐ Suggested change in licensing procedure (enclosed): _____

☐ Problem/Issue: The license authorized the use of tritium and carbon-14 in a groundwater tracer experiment. The material was injected into the ground in June, 1990. The licensee has concluded its studies of the injection area and wants to terminate its license. The licensee enclosed a NRC Form 314, a description of the experiment, the remaining radioactive material and an estimate of the health hazard it represents. Issue is to determine if based upon information submitted, is injection site suitable for release for unrestricted use.

☐ Action Required: Review material submitted by licensee and determine if license should be terminated.

Recommended Action (with revisions): ☒ Approve or ☐ Reject
Based upon the information submitted by the licensee, it appears that the amount of licensed material remaining in the ground at the site does not exceed any regulatory limits. Recommend the license be terminated.

Remarks: Licensee requested expedited review. Submitted requested additional information in a letter dated 8/6/96.

Headquarter Reviewer: _____

Regional Reviewer: J. Henson

Reviewer Code: G-3

Reviewer Phone No.: (404) 331-0344 FAX No.: (404) 331-7437

Request Needed by: / / (date)

Form TAR-10



Tennessee Valley Authority, 221 West Summit Hill Drive, Knoxville, Tennessee 37902

March 27, 1996

Ms. Diane Heim
Materials Licensing Section
U.S. Nuclear Regulatory Commission
101 Marietta Street, Northwest
Atlanta, Georgia 30323

Dear Ms. Heim:

REQUEST FOR TERMINATION OF BY-PRODUCT LICENSE 41-25047-02

This is a request to terminate by-product license 41-25047-02.

This license authorized the use of tritium and carbon-14 in a groundwater tracer experiment. The material was injected into the ground during June 1990. Studies of the dispersion and transport of this material have concluded. We wish to terminate this license because the trivial hazard represented by the remaining radioactive material does not justify the continuing expense of a radiation safety program and the annual license fees. These expenses represent a substantial portion of our limited research budget.

Enclosed is a Nuclear Regulatory Commission Form 314 (Certificate of Disposition of Materials), a description of the experiment in which the material was injected into the ground, a description of the remaining radioactive material, and an estimate of the health hazard that it represents.

We would appreciate it if you would expedite this request for the termination of this license and a release of the land for unrestricted

use

If you have any questions regarding this, please write to me or call J. Markus Boggs at (423) 632-1894 or Jesse Coleman at (205) 386-2993.

Sincerely,

Gregory W. Lowe, Manager
River Systems Operations

Enclosure

257000

CERTIFICATE OF DISPOSITION OF MATERIALS

INSTRUCTIONS: SEND THE COMPLETED CERTIFICATE TO THE
NRC OFFICE SPECIFIED ON THE REVERSE.

(All items **MUST** be completed—
print or type)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS
INFORMATION COLLECTION REQUEST: 30 MIN. FORWARD
COMMENTS REGARDING BURDEN ESTIMATE TO THE
INFORMATION AND RECORDS MANAGEMENT BRANCH
(MNB8-7714), U.S. NUCLEAR REGULATORY COMMISSION,
WASHINGTON, DC 20555, AND TO THE PAPERWORK
REDUCTION PROJECT (3150-0028), OFFICE OF MANAGE-
MENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE NAME AND ADDRESS

Tennessee Valley Authority, River Basin Operations, Systems
Engineering
Engineering Laboratories
129 Pine Road
Norris, TN 37828

LICENSE NUMBER

41-25047-02

LICENSE EXPIRATION DATE

July 31, 1999

THE LICENSEE OR ANY INDIVIDUAL EXECUTING THIS CERTIFICATE ON BEHALF OF THE LICENSEE CERTIFIES THAT:
(Check and/or complete the appropriate item(s) below.)

A. MATERIALS DATA (Check one and complete as necessary)

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IN THE FOLLOWING MANNER. (If additional space is needed, use the reverse side or provide attachments.)
- Describe specific material transfer actions and, if there were radioactive wastes generated in terminating this license, the disposal actions, including the
disposition of low-level radioactive waste, mixed waste, Greater-than-Class-C waste, and sealed sources, if applicable.
- For transfers, specify the date of the transfer, the name of the licensed recipient, and the recipient's NRC license number or Agreement State name and
license number.
- If materials were disposed of directly by the licensee rather than transferred to another licensee, licensed disposal site or waste contractor, describe the
specific disposal procedures (e.g., decay in storage).
- See attached materials.

B. OTHER DATA

- ☒ 1. OUR LICENSE HAS NOT YET EXPIRED; PLEASE TERMINATE IT.
- ☐ 2. WAS A RADIATION SURVEY CONDUCTED TO CONFIRM THE ABSENCE OF LICENSED RADIOACTIVE MATERIALS AND TO DETERMINE WHETHER
ANY CONTAMINATION REMAINS ON THE PREMISES COVERED BY THE LICENSE? (Check one)
- ☐ NO (Attach explanation)
- ☒ YES, THE RESULTS (Check one)
- ☒ ARE ATTACHED, or
- ☐ WERE FORWARDED TO NRC ON (Date)

3. THE PERSON TO BE CONTACTED REGARDING THE INFORMATION PROVIDED ON THIS FORM

NAME

J. Markus Boggs

TELEPHONE NUMBER

(423) 632-1894

4. MAIL ALL FUTURE CORRESPONDENCE REGARDING THIS LICENSE TO

J. Markus Boggs
Tennessee Valley Authority - LAB 1A-N
129 PINE ROAD
Norris, TN 37828

CERTIFYING OFFICIAL

I CERTIFY UNDER PENALTY OF PERJURY THAT THE FOREGOING IS TRUE AND CORRECT.

SIGNATURE

Gregory W. Lowe

DATE

March 27, 1996

PRINTED NAME AND TITLE

Gregory W. Lowe, Manager, River Systems Operations

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TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

Enclosure 1 to Form 314

RADIOACTIVE MATERIALS REMAINING IN THE ENVIRONMENT
DUE TO THE GROUNDWATER TRACER EXPERIMENT
CONDUCTED AT COLUMBUS AIR FORCE BASE, COLUMBUS, MISSISSIPPI,
AND ESTIMATIONS OF THEIR DOSES TO THE PUBLIC,
BY-PRODUCT LICENSE 41-25047-02

By-product license 41-25047-02, issued to the Tennessee Valley Authority, authorizes the possession of radioactive materials that were used in an experiment conducted almost six years ago. The results of these activities are discussed below.

On June 26 and 27, 1990, an experiment to more accurately determine the characteristics of the flow of organic pollutants in groundwater was begun at Columbus Air Force Base (CAFB) near Columbus, Mississippi. Tritiated water (538.7 milli Ci) was used as a conservative tracer to accurately determine the flow of underground water. Also, 26.8 mCi of C-14 tagged p-xylene (an organic compound used to simulate pollution from leaking underground fuel storage tanks) was injected into the groundwater.

Some of the p-xylene evaporated from the water solution and attached to the equipment used to pump it during the injection process. Over 400 g of stable isotope p-xylene was also injected to act as a carrier. The equipment used in the injection process became contaminated and substantial effort was later spent in decontaminating it. Many parts of the equipment could not be economically decontaminated and were disposed of as radioactive waste and transferred to a licensed broker for ultimate disposal.

Three other nonradioactively tagged, organic chemicals were also injected, but they are of no interest here.

The experiment was conducted in accordance with the original documents that were included in the application for the license. Details on the results of the experiment and on the subsequent fate of the radioactive material are submitted in enclosure 3 and in the EPRI 1993, Transport of Tritium and Four Organic Compounds During a Natural-Gradient Experiment (MADE-2), Final Report TR-101998, also enclosed.

Thus, 538.7 mCi of H-3 and 26.8 mCi of C-14 was injected into the ground water at CAFB in June of 1990. The initial concentrations of these two isotopes was 0.05561 micro Ci/ml of C-14 and 0.00277 micro Ci/ml of H-3.

As the enclosed reports show, the low-level radioactive material is flowing north-northwesterly toward the Buttahatchee River, approximately 3 km north of the injection point. No one lives in this area. This region is unoccupied by dwellings or significant commercial activities. No agricultural activities take place there. This land is the site of several gravel quarries and a pine forest.

257000

Due to the 12.35 year half of tritium, the total quantity of this isotope remaining is 388.3 milli Ci (72.1 percent of the original quantity) due to radiological decay for 5.83 years. Because of its long (5730 yr.) half life, the original quantity, 26.8 mCi of C-14, remains.

The maximum concentrations of H-3 and C-14 in ground water, based on monitoring and modeling predictions, are 4 and 0.2 pico Ci/ml, above background, see Figures 8 and 9 in enclosure 3.

These concentrations and quantities of H-3 and C-14 present no hazard from direct radiation or from inhalation of these materials. The only credible hazard that they may present is from ingestion, primarily drinking water that is contaminated by these low level radioactive materials. We present two calculations to demonstrate that these materials are not hazardous to the public.

First, let us assume that an individual consumes 2,000 ml of this water each day for a year. Thus, 730,000 ml would be consumed in one year. If maximally contaminated water were consumed at this rate, then the quantities consumed in one year would be: $(4 \text{ pico Ci/ml}) \times (7.3 \times 10^5 \text{ ml/yr.}) = 2.92 \text{ micro Ci/yr. of H-3}$ and $(0.2 \text{ pico Ci/ml}) \times (97.3 \times 10^5 \text{ ml/yr.}) = 0.15 \text{ micro Ci/yr. of C-14}$.

According to EPA Report No. EPA-520/1-88-020 (Federal Guidance Report No. 11), the Annual Limits on Intake for the ingestion of H-3 and C-14 are 80,000 and 2,000 micro Ci, respectively. Each of these quantities, if ingested, would give reference man a committed effective dose equivalent of 5,000 mrem.

This conservative, hypothetical ingestion of the maximal concentration of H-3 for an entire year would result in a total effective dose equivalent (TEDE) of $(2.92/80,000) \times 5,000 = 0.18 \text{ mrem/yr.}$ The hypothetical ingestion of the maximal concentration of C-14 would result in a committed effective dose equivalent of $(0.15/2,000) \times 5,000 = 0.38 \text{ mrem/yr.}$ This would result in a combined TEDE of 0.56 mrem in a year from both radionuclides. We used the above technique to estimate the dose from the drinking water pathway, rather than the factors given in Table A-4 of NUREG 1500, Working Draft Regulatory Guide on Release Criteria for Decommissioning: JRC Staff's Draft Comment. The factors given in that table do not seem to consider the rapid underground flow of this slightly contaminated water.

Second, let us use the dose factors given in Table A-1 of NUREG 1500 to estimate the TEDE from all pathways. We conservatively assume that the density of soil is 1 g/ml so that the above concentrations of radionuclides in water can be taken as concentrations in soil. The use of the factors in Table A-1 assumes that an individual lives on the maximally contaminated soil and that he eats food grown there and ingests radionuclides from various other hypothetical pathways. These factors also include doses from direct radiation. The following table shows the doses calculated for these two radionuclides, using the factors in Table A-1 of NUREG 1500.

Radionuclide	Concentration in Soil (pCi/g)	Annual TEDE Factor (mrem/yr. per pCi/g)	Total Dose (mrem/yr.)
H-3	4.0	3.62E-2	0.14
C-14	0.2	4.10E-1	0.08

Thus, the total annual dose to a maximally exposed hypothetical individual would be $0.14 + 0.08 = 0.22$ mrem/yr., a trivial dose.

The trivial doses calculated using the above two methods are well below all guidelines and standards promulgated by both the Nuclear Regulatory Commission and the Environmental Protection Agency for doses to members of the public.

Enclosure 2 to Form 314

FINAL SURVEYS OF SITES WHERE MATERIAL WAS USED

RD/°F pH



Mississippi State

UNIVERSITY

attached to
RS-95-222

December 6, 1995

Mark Boggs
TVA
Engineering Laboratory
P.O. Drawer E
Norris, TN 37828

Dear Sir,

Enclosed are the radioisotope analysis for the water samples delivered to my laboratory by Phillip Llewellyn on November 30, 1995.

sample number	dpm tritium	dpm carbon-14
W1	27	29
W2	24	29
W3	24	31
W4	28	31
W5	26	29
W6	26	30
W7	26	29
W8	26	32
W9	29	29
MSU	18	28

attached to
RS-95-222

Page 2

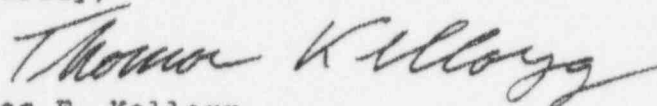
WIPE SAMPLES

1	20	23
2	20	23
3	17	25
4	19	25
5	23	22
6	21	21
7	22	22
8	21	23
9	21	21
10	20	23

The water samples are accurate to a standard deviation of less than 3.0%.

The samples marked "MSU" are laboratory blanks and are expected values for assays of non radioactive substances.

Sincerely,



Thomas F. Kellogg
Professor of Biochemistry
and Molecular Biology

RADIOLOGICAL SURVEY

Survey Number RS&C 92-154 Location 401 Bldg Chert Date 7/24/92
 Reason for this survey: Clean-up of C-14/H3 work Area

ITEM OR LOCATION	TIME	DIST.	Dose Rates				Contamination		Instrument Serial No.	Remarks	Surveyed By
			Beta mRad/hr	Neutron mRem/hr	Gamma mR/hr	Total mRem/hr	Direct	Transferrable dpm/100 cm ²	Type		
Counter Tops Floors Floor Lignids.	1300	CONTACT	NA	NA	<0.1	<0.1	ND	<1000	P	Bicon 552067	SEE Attached Party Hend
	↓	12"	↓	↓	↓	↓					
		GA									See Report from M. Gross to R. Maxwell Aug. 31, 92.
		CONTACT									
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		CONTACT									

Reviewed by: [Signature] NA = Not Applicable GA = General Area ND = Not Detectable NDA = Nearest Occupiable Area

August 31, 1992

R. B. Maxwell, MPB 1B-M

RESULTS OF SURVEY RS&C 92-154 (WATER: CARBON-14/TRITIUM)

Analysis is complete on the subject survey. Due to the cloudiness of the sample, it was filtered before performing the liquid scintillation analysis. The carbon-14 analysis was taken from the filtered sample. The sample was then distilled and once again counted by a liquid scintillation technique. The tritium portion was calculated from this second analysis. The carbon-14 results were not calculated from this run since any carbon-14 present would be volatilized during the distillation process. Attached are the measured values in picocuries per liter.

The filtrate obtained during the filtering process was also counted by liquid scintillation technique. The millipore filter was placed in a liquid scintillation vial and counted for the presence of carbon-14 and tritium. No activity was detected.

If you have any questions, please call me at extension 3769.

Monica H. Cross

Monica H. Cross
Chemist
Radioanalytical Laboratory
WAR 1A-M

MHC:DHS
Attachments
cc: RIMS, MR 2F-C

	A	B	C	D	E	F	G
1	blank-channel a	9.75	eff a C-14	0.508	0.012	uncertainty	
2	blank-channel b	11.9	eff b C-14	1.223	0.026	uncertainty	
3	cpm c14-channel a	407.8	eff a H-3	0.920	0.020	uncertainty	
4	cpm c14-channel b	970.55	eff b H-3	-0.003	0.001	uncertainty	
5	pCi c14	783.8					
6	cpm h3-channel a	703.45	VOLUME	0.003			
7	cpm h3-channel b	9.9	count time(min)	20	determinant	-1.1263142	
8	pCi h3	754			uncertainty	0.03426901	
9	1-Jun-91	26-Aug-92	251.40	3	704		
10	cpm a sam	cpm b sam	SAMPLE ID -	pCi C-14/liter	err c-14	pCi H-3/liter	err h-3
11	12.35	11.20	RS&C 92-154	-189	298	1046	415
12							
13							
14							
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32							
33	REVIEWED BY	<i>M. J. Cross</i>					
34	APPROVED BY	<i>Chris E. Gadenick</i>					
35							

0007000

A-1-1-1-1 *

WATER AND SOIL SAMPLE DATA FORM

TYPE OF SAMPLE:

WATER * SOIL _____ OTHER _____

DATE COLLECTED: 7/24/92

LOCATION OF SAMPLE COLLECTED: 401 Bldg Chatt

DATE SUBMITTED TO WARL: 8/3/97

TYPE OF ANALYSIS FOR SAMPLE: C-14, H-3

WARL LAB SAMPLE NUMBER: _____

NOTES:

(DISPOSITION OF SAMPLE SENT TO WARL, DISPOSITION OF CARBOYS OR SEDIMENT SAMPLED, ETC.)

* The above referenced RS+C # (92-154) was not reflected on the sample container. the number written on it was RS+C-92-153. M.H. Cross
8-5-92

THIS FORM SHOULD ACCOMPANY EACH SAMPLE RS&C SUBMITS TO WARL FOR ANALYSIS.

August 12, 1992

R. B. Maxwell, MPB 1B-M

RESULTS OF SURVEY RS&C 92-154 (TRITIUM/CARBON-14)

Analysis is complete on the subject survey. Tritium and carbon-14 analyses were performed using a liquid scintillation technique. Attached are the measured values.

If you have any questions, please call me at extension 3769.

Monica H. Cross

Monica H. Cross
Chemist
Radioanalytical Laboratory
WAR 1A-M

MHC:DHS
Attachments
cc: RIMS, MR 2F-C

RADIOACTIVITY COUNTING RECORD SHEET FOR SMEARS

Date and Time 6 AUG 92 @ 1410

Inst. Eff. BKG

β - γ

β 283

α

Isotope H-3 / C-14

Sampling Information

RS&C# 92-154

Date 7-30-92

Location 401 Bldg.

Name P. Llewellyn Ph. 3778

Address 365 IE MPB

Smear Number	Sampling Location	Analysis	Total Counts	Count Time (mins)	Total CPM	Average BKG CPM	Net CPM	Counter Efficiency	DPM
BKG		β		10		N/A	N/A	N/A	N/A
		α							
1		β		10					
		α							
2		β		10					
		α							
3		β		10					
		α							
4		β		10					
		α							
5		β		10					
		α							
BKG		β		10		N/A	N/A	N/A	N/A
		α							
6		β		10					
		α							
7		β		10					
		α							
8		β		10					
		α							
9		β		10					
		α							
10		β		10					
		α							
BKG		β		10		N/A	N/A	N/A	N/A
		α							
		β		10					
		α							
		β		10					
		α							
		β		10					
		α							
		β		10					
		α							
BKG		β		10		N/A	N/A	N/A	N/A
		α							

Counted by M. H. Cross
 Calculated by M. H. Cross

Checked by Charles E. Frederich

PREDICTED EXPOSURE POINT CONCENTRATIONS FOR
TRITIUM AND C-14

1. SITE DESCRIPTION

A brief hydrogeologic description of the groundwater test site at Columbus Air Force Base (CAFB) is presented below. A more comprehensive description may be found in the EPRI [1993] report included with this submittal.

Aquifer Characteristics

The site of the proposed study is underlain by a shallow unconfined aquifer consisting of alluvial terrace deposits. This unit averages approximately 11 m in thickness, and is composed of poorly to well-sorted sandy gravel and gravelly sand with variable silt and clay content. Sediments are generally unconsolidated and occur as irregular horizontal or nearly horizontal lenses and layers. The hydraulic conductivity (K) profile and the vertically averaged conductivity map presented on Figure 1 illustrate the extreme heterogeneity of the aquifer. These data were obtained from borehole flowmeter tests conducted at 59 fully screened wells located in and around the test site. Hydraulic conductivities typically range over two to four orders of magnitude at each well test site. The mean hydraulic conductivity along the tracer travel path increases from approximately 10^{-3} cm/s in the vicinity of the tracer injection point to 10^{-2} cm/s or larger in the far field. At the northern extreme of the test site the mean K again decreases to about 10^{-3} cm/s.

Marine sediments belonging to the Eutaw Formation and consisting of clays, silts, and fine-grained sands lie below the alluvial aquifer. Over most of the site the upper surface of the Eutaw consists of dense clay that forms an aquitard beneath the alluvial aquifer. However, a fine-grained sand unit ranging up to 3m in thickness forms the upper Eutaw surface in one subregion of the site. Where present, this sand unit is underlain by the same clay aquitard found elsewhere.

Groundwater Movement

The general direction of groundwater flow at the test site is from southeast to northwest as shown on Figure 2. An important feature of the groundwater flow field is the region of horizontally converging flow indicated by the V-shaped contours in the southern part of the site. This feature is produced by large-scale spatial variations in mean hydraulic conductivity at the test site. The convergent flow zone coincides with the relatively high hydraulic conductivity sediments known to exist in the area downgradient of the injection point.

Based on the observed migration of the conservative tracers in the two previous field experiments, groundwater accelerates upon entering this zone of convergent flow producing a sharp contrast between the near-field and far-field groundwater velocities. Examination of tritium breakthrough curves for 17 selected sampling points in the near field indicated an average velocity of approximately 28 m/yr. The velocity in the far field is estimated to be on the order of 425 m/yr. based on the observed rate of advance of the leading edge of the tritium plume during MADE-2.

Groundwater exiting the test site is expected, based on topographic considerations, to continue to flow in a northwesterly direction, passing through the contiguous Holocene floodplain alluvium which borders the older terrace alluvial deposits to the north, and ultimately discharging into the Buttahatchee River located approximately 3 km north of the site (Figure 3).

Groundwater Chemistry

Groundwater at the test site has a low total dissolved solids content averaging 43 mg/L. The ionic composition of the groundwater is dominated by sodium, silica, and chloride. Total acidity averages 71 mg/L (as CaCO_3). Alkalinity averages 9.6 mg/L and is mainly in the form of carbon dioxide and bicarbonate. Because of the low acid-neutralizing capacity of the groundwater, dissolved carbon dioxide strongly affects the pH which averages 4.8. Background concentrations of tritium and C-14 in groundwater average 2.0 and 2.8 pCi/ml, respectively.

2. DESCRIPTION OF GROUNDWATER TRACER EXPERIMENT

The tracers selected for the experiment are listed in Table 1 along with the initial concentration and total injected mass (activity) for each tracer. Note that a small portion of the p-xylene was labeled with C-14 to permit the study of biological or chemical transformation of the p-xylene.

Table 1. Initial Tracer Concentrations and Masses (Activities)

Tracer	Initial Concentration	Mass Injected
tritium	55,610 pCi/ml	0.5387 Ci
C-14 (p-xylene)	2,770 pCi/ml	0.0268 Ci
benzene	68.1 mg/L	659.7 g
p-xylene	51.5 mg/L	402.0 g
o-dichlorobenzene	32.8 mg/L	317.7 g
naphthalene	7.23 mg/L	70.0 g

Tracers were mixed with 9700 L of ambient groundwater and injected into the alluvial aquifer through five wells spaced one-meter apart in a linear array (Figure 4). Each well was screened over a 0.6 m interval located in approximately the middle of the aquifer. The

injection was conducted over a 48.5 hr period beginning June 26, 1990, at a uniform rate of 3.3 L/min. Following the injection, tracers were periodically monitored using an array of 328 multilevel sampling wells (Figure 4). Sampling results and interpretation of the experimental data are given in EPRI [1993].

Safeguard monitoring was also performed periodically during and after the experiment to ensure that no local groundwater supply wells were adversely affected by the study. Sampling results for the four private wells monitored are given in Table 2. There was no indication of tritium or C-14 levels significantly above background for any of the samples collected from the private wells.

Table 2. Tritium and Carbon 14 Measurements Local Domestic Wells During and After MADE-2
(Measurements Include Background)

Well Number	Date	Tritium (pCi/ml)	Carbon-14 (pCi/ml)
1	8/90	2.0	2.2
	1/91	2.0	2.8
	5/91	2.5	3.4
	12/91	1.6	3.1
	7/92	1.7	3.1
2	8/90	2.0	2.0
	1/91	2.0	2.8
	5/91	1.8	3.6
	12/91	1.3	2.9
	7/92	1.6	2.8
3	8/90	(a)	(a)
	1/91	2.0	2.6
	5/91	1.4	3.5
	12/91	1.6	2.9
	7/92	1.5	2.9
5	8/90	2.0	2.2
	1/91	2.1	2.8
	5/91	2.0	3.8
	12/91	1.7	2.9
	7/92	1.7	3.1

(a) Well not available in 8/90.

In addition, tracer data were examined for sampling points located along the last row of the multilevel sampling well network to determine the maximum tracer concentrations exiting the test site. Tritium and C-14 results for sampling points exhibiting the highest measured concentrations are given in Figures 5 and 6. It appears that the maximum concentrations for tritium and C-14 were on the order of 13 and 3.6 pCi/ml, respectively. Most of the sampling

points experienced their peak concentrations within 500 to 600 days after tracer injection. Note that the mean concentrations of tritium and C-14 passing the last row of the sampling network were only about 4 and 3 pCi/ml, respectively.

3. EVALUATION OF FUTURE IMPACTS

Methods

A conservative assessment was performed to determine whether concentrations of tritium and C-14 released to groundwater in the MADE-2 field experiment pose any future risk to offsite water users. The extensive knowledge of the local groundwater flow system derived from the two previous groundwater tracer experiments allowed these risks to be evaluated with a high degree of confidence.

Estimates of the future tritium and C-14 tracer concentrations at potential downgradient receptors were made using a three-dimensional groundwater transport model developed by Yeh [1981]. The model accounts for convection, dispersion, and first-order decay of groundwater solutes in a uniform, unidirectional flow field. Because of the presence of two contrasting groundwater velocity zones at the test site, a two-step procedure was followed in conducting the transport analysis. First, the rate of release of the radiotracers from the low-velocity zone occurred to the high-velocity zone which comprises most of the test site was estimated. Release rates were computed from observed changes in the total tritium and total C-14 activity present in the low velocity zone during the experiment (Table 3). For example, the estimated average tritium release rate ($q(t)$) from the low-velocity zone between days 27 and 132 is,

$$q(t) = -M_o \cdot (m_1 - m_2) / (t_1 - t_2) = 5.39 \text{e}11 \cdot (1.00 - 0.94) / (27 - 132) = 3.08 \text{e}08 \text{ pCi/day}$$

The presumption here (which has been verified by separately integrating the tracer mass in the low and high velocity zones) is that an observed decrease in tracer mass in the low velocity zone between two sampling dates corresponds to an increase in mass within the high velocity zone. In order to extrapolate beyond the experimental period (i.e., 328 days), the observed tritium and C-14 mass data were fit to a negative exponential function. These results are also given in Table 3.

Table 3. Data Used in Estimating Tritium and C-14 Release Rates to High-Velocity Zone

Days Since Injection	Relative Tritium Mass in Low Velocity Zone	Estimated Tritium Release Rate (pCi/day)	Relative C-14 Mass in Low Velocity Zone	Estimated C-14 Release Rate (pCi/day)
0	1.00	--	1.00	--
27	1.00	0.00e00	0.72	2.78e08
132	0.94	3.08e08	0.64	2.04e07
224	0.62	1.86e09	0.36	8.16e07
328	0.38	1.26e09	0.21	3.87e07

Note: Relative mass equals mass divided by initial mass (M_0); initial mass values for tritium and C-14 given in Table 1.

In the second step of the analysis, the tracer release rates from the low-velocity zone were used as influx boundary conditions in the groundwater transport model to predict tracer concentrations at selected downgradient receptors within the high-velocity zone. A groundwater seepage velocity of 425 m/yr. was assumed based on the observed tritium plume movement during the actual experiment. A longitudinal dispersivity of 10 m was used based on spatial moments analysis of the tritium plume [EPRI, 1993], while transverse and vertical dispersivity values of 1m and 0.3 m were assumed for the analysis. The aquifer was assumed to have a saturated thickness of 8 m, and to be of infinite extent in the longitudinal and transverse directions. An effective porosity of 0.25 was applied.

Figure 7 shows a comparison of predicted and observed tritium concentrations for selected sampling points on the last row of the sampling network located approximately 250 m downgradient of the source. Recall that the observed data represent tritium breakthrough curves exhibiting the highest observed peak concentrations for sampling points on the last row. The predicted result is also the maximum value calculated at a longitudinal distance of 250 m. The favorable comparison of the predicted and observed breakthrough histories lends credibility to subsequent tracer concentration predictions for downgradient receptors.

Results

The downgradient receptors selected for analysis include the two existing private wells located north of CAFB (wells 3 and 5 shown on Figure 3), a hypothetical water supply well located near the northern CAFB property line (well 4 of Figure 3), and the Buttahatchee River. For conservatism, the shortest straight-line distance between the tracer source and each receptor was used in the predictions (see Table 4), despite the fact that the two existing wells lie east of the expected trajectory of the tracer plumes. The maximum predicted concentrations at each longitudinal distance were used in the analysis.

Table 4. Predicted Maximum Tritium and C-14 Concentrations at Potential Receptors

Potential Receptor	Approx. Distance from Source (m)	Tritium (pCi/ml)	C-14 (pCi/ml)
Well 3	1250	5.48	2.94
Well 4 (hypothetical)	1250	5.48	2.94
Well 5	2400	4.00	2.88
Buttahatchee River	3000	3.62	2.87

The tritium and C-14 concentration breakthrough histories for each receptor are shown in Figures 8 and 9, and data are tabulated in Table 5. The maximum predicted concentrations at each location are given in Table 4. Results indicate even using conservative assumptions, the concentration of tritium at the nearest receptor is only about three times background, whereas, the predicted increase in C-14 above background is negligible.

4. REFERENCES

- Electric Power Research Institute (EPRI), 1993. Transport of Tritium and Four Organic Compounds During a Natural-Gradient Experiment (MADE-2), *Final Report TR-101998*, Palo Alto, CA.
- Yeh, G.T., 1981. AT123D: Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Transport in the Aquifer System, *Oak Ridge National Laboratory report ORNL-5602*.

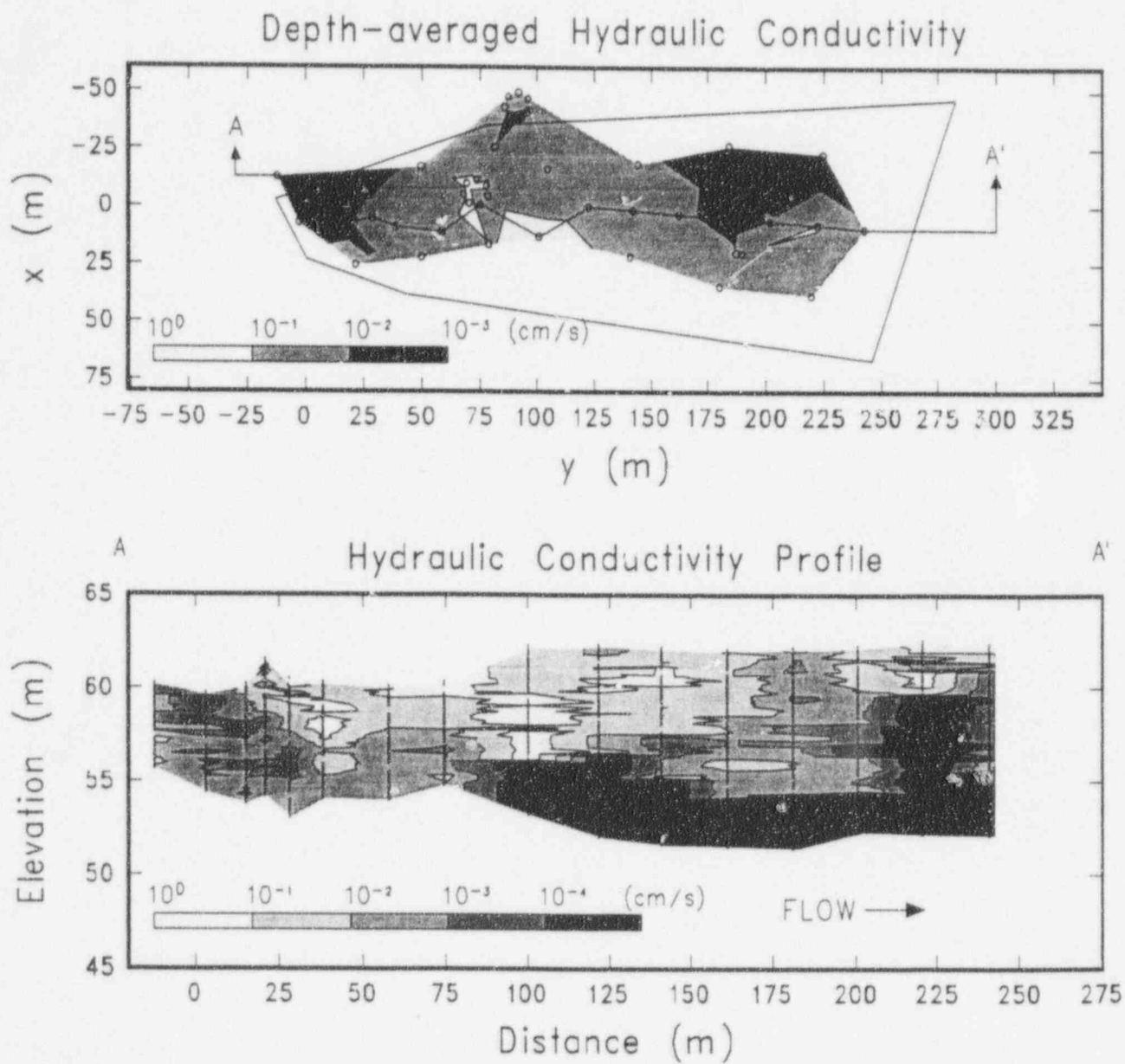


Figure 1. Map of Vertically Averaged Hydraulic Conductivity (Upper Diagram) and Hydraulic Conductivity Profile Along Section A-A' (Lower Diagram)

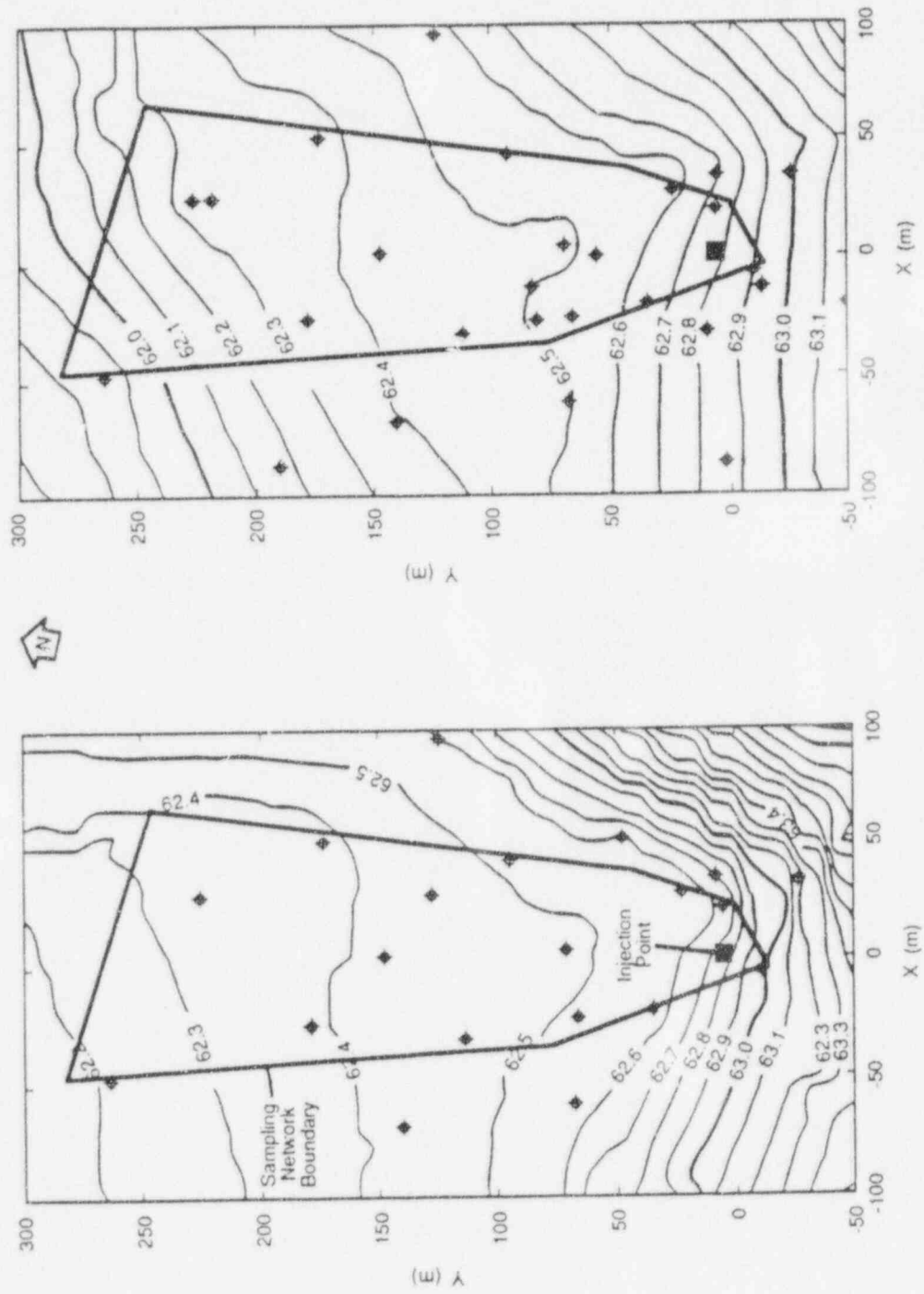


Figure 2. Potentiometric Surface Maps Derived From June 1990 Head Measurements in Shallow (Left) and Deep (Right) Observation Wells

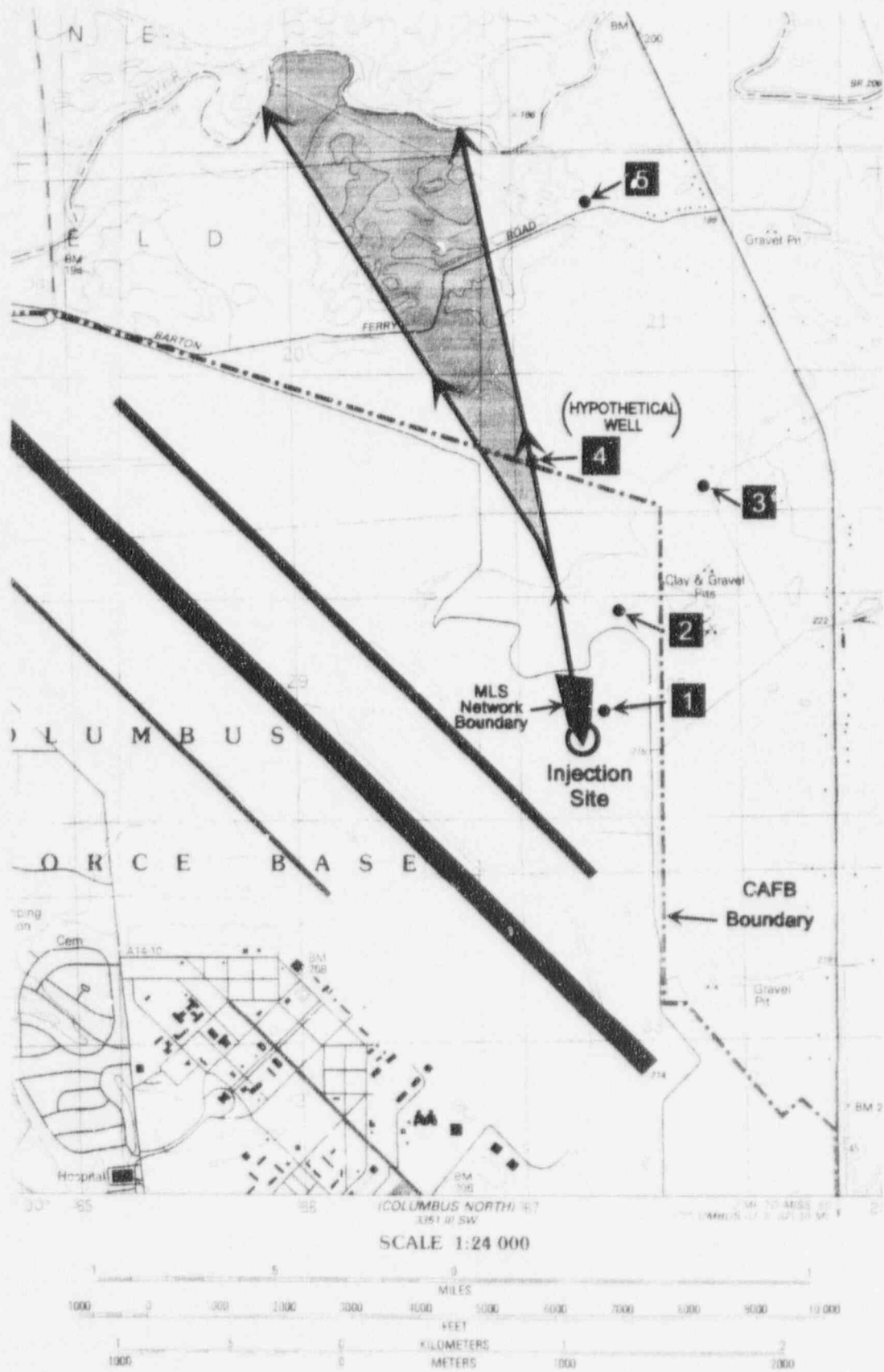


Figure 3. Projected Tracer Plume Pathway in Relation to Local Wells

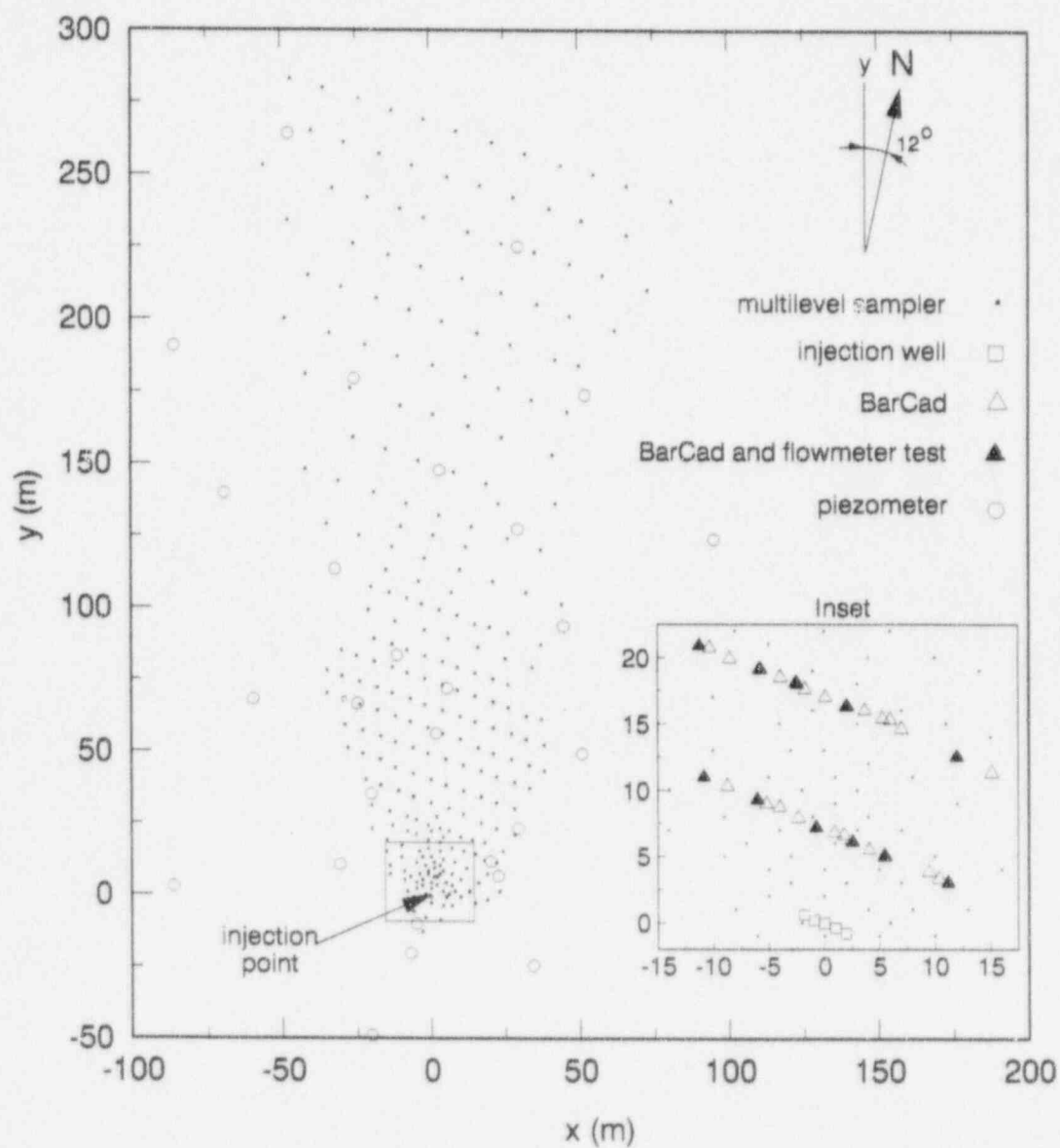


Figure 4. Sampling Well Network Showing Injection Wells, MLS, and BarCad Samplers

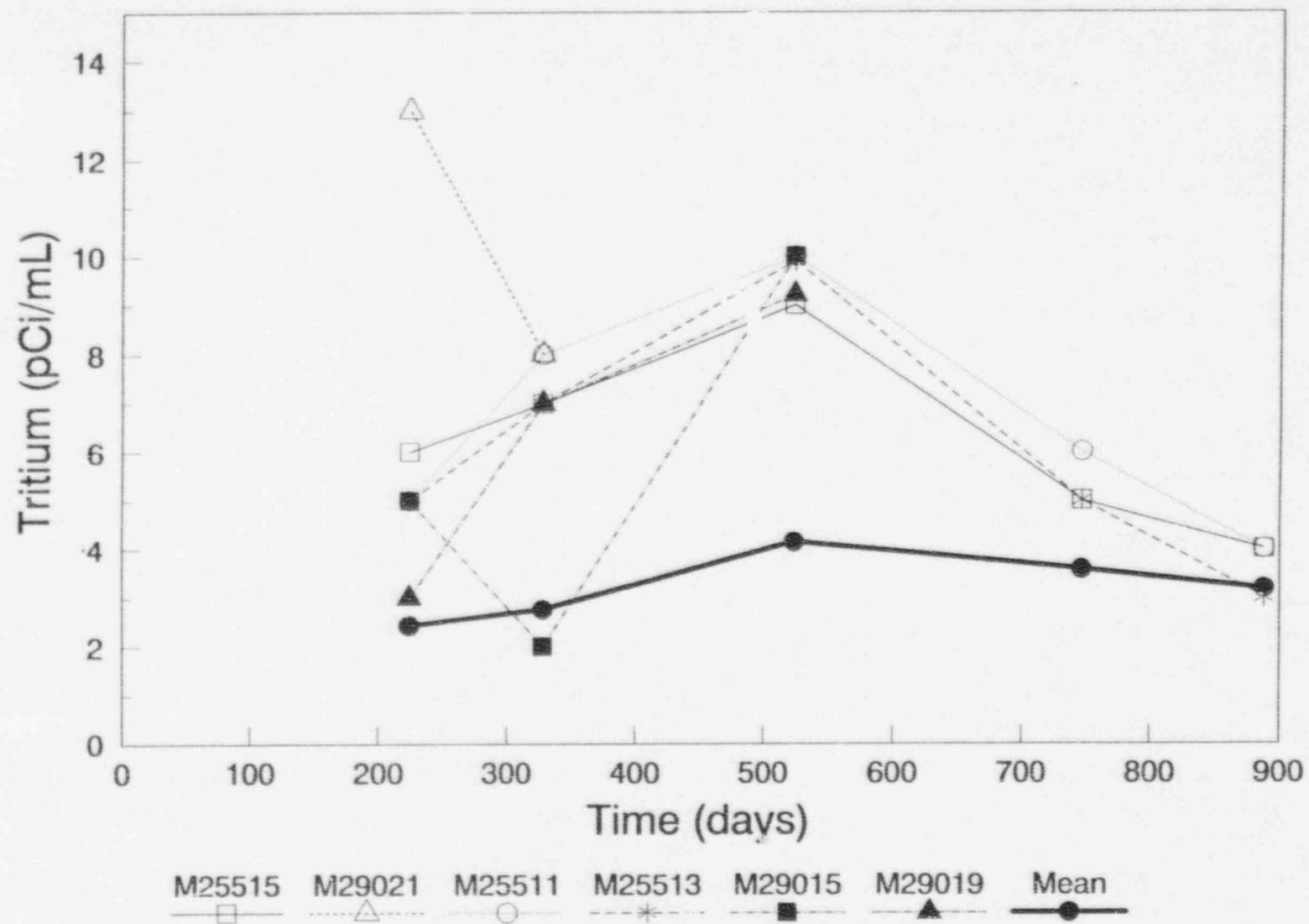


Figure 5. Observed Tritium Concentration Histories for Selected Sampling Points Located In Last Row of Monitoring Network

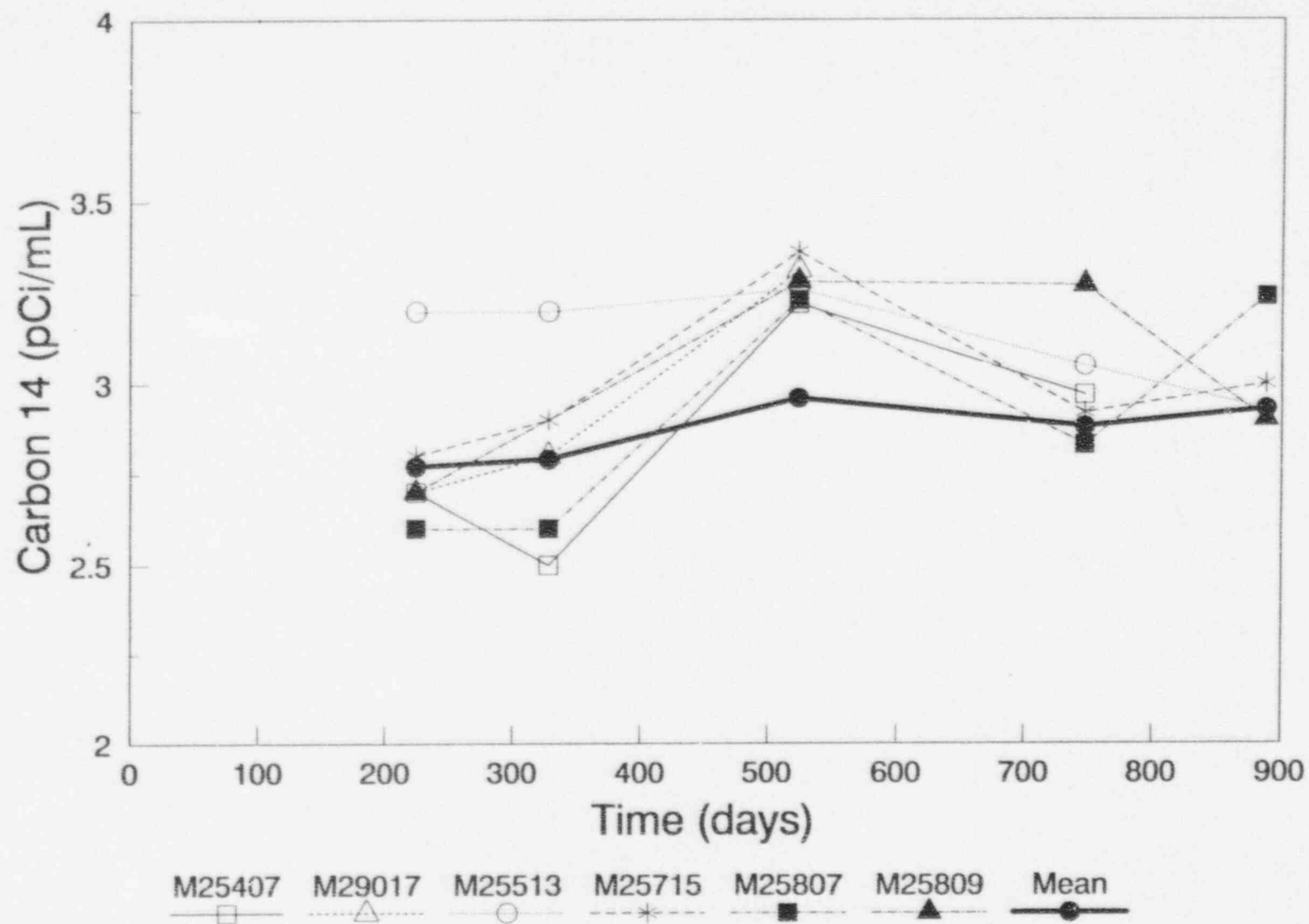


Figure 6. Observed C-14 Concentration Histories for Selected Sampling Points Located In Last Row of Monitoring Network

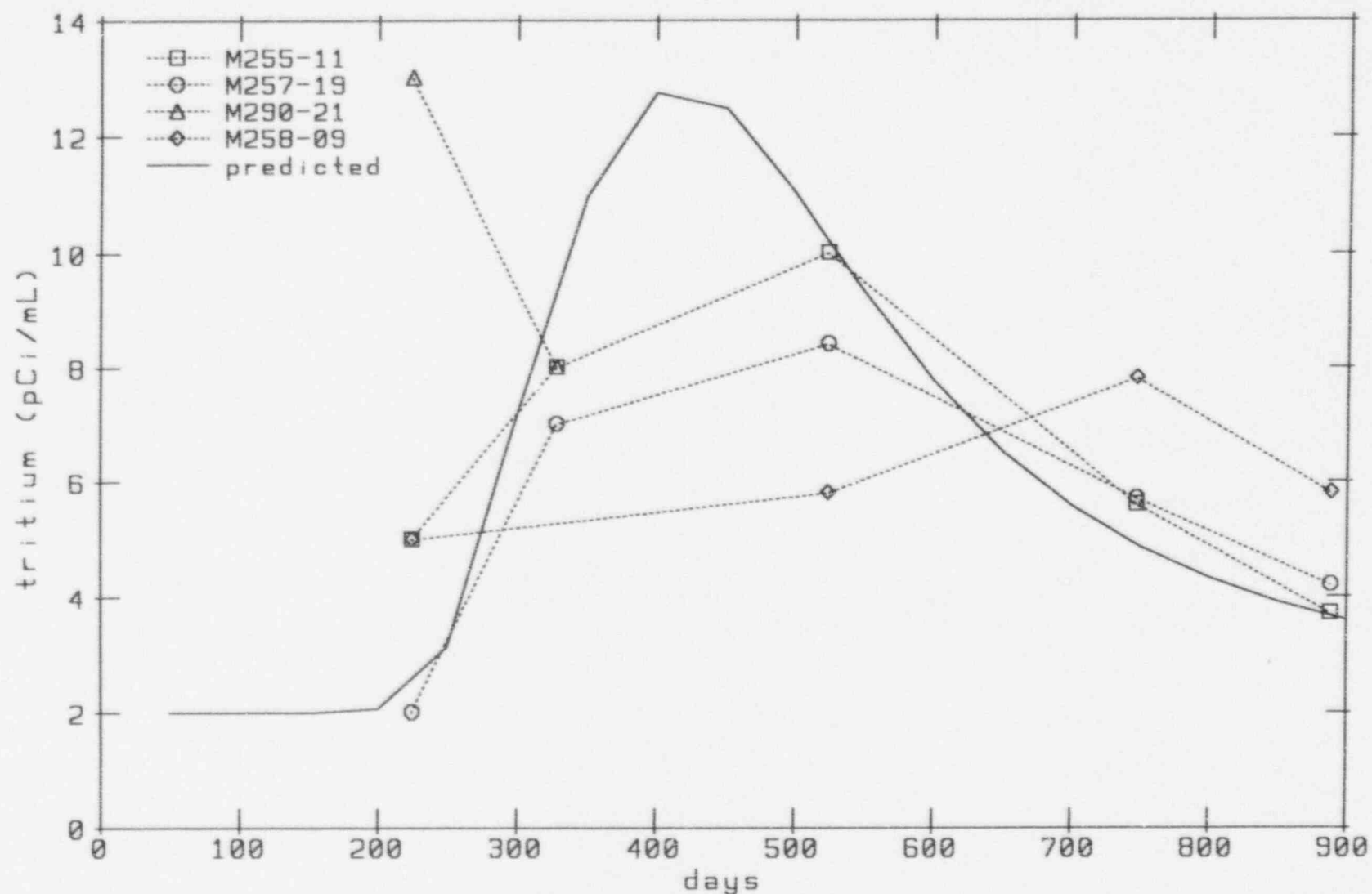


Figure 7. Observed v. Predicted Tritium at Last Row of Network

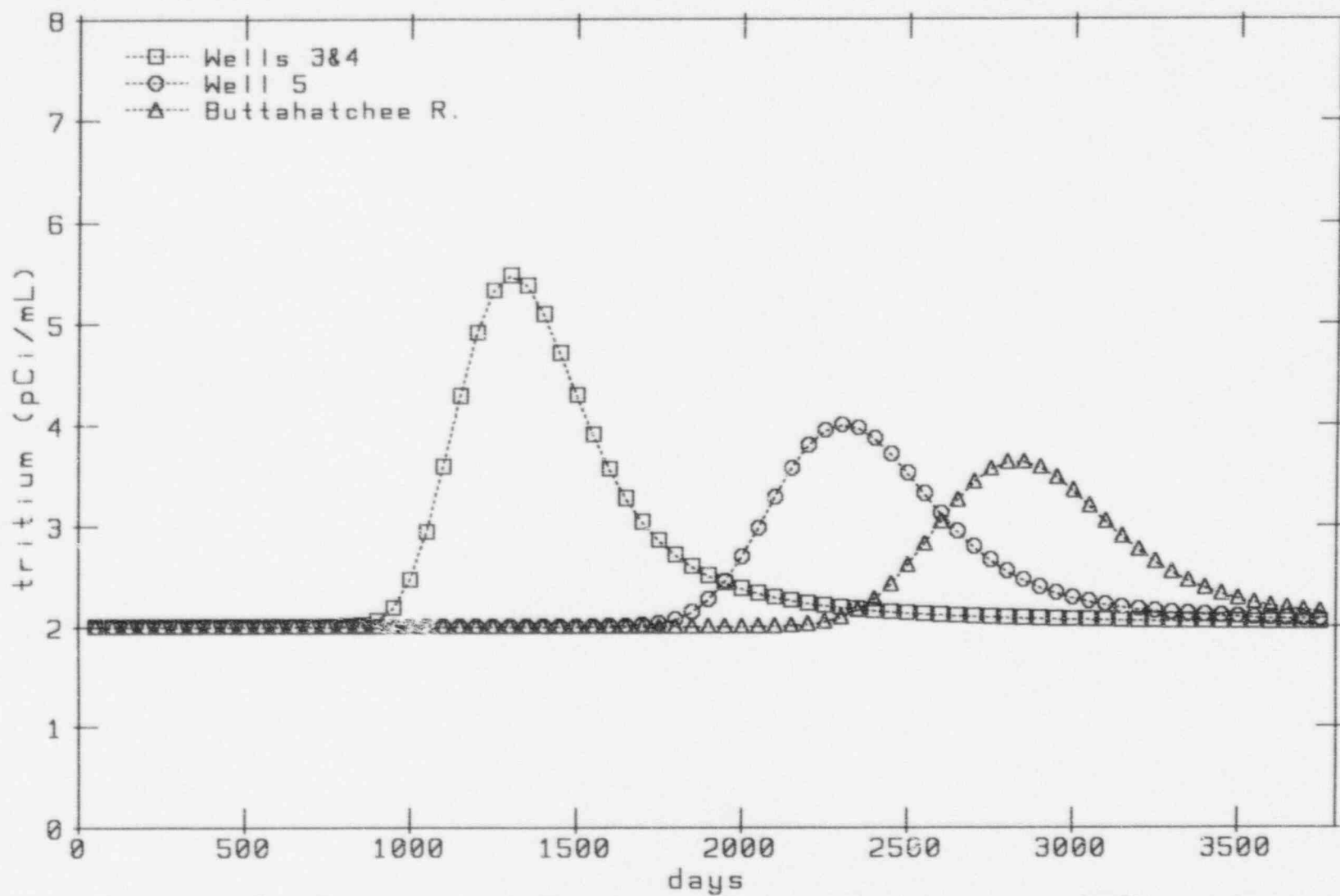


Figure 8. Predicted Tritium Concentrations at Receptors

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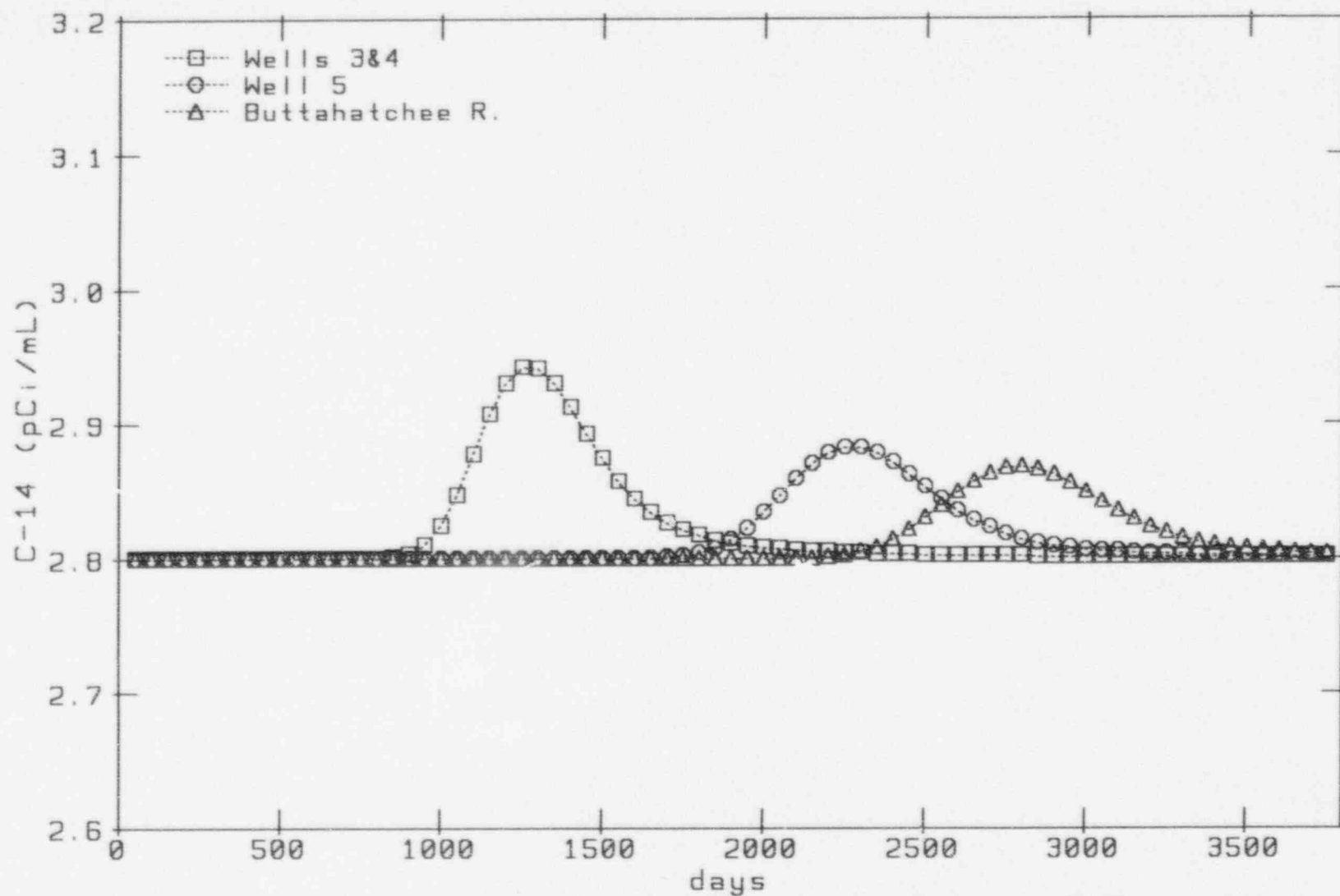


Figure 9. Predicted C-14 Concentrations at Receptors



Tennessee Valley Authority, Post Office Box 1010, Muscle Shoals, Alabama 35662-1010

'96 AUG -6 A7:44

July 29, 1996

Mr. Jay Henson
Materials Licensing Section
U.S. Nuclear Regulatory Commission
101 Marietta Street, Northwest
Atlanta, Georgia 30323

Dear Mr. Henson:

REQUEST FOR TERMINATION OF BYPRODUCT LICENSE 41-25047-02, ADDITIONAL
INFORMATION

In response to our recent telephone conversations, I submit the following information regarding the letter dated March 27, 1996, from Mr. G. W. Lowe of TVA to Ms. D. Heim of the Nuclear Regulatory Commission.

First, corrections to the first two pages of enclosure 1 to form 314, submitted with the letter of March 27, 1996:

The last sentence of the second from the last paragraph, first page should read: "The initial concentrations of these two isotopes was 0.05561 micro Ci/ml of H-3 and 0.00277 micro Ci/ml of C-14."

In the last sentence of the fourth paragraph on the second page, the factor 97.3×10^5 should be 7.3×10^5 .

Second, figure 5 of enclosure 3 to form 314 of the March 27, 1996 letter was omitted. It is enclosed with this memorandum.

Third, additional data, collected at later dates, on the concentrations of radionuclides in ground water in the area where this field experiment was conducted are enclosed.

If you have any additional questions or comments, please call me at (205) 386-2993.

Jesse H. Coleman
Jesse H. Coleman, Radiation Safety Officer
Radiation Safety

Enclosures

TABLE 5
PREDICTED TRITIUM AND C-14 CONCENTRATIONS AT DOWNGRAIDENT RECEPTORS

Time (days)	Tritium Concentrations* (pCi/mL)			C-14 Concentrations* (pCi/mL)		
	Wells 3 & 4	Well 5	At The Buttahatchee River	Wells 3 & 4	Well 5	At The Buttahatchee River
50	2.00	2.00	2.00	2.80	2.80	2.80
100	2.00	2.00	2.00	2.80	2.80	2.80
150	2.00	2.00	2.00	2.80	2.80	2.80
200	2.00	2.00	2.00	2.80	2.80	2.80
250	2.00	2.00	2.00	2.80	2.80	2.80
300	2.00	2.00	2.00	2.80	2.80	2.80
350	2.00	2.00	2.00	2.80	2.80	2.80
400	2.00	2.00	2.00	2.80	2.80	2.80
450	2.00	2.00	2.00	2.80	2.80	2.80
500	2.00	2.00	2.00	2.80	2.80	2.80
550	2.00	2.00	2.00	2.80	2.80	2.80
600	2.00	2.00	2.00	2.80	2.80	2.80
650	2.00	2.00	2.00	2.80	2.80	2.80
700	2.00	2.00	2.00	2.80	2.80	2.80
750	2.00	2.00	2.00	2.80	2.80	2.80
800	2.00	2.00	2.00	2.80	2.80	2.80
850	2.01	2.00	2.00	2.80	2.80	2.80
900	2.06	2.00	2.00	2.80	2.80	2.80
950	2.18	2.00	2.00	2.81	2.80	2.80
1000	2.46	2.00	2.00	2.82	2.80	2.80
1050	2.94	2.00	2.00	2.85	2.80	2.80
1100	3.58	2.00	2.00	2.88	2.80	2.80
1150	4.29	2.00	2.00	2.91	2.80	2.80
1200	4.91	2.00	2.00	2.93	2.80	2.80
1250	5.33	2.00	2.00	2.94	2.80	2.80
1300	5.48	2.00	2.00	2.94	2.80	2.80
1350	5.38	2.00	2.00	2.93	2.80	2.80
1400	5.09	2.00	2.00	2.91	2.80	2.80
1450	4.70	2.00	2.00	2.89	2.80	2.80
1500	4.29	2.00	2.00	2.87	2.80	2.80
1550	3.90	2.00	2.00	2.86	2.80	2.80
1600	3.55	2.00	2.00	2.84	2.80	2.80
1650	3.27	2.00	2.00	2.83	2.80	2.80
1700	3.04	2.01	2.00	2.83	2.80	2.80
1750	2.85	2.03	2.00	2.82	2.80	2.80
1800	2.71	2.07	2.00	2.82	2.80	2.80
1850	2.59	2.14	2.00	2.81	2.81	2.80
1900	2.50	2.27	2.00	2.81	2.81	2.80
1950	2.43	2.45	2.00	2.81	2.82	2.80
2000	2.38	2.69	2.00	2.81	2.83	2.80
2050	2.33	2.97	2.00	2.81	2.85	2.80
2100	2.29	3.27	2.00	2.81	2.86	2.80

TABLE 5, CONTINUED
PREDICTED TRITIUM AND C-14 CONCENTRATIONS AT DOWNGRADIENT RECEPTORS

Time (days)	Tritium Concentrations* (pCi/mL)			C-14 Concentrations* (pCi/mL)		
	Wells 3 & 4	Well 5	At The Buttahatchee River	Wells 3 & 4	Well 5	At The Buttahatchee River
2150	2.26	3.56	2.01	2.81	2.87	2.80
2200	2.23	3.79	2.02	2.81	2.88	2.80
2250	2.21	3.94	2.05	2.80	2.88	2.80
2300	2.19	4.00	2.09	2.80	2.88	2.81
2350	2.17	3.96	2.16	2.80	2.88	2.81
2400	2.16	3.86	2.27	2.80	2.87	2.81
2450	2.14	3.70	2.42	2.80	2.86	2.82
2500	2.13	3.51	2.61	2.80	2.85	2.83
2550	2.12	3.31	2.82	2.80	2.84	2.84
2600	2.11	3.12	3.04	2.80	2.84	2.85
2650	2.10	2.94	3.25	2.80	2.83	2.86
2700	2.10	2.79	3.43	2.80	2.82	2.86
2750	2.09	2.65	3.55	2.80	2.82	2.87
2800	2.09	2.55	3.62	2.80	2.81	2.87
2850	2.08	2.46	3.62	2.80	2.81	2.87
2900	2.08	2.39	3.57	2.80	2.81	2.86
2950	2.07	2.33	3.47	2.80	2.81	2.86
3000	2.07	2.28	3.34	2.80	2.81	2.85
3050	2.06	2.24	3.19	2.80	2.81	2.84
3100	2.06	2.21	3.04	2.80	2.81	2.84
3150	2.06	2.19	2.89	2.80	2.80	2.83
3200	2.06	2.17	2.76	2.80	2.80	2.82
3250	2.05	2.15	2.64	2.80	2.80	2.82
3300	2.05	2.13	2.54	2.80	2.80	2.82
3350	2.05	2.12	2.45	2.80	2.80	2.81
3400	2.05	2.11	2.38	2.80	2.80	2.81
3450	2.04	2.10	2.32	2.80	2.80	2.81
3500	2.04	2.09	2.28	2.80	2.80	2.81
3550	2.04	2.09	2.24	2.80	2.80	2.81
3600	2.04	2.08	2.21	2.80	2.80	2.81

* Listed Concentrations Include Background

Tritium Background is 2.00 pCi/mL

C-14 Background is 2.80 pCi/mL.

**Columbas AFB, Concentrations of Radionuclides Remaining in Groundwater
Data Collected Nov. 3, 1993**

Well No	Distance From Injection Pt. (m)	Top of Layer (m)	Bottom of Layer (m)	H-3 Av Conc (micro Ci/ml)	C-14 Av Conc (micro Ci/ml)
D018	9.7	4.9	9.5	3.5E-04	5.8E-06
D021	3.3	5.0	10.4	1.1E-04	2.3E-06
M050	13.5	5.9	11.2	8.2E-05	3.1E-06
M066	17.7	4.5	11.3	6.4E-06	6.0E-07
M088	33.8	4.7	11.5	1.7E-06	3.0E-07
M109	48.8	6.0	11.3	2.8E-06	5.0E-07

Data Collected From Nov. 2 to Nov. 10, 1995

Location: Area of Injection Well

	H-3 Av. Conc. Above Background (pCi/ml)	C-14 Av. Conc. Above Background (pCi/ml)
	0.9	0.2
Background(pCi/ml):	2.0	2.8