UNIVERSITY OF VIRGINIA
NUCLEAR REACTOR FACILITY

U.S. MAIL ADDRESS
P.O. Box 400322
Charlottesville, VA
22904-4322

STREET ADDRESS
675 Old Reservoir Road
Charlottesville, VA 22903
Telephone: 804-982-5440
Fax: 804-982-5473

May 11, 2001
Docket No. 50-62, License R-66

Mr. Alexander Adams, Jr., Senior Project Manager
Events Assessment, Generic Communications and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Mail Stop O12-D1
Rockville, MD 20852-2738

Subject: Response to a telephone request from Mr. Adams on May 10, 2001 for additional information on the reactor site hydrology. This submission is therefore an addendum to the submission to the NRC from the University of Virginia dated May 4, 2001, which was the University's response to a second set of questions related to the approval of the decommissioning plan for the University's Reactor Facility (TAC No. MA8186).

Dear Mr. Adams,

As per your request, attached to this letter you will find a couple letters/reports related to the ground water hydrology in the vicinity of the University of Virginia Reactor. This should provide the additional information you require to supplement the University's answer to question #10 in our submittal dated May 4, 2001.

Sincerely,

Paul E Benneche

Paul E. Benneche, Supervisor
University of Virginia Nuclear Reactor Facility

cc: Document Control Desk, NRC, Washington, DC
(original to be sent to this address)

Attachments

City/County of Albemarle
Commonwealth of Virginia.

I hereby certify that the attached document is a true and exact copy of a letter (type of document) presented before me this 11th day of May, 19 2001.
by Paul Benneche (name of person seeking acknowledgement)

Vickie S. Thomas
Notary Public

My commission expires 2/28, 19 2002

A020

DEPARTMENT OF ENVIRONMENTAL SCIENCES
CLARK HALL • UNIVERSITY OF VIRGINIA • CHARLOTTESVILLE, • VIRGINIA • 22903
FAX # (804) 982-2137 (804) 924-7761

20 December, 1995

Robert U. Mulder, Director
Reactor Facility
Observatory Mountain

Dear Bob:

We offer below a few comments on ground-water flow in the vicinity of the Reactor Facility. Our comments are based on a visit to the facility last week and on some general information about the geology of the region. This is very much a quick assessment, reflecting our best judgment based on limited information.

Observatory Mountain is formed from the Rockfish conglomerate, a formation that occurs in a belt on the southeast side of the Lovingston gneiss from a point on the Nelson County line to the northwestern edge of Charlottesville (Nelson 1962[1]). The rocks show steeply dipping joints (as seen in the exposure directly outside the Reactor Facility). The rocks are quite permeable. Nelson (1962), for example, reports that "The Rockfish conglomerate formation produces a much higher yield of water per well than the wells from any other formation with the exception of the infolded Swift Run sediments around Crozet." The steep hillslopes in the vicinity of the Reactor Facility, coupled with the permeable nature of the rocks, suggests that ground-water flow in "undisturbed" areas will be dictated by the surface topography and that ground water will traverse relatively short paths to surface streams. In areas where the natural surface has been disturbed, e.g., at the Reactor Facility where the top part of the site has been excavated and the bottom part filled, surface drainage is likely to be changed, but ground-water flow, although altered somewhat by the excavation, is likely to continue to follow the topography.

We believe that water that may leak from the facility through the foundation of the building and thence into the rock or fill most probably drains into the pond below the building. The topographic gradient from the base of the Facility to the pond, crudely estimated by us to be about 3 m in 50 m, is the steepest direction from the facility and thus the most likely flow path. Any leakage from the Facility will be diluted by the natural ground water. Without a detailed topographic map, we cannot determine a precise figure for the catchment area of the pond. For purposes of a sample calculation, assume that an area equivalent to 200 m by 200 m or 4×10^4 m^2 drains to the pond. Typical annual runoff for this area is about a third of a meter. Thus, on average, we would expect drainage to

[1] Nelson, W.A. 1962. Geology and Mineral Resources of Albemarle County. Virginia Division of Mineral Resources, Bulletin 77.

be some 36,000 L/day for the catchment, so a leakage of 400 L/day would be diluted one-hundred fold. In summary, leakage water is expected to be drained to the pond below the Facility and to be diluted significantly by mixing with both ground water and with water stored in the pond. Without very extensive studies that would include the use of ground-water tracers, it is not possible to say more than this.

If you want to try to obtain data that might provide evidence relative to the potential transport by ground water of radionuclides from the Facility, we have a few suggestions. First, it is not likely that an expensive well-drilling and sampling program will be effective. Rather, we would suggest that installation of seepage meters be considered. The lack of a "signal" from your sampling of the water of the pond is not surprising for a number of reasons (small releases, short half lives, ion exchange with construction and natural materials, etc.), and the large dilution of any ground-water seepage into the pond makes concentration measurements in the pond insensitive as monitoring data. Seepage meters placed near the shore of the pond below the reactor facility would be easy to install (involving no excavation or drilling), inexpensive, and would sample the ground water draining the hillslope at the Facility. If you want to alleviate concern that ground water is migrating from the facility to a point on the surface below the dam, you might consider placing a few shallow piezometers near the stream below the dam and collecting water samples from them. Again, we probably could install and sample these with very minimal effort.

We hope that this quick assessment is of some use to you. If we can be of any further assistance, please let us know.

Sincerely,

George

George M. Hornberger
Ernest H. Ern Professor

Jeffrey P. Raffensperger
Assistant Professor

Jeffrey A. Sitler - Environmental Services, Inc.
P.O. Box 6038
Charlottesville, VA 22906
(804) 974-7080
Fax: (804) 974-1657

January 17, 1997

Mr. Robert Mulder
Director, Nuclear Reactor Facility
Nuclear Reactor Facility
University of Virginia
Charlottesville, VA 22903- 2442

RE: Proposal/Contract to Install and Geologically Log Two Monitoring Wells at the UVA Reactor Facility. JAS Proposal Number 7006.

Dear Dr. Mulder:

As requested by you, this proposal/contract sets forth the Jeffrey A. Sitler Environmental Services, Inc. (JAS) scope of services to install two monitoring well in the saprolitic soil at the Reactor Facility. This proposal is based on some discussions with you and Dr. Raffensperger, my visits to the Site, and my extensive knowledge of local geology and hydrogeology.

BACKGROUND INFORMATION AND REQUIREMENTS

According to you, there has been some leakage of water from the pool in the reactor building. In order to understand the hydrogeology of the site and the flow paths the leaking water might take, it is necessary to install a number of monitoring wells at the site. Several shallow wells have already been installed downhill of the building near the pond. Two wells are required in the parking lot between the reactor and pond.

TECHNICAL APPROACH

The scope of services proposed by JAS to complete this work is outlined below.

- JAS will emplace two (2) soil borings on the subject Site for the installation of the wells and the determination of the subsurface geology. The soil borings will be emplaced using hollow stem auger drilling methods. The borings will be advanced to ten to 15 feet below the water table surface or to the surface of bedrock, whichever occurs first. Split-spoon soil samples will be obtained at five-foot

intervals within each boring in accordance with ASTM D1586-84 Standard Penetration Test methods. The soil samples will be geologically logged by a Virginia Certified Professional Geologist.

- JAS will install a two-inch monitoring well within each boring. The wells will be capped with a locking cap and finished with a manhole. JAS estimates that the wells will be approximately 25 feet deep. Each will be screened at the water table to allow for the collection of shallow groundwater samples.

DELIVERABLES

Upon completion of the site work, JAS will submit to you a letter report that includes geologic logs of the boring and as-build logs of the wells.

COST SUMMARY

The total project cost for the above described work is $2,312 (Attachment 1). If you agree to contract with and pay all subcontractors directly, the total project cost will be reduced to $2,086.

Because the volume and quality of soil and water generated during this investigation is not known at this time, this job cost estimate does not include the fees for the testing and disposal of soils or water generated in the course of this investigation. The disposal of the cuttings and water is the responsibility of UVA.

If bedrock is encountered before the water table, it will be necessary, at an additional cost, to utilize an air rotary drilling to install the proposed monitoring wells. If this case arrises, JAS will provide you with those costs and JAS will not proceed with any additional work without your prior written approval.

Invoices for subcontracted and vendor supplied services and/or materials will be billed when thoso services and/or materials are delivered to JAS. Invoices for services and/or materials supplied by JAS will be submitted to the Client monthly or at the end of the project, whichever occurs first. Payment on all invoices is due within 30 days of the date of the invoice. Late payment will be subject to a late fee equal to 0.049% per day on any amounts past due.

SCHEDULE

It is anticipated that the proposed work will require approximately one day on site and one day in the office to complete.

LIMITATIONS AND CONDITIONS

Upon authorization, Client shall furnish or cause to be furnished to JAS all documents or available information, such as site plans, property plats, studies, specifications, and analytical data, required by JAS for proper performance of this work. JAS shall be entitled to rely upon Client-provided documents and information and assumes no responsibility or liability for inaccurate or incomplete data.

It is Client's responsibility to locate and clearly mark all underground tanks, lines, and structures. This includes: utilities; USTs; product lines; and power lines to signs, pumps, and/or other equipment or buildings.. UVA must contact Miss Utility to confirm public utility locations prior to the starting of our drilling program. JAS shall not be liable for damages attributable to the improper marking or lack of marking of these subsurface features.

The client shall provide for JAS' right to enter the subject property at agreed upon times in order for JAS to fulfill the scope of services outlined herein.

While JAS and its contractors will make every effort to minimize disturbances and damage to the property, the nature of this work necessitates the utilization of heavy equipment which by its own weight can crack or damage pavement and sidewalks, and cause rutting in nonpaved areas. In addition, tree limbs may interfere with the safe operation of the drilling rig and they may need to be trimmed or removed. JAS and its contractors will not be responsible for such damages caused by the normal course of completing the required contract tasks.

HEALTH AND SAFETY

JAS will observe all relevant health and safety measures while working on this project. All field personnel will be 40-hour OSHA health and safety certified when relevant to site activities. The scope of work and associated costs are presented under the assumption that working conditions will be within Level D of JAS' Health and Safety Plan that has been implemented according to OSHA regulations. If conditions require workers to go to Level C (i.e., respirators, Tyvek suits, etc.), a 30% surcharge will be applied to all charges during that portion of the work conducted under Level C.

UVA shall provide JAS and its contractors with the necessary radiation and facility health and safety programs as required for the completion of this work. UVA will be responsible for all radiation monitoring during the course of this work.

CONFIDENTIALITY

The report prepared by JAS, as well as all data generated during this investigation, will be kept confidential and will not be disclosed to any person or entity, other than necessary JAS' employees and subcontractors, without prior consent of Client. Emergency actions required in the event of the determination of a potential hazard due to fire, explosion, or vapors may require JAS to notify governmental authorities, fire departments and police, other persons employed by the client at the Site, or other persons who may be potentially threatened by such potential hazards. In such cases, JAS will attempt to notify the client as soon a possible while mitigating any potential hazards.

INSURANCE

For your records, JAS maintains professional liability insurance in the amount of $1,000,000. In addition, we maintain a General Comprehensive Liability policy in the amount of $2,000,000. Certificates of insurance can be provided to you.

JAS appreciates the opportunity to provide this proposal/contract for your review. Please reflect your acceptance of these terms and formally authorize us to proceed with the work as described by signing and returning a single copy of this contract to me. Should you have any questions regarding this document or the procedures outlined herein, please feel free to contact me at (804) 974-7080.

Respectfully submitted,
Jeffrey A. Sitler Environmental Services, Inc.

Jeffrey A. Sitler, CPG
President

Attachment

I hereby approve this proposal, understand the terms and conditions, and authorize JAS to proceed with the work as described above.

______________________________ ______________________
Signature Date

____
Title

ATTACHMENT 1

Cost Proposal

Jeffrey A. Sitler - Environmental Services, Inc.

#	Item					
1	COST PROPOSAL					PAGE 1 OF 2
2	PROJECT NAME:	Well Installation, Nuclear Reactor		PROPOSAL NUMBER:		7006
3	CLIENT NAME:	University of Virginia		PROPOSAL DATE:		01/17/97
4	ADDRESS:	Nuclear Reacton Facility, UVA		EST START DATE:		01/22/97
5		Charlottesville, VA 22903-2442		EST FINISH DATE:		03/08/97
6	CLIENT CONTACT:	Robert U. Mulder				
7	PROJECT MANAGER:	Jeffrey Sitler		PROJECT NUMBER:		
8	DIRECT LABOR:	HOURS		RATE/HR	SUBTOTALS	
9	7. PRINCIPAL SCIENTIST	0		$95	$0	
10	6. SENIOR 1 SCIENTIST	0		$85	$0	
11	5. PROJECT SCIENTIST	0		$60	$0	
12	4. STAFF SCIENTIST	10		$50	$500	
13	3. STAFF SCIENTIST	0		$40	$0	
14	2. ADMINISTRATIVE/TECHNICIAN	0		$35	$0	
15	1. TECHNICAL/CLERICAL LEVEL	0		$30	$0	
16	TOTAL LABOR	10				$500
17	TRAVEL COSTS:					
18	TRANSPORTATION	QTY.	UNITS	UNIT COST	SUBTOTALS	
19	AIRFARE:		RT Tickets		$0	
20	RENTAL CAR		Days		$0	
21	PRIVATE AUTO	20	Miles	$0.29	$6	
22	COMPANY TRUCK		Miles	$0.40	$0	
23	TOLLS, PARKING, TAXI, MISC.		Each		$0	
24	PER DIEM:					
25	LODGING		Nights		$0	
26	MEALS		Person Days		$0	
27	TOTAL TRAVEL					$6
28	GENERAL & ADMIN FOR TRAVEL	15 % OF LINE 27				$1
29	OTHER DIRECT COSTS:				COST	
30	SUBCONTRACT LABORATORY SERVICES (SCHEDULE A, LINE 48)				$0	
31	OTHER SUBCONTRACT SERVICES (FROM SCHEDULE B, LINE 48)				$1,510	
32	SHIPPING, POSTAGE, TELEPHONE, AND REPRODUCTION				$10	
33	EXPENDABLE FIELD SUPPLIES				$50	
34						
35						
36	JAS FIELD EQUIPMENT (OVA, ETC.)	UNITS	UNIT COST	QTY.		
37	OVA	days	$100.00			
38						
39						
40	SUBTOTAL OTHER DIRECT COSTS					$1,570
41	GENERAL & ADMIN. FOR ODC	15 % OF LINE 40				$236
42	**ESTIMATED TOTAL PROJECT COST IF JAS PAYS SUBCONTRACTORS**					**$2,312**
43	**ESTIMATED TOTAL PROJECT COST IF YOU PAY SUBCONTRACTORS**					**$2,086**
44	THIS COST PROPOSAL IS VALID UNTIL	18-Mar-97				

P.O. Box 6038, Charlottesville, VA 22906

(804) 974-7080, Fax (804) 974-1657

MONITORING WELL SAMPLING PLAN

NUCLEAR REACTOR FACILITY

UNIVERSITY OF VIRGINIA

April 16, 1997

PREPARED BY:

OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY
UNIVERSITY OF VIRGINIA
JEFFREY A. SITLER, CPG

5.5 Monitoring Well Sampling Plan

1.0 INTRODUCTION

This sampling plan details the procedures to be followed in all aspects of the sampling of the monitoring wells at the University of Virginia Reactor Facility. Details covered in this plan include container sizes and types, sampling equipment, sampling procedures, chain-of-custody requirements, analytical procedures, and record keeping requirements. This plan is necessary to insure that consistent and correct procedures are followed regardless of the individual that performs the sampling.

2.0 BACKGROUND

It is known that variable volumes of water periodically leak from the reactor pool or associated piping. While this volume is normally small, the University has instituted this monitoring program to determine the direction of groundwater flow beneath the reactor pool and to monitor groundwater quality. There are three monitoring wells at the site.

3.0 WELL SAMPLING PROCEDURES

3.1 Well Access

Sampling of the groundwater monitoring wells consists of several discrete steps. First each well is equipped with a locking cap and in the case of the well in the parking area, a bolt-down manhole. The manhole is opened using 9/16 wrench. The locks are combination locks, all set to the same combination. Once the locks are removed the well cap is removed by unscrewing the thumbscrew on the cap until the cap releases.

3.2 Water level Measurement

To accurately determine the direction of groundwater flow, the depth to water in the well below the top of the casing must be measured before any sampling is conducted. The water level is measured by lowering an electronic water level probe into the well until it indicates that water has been encountered. That depth is then recorded on the sampling form shown in Attachment 2.

3.3 Well Purging

Before a well can be sampled, industry accepted standards call for the well to be purged of at least three volumes of water standing in the casing. Attachment 1 is a chart that correlates the height of the water column in the well with the volume and the three times purging volume. The height of the water column is calculated by subtracting the water level measured above from the total cased depth of the well found in Table 1. Once the purged volume is determined, the dedicated stainless steel bailer can be extracted from the well using the rope attached to the cap. The bailer is then emptied into a calibrated

5-gallon bucket and lowered in the well again until it fills. This is repeated until three well volumes have been removed from the well as estimated by the volume of purged water collected in the bucket. If the well is bailed dry, it is assumed to be purged and no further bailing is necessary. The volume of water purged is recorded on the sampling form. Other items including clarity of the water and unusual circumstances are recorded. The current weather conditions are also to be recorded.

Table 1. Monitoring Wells Depth Data

Well Number	MW-1	MW-2	MW-3
Depth of Well from top of Casing (FT)	14.50	8.85	29.70

3.4 Well Sampling

Immediately after purging, the bailer is lowered into the well to retrieve a sample of groundwater for collection and analysis. A volume of at least 500 ml should be collected. (A volume of 1.5 L should be collected if the sample is to be split with a commercial laboratory). The sample is poured directly into a new container supplied by EHS laboratory. The container has a volume of two liters and is made of plastic. The label on the bottle is filled out with time sampled, date sampled, sampler's name, well number, site (reactor), and analysis required (tritium and gamma isotopic analyses).

Following sampling, the bailer is placed back in the well and the cap and lock replaced. At MW-3, the manhole seal must be cleaned of all dirt and debris before the lid is replaced to ensure that it seals out surface water.

3.5 Recordkeeping

Record all sampling information on the Reactor Monitoring Wells Sampling Form. (See Attachment 2)

4.0 SAMPLE HANDLING AND ANALYSIS

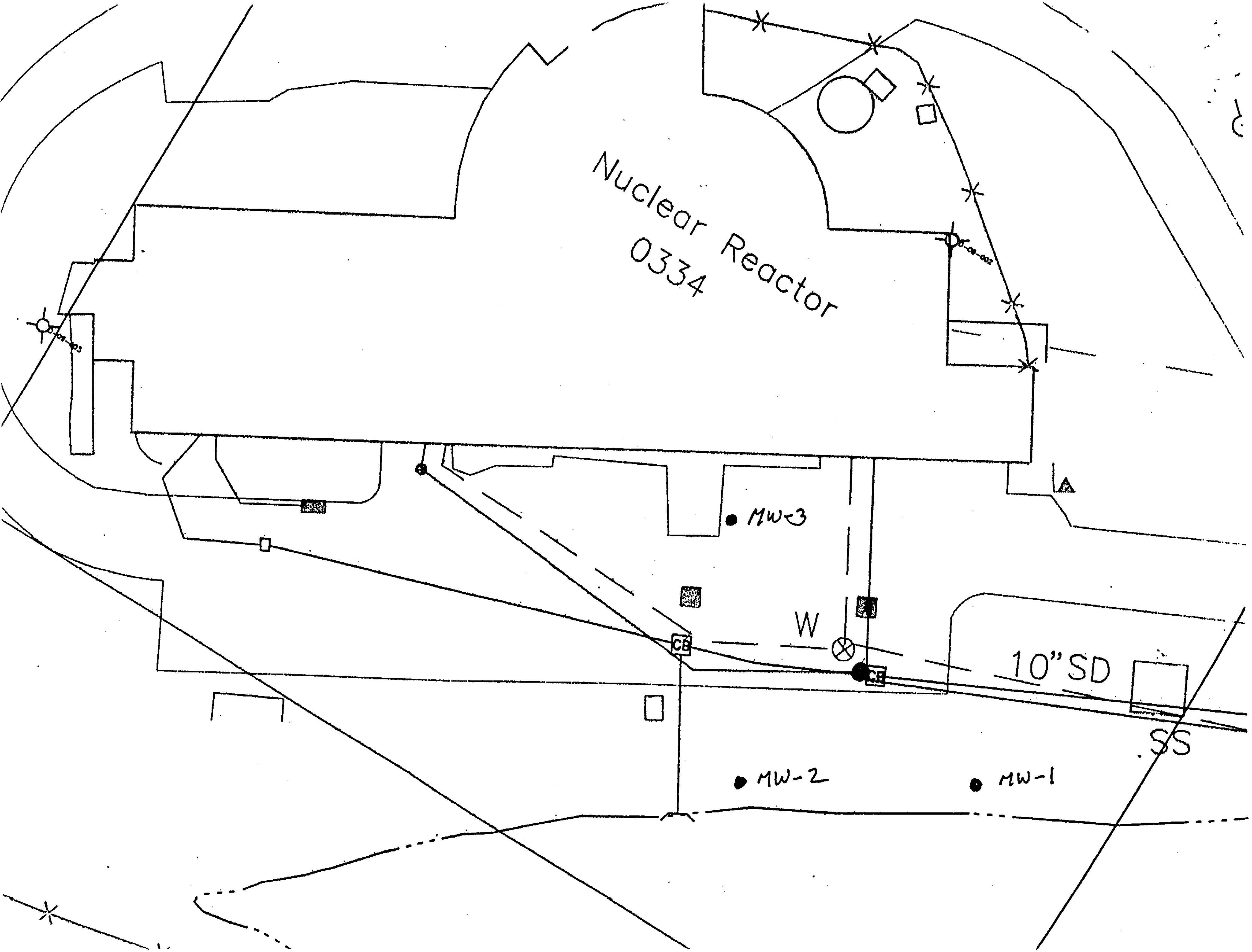
The samples are to be placed in a secure container during collection and transport to the laboratory. It is not necessary to keep the samples on ice. A chain-of-custody (COC) should be filled out and delivered to the laboratory with the samples. The sampler is to keep the samples secure until delivery to the laboratory. The sampler will sign off as relinquishing the samples to the lab and the receiving person at the lab will sign off as receiving the samples. The COC details collection point, date and time collected, number of containers, and analysis required.* The groundwater samples will be analyzed for tritium concentrations at the OEHS laboratory by Method 6.2 - Tritium Analysis of Water Samples. Gamma isotopic analysis will be performed at the reactor facility. On a periodic basis samples may be split with an independent analytical laboratory.

* Will normally not be necessary if person collecting samples and person performing analysis are one in the same.

ATTACHMENT 1

WELL PURGING VOLUME FOR A 2 INCH ID WELL

Water column Height (ft)	volume in well (gallons)	3 X purge volume (gallons)
1	0.2	0.5
2	0.3	1.0
3	0.5	1.5
4	0.7	2.0
5	0.8	2.4
6	1.0	2.9
7	1.1	3.4
8	1.3	3.9
9	1.5	4.4
10	1.6	4.9
11	1.8	5.4
12	2.0	5.9
13	2.1	6.4
14	2.3	6.9
15	2.4	7.3
16	2.6	7.8
17	2.8	8.3
18	2.9	8.8
19	3.1	9.3
20	3.3	9.8
21	3.4	10.3
22	3.6	10.8
23	3.8	11.3
24	3.9	11.8
25	4.1	12.2
26	4.2	12.7
27	4.4	13.2
28	4.6	13.7
29	4.7	14.2
30	4.9	14.7


Nuclear Reactor
0334
MW-3
W
CB
CB
10"SD
SS
MW-2
MW-1

MEMORANDUM

April 25, 1997

TO: Reactor Staff
FROM: Bouvard Hosticka

Subject: Well Drilling at the UVAR

On April 25, 1997, monitoring wells were drilled behind the UVAR. Below are a few notes on what went on.

The first well, designated NW-3, was drilled just south of the parking lot at the top of the bank of the pond. The first 10 feet was fill, then about 3 feet of original top soil, then about 7 feet of weathered bed rock and finally real bed rock that became to hard to drill beyond a total depth of 21 feet. The well was allowed to rest for about an hour and was found to be dry after that time. The well was subsequently filled with the spoils of the second well.

The second well, designated NW-4 was drilled just to the east of the concrete pad at the back truck door. After getting through the paving, there was 3 feet of undisturbed soil then weathered bed rock for the remainder of the hole for a total depth of 30 feet. Water and a very thin strata of iron rich rock was found at 20 feet. A 2-inch plastic casing, slotted for the bottom 15 feet, was installed in the hole. Filter sand (grade #3) was placed around the slotted portion of the casing then a seal of bentonite was poured in. The rest of the hole around the casing was filled with concrete to the surface where an access cover was installed in the parking lot. The well is capped and will be locked by EHS. Unused spoils from both wells were thrown over the bank of the pond.

Core samples were taken at 10, 15, and 20 feet on NW-3. Side dirt samples with a broad depth uncertainty were taken from the spoils brought up by the auger when it was at about 17, 20, and 21 feet on NW-3.

Core samples were taken at 5, 10, 15, and 20 feet on NW-4. Side dirt samples were taken with the auger at 1, 8, 13, 17, 23, and 28 feet on NW-4

Samples of the filter sand and sealing compound were also taken.

All of the samples will be counted for three hours each in as close to a standard Marenelli geometry as possible of detector D over the next week or so. Preliminary counts of the last soil brought up from NW-3 shows a strong signal from natural thorium and uranium along with their progeny as well as potassium 40. So far, no anthropogenic radionuclides have been seen.

UNIVERSITY OF VIRGINIA
ENVIRONMENTAL HEALTH AND SAFETY

SPECIAL MATERIALS HANDLING FACILITY
EDGEMONT ROAD

P.O. BOX 3425
CHARLOTTESVILLE, VA 22903
TELEPHONE (804) 982-4911

October 24, 1997

Dr. Robert Mulder, Director
Nuclear Reactor Facility
University of Virginia
Charlottesville, VA 22903-2442

RE: Groundwater Monitoring System Report

Dear Dr. Mulder

Attached you will find the final report on the groundwater monitoring system installed by the UVA Office of Environmental Health and Safety (OEHS). This report details the the system construction and presents the first two rounds of sampling data.

If you or your staff have any questions, please contact me at 982-4901 or Deborah Steva at 982-4917.

Respectfully submitted,
Office of Environmental Health and Safety

Jeffrey A. Sitler, CPG
Hydrogeologist

Deborah P. Steva
Radiation Safety Specialist

GROUNDWATER MONITORING SYSTEM AND ANALYTICAL RESULTS UNIVERSITY OF VIRGINIA NUCLEAR REACTOR

October 24, 1997

Prepared For:

Dr. Robert Mulder, Director
Nuclear Reactor Facility
University of Virginia
Charlottesville, VA 22903-2442

Prepared By:

UVA Office of Environmental Health and Safety
Special Materials Handling Facility
Edgemont Road
University of Virginia
Charlottesville, Virginia 22903

Contacts
Jeffrey A. Sitler, CPG

Deborah P. Steva

GROUNDWATER MONITORING SYSTEM AND ANALYTICAL RESULTS
UNIVERSITY OF VIRGINIA NUCLEAR REACTOR

INTRODUCTION

Recent information has shown that a small volume of water has been leaking from the reactor pool and/or associated piping. While this volume is reported to be small, the reactor staff were directed to definitively determine if groundwater has become contaminated by the reported release and in what direction groundwater is moving beneath the reactor facility. Initially, the Department of Environmental Sciences was tasked to conduct this investigation; however, difficulties in installing the monitoring prevented them from finishing the work. The UVA Office of Environmental Health and Safety (OEHS) was then tasked to complete the study.

FACILITY LOCATION AND SITE DESCRIPTION

The University of Virginia Reactor is located on the southeastern side of a ridge between Observatory Hill and Lewis Mountain on the Grounds of the University in Charlottesville, Virginia (Figure 1, Appendix A). Access to the Site is via Old Reservoir Road that originates at McCormick Road. The facility is located within a fenced area and consists of a single building that houses a small research nuclear reactor, offices, laboratories, and support services; a parking area around the building; and a surrounding wooded area. Within the fenced in area and directly downhill of the reactor building is a pond that was formerly a water supply reservoir for the City of Charlottesville. The reservoir (hereafter reactor facility pond) is considered part of the reactor facility and is monitored for water quality before water is released to the stream downhill of the dam.

TECHNICAL APPROACH

Previous to OEHS taking on this project, students from the Department of Environmental Sciences at the University installed two shallow monitoring wells immediately upslope from the

reactor facility pond using a small power auger. This auger was used to bore an approximate three-inch diameter borehole to at least five feet below the water table. Following the removal of the auger flights, 2-inch ID schedule 40 PVC well casing and screen were installed in the borehole. Two shallow wells were completed using this method. The wells designated as MW-1 and MW-2 are located on the steep slope approximately five feet vertically uphill of the reactor facility pond (Figure 2, Appendix A). Attempts to install wells further upslope were thwarted by large rocks in the overburden fill material that was emplaced during the construction of the parking lot.

EHS contracted with Certified Environmental Drilling of Charlottesville to install two borings and monitoring wells in the parking lot area between the Reactor building and the slope to the pond. The borings/wells were installed using a truck-mounted hollow-stem augering rig. The borings were emplaced by Certified Environmental Drilling using hollow stem auger drilling methods. Split-spoon soil samples were obtained at five-foot intervals within the borings in accordance with ASTM D1586-84 Standard Penetration Test methods. Prior to sampling, the split-spoon sampler was decontaminated. The soil samples collected from the split-spoons were geologically logged by Jeffrey Sitler of OEHS. Soil samples were also given to the reactor staff for analysis. The results of the analysis are included in Appendix B, Table 1.

Following the completion of the second boring, a two-inch monitoring well was constructed in the borehole. The well was constructed concurrent with the withdrawal of the augers to permit the accurate placement of the well screen, filter pack, bentonite seal, riser and grout. The construction details for the all of the site wells are included with the boring logs in Appendix B and are summarized in Table 1 on the following page.

The wells were developed by pumping each with a 12-volt submersible pump until the water from each well ran clear and between two and ten-well volumes had been removed. Following a short recovery period that day, Monitoring Wells MW-1 and MW-2 were sampled using a clean decontaminated stainless steel bailer for each well. Because of the large volume of standing water in Monitoring Well MW-3, it was purged and sampled using the submersible pump

Table 1. Monitoring Well Construction Data, UVA Nuclear Reactor, Charlottesville, Virginia.			
Data	MW-1	MW-2	MW-3
Top of casing elevation (feet AMSL (2))	600.00	598.42	606.95
Water level from TOC(3) (5/1/97)	8.37	6.79	5.20
Water table elevation (ft AMSL)	591.63	591.63	601.75
Total Well Depth below surface	9.56	6.40	30
Screened interval length (ft)	1.25	1.25	15
Standing water in well (ft)	3.13	2.06	24.50

(1) MW-1 estimated elevation from USGS Topographic map (feet above mean sea level).

(2) AMSL = above mean sea level

(3) TOC = top of casing

HYDROGEOLOGY

The reactor and all of Albemarle County are located in the Piedmont Physiographic Province. According to the Virginia Geologic Map and the Geologic Map of Albemarle County, the site is underlain by the Precambrian-age rocks of the Lynchburg Group. Specifically the Site is underlain by the Rockfish Conglomerate. The Rockfish Conglomerate consists of a 1,200 foot thick metamorphosed sandstone specifically characterized as a metagraywacke and quartzose schist that has a 100 foot basal conglomerate.

Typically overlying the bedrock in this area are residual soils or saprolites formed by the in-place weathering of the underlying bedrock. The saprolite retains the structure of the underlying bedrock and grades from competent bedrock to surficial soils within a few feet of the ground surface. The saprolite encountered during this investigation consisted of micaceous sandy silt and varied in thickness from ten feet to over 30 feet. Competent bedrock was not encountered by 30 feet in the boring immediately adjacent to the building while competent bedrock was encountered at 21 feet below the surface at the lower edge of the parking lot. This shows that the bedrock surface is not plainer in nature.

Above the saprolite are the clay-rich surficial soils and in much of the area of the parking lot, fill material used to build the parking lot. Along the back edge of the parking lot, ten feet of fill material was penetrated before the original land surface was encountered.

Groundwater storage and movement occur in both the saprolite and underlying bedrock. Recharge to groundwater is derived from precipitation and occurs over broad areas as a result of the infiltration of precipitation into the saprolite. The Virginia Department of Mines, Minerals, and Energy estimates that 15% of all precipitation infiltrates as recharge to groundwater. Using an average rainfall of 45 inches, 6.75 inches of rainfall is recharged to the aquifer in an average year.

The saprolite has a high porosity and stores a vast quantity of water; however, because of its fine-grained texture groundwater movement within the unit is very slow. Groundwater in the bedrock is recharged by the saprolite. Overall, the igneous and metamorphic bedrock types found in the Piedmont are considered to be fair to poor aquifers because of the lack of primary porosity and permeability. Groundwater movement and storage takes place mainly in fractures and other secondary features of bedrock that typically do not yield large quantities of water in this geographic area. Groundwater flow and yield are dependent on the frequency and interconnection of the fractures. Local wells are predominantly bedrock wells between 60 and 400 feet deep. The depth to groundwater, based on OEHS's experience in this region, can be expected to range from a few feet to 50 feet below the surface. At this Site, the depth to the water table ranges from at the surface near the pond to ten feet at the top of the slope above the

pond. The depth to the water table at MW-3 over the period since the well was installed has ranged from five feet below the surface in early summer to ten feet below the surface on October 10, 1997.

The watertable in the Piedmont Physiographic Province generally mimics the topographic surface with the watertable being closer to the surface at valley bottoms than at ridge tops. The resulting groundwater flow is from ridge tops to valley bottoms where groundwater discharges to streams and rivers providing base flow. Base flow is what sustains a stream when surface runoff from precipitation events is not occurring. Based on the water levels measured in the wells installed at the Site, groundwater is flowing to the southeast from the reactor building to the former reservoir. Figure 3 is a water table contour map constructed using this water level data (Appendix A). Under this scenario, releases to groundwater in the area of the reactor should move with groundwater and discharge to the reservoir.

The hydraulic conductivity of the materials encountered in MW-3 at the Site was determined to be 1.5×10^{-4} feet/minute based on a slug test conducted on October 10, 1997. The slug test data are included in Appendix C. The slug test was conducted by the insertion of a solid slug into the well. The change in water level was measured using a pressure transducer attached to a Campbell Scientific data logger. The data was then downloaded to a computer analyzed to determine the hydraulic conductivity. Based on the water level measurements in all of the wells at the Site, a hydraulic gradient of 5.45×10^{-3} ft/ft was calculated. Using an effective porosity of 40% for the saprolite, groundwater at the Site is moving at a rate of 9.11×10^{-2} feet/day or 33 ft/yr.

SOIL SAMPLE ANALYSIS RESULTS

Table 2 is a summary of the radionuclide analysis of the soil samples taken during the installation of Boring SB-3 and SB-4/MW-3. With the exception of two samples from Soil Boring SB-3, these analyses revealed the presence of only naturally occurring radionuclides in the soil samples.

Table 2 - Radiological Analysis Results on Soil

Well #	Core Depth	Results		Well #	Core Depth	Results
SB-3	Spoon sample	Zn-65: 9.2E-8		MW-3	Cuttings	K-40: 3.5E-5
	9-11 ft.	K-40: 3.6E-5			From	Ra-226: 1.3E-6
		Ra-226: 1.9E-6			Depth of	
		Pb-214: 2.2E-4			About 1 ft.	
		Bi-214: 1.2E-3				
SB-3	Spoon sample	K-40: 3.9E-5		MW-3	Spoon sample	K-40: 4.2E-5
	14-16 ft.	Ra-226: 8.6E-7			4-6 ft.	Ra-226: 1.4E-6
SB-3	Spoon sample	Zr-97: 6.1E-6		MW-3	Cuttings	K-40: 4.5E-5
	19-20 ft.	K-40: 4.1E-5			From	Ra-226: 1.4E-6
		Ra-226: 1.2E-6			depth of	U-235: 3.2E-7
					about 8 ft.	
SB-3	Cuttings	K-40: 4.0E-5		MW-3	Spoon sample	K-40: 4.8E-5
	From	Ra-226: 1.2E-6			9-11 ft.	Ra-226: 1.0E-6
	About 21 ft.					
				MW-3	Cuttings	K-40: 4.7E-5
					From a	Ra-226: 1.2E-6
					Depth of	
					About 13 ft.	
				MW-3	Spoon sample	K-40: 4.6E-5
					14-16 ft.	Ra-226: 1.0E-6
				MW-3	Cuttings	K-40: 5.1E-5
					From	Ra-226: 1.3E-6
					About 17 ft.	
				MW-3	Spoon sample	K-40: 4.7E-5
					19-21 ft.	Ra-226: 1.5E-6
				MW-3	Cuttings	K-40: 4.1E-5
					from	Ra-226: 1.2E-6
					About 28 ft.	

GROUNDWATER QUALITY RESULTS

Groundwater samples were collected for analysis from the three wells on two occasions, May 1, 1997 and August 7, 1997. The analysis results are presented below in Table 3.

Table 3. Radiological Analysis Results on Groundwater

Sample Date	Well Number	Gamma 1, K-40, µCi/ml	Ra-226 µCi/ml	Other, Specify	Other, concentration µCi/ml	H-3 µCi/ml	Comments
5/1/97	MW-1	No data				<7 E-7	
	MW-2	No data				<7 E-7	
	MW-3	1.7 E-5	5.5 E-7			<7 E-7	
5/1/97 re-analysis	MW-1	1.7 E-5	3.1 E-7	Cs-137	2.3 E-8		
	MW-2	1.7 E-5	2.7 E-7				
	MW-3	1.7 E-5	3.4 E-7				
8/7/97	MW-1	1.7 E-5	3.0 E-7			<7 E-7	
	MW-2	1.7 E-5	4.0 E-7			8 E-7	
	MW-3	1.7 E-5	2.4 E-7			<7 E-7	
8/7/97	Background	1.8 E-5	2.3 E-7				Distilled H_20

Based on the data presented above, there is no evidence that water reportedly released from the reactor pool through leakage has impacted the groundwater quality downgradient of the reactor building. With the exception of two samples, all analysis results indicated the presence of naturally occurring radionuclides only. Cs–137 was detected in the May sample from MW-1 but not in the August sample. The tritium detected in MW-2 on August 7, 1997 was just slightly

above the lower limit of detection but well below the release limit of 1E-3 μCi/ml. Further data collection will be necessary to determine the significance of these results.

CONCLUSIONS AND RECOMMENDATIONS

The data gathered during this investigation confirms that shallow groundwater is moving from the area of the reactor to the pond (former reservoir) where it discharges to the surface. Therefore, the monitoring wells placed in the area between the reactor building and the reservoir should be in good positions to allow for the monitoring of groundwater that travels beneath and/or originates from the area of the reactor. To date, there is little evidence that the suspected releases from the reactor have impacted groundwater quality in the area downgradient of the reactor. However, until it can be substantiated that the leakage has been stopped, monitoring of the groundwater should continue on a quarterly basis. Further monitoring will also serve to increase the size of the database which will allow OEHS to conduct a more rigorous analysis of the data.

APPENDIX A

FIGURES

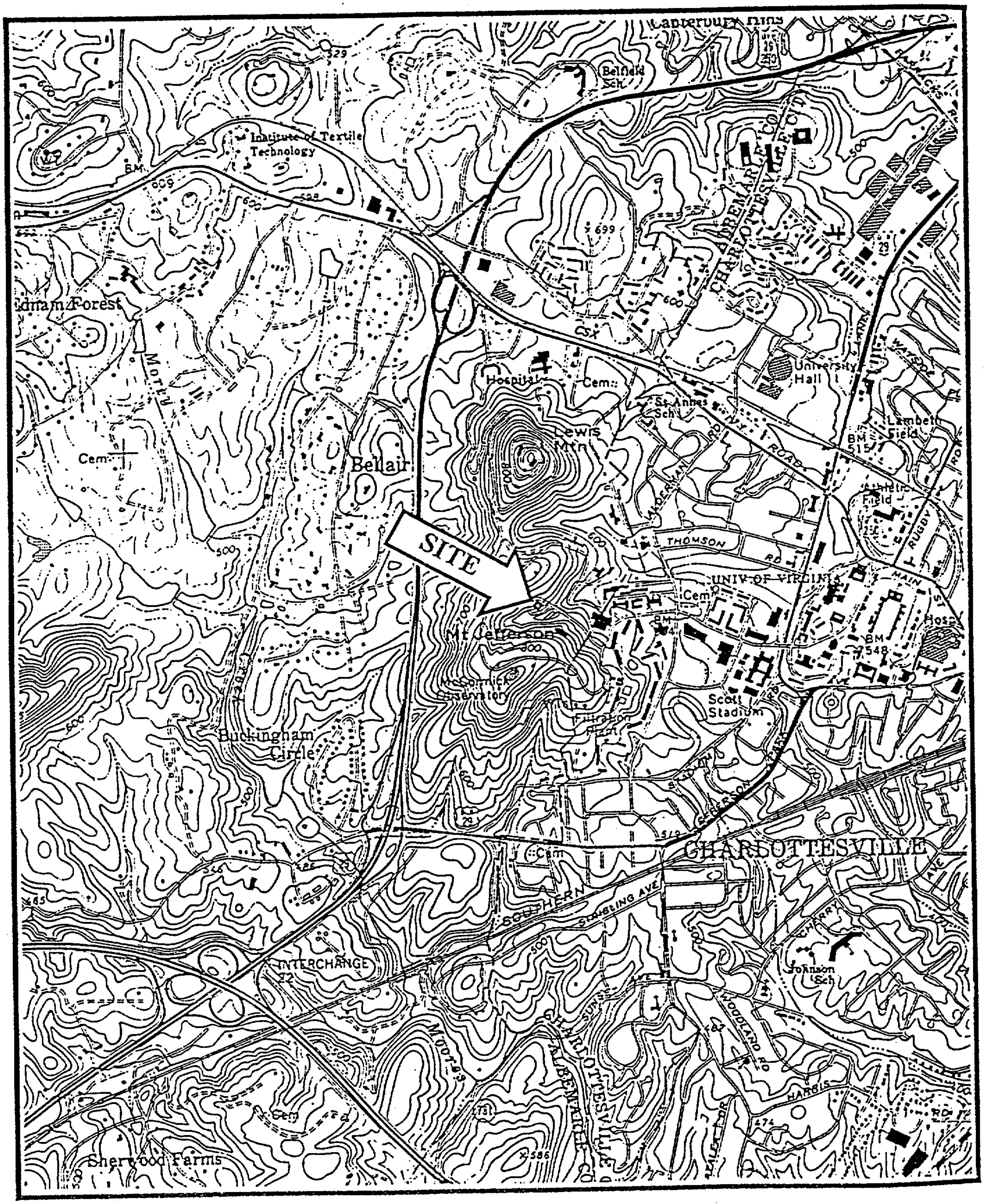


Figure 1. Site Location Map, USGS Charlottesville West 7.5 minute Topographic Map, Photorevised 1987, North to top of page, Scale 1 inch = 2000 feet.

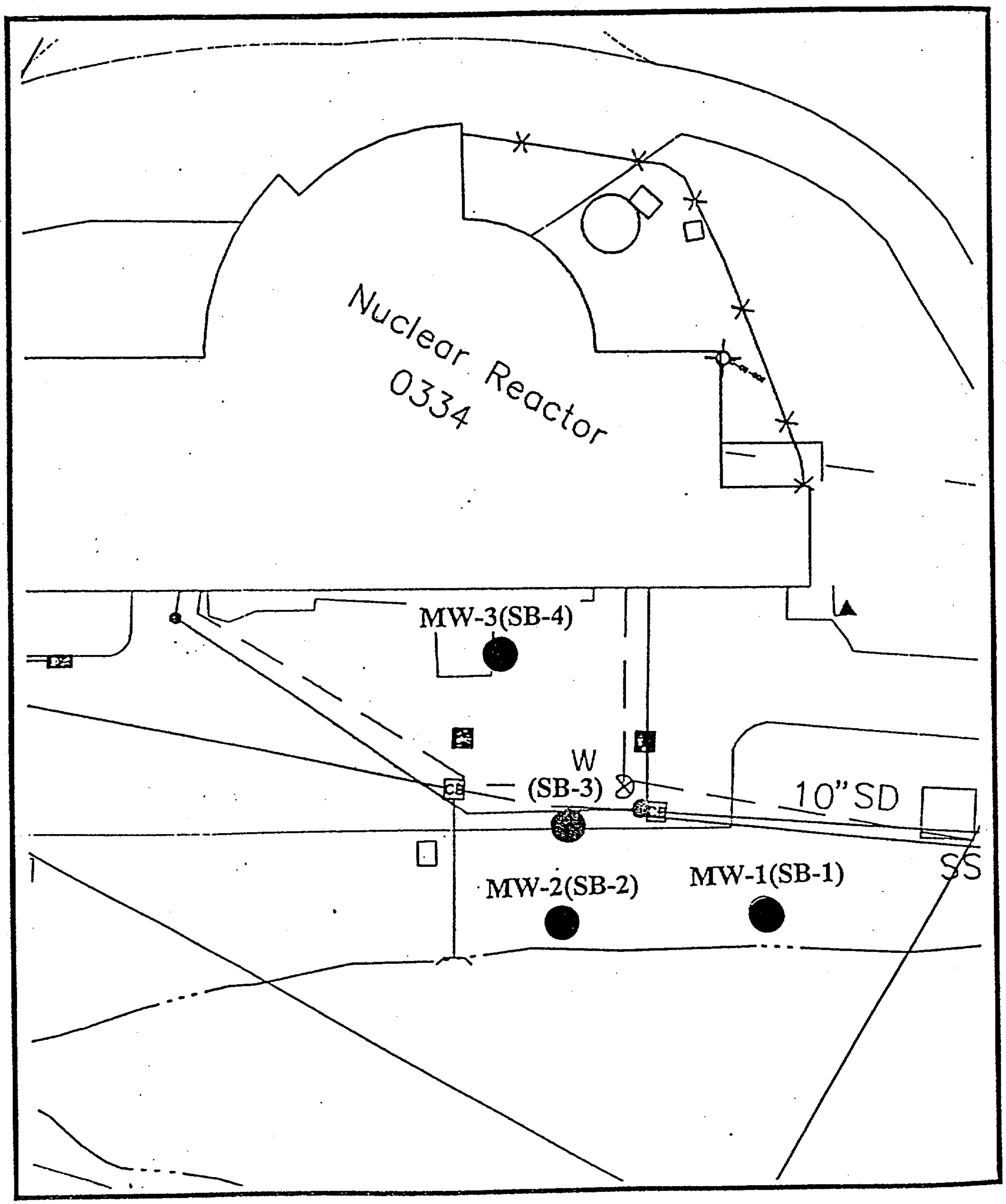


Figure 2. Boring and Monitoring Well Location Map, Scale: 1 inch = 30 feet, north to top of page.

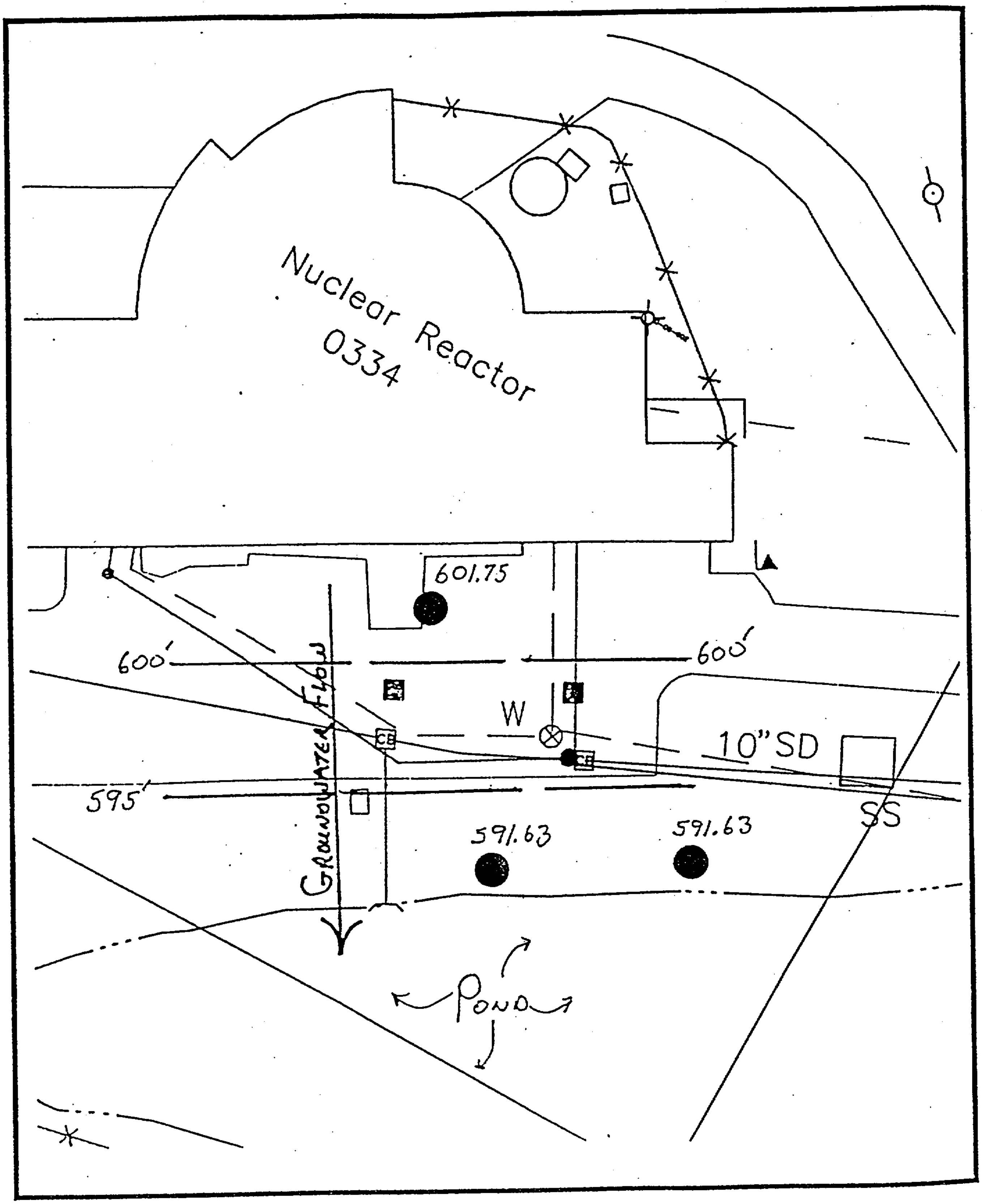


Figure 3. Watertable Contour Map, Scale: 1 inch = 30 feet, North to top of page.

APPENDIX B

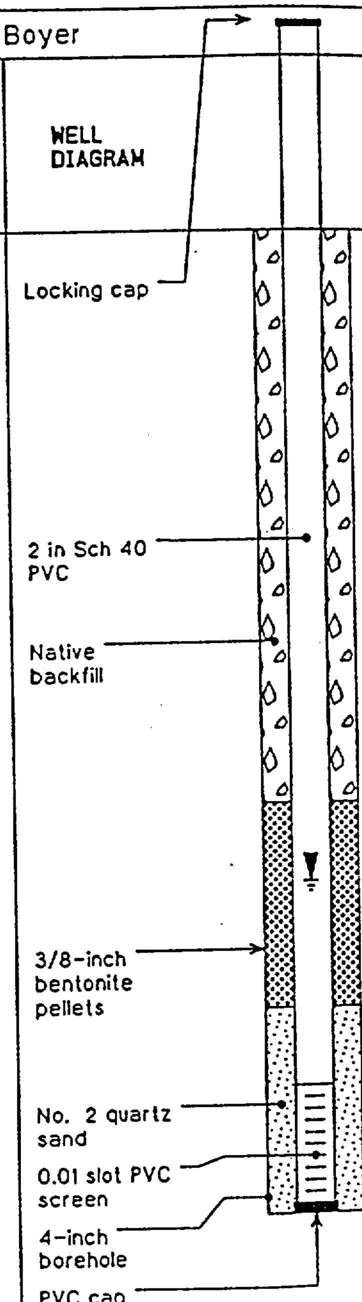
SOIL BORING AND WELL LOGS

UVA – ENVIRONMENTAL HEALTH AND SAFETY

LOG OF MW-1

PROJECT: Groundwater Monitoring	LOCATION: University of Virginia
DATE DRILLED: 7/2/96	TOP OF CASING ELEVATION: 600 Feet
DRILLING METHOD: Small Rotary Auger	TOTAL DEPTH: 9.56 Feet
DRILLING COMPANY: Department of Env. Sciences	GEOLOGIST: Beth Boyer

DEPTH feet	SAMPLE NUMBER	BLOWS	OVA (ppm) VALUES	OVA (ppm) PROFILE	GRAPHIC LOG	GEOLOGIC DESCRIPTION	WELL DIAGRAM
5							
10							



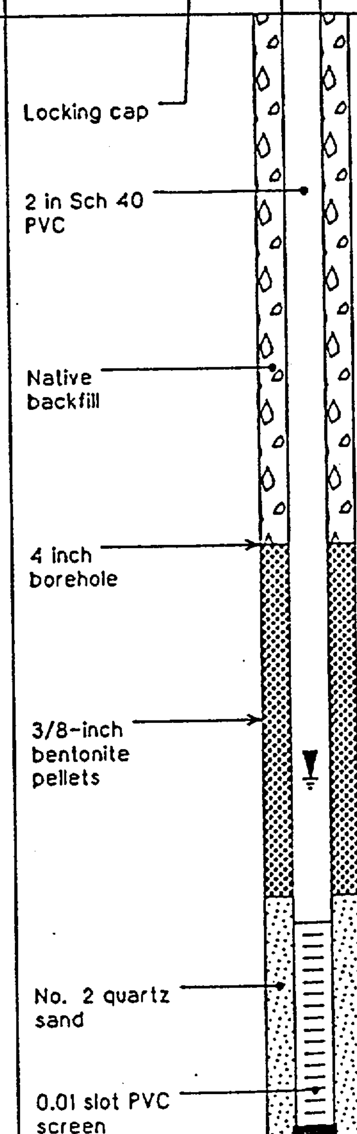
JOB NUMBER: UVA Reactor

UVA – ENVIRONMENTAL HEALTH AND SAFETY

LOG OF MW-2

PROJECT: Groundwater Monitoring	LOCATION: University of Virginia
DATE DRILLED: 7/2/96	TOP OF CASING ELEVATION: 598.42 Feet
DRILLING METHOD: Small Rotary Auger	TOTAL DEPTH: 6.4 Feet
DRILLING COMPANY: Department of Env. Sciences	GEOLOGIST: Beth Boyer

DEPTH feet	SAMPLE NUMBER	BLOWS	OVA (ppm) VALUES	OVA (ppm) PROFILE	GRAPHIC LOG	GEOLOGIC DESCRIPTION	WELL DIAGRAM
5							



JOB NUMBER: UVA Reactor

UVA – ENVIRONMENTAL HEALTH AND SAFETY

LOG OF SB-3

PROJECT: Ground Water Monitoring	LOCATION: University of Virginia
DATE DRILLED: 4/25/97	TOP OF CASING ELEVATION: 659 Feet
DRILLING METHOD: Hollow-Stem/split spoon	TOTAL DEPTH: 21 Feet
DRILLING COMPANY: Certified Environmental Drilling	GEOLOGIST: Jeffrey A. Sitler

DEPTH feet	SAMPLE NUMBER	BLOWS	OVA (ppm) VALUES	OVA (ppm) PROFILE	GRAPHIC LOG	GEOLOGIC DESCRIPTION	WELL DIAGRAM
5	SS-1	2,3, 5,9				**FILL.** Gray micaceous fill, sandy silt with upto 5% gravel, very friable to granular, moist	
10	SS-2	2,2 2,1				**FILL and Native Soil.** Gray micaceous fill in top half of sample and original top soil horizon in bottom half (black loam layer, followed by a brown clayey silt, moist, very friable)	
15	SS-3	45, Refusal				**SAPROLITE.** Very hard saprolite or soft bedrock, moist, gray-brown silt, firm to friable, spoon refusal after six inches	
20	SS-4	50, refusal				**BEDROCK.** Spoon refusal at 19 feet and auger refusal at 21 feet	
						Bedrock refusal before water was encountered, boring checked for water later and found to be dry. Well was not constructed.	
25							

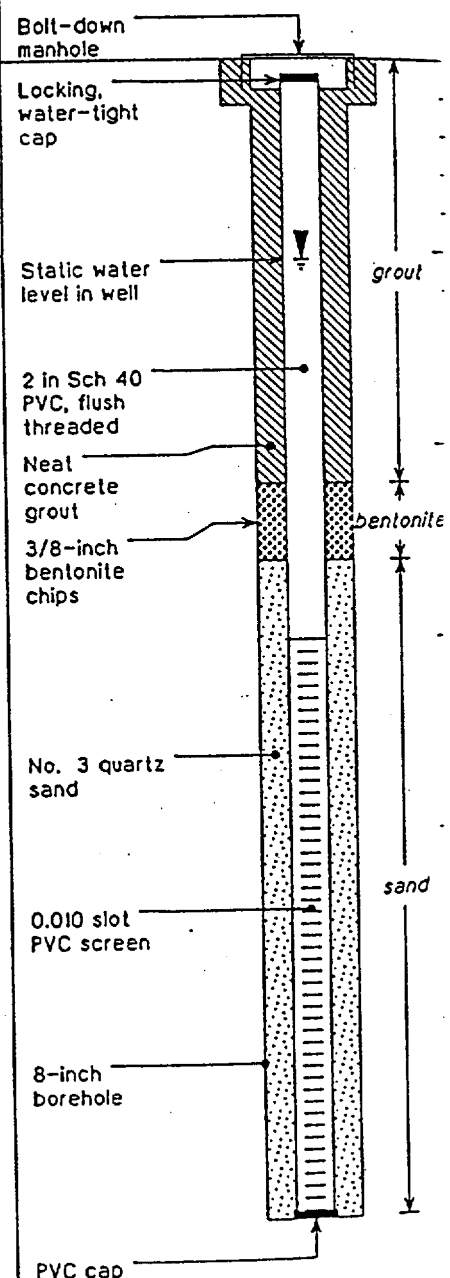
JOB NUMBER: UVA Reactor

UVA - ENVIRONMENTAL HEALTH AND SAFETY	LOG OF SB-4, MW-3	Page 1 of 1

PROJECT: Ground Water Monitoring	**LOCATION:** University of Virginia
DATE DRILLED: 4/25/97	**TOP OF CASING ELEVATION:** 660 Feet
DRILLING METHOD: Hollow-Stem/split spoon	**TOTAL DEPTH:** 30 Feet
DRILLING COMPANY: Certified Environmental Drilling	**GEOLOGIST:** Jeffrey A. Sitler

DEPTH feet	SAMPLE NUMBER	BLOWS	OVA (ppm) VALUES	OVA (ppm) PROFILE	GRAPHIC LOG	GEOLOGIC DESCRIPTION
0–4						FILL, Lt. orange-brown clayey silt and gravel, fill mateiral under asphalt
5	SS-1					
						SAPROLITE, Gray micaceous clayey silt saprolite, moist, friable
10	SS-2					SAPROLITE, Gray micaceous clayey silt saprolite, moist, very friable
15	SS-3					SAPROLITE, Gray and brown micaceous sandy silt saprolite, wet, very friable
20	SS-4					SAPROLITE, Gray and brown micaceous sandy silt saprolite, iron staining on partings and joints
25						
						Boring terminated at 30 feet and well constructed. Bedrock was not encountered
30						

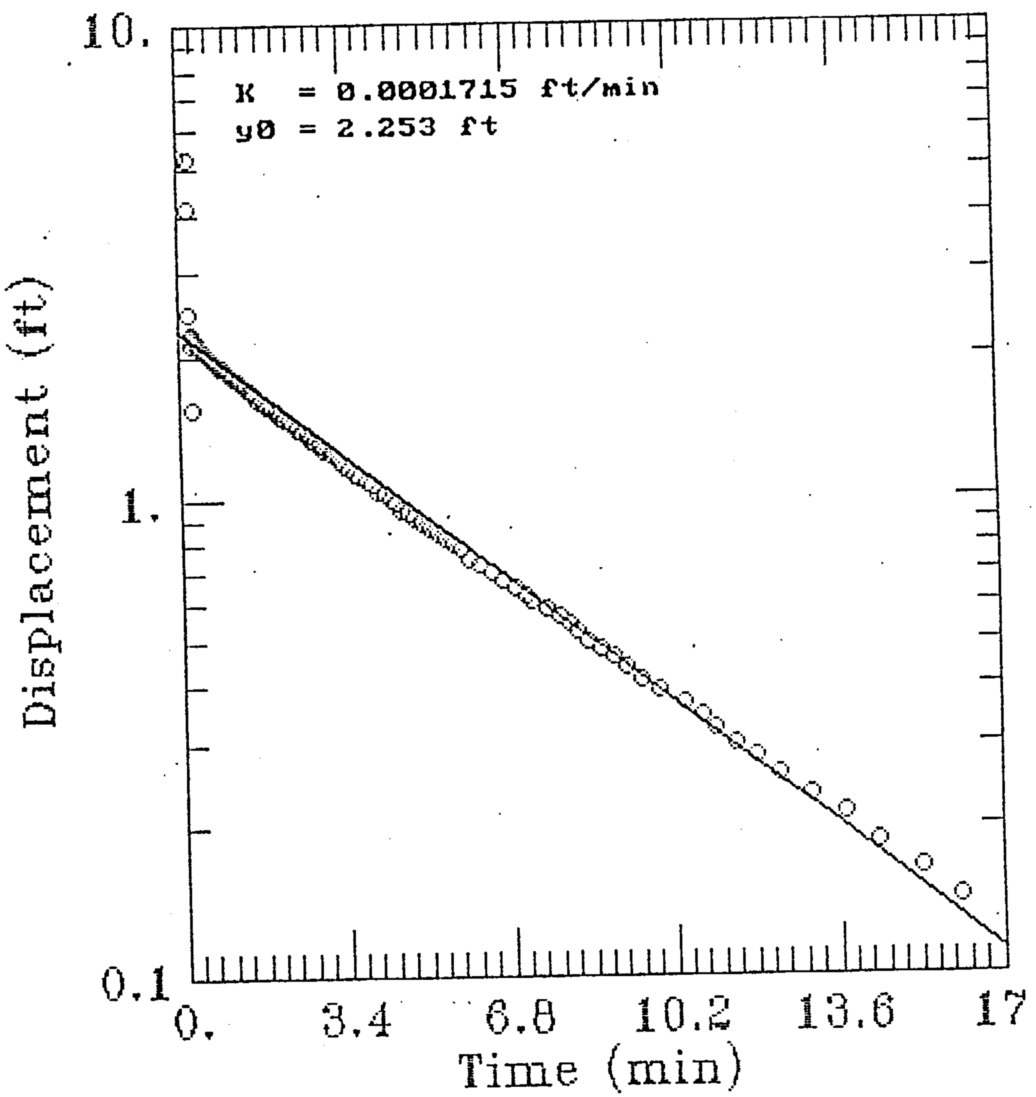
WELL DIAGRAM



JOB NUMBER: UVA Reactor

APPENDIX C
SLUG TEST DATA

MW-3 Falling Head Test



MW-3 Recovery Test